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INTRODUCTION.

This paper is devoted largely to a review of the coal-mining industry during the period covered by the preceding ten volumes of Mineral Resources, as well as the year under discussion, and the usual method of treatment will be maintained as far as possible.

The statistics of coal production in the United States during 1894 have, as for a number of years past, been compiled almost entirely from direct returns by operators to the Geological Survey or its duly appointed and sworn agents.

The one exception, as usual, is the State of Illinois, whose bureau of labor statistics has, through its secretaries (formerly Col. John S. Lord, and for the past three years Mr. George A. Schilling), kindly furnished the figures and other data, frequently in advance of its ordinary publication. In collecting the statistics for Alabama and Kentucky, the chief mine inspectors, Messrs. James D. Hillhouse and C. J. Norwood, have cooperated with the Survey, with highly satisfactory results, and their services are deserving of special acknowledgment. In addition to collecting the statistics of commercial mines in his State, Mr. Norwood undertook to collect the statistics of production at the country banks, the result of which investigation is given in connection with the report on Kentucky, page 132.

The statistics relating to Pennsylvania anthracite are the work of Messrs. John H. Jones and William W. Ruley, of Philadelphia, who for several years have furnished this feature of the report. The usual acknowledgments are due to Mr. A. S. Bolles, chief of the bureau of industrial statistics of Pennsylvania, for assistance rendered in connection with bituminous production in some counties of that State.

Contributions from secretaries of boards of trade and others regarding the movement of coal at the important trade centers and shipping ports are gratefully acknowledged here, and also by name in connection with the articles which will be found under the general head of

Coal Trade Review on pages 28 to 57. Where any reference has been made to the files of technical periodicals, due credit is given in the proper place.

Some confusion is apt to occur by the fact that both the long ton of 2,240 pounds and the short ton of 2,000 pounds are used in this chapter. This is unfortunate, but can not be avoided. Pennsylvania anthracite is always measured by the long ton. In cases where Pennsylvania bituminous coal is sold in the Eastern markets the long ton is used. The same is true of West Virginia and of the Tazewell and Wise County coals of Virginia. The laws of Maryland permit the use of the long ton only. In all other cases bituminous coal is sold by the short ton. For the sake of convenience the bituminous product has, in this report, been reduced to short tons, and when the anthracite and bituminous products are tabulated together the short ton is used. In the section devoted entirely to Pennsylvania anthracite the long ton only is used, and in the table of shipments from the Cumberland region this is also the case.

THE COAL FIELDS OF THE UNITED STATES.

For convenience the coal areas of the United States are divided into two great classes, the anthracite and bituminous. These are subdivided into distinct fields, and many of the bituminous fields are divided within State lines into minor regions separated from one another by local conditions and bearing local names, such as the Hocking Valley and Massillon fields in Ohio, the Cahaba, Coosa, and Warrior fields in Alabama, etc. These will be discussed under the section devoted to State statistics.

In a commercial sense, particularly in the East, when the anthracite fields are mentioned the fields of Pennsylvania are considered, though Colorado and New Mexico are now supplying anthracite coal of good quality to the Rocky Mountain region, and small amounts are mined annually in Virginia. This small quantity from Virginia and a semi-anthracitic product from Arkansas are considered with the bituminous output. In previous years some coal which was classed as anthracite has been 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. The classing of this product as anthracite coal was erroneous. The original beds have been metamorphosed into graphite or graphitic coal, and the product requires such a high degree of heat for combustion that it can be used only with other combustible material or under a heavy draft. It is, therefore, not an economical practice to use this product for fuel in competition with the anthracite coal from Pennsylvania or the bituminous coals from the New River and Pocahontas fields, which are now sent in large quantities to New England points, and its mining for fuel purposes has been abandoned.

THE PENNSYLVANIA ANTHRACITE FIELDS.

In Mineral Resources for 1886 the anthracite fields of Pennsylvania are described as grouped into five principal divisions: (1) The southern or Pottsville field, extending from the Lehigh River at Mauch Chunk southwest to within a few miles of the Susquehanna River north of Harrisburg; (2) the western or Mahanoy and Shamokin field, lying between the eastern head waters of the Little Schuylkill River and the Susquehanna; (3) the eastern middle or the upper Lehigh field, lying between the Lehigh River and Catawissa Creek, principally in Luzerne County; (4) the northern or Wyoming and Lackawanna field, which lies in the two valleys from which its geographical name is derived; (5) the Loyalsock and Mehoopany field, named from the two creeks whose head waters drain it. The latter is a small field about 20 or 25 miles northwest of the western end of the northern field.

In addition to this geological division, the fields are also subdivided under different names and in a different way for trade purposes, the divisions being known as trade regions. These are: (1) The Wyoming region, embracing the entire northern and Loyalsock fields; (2) the Lehigh region, embracing all of the eastern middle field and the Panther Creek district of the southern field; and (3) the Schuylkill region, embracing the western middle field and all of the southern field except the Panther Creek district.

The entire area of workable coal in all the anthracite fields does not exceed 480 square miles. Out of this there has been shipped since 1820, 906,013,403 long tons, an average of 12,080,179 long tons per year, and of 1,887,528 tons for each square mile. The amount consumed at the collieries and sold to local trade would average not less than 10 per cent of the shipments. Adding that to the shipments, the enormous production of about 1,000,000,000 long tons is shown.

THE BITUMINOUS FIELDS.

The bituminous areas of the United States are grouped, for the sake of convenience, into the (1) Triassic, (2) Appalachian, (3) Northern, (4) Central, (5) Western, (6) Rocky Mountain, and (7) Pacific Coast. They may be briefly described as follows:

The Triassic area comprises what is known as the Richmond basin in Chesterfield and Henrico counties, Va., and the Deep River and Dan River fields in North Carolina. The late Dr. Charles A. Ashburner, in Mineral Resources for 1886, says that the first coal mined systematically in the United States was taken from the Richmond basin, and that in 1822 about 48,214 tons of coal were produced there, more than twelve times the total amount produced in the Pennsylvania anthracite field in the same year. Its maximum output was reached in 1833, when 142,587 tons were mined. This was nearly one-third of the total output of anthracite in that year. In the last two or three years mining in this field has been resumed on a larger scale. New machinery and modern methods have been introduced, and experiments are being made with by-product coke ovens. In 1886 Dr. Ashburner stated the output to be 50,000 tons. In 1887 and 1888 the output was 30,000 and 33,000 tons, respectively. Mr. John H. Jones reported for the census year of 1889 a product of 49,411 tons. Since then the output has fluctuated considerably, as shown in the subsequent table. In 1894 the product was 52,079 short tons.

The Triassic areas in North Carolina, in which coal beds have been opened, occur in two isolated localities, one on the Deep River and the other on the Dan. The only record of production is from the Deep River division, which began in 1889, with a total of 222 tons. As in the Richmond basin, the production since then has fluctuated, reaching as high as 20,355 short tons in 1891. The output in 1894 was 16,900 short tons, making the total product of the Triassic field for the past year 68,979 short tons.

The Appalachian field, while not the largest in area, is by far the most important, furnishing about two-thirds of all the bituminous output. The field extends from the northern part of Pennsylvania in a southwesterly direction, following the Appalachian Mountain system, which it embraces, to the central part of Alabama. Its length is a little over 900 miles, and it ranges in width from 30 to 180 miles. Its area is about 62,690 square miles, covering nearly all of western Pennsylvania, the southeastern part of Ohio, the western part of Maryland, the southwestern corner of Virginia, nearly all of West Virginia, the eastern part of Kentucky, a portion of eastern Tennessee, the northwestern corner of Georgia, and nearly all of northern Alabama. All of the coals are bituminous, except for a little anthracite in southwestern Virginia (Montgomery County), and are of great variety in chemical composition and physical structure. It contains the famous Connellsville coking coal, the Clearfield and Pittsburg steam coals, the smithing coals of Blossburg and Cumberland, the gas coals of the Upper Potomac and Monongahela rivers, the Massillon and Hocking coals, the steam, gas, and coking coals of the Flat Top, New River, and Kanawha River regions, the Jellico coal of Kentucky and Tennessee, and the excellent coking coals of southeastern Tennessee and Alabama.

The Appalachian field produced 46,186,522 short tons in 1886. It reached its maximum output in 1892, when 83,122,190 short tons were produced, an increase in six years of 36,935,668 short tons, or nearly 75 per cent. The business depression of 1893 and the general strike in the spring of 1894 caused a decrease in the output in those years, but with favorable trade conditions the large yield of 1892 will soon be eclipsed. The output of the field in 1894 was 76,278,748 short tons.

The Northern field is altogether in Michigan. While it covers an area of 6,700 square miles and is spread over nearly all the central portion of the State, its importance commercially is comparatively insignificant. The coal is much inferior to that of adjoining regions in Ohio, Indiana, and Illinois, and the facilities for bringing the superior coals, either by rail or water, being excellent and transportation cheap, there has been little inducement to develop the Michigan coals. What mining is done is principally to supply a local trade. The annual output has not varied much during the past decade. The largest product was in 1882, when 135,339 short tons were mined. The smallest was in 1884, when the output declined to 36,712 short tons. Since then it has ranged from about 45,000 to 80,000 short tons annually. In 1894 the product was 70,022 short tons.

The Central field includes all the areas of Indiana and Illinois and the Western coal field of Kentucky. Its total area is about 47,750 square miles, of which Illinois contains more than three-quarters. The portion of the field lying in Illinois is more than five times that of Indiana and about eight times that of Kentucky. For this reason the region is sometimes known as the Illinois field. It is from this field, particularly the Indiana and Illinois portions, that the well-known "block" coal (so called from its peculiar fracture into cubical blocks) is obtained. This field is third in area and second in producing importance. The output has shown an almost uninterrupted annual increase since 1886, when the amount of coal mined was 13,151,473 short tons. The exceptions were in 1889, when a general reaction from the overproduction of 1888 set in, and in 1894, when the operatives joined in the great strike. In 1894 the product was 22,430,617 short tons.

The Western field embraces all the coal areas west of the Mississippi River, south of the forty-third parallel, and east of the Rocky Mountains. It includes the States of Iowa, Missouri, Nebraska, Kansas, Arkansas, and Texas, and the Indian Territory. In extent this is the largest field in the United States of which any accurate estimate has been made, and ranks third in production. Extensive operations are carried on in Iowa, Kansas, Missouri, and the Indian Territory. Owing, doubtless, to their proximity to the larger cities and their markets, the production in the three States named is the most important, but the Territory coals are superior in quality, and with the increase of population, which is sure to come, its output will equal, if not exceed, that of the other States. The output of the Western field in 1886 was 8,272,501 short tons. Since that time its production has not fallen below 10,000,000 nor exceeded 12,000,000 short tons. In 1894 the yield was 11,503,623 short tons.

The Rocky Mountain field includes the areas contained in the States of Colorado, Idaho, Montana, New Mexico, North Dakota, Utah, and Wyoming. According to Mr. R. C. Hills, the Colorado fields cover an area of 18,100 square miles, but the available coals are contained within an area of 2,913 square miles. No reliable estimate of the areas in the other States has been made. The estimated quantity of workable coal in Colorado alone is put, by Mr. Hills, at 45,197,100,000 tons, of which 33,897,800.000 tons may be won. In 1887 the total output from the Rocky Mountain field was 3,646,280 short tons. This increased annually until 1893, when 8,468,360 tons were mined, an increase in six years of 4,822,080 short tons, or more than 130 per cent. In 1894 the output decreased to 7,175,628 short tons.

The Pacific Coast field embraces the three States bordering on the Pacific Ocean—California, Oregon, and Washington. The areas underlain by coal beds have not been definitely determined. All the coals produced in California are of the lignite variety and of poor quality. Oregon's product is also lignite, but of better quality, and, having conditions favorable for mining and shipping, operations of magnitude are successfully carried on. Washington contains a number of valuable beds, some of the coals possessing excellent coking qualities. The total output of coal mines on the Pacific Coast in 1887 was 854,308 short tons. The largest output was in 1890, when 1,435,914 tons were produced. In 1894 the product was 1,221,238 short tons.

The following table contains the approximate areas of these coal fields, with the total product of each from 1887 to 1894:

Classification of the coal fields of the United States.

	Area.	Product in— 1887.	1888.	1889.
Anthracite.				
New England (Rhode Island and Massachusetts)	*Sq. miles.* 500	*Short tons.* 6,000	*Short tons.* 4,000	*Short tons.* 2,000
Pennsylvania	480	39,506,255	43,922,897	45,544,970
Colorado and New Mexico	15	36,000	44,791	53,517
	995	39,548,255	43,971,688	45,600,487
Bituminous. (*a*)				
Triassic:				
Virginia	180	30,000	33,000	49,411
North Carolina	2,700	....	....	222
Appalachian:				
Pennsylvania	9,000	30,866,602	30,796,727	36,174,089
Ohio	10,000	10,301,708	10,910,946	9,976,787
Maryland	550	3,278,023	3,479,470	2,939,715
Virginia	2,000	795,263	1,040,000	816,375
West Virginia	16,000	4,836,820	5,498,800	6,231,880
Kentucky	11,180	950,903	1,193,000	1,108,770
Tennessee	5,100	1,900,000	1,967,297	1,925,689
Georgia	200	313,715	180,000	225,934
Alabama	8,660	1,950,000	2,900,000	3,572,983
	62,690	55,193,034	60,966,240	62,972,222
Northern:				
Michigan	6,700	71,461	81,407	67,431
Central:				
Indiana	6,450	3,217,711	3,140,979	2,845,057
Kentucky	4,500	982,282	1,377,000	1,290,985
Illinois	36,800	10,278,890	14,655,188	12,104,272
	47,750	14,478,883	19,173,167	16,240,314
Western:				
Iowa	18,000	4,473,828	4,952,440	4,045,358
Missouri	26,700	3,209,916	3,909,967	2,557,823
Nebraska	3,200	1,500	1,500	} 2,222,443
Kansas	17,000	1,596,879	1,850,000	
Arkansas	9,100	150,000	276,871	279,584
Indian Territory	20,000	685,911	761,986	752,832
Texas	4,500	75,000	90,000	128,216
	98,500	10,193,034	11,842,764	10,036,256
Rocky Mountain, etc.:				
Dakota	....	21,470	34,000	28,907
Montana	....	10,202	41,467	363,301
Idaho	....	500	400	....
Wyoming	....	1,170,318	1,481,540	1,388,947
Utah	....	180,021	258,961	236,651
Colorado	2,913	1,755,735	2,140,686	2,544,144
New Mexico	....	508,034	626,665	486,463
	....	3,646,280	4,583,719	5,048,413
Pacific Coast:				
Washington	....	772,612	1,215,750	1,030,578
Oregon	....	31,696	75,000	64,359
California	....	50,000	95,000	119,820
	....	854,308	1,385,750	1,214,757
Total product sold	....	124,015,255	142,037,735	....
Colliery consumption	....	5,960,302	6,621,667	....
Total product, including colliery consumption	....	129,975,557	148,659,402	141,229,513

a Including lignite, brown coal, and scattering lots of anthracite.

Classification of the coal fields of the United States—Continued.

	Product in— 1890.	1891.	1892.	1893.	1894.
Anthracite.					
New England (Rhode Island and Massachusetts)	*Short tons.*	*Short tons.* 500	*Short tons.*	*Short tons.*	*Short tons.*
Pennsylvania	46, 468, 641	50, 665, 431	52, 472, 504	53, 967, 543	51, 921, 121
Colorado and New Mexico	(*a*)	(*a*)	64, 963	93, 578	71, 550
	46, 468, 641	50, 665, 931	52, 537, 467	54, 061, 121	51, 992, 671
Bituminous. (*b*)					
Triassic:					
Virginia	19, 346	17, 290	37, 219	19, 878	52, 079
North Carolina	10, 262	20, 355	6, 679	17, 000	16, 900
Appalachian:					
Pennsylvania	42, 302, 173	42, 788, 490	46, 694, 576	44, 070, 724	39, 912, 463
Ohio	11, 494, 506	12, 868, 683	13, 562, 927	13, 253, 646	11, 909, 856
Maryland	3, 357, 813	3, 820, 239	3, 419, 962	3, 716, 041	3, 501, 428
Virginia	764, 665	719, 109	637, 986	800, 461	1, 177, 004
West Virginia	7, 394, 494	9, 220, 665	9, 738, 755	10, 708, 578	11, 627, 757
Kentucky	1, 206, 120	1, 222, 918	1, 231, 110	1, 245, 785	1, 218, 072
Tennessee	2, 169, 585	2, 413, 678	2, 092, 064	1, 902, 258	2, 180, 879
Georgia	228, 337	171, 000	215, 498	372, 740	354, 111
Alabama	4, 090, 409	4, 759, 781	5, 529, 312	5, 136, 935	4, 397, 178
	73, 008, 102	77, 984, 563	83, 122, 190	81, 207, 168	76, 278, 748
Northern:					
Michigan	74, 977	80, 307	77, 990	45, 979	70, 022
Central:					
Indiana	3, 305, 737	2, 973, 474	3, 345, 174	3, 791, 851	3, 423, 921
Kentucky	1, 495, 376	1, 693, 151	1, 794, 203	1, 761, 394	1, 893, 120
Illinois	15, 292, 420	15, 660, 698	17, 862, 276	19, 949, 564	17, 113, 576
	20, 093, 533	20, 327, 323	23, 001, 653	25, 502, 809	22, 430, 617
Western.					
Iowa	4, 021, 739	3, 825, 495	3, 918, 491	3, 972, 229	3, 967, 253
Missouri	2, 735, 221	2, 674, 606	2, 733, 949	2, 897, 442	2, 245, 039
Nebraska	} 2, 259, 922	1, 500	1, 500		
Kansas		2, 716, 705	3, 007, 276	2, 652, 546	3, 388, 251
Arkansas	399, 888	542, 379	535, 558	574, 763	512, 626
Indian Territory	869, 229	1, 091, 032	1, 192, 721	1, 252, 110	969, 606
Texas	184, 440	172, 100	245, 690	302, 206	420, 848
	10, 470, 439	11, 023, 817	11, 635, 185	11, 651, 296	11, 503, 623
Rocky Mountain, etc.:					
Dakota	30, 000	30, 000	40, 725	49, 630	42, 015
Montana	517, 477	541, 861	564, 648	892, 309	927, 395
Idaho					
Wyoming	1, 870, 366	2, 327, 841	2, 503, 839	2, 439, 311	2, 417, 463
Utah	318, 159	371, 045	361, 013	413, 205	431, 550
Colorado	3, 094, 003	3, 512, 632	3, 447, 967	4, 018, 793	2, 776, 817
New Mexico	375, 777	462, 328	659, 230	655, 112	580, 238
Nevada					150
	6, 205, 782	7, 245, 707	7, 577, 422	8, 468, 360	7, 175, 628
Pacific Coast:					
Washington	1, 263, 689	1, 056, 249	1, 213, 427	1, 264, 877	1, 106, 470
Oregon	61, 514	51, 826	34, 661	41, 683	47, 521
California	110, 711	93, 301	85, 178	72, 603	67, 247
	1, 435, 914	1, 201, 376	1, 333, 266	1, 379, 163	1, 221, 238
Total product, including colliery consumption	157, 788, 656	168, 566, 669	179, 329, 071	182, 352, 774	170, 741, 526

a Included in bituminous product.
b Including lignite, brown coal, and scattering lots of anthracite.

PRODUCTION.

The total product of coal of all kinds in 1894 was 152,447,791 long tons, equivalent to 170,741,526 short tons, having an aggregate value at the mines of $186,141,564. Included in this product is the coal shipped, the amount sold to local trade and used by employees, and the amount consumed at the mines by private locomotives or in furnishing power for ventilation, haulage, etc. It also includes the amount made into coke.

The total marketable product was 146,816,277 long tons, or 164,434,230 short tons. This includes all the product except that used by the operators themselves and known technically as "colliery consumption." At the anthracite mines this item consists usually of culm or slack which would otherwise go on the dump. As a rule, no account is kept of the amount so used, and it is returned in the statement of production as "estimated." For this reason, though included in the total product, no value is placed upon it, the value given for anthracite being that of the merchantable product only.

Compared with 1893, the production of coal in 1894, in both the anthracite and the bituminous fields, shows a marked decrease. In 1893 the total product was 162,814,977 long tons, or 182,352,774 short tons, showing a decrease in 1894 of 10,367,186 long tons, or 11,611,248 short tons, or a little more than 6 per cent. The total value shows a decrease of $22,297,132, or more than 10 per cent. The average price per short ton received for all kinds of coal in 1893 was $1.14; in 1894, $1.09, a decrease of 5 cents. The decrease in bituminous production was due chiefly to the prolonged strike in the spring and summer of 1894. This created a scarcity for awhile and caused increased activity at the anthracite mines, but this temporary activity was not sufficient to offset the effects of the trade depression at manufacturing centers, which is responsible for the decrease in anthracite production.

The total number of men employed in the coal mines of the United States in 1894 was 376,206, who worked an average of 178 days, against 363,309 men for an average of 201 days in 1893.

ANTHRACITE.

The output from the Pennsylvania anthracite mines in 1894 was 46,358,144 long tons, or 51,921,121 short tons, valued at $78,488,063. In 1893 the product was 48,185,306 long tons, or 53,967,543 short tons, valued at $85,687,078, showing a decrease in 1894 of 1,827,162 long tons, or 2,046,422 short tons. The average price declined from $1.94 per long ton in 1893 to $1.85 in 1894. In quoting the average price per ton it must be remembered that only the marketed product of anthracite is considered, no value being placed on the colliery consumption. The average price obtained by dividing the total value by the total product would be $1.78 in 1893 and $1.69 in 1894.

The number of men employed in the anthracite mines in 1894 was 131,603, who averaged 190 working days, against 132,944 men for 197 days in 1893.

In addition to the anthracite production of Pennsylvania in 1894 there were 71,550 short tons mined in Colorado and New Mexico, making the total output of anthracite coal in the United States 51,992,671 short tons.

Except in the tables on pages 13 and 14 the anthracite product of Colorado and New Mexico, for sake of convenience, is included in the bituminous product, and, unless expressly stated to the contrary, reference in this chapter to anthracite production means that of Pennsylvania only.

BITUMINOUS.

The production of bituminous coal in 1894 (including lignite, brown coal, and scattering lots of anthracite, as previously mentioned) was 118,820,405 short tons, valued at $107,653,501. This was a decrease of 9,564,826 short tons, as compared with 1893, when the output was 128,385,231 short tons, worth $122,751,618. The decrease in value was $15,098,117. The percentage decrease in product was 6; the percentage decrease in value, 12. While there is little doubt that the general trade depression had something to do with the decreased production, the chief cause was the long strike, organized in April and continued until July, and in some cases until August, and which will make the year 1894 memorable in the history of coal mining in the United States. The details of the strike, the causes leading up to it, and its effects are treated under a separate head. It may be noted here, however, that in addition to the loss in tonnage and in value of the product, which falls upon the mine owners, the loss to the mine workers is shown in the fact that 230,365 men worked an average of 204 days in 1893, and 244,603 men worked an average of 171 days in 1894. This is equivalent to a loss of one day by 5,167,357 men, or the compulsory idleness of 17,224 men for a year of 300 full working days.

In calculating these items, all employees in and about the mines are included except coke workers.

The following tables exhibit the production of all kinds of coal in the United States during 1893 and 1894:

Coal product of the United States in 1893, by States.

States and Territories.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
Alabama	3, 536, 935	59, 599	96, 412	1, 443, 989
Arkansas	549, 504	11, 778	13, 481	....
California	64, 733	5, 336	2, 534	....
Colorado	3, 345, 951	65, 386	178, 993	512, 059
Georgia	196, 227	....	4, 869	171, 644
Illinois	16, 260, 463	2, 931, 846	753, 955	3, 300
Indiana	3, 461, 830	252, 879	69, 797	7, 345
Indian Territory	1, 197, 468	9, 234	21, 663	23, 745
Iowa	3, 442, 584	449, 639	80, 006	....
Kansas	2, 364, 810	227, 321	60, 412	3
Kentucky	2, 613, 645	281, 115	30, 969	81, 450
Maryland	3, 676, 137	26, 833	13, 071	....
Michigan	27, 787	16, 367	1, 825	....
Missouri	2, 525, 227	322, 754	49, 461	....
Montana	789, 516	27, 063	17, 960	57, 770
New Mexico	636, 002	5, 618	8, 776	14, 698
North Carolina	15, 000	....	2, 000	....
North Dakota	47, 968	1, 612	50	....
Ohio	11, 713, 116	1, 348, 743	167, 002	24, 785
Oregon	37, 835	3, 594	254	....
Pennsylvania	33, 322, 328	1, 934, 429	426, 122	8, 387, 845
Tennessee	1, 427, 219	42, 560	20, 921	411, 558
Texas	300, 064	462	1, 680	....
Utah	350, 423	7, 649	4, 258	50, 875
Virginia	714, 188	20, 578	4, 609	80, 964
Washington	1, 186, 109	18, 888	48, 506	11, 374
West Virginia	8, 591, 962	390, 689	46, 898	1, 679, 029
Wyoming	2, 280, 685	64, 188	87, 086	7, 352
Total	104, 675, 716	8, 526, 160	2, 213, 570	12, 969, 785
Pennsylvania anthracite	48, 266, 174	1, 202, 655	4, 498, 714	....
Grand total	152, 941, 890	9, 728, 815	6, 712, 284	12, 969, 785

States and Territories.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.				
Alabama	5, 136, 935	$5, 096, 792	$0. 99	237	11, 294
Arkansas	574, 763	773, 347	1. 34	151	1, 559
California	72, 603	167, 555	2. 31	208	158
Colorado	4, 102, 389	5, 104, 602	1. 24	188	7, 202
Georgia	372, 740	365, 972	. 98	342	736
Illinois	19, 949, 564	17, 827, 595	. 89	229	35, 390
Indiana	3, 791, 851	4, 055, 372	1. 07	201	7, 644
Indian Territory	1, 252, 110	2, 235, 209	1. 79	171	3, 446
Iowa	3, 972, 229	5, 110, 460	1. 30	204	8, 863
Kansas	2, 652, 546	3, 375, 740	1. 27	147	7, 310
Kentucky	3, 007, 179	2, 613, 569	. 86	202	6, 581
Maryland	3, 716, 041	3, 267, 317	. 88	240	3, 935
Michigan	45, 979	82, 462	1. 79	154	162
Missouri	2, 897, 442	3, 562, 757	1. 23	206	7, 375
Montana	892, 309	1, 772, 116	1. 99	242	1, 401
New Mexico	665, 094	979, 044	1. 47	229	1, 011
North Carolina	17, 000	25, 500	1. 50	80	70
North Dakota	49, 630	56, 250	1. 13	193	88
Ohio	13, 253, 646	12, 351, 139	. 92	188	23, 931
Oregon	41, 683	164, 500	3. 57	192	110
Pennsylvania	44, 070, 724	35, 260, 674	. 80	190	71, 931
Tennessee	1, 902, 258	2, 048, 449	1. 08	232	4, 976
Texas	302, 206	688, 407	2. 28	251	996
Utah	413, 205	611, 092	1. 48	226	576
Virginia	820, 339	692, 748	. 84	253	961
Washington	1, 264, 877	2, 920, 876	2. 31	241	2, 757
West Virginia	10, 708, 578	8, 251, 170	. 77	219	16, 524
Wyoming	2, 439, 311	3, 290, 904	1. 35	189	3, 378
Total	128, 385, 231	122, 751, 618	. 96	204	230, 365
Pennsylvania anthracite	53, 967, 543	85, 687, 078	1. 59	197	132, 944
Grand total	182, 352, 774	208, 438, 696	1. 14	201	363, 309

Coal product of the United States in 1894, by States.

States and Territories.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
Alabama	3, 269, 548	43, 911	130, 404	953, 315
Arkansas	488, 077	7, 870	16, 679	
California	52, 736	8, 143	6, 368	
Colorado	2, 181, 048	56, 688	112, 414	481, 259
Georgia	178, 610		8, 978	166, 523
Illinois	13, 948, 910	2, 590, 414	570, 452	3, 800
Indiana	3, 085, 664	248, 398	67, 545	22, 314
Indian Territory	923, 581	4, 632	30, 878	10, 515
Iowa	3, 390, 751	511, 683	64, 819	
Kansas	3, 066, 398	275, 565	45, 523	765
Kentucky	2, 734, 847	281, 235	47, 344	47, 766
Maryland	3, 435, 600	51, 750	14, 078	
Michigan	60, 817	7, 055	2, 150	
Missouri	1, 955, 255	242, 501	47, 283	
Montana	861, 171	12, 900	17, 324	36, 000
Nevada		150		
New Mexico	561, 523	8, 266	14, 365	13, 042
North Carolina	13, 500	1, 000	2, 400	
North Dakota	37, 311	4, 480	224	
Ohio	10, 636, 402	1, 101, 940	126, 397	45. 117
Oregon	45, 068	2, 171	282	
Pennsylvania	29, 722, 803	1, 589, 595	342, 294	8, 257, 771
Tennessee	1, 571, 406	59, 985	28, 993	520, 495
Texas	417, 281	2, 412	1, 155	
Utah	364, 675	11, 173	6, 892	48, 810
Virginia	1, 015, 713	21, 162	4, 690	187, 518
Washington	1, 030, 232	10, 822	56, 853	8, 563
West Virginia	9, 116, 314	428, 202	64, 126	2, 019, 115
Wyoming	2, 309, 934	21, 482	72, 362	13, 685
Total	96, 475, 175	7, 605, 585	1, 903, 272	12, 836, 373
Pennsylvania anthracite	46, 358, 144	1, 158, 953	4, 404, 024	
Grand total	142, 833, 319	8, 764, 538	6, 307, 296	12, 836, 373

States and Territories.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.				
Alabama	4, 397, 178	$4, 085, 535	$0. 93	238	10, 859
Arkansas	512, 626	631, 988	1. 22	134	1, 493
California	67, 247	155, 620	2. 31	232	125
Colorado	2, 831, 409	3, 516, 340	1. 24	155	6, 507
Georgia	354, 111	299, 290	. 85	304	729
Illinois	17, 113, 576	15, 282, 111	. 89	183	38, 477
Indiana	3, 423, 921	3, 295, 034	. 96	149	8, 603
Indian Territory	969, 606	1, 541, 293	1. 59	157	3, 101
Iowa	3, 967, 253	4, 997, 939	1. 26	170	9, 995
Kansas	3, 388, 251	4, 178, 998	1. 23	164	7, 339
Kentucky	3, 111, 192	2, 749, 932	. 88	145	8, 083
Maryland	3, 501, 428	2, 687, 270	. 77	215	3, 974
Michigan	70, 022	103, 049	1. 47	224	223
Missouri	2, 245, 039	2, 634, 564	1. 17	138	7, 523
Montana	927, 395	1, 887, 390	2. 04	192	1, 782
Nevada	150	475	3. 15	60	2
New Mexico	597, 196	935, 857	1. 57	182	985
North Carolina	16, 900	29, 675	1. 76	145	95
North Dakota	42, 015	47, 049	1. 12	156	77
Ohio	11, 909, 856	9, 841, 723	. 83	136	27, 105
Oregon	47, 521	183, 914	3. 87	243	88
Pennsylvania	39, 912, 463	29, 479, 820	. 74	165	75, 010
Tennessee	2, 180, 879	2, 119, 481	. 97	210	5, 542
Texas	420, 848	976, 458	2. 32	283	1, 062
Utah	431, 550	603, 479	1. 40	199	671
Virginia	1, 229, 083	933, 576	. 76	234	1, 635
Washington	1, 106, 470	2, 578, 441	2. 33	207	2, 662
West Virginia	11, 627, 757	8, 706, 808	. 75	186	17, 824
Wyoming	2, 417, 463	3, 170, 392	1. 31	190	3, 032
Total	118, 820, 405	107, 653, 501	. 91	171	244, 603
Pennsylvania anthracite	51, 921, 121	78, 488, 063	1. 85	190	131, 603
Grand total	170, 741, 526	186, 141, 564	1. 09	178	376, 206

PRODUCTION IN PREVIOUS YEARS.

The following table shows the annual production of anthracite and bituminous coal since 1880. The quantities are expressed both in long tons of 2,240 pounds and in short tons of 2,000 pounds.

Annual production of coal in the United States since 1880.

Years.	Bituminous coal.			Pennsylvania anthracite.			Total.		
	Long tons of 2,240 pounds.	Short tons of 2,000 pounds.	Value.	Long tons of 2,240 pounds.	Short tons of 2,000 pounds.	Value.	Long tons.	Short tons.	Value.
1880	38, 242, 641	42, 831, 758	$53, 443, 718	25, 580, 189	28, 649, 811	$42, 196, 678	63, 822, 830	71, 481, 569	$95, 640, 396
1881	48, 365, 341	53, 961, 012	60, 224, 344	28, 500, 016	31, 920, 018	64, 125, 036	76, 865, 357	85, 881, 030	124, 349, 380
1882	60, 861, 190	68, 164, 533	76, 076, 487	31, 358, 264	35, 121, 256	70, 556, 094	92, 219, 454	103, 285, 789	146, 632, 581
1883	68, 531, 500	76, 755, 280	82, 237, 800	34, 336, 469	38, 456, 845	77, 257, 055	102, 867, 969	115, 212, 125	159, 494, 855
1884	73, 730, 539	82, 578, 204	77, 417, 066	33, 175, 756	37, 156, 847	66, 351, 512	106, 906, 295	119, 735, 051	143, 768, 578
1885	64, 840, 668	72, 621, 548	82, 347, 648	34, 228, 548	38, 335, 974	76, 671, 948	99, 069, 216	110, 957, 522	159, 019, 596
1886	65, 810, 676	73, 707, 957	78, 481, 056	34, 853, 077	39, 035, 446	76, 119, 120	100, 663, 753	112, 743, 403	154, 600, 176
1887	78, 470, 857	87, 887, 360	98, 004, 656	37, 578, 747	42, 088, 197	84, 552, 181	116, 049, 604	129, 975, 557	182, 556, 837
1888	91, 106, 998	102, 039, 838	101, 860, 529	41, 624, 611	46, 619, 564	89, 020, 483	132, 731, 609	148, 659, 402	190, 881, 012
1889	85, 432, 628	95, 685, 543	94, 504, 745	40, 665, 152	45, 544, 970	65, 721, 578	126, 097, 780	141, 229, 514	160, 226, 323
1890	99, 392, 871	111, 320, 016	110, 420, 801	41, 489, 858	46, 468, 641	66, 383, 772	140, 882, 729	157, 788, 657	176, 804, 573
1891	105, 268, 962	117, 901, 237	117, 188, 400	45, 236, 992	50, 665, 431	73, 944, 735	150, 505, 954	168, 566, 668	191, 133, 135
1892	113, 264, 792	126, 856, 567	125, 124, 381	46, 850, 450	52, 472, 504	82, 442, 000	160, 115, 242	179, 329, 071	207, 566, 381
1893	114, 629, 671	128, 385, 231	122, 751, 618	48, 185, 306	53, 967, 543	85, 687, 078	162, 814, 977	182, 352, 774	208, 438, 696
1894	106, 089, 647	118, 820, 405	107, 653, 501	46, 358, 144	51, 921, 121	78, 488, 063	152, 447, 791	170, 741, 526	186, 141, 564

The total amount and value of coal produced in the United States, by States, since 1886, is shown in the following table. The amounts in this table are expressed in short tons of 2,000 pounds:

Amount and value of coal produced in the United States, by States and Territories, from 1886 to 1894.

States and Territories.	1886.		1887.		1888.	
	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Alabama	1,800,000	$5,574,000	1,950,000	$2,535,000	2,900,000	$3,335,000
Arkansas	125,000	200,000	150,000	252,500	276,871	415,306
California	100,000	300,000	50,000	150,000	95,000	380,000
Colorado	1,368,338	3,215,594	1,791,735	3,941,817	2,185,477	4,808,049
Georgia	223,000	334,500	313,715	470,573	180,000	270,000
Idaho	1,500	6,000	500	2,000	400	1,800
Illinois	9,246,435	10,263,543	10,278,890	11,152,596	14,655,188	16,413,811
Indiana	3,000,000	3,450,000	3,217,711	4,324,604	3,140,979	4,397,370
Indian Territory	534,580	855,328	685,911	1,286,692	761,986	1,432,072
Iowa	4,312,921	5,391,151	4,473,828	5,991,735	4,952,440	6,438,172
Kansas	1,400,000	1,680,000	1,596,879	2,235,631	1,850,000	2,775,000
Kentucky	1,550,000	1,782,500	1,933,185	2,223,163	2,570,000	3,084,000
Maryland	2,517,577	2,391,698	3,278,023	3,114,122	3,479,470	3,293,070
Michigan	60,434	90,651	71,461	107,191	81,407	135,221
Missouri	1,800,000	2,340,000	3,209,916	4,298,994	3,909,967	8,050,800
Montana	49,846	174,460	10,202	35,707	41,467	145,135
Nebraska			1,500	3,000	1,500	3,375
New Mexico	271,285	813,855	508,034	1,524,102	626,665	1,879,995
North Carolina						
North Dakota	25,955	41,277	21,470	32,205	34,000	119,000
Ohio	8,435,211	8,013,450	10,301,708	9,096,848	10,910,946	10,147,180
Oregon	45,000	112,500	31,696	70,000	75,000	225,000
Pennsylvania:						
Anthracite	36,696,475	71,558,126	39,506,255	79,365,244	43,922,897	85,649,649
Bituminous	26,160,735	21,016,235	30,866,602	27,806,941	33,796,727	32,106,891
Rhode Island			6,000	16,250	4,000	11,000
Tennessee	1,714,290	1,971,434	1,900,000	2,470,000	1,967,297	2,164,026
Texas	100,000	185,000	75,000	150,000	90,000	184,500
Utah	200,000	420,000	180,021	360,042	258,961	543,818
Virginia	684,951	684,951	825,263	773,360	1,073,000	1,073,000
Washington	423,525	952,931	772,612	1,699,746	1,215,750	3,647,250
West Virginia	4,005,796	3,805,506	4,836,820	4,594,979	5,498,800	6,048,680
Wyoming	829,355	2,488,065	1,170,318	3,510,954	1,481,540	4,444,620
Total product sold	107,682,209	147,112,755	124,015,255	173,595,996	142,037,735	204,222,790
Colliery consumption	5,061,194		5,960,302	8,960,841	6,621,667	7,295,834
Total	112,743,403	147,112,755	129,975,557	182,556,837	148,659,402	211,518,624

Amount and value of coal produced in the United States, by States and Territories, from 1886 to 1894—Continued.

States and Territories.	1889.		1890.		1891.	
	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Alabama	3, 572, 983	$3, 961, 491	4, 090, 409	$4, 202, 469	4, 759, 781	$5, 087, 596
Arkansas	279, 584	395, 836	399, 888	514, 595	542, 379	647, 560
California	184, 179	434, 382	110, 711	283, 019	93, 301	204, 902
Colorado	2, 544, 144	3, 843, 992	3, 094, 003	4, 344, 196	3, 512, 632	4, 800, 000
Georgia	226, 156	339, 382	228, 337	238, 315	171, 000	256, 500
Idaho	....	....	....	....	....	....
Illinois	12, 104, 272	11, 755, 203	15, 292, 420	14, 171, 230	15, 660. 698	14, 237, 074
Indiana	2, 845, 057	2, 887, 852	3, 305, 737	3, 259, 233	2, 973, 474	3, 070, 918
Indian Territory	752, 832	1, 323, 807	869, 229	1, 579, 188	1, 091, 032	1, 897, 037
Iowa	4, 095, 358	5, 426, 509	4, 021, 739	4. 995, 739	3, 825, 495	4, 867, 999
Kansas	2, 220, 943	3, 297, 288	2, 259, 922	2, 947, 517	2, 716, 705	3, 557, 303
Kentucky	2, 399, 755	2, 374, 339	2, 701, 496	2, 472, 119	2, 916, 069	2, 715, 600
Maryland	2, 939, 715	2, 517, 474	3, 357, 813	2, 899, 572	3, 820, 239	3, 082, 515
Michigan	67, 431	115, 011	74, 977	149, 195	80, 307	133, 387
Missouri	2, 557, 823	3, 479, 057	2, 735, 221	3, 382, 858	2, 674, 606	3, 283. 242
Montana	363, 301	880, 773	517, 477	1, 252, 492	541, 861	1, 228, 630
Nebraska	1, 500	4, 500	1, 500	4, 500	1, 500	4, 500
New Mexico	486, 463	870, 468	375, 777	504, 390	462, 328	779, 018
North Carolina	(*a*)	....	10, 262	17, 864	20, 355	39, 365
North Dakota	28, 907	41, 431	30, 000	42, 000	30, 000	42, 000
Ohio	9, 976, 787	9, 355, 400	11, 494, 506	10, 783, 171	12, 868, 683	12, 106, 115
Oregon	(*b*)	....	61, 514	177, 875	51, 826	155, 478
Pennsylvania:						
Anthracite	*c*45, 598, 487	65, 873, 514	46, 468, 641	66, 383, 772	50, 665, 431	73, 944, 735
Bituminous	36, 174, 089	27, 953, 315	42, 302, 173	35, 376, 916	42, 788, 490	37, 271, 053
Rhode Island	2, 000	6, 000	....	....	500	10, 000
Tennessee	1, 925, 689	2, 338, 309	2, 169, 585	2, 395, 746	2, 413, 678	2, 668, 188
Texas	128, 216	340, 620	184, 440	465, 900	172, 100	412, 360
Utah	236, 651	377, 456	318, 159	552, 390	371, 045	666, 045
Virginia	865, 786	804, 475	784, 011	589, 925	736, 399	611, 654
Washington	1, 030, 578	2, 393, 238	1, 263, 689	3, 426, 590	1, 056, 249	2, 437, 270
West Virginia	6, 231, 880	5, 086, 584	7, 394, 654	6, 208, 128	9, 220, 665	7, 359, 816
Wyoming	1, 388, 947	1, 748, 617	1, 870, 366	3, 183, 669	2, 327, 841	3, 555, 275
Total product sold	141, 229, 513	160, 226, 323	157, 788, 656	176, 804, 573	168, 566, 669	191, 133, 135

a Product included in Georgia.

b Product included in California.

c Includes the product of anthracite in Colorado and New Mexico.

Amount and value of coal produced in the United States, by States and Territories, from 1886 to 1894—Continued.

States and Territories.	1892.		1893.		1894.	
	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Alabama	5, 529, 312	$5, 788, 898	5, 136, 935	$5, 096, 792	4, 397, 178	$4, 085, 535
Arkansas	535, 558	666, 230	574, 763	773, 347	512, 626	631, 988
California	85, 178	209, 711	72, 603	167, 555	67, 247	155, 620
Colorado	3, 510, 830	5, 685, 112	4, 102, 389	5, 104, 602	2, 831, 409	3, 516, 340
Georgia	215, 498	212, 761	372, 740	365, 972	354, 111	299, 290
Idaho	....	....	....	....	....	....
Illinois	17, 862, 276	16, 243, 645	19, 949, 564	17, 827, 595	17, 113, 576	15, 282, 111
Indiana	3, 345, 174	3, 620, 582	3, 791, 851	4, 055, 372	3, 423, 921	3, 295, 034
Indian Territory	1, 192, 721	2, 043, 479	1, 252, 110	2, 235, 209	969, 606	1, 541, 293
Iowa	3, 918, 491	5, 175, 060	3, 972, 229	5, 110, 460	3, 967, 253	4, 997, 939
Kansas	3, 007, 276	3, 955, 595	2, 652, 546	3, 375, 740	3, 388, 251	4, 178, 998
Kentucky	3, 025, 313	2, 771, 238	3, 007, 179	2, 613, 569	3, 111, 192	2, 749, 932
Maryland	3, 419, 962	3, 063, 580	3, 716, 041	3, 267, 317	3, 501, 428	2, 687, 270
Michigan	77, 990	121, 314	45, 979	82, 462	70, 022	103, 049
Missouri	2, 733, 949	3, 369, 659	2, 897, 442	3, 562, 757	2, 245, 039	2, 634, 564
Montana	564, 648	1, 330, 847	892, 309	1, 772, 116	927, 395	1, 887, 390
Nebraska	1, 500	4, 500	....	....	....	....
Nevada	....	....	....	....	150	475
New Mexico	661, 330	1, 074, 601	665, 094	979, 044	597, 196	935, 857
North Carolina	6, 679	9, 599	17, 000	25, 500	16, 900	29, 675
North Dakota	40, 725	39, 250	49, 630	56, 250	42, 015	47, 049
Ohio	13, 562, 927	12, 722, 745	13, 253, 646	12, 351, 139	11, 909, 856	9, 841, 723
Oregon	34, 661	148, 546	41, 683	164, 500	47, 521	183, 914
Pennsylvania:						
Anthracite	52, 472, 504	82, 442, 000	53, 967, 543	85, 687, 078	51, 921, 121	78, 488, 063
Bituminous	46, 694, 576	39, 017, 164	44, 070, 724	35, 260, 674	39, 912, 463	29, 479, 820
Rhode Island	....	....	....	....	....	....
Tennessee	2, 092, 064	2, 355, 441	1, 902, 258	2, 048, 449	2, 180, 879	2, 119, 481
Texas	245, 690	569, 333	302, 206	688, 407	420, 848	976, 458
Utah	361, 013	562, 625	413, 205	611, 092	431, 550	603, 479
Virginia	675, 205	578, 429	820, 339	692, 748	1, 229, 083	933, 576
Washington	1, 213, 427	2, 763, 547	1, 264, 877	2, 920, 876	1, 106, 470	2, 578, 441
West Virginia	9, 738, 755	7, 852, 114	10, 708, 578	8, 251, 170	11, 627, 757	8, 706, 808
Wyoming	2, 503, 839	3, 168, 776	2, 439, 311	3, 290, 904	2, 417, 463	3, 170, 392
Total product sold	179, 329, 071	207, 566, 381	182, 352, 774	208, 438, 696	170, 741, 526	186, 141, 564

Comparing the amount and value of the product in 1894 with that of 1893, the following statement of increases and decreases is obtained:

Increases and decreases in coal production during 1894 compared with 1893, by States.

States.	Increases.		Decreases.	
	Short tons.	Value.	Short tons.	Value.
Alabama			739, 757	$1, 011, 257
Arkansas			62, 137	141, 359
California			5, 356	11, 935
Colorado			1, 270, 980	1, 588, 262
Georgia			18, 629	66, 682
Illinois			2, 835, 988	2, 545, 484
Indiana			367, 930	760, 338
Indian Territory			282, 504	693, 916
Iowa			4, 976	112, 521
Kansas	735, 705	$803, 258		
Kentucky	104, 013	136, 363		
Maryland			214, 613	580, 047
Michigan	24, 043	20, 587		
Missouri			652, 403	928, 193
Montana	35, 086	115, 274		
Nevada	150	475		
New Mexico			67, 898	43, 187
North Carolina		4, 175	100	
North Dakota			7, 615	9, 201
Ohio			1, 343, 790	2, 509, 416
Oregon	5, 838	19, 414		
Pennsylvania bituminous			4, 158, 261	5, 780, 854
Tennessee	278, 621	71, 032		
Texas	118, 642	288, 051		
Utah	18, 345			7, 613
Virginia	408, 744	240, 828		
Washington			158, 407	342, 435
West Virginia	919, 179	455, 638		
Wyoming			21, 848	120, 512
Total			9, 564, 826	15, 098, 117
Pennsylvania anthracite			2, 046, 422	7, 199, 015
Grand total			11, 611, 248	22, 297, 132

LABOR STATISTICS.

The following table shows under one head the total number of employees in the coal mines of the United States for a period of five years, and the average time made by each:

Labor statistics of coal mining since 1890.

States and Territories.	1890.		1891.		1892.		1893.		1894.	
	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	217	10,642	268	9,302	271	10,075	237	11,294	238	10,859
Arkansas	214	938	214	1,317	199	1,128	151	1,559	134	1,493
California	301	364	222	256	204	187	208	158	232	125
Colorado	220	5,827	......	6,000	229	5,747	188	7,202	155	6,507
Georgia	313	425	312	850	277	467	342	736	304	729
Illinois	204	28,574	215½	32,951	219½	34,585	229	35,390	183	38,477
Indiana	220	5,489	190	5,879	224	6,436	201	7,644	149	8,603
Indian Territory	238	2,571	221½	2,891	211	3,257	171	3,446	157	3,101
Iowa	213	8,130	224	8,124	236	8,170	204	8,863	170	9,995
Kansas	210	4,523	222	6,201	208½	6,559	147	7,310	164	7,339
Kentucky	219	5,259	225	6,355	217	6,724	202	6,581	145	8,083
Maryland	244	3,842	244	3,891	225	3,886	240	3,935	215	3,974
Michigan	229	180	205	223	195	230	154	162	224	223
Missouri	229	5,971	218	6,199	230	5,893	206	7,375	138	7,523
Montana	218	1,251	......	1,119	258	1,158	242	1,401	192	1,782
Nevada	......	......	......	......	......	......	......	......	60	2
New Mexico	192	827	265	806	223	1,083	229	1,011	182	985
North Carolina	200	80	254	80	160	90	80	70	145	95
North Dakota	......	......	......	......	216	54	193	88	156	77
Ohio	201	20,576	206	22,182	212	22,576	188	23,931	136	27,105
Oregon	305	208	125	100	120	90	192	110	243	88
Pennsylvania bituminous.	232	61,333	223	63,661	223	66,655	190	71,931	165	75,010
Tennessee	263	5,082	230	5,097	240	4,926	232	4,976	210	5,542
Texas	241	674	225	787	208	871	251	996	283	1,062
Utah	289	429	......	621	230	646	226	576	199	671
Virginia	296	1,295	246	820	192	836	253	961	234	1,635
Washington	270	2,206	211	2,447	247	2,564	241	2,757	207	2,662
West Virginia	227	12,236	237	14,227	228	14,867	219	16,524	186	17,824
Wyoming	246	3,272	......	3,411	225	3,133	189	3,378	190	3,032
Total	226	192,204	*a* 223	205,803	219	212,893	204	230,365	171	244,603
Pennsylvania anthracite	200	126,000	203	126,350	198	129,050	197	132,944	190	131,603
Grand total.	216	318,204	215	332,153	212	341,943	201	363,309	178	376,206

a General average obtained from the average days made in the different States, exclusive of Colorado, Montana, Utah, and Wyoming.

AVERAGE PRICES.

The following table will be of interest as showing the fluctuations in the average prices ruling in each State since 1886. Prior to that year the statistics were not collected with sufficient accuracy to make a statement of the average prices of any practical value. These averages are obtained by dividing the total value by the total product, except for the years 1886, 1887, and 1888, when the item of colliery consumption was not considered:

Average prices for coal at the mines since 1886.

States and Territories.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama	$3.09	$1.30	$1.15	$1.11	$1.03	$1.07	$1.05	$0.99	$0.93
Arkansas	1.60	1.68	1.50	1.42	1.29	1.19	1.24	1.34	1.22
California	3.00	3.00	4.00	2.36	2.56	2.20	2.46	2.31	2.31
Colorado	2.35	2.20	2.20	1.51	1.40	1.37	1.62	1.24	1.24
Georgia	1.50	1.50	1.50	1.50	1.04	1.50	.99	.98	.85
Illinois	1.11	1.09	1.12	.97	.93	.91	.91	.89	.89
Indiana	1.15	1.34	1.40	1.02	.99	1.03	1.08	1.07	.96
Indian Territory	1.60	1.87	1.88	1.76	1.82	1.74	1.71	1.79	1.59
Iowa	1.25	1.34	1.30	1.33	1.24	1.27	1.32	1.30	1.26
Kansas	1.20	1.40	1.50	1.48	1.30	1.31	1.31½	1.27	1.23
Kentucky	1.15	1.15	1.20	.99	.92	.93	.92	.86	.88
Maryland	.95	.95	.95	.86	.86	.81	.89	.88	.77
Michigan	1.50	1.50	1.66	1.71	1.99	1.66	1.56	1.79	1.47
Missouri	1.30	1.34	2.21	1.36	1.24	1.23	1.23	1.23	1.17
Montana	3.50	3.50	3.50	2.42	2.42	2.27	2.36	1.99	2.04
Nevada	....	....	....	....	....	....	....	....	3.15
New Mexico	3.00	3.00	3.00	1.79	1.34	1.68	1.62	1.47	1.57
North Carolina	....	....	....	....	1.74	1.93	1.44	1.50	1.76
North Dakota	1.59	1.50	3.50	1.43	1.40	1.40	.96	1.13	1.12
Ohio	.95	.88	.93	.93	.94	.94	.94	.92	.83
Oregon	2.50	2.20	3.00	....	2.89	3.00	4.29	3.57	3.87
Pennsylvania bituminous	.80	.90	.95	.77	.84	.87	.84	.80	.74
Tennessee	1.15	1.30	1.10	1.21	1.10	1.11	1.13	1.08	.97
Texas	1.85	2.00	2.05	2.66	2.53	2.40	2.32	2.28	2.32
Utah	2.10	2.00	2.10	1.59	1.74	1.80	1.56	1.48	1.40
Virginia	1.00	.94	1.00	.93	.75	.83	.86	.84	.76
Washington	2.25	2.20	3.00	2.32	2.71	2.31	2.28	2.31	2.33
West Virginia	.94	.95	1.10	.82	.84	.80	.80	.77	.75
Wyoming	3.00	3.00	3.00	1.26	1.70	1.53	1.27	1.35	1.31
Total bituminous.	*a* 92	*a* 99	*a* 1.21	1.00	.99	.99	.99	.96	.91
Pennsylvania anthracite	*a* 1.95	*a* 2.01	*a* 1.95	1.44	1.43	1.46	1.57	1.59	1.52
General average	*a* 1.30	*a* 1.45	*a* 1.42	1.13	1.12	1.13	1.16	1.14	1.09

a Exclusive of colliery consumption.

IMPORTS AND EXPORTS.

The following tables have been compiled from official returns to the Bureau of Statistics of the Treasury Department, and show the imports and exports of coal from 1867 to 1894, 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. 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.

The exports consist both of anthracite and bituminous coal, the amount 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.

Coal imported and entered for consumption in the United States, 1867 to 1894.

Years ending—	Anthracite.		Bituminous and shale.	
	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*	
June 30, 1867	....	....	509,802	$1,412,597
1868	....	....	394,021	1,250,513
1869	....	....	437,228	1,222,119
1870	....	....	415,729	1,103,965
1871	973	$4,177	430,508	1,121,914
1872	390	1,322	485,063	1,279,686
1873	2,221	10,764	460,028	1,548,208
1874	471	3,224	492,063	1,937,274
1875	138	963	436,714	1,791,601
1876	1,428	8,560	400,632	1,592,846
1877	630	2,220	495,816	1,782,941
1878	158	518	572,846	1,929,660
1879	488	721	486,501	1,716,209
1880	8	40	471,818	1,588,312
1881	1,207	2,628	652,963	1,988,199
1882	36	148	795,722	2,141,373
1883	507	1,172	645,924	3,013,555
1884	1,448	4,404	748,995	2,494,228
1885	4,976	15,848	768,477	2,548,432
Dec. 31, 1886	2,039	4,920	811,657	2,501,153
1887	14,181	42,983	819,242	2,609,311
1888	24,093	68,710	1,085,647	3,728,060
1889	20,652	117,434	1,001,374	3,425,347
1890	15,145	46,695	819,971	2,822,216
1891	37,607	112,722	1,363,313	4,561,105
1892	65,058	197,583	1,143,304	3,744,862
1893	53,768	148,112	*a* 1,082,993	3,623,892
1894	90,068	234,024	*b* 1,242,714	3,785,513

a Including 14,632 tons of slack or culm, valued at $16,906; *b* including 30,453 tons of slack or culm, valued at $32,267.

Coal of domestic production exported from the United States, 1867 to 1894.

Years ending—	Anthracite.		Bituminous and shale.	
	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*	
June 30, 1867	192, 912	$1, 333, 457	92, 189	$512, 742
1868	192, 291	1, 082, 745	86, 367	433, 475
1869	283, 783	1, 553, 115	....	....
1870	121, 098	803, 135	106, 820	503, 223
1871	134, 571	805, 169	133, 380	564, 067
1872	259, 567	1, 375, 342	141, 311	586, 264
1873	342, 180	1, 827, 822	242, 453	1, 086, 253
1874	401, 912	2, 236, 084	361, 490	1, 587, 666
1875	316, 157	1, 791, 626	203, 189	828, 943
1876	337, 934	1, 869, 434	230, 144	850, 711
1877	418, 791	1, 891, 351	321, 665	1, 024, 711
1878	319, 477	1, 006, 843	340, 661	1, 352, 624
1879	386, 916	1, 427, 886	276, 000	891, 512
1880	392, 626	1, 362, 901	222, 634	695, 179
1881	462, 208	2, 091, 928	191, 038	739, 532
1882	553, 742	2, 589, 887	314, 320	1, 102, 898
1883	557, 813	2, 648, 033	463, 051	1, 593, 214
1884	649, 040	3, 053, 550	646, 265	1, 977, 959
1885	588, 461	2, 586, 421	683, 481	1, 989, 541
Dec. 31, 1886	667, 076	2, 718, 143	544, 768	1, 440, 631
1887	825, 486	3, 469, 166	706, 364	2, 001, 966
1888	969, 542	4, 325, 126	860, 462	2, 529, 472
1889	857, 632	3, 636, 347	935, 151	2, 783, 592
1890	794, 335	3, 272, 697	1, 280, 930	4, 004, 995
1891	861, 251	3, 577, 610	1, 615, 869	5, 104, 850
1892	851, 639	3, 722, 903	1, 645, 869	4, 999, 289
1893	1, 333, 287	6, 241, 007	2, 324, 591	6, 009, 801
1894	1, 440, 625	6, 359, 021	2, 195, 716	4, 970, 270

WORLD'S PRODUCT OF COAL.

In the following table is given the coal product of the principal countries for the years nearest the one under review for which figures could be obtained. For the sake of convenience the amounts are expressed in the unit of measurement adopted in each country and reduced for comparison to short tons of 2,000 pounds. In each case the year is named for which the product is given.

The world's product of coal.

Countries.		Usual unit in producing country.	Equivalent in short tons.
Great Britain (1894)	long tons	188, 277, 525	210, 870, 828
United States (1894)	do	152, 447, 791	170, 741, 526
Germany (1893)	metric tons	85, 211, 326	93, 934, 409
France (1893)	do	25, 651, 000	28, 276, 898
Austria (1893)	do	26, 549, 000	29, 266, 821
Belgium (1893)	do	19, 411, 000	21, 398, 104
Russia (1892)	do	6, 913, 351	7, 621, 969
Canada (1894)	short tons	3, 853, 235	3, 853, 235
Japan (1893)	do	3, 400, 000	3, 400, 000
Spain (1893)	metric tons	1, 520, 109	1, 675, 723
New Zealand (1893)	short tons	691, 548	691, 548
Sweden (1892)	metric tons	382, 000	421, 155
Italy (1893)	do	317, 000	349, 451
Total		....	572, 501, 667
Percentage of the United States		....	30

COAL TRADE REVIEW.

Coal mining in the United States took a backward stride in 1894, the product falling below that of either 1892 or 1893 and exceeding that of 1891 by a very narrow margin, about three-fourths of 1 per cent. The influences which produced this decrease were (1) the prevailing business distress which, contrary to general expectations, extended from 1893 through 1894 and affected the coal trade in sympathy with manufacturing industries, and (2) the memorable strike inaugurated the latter part of April and continued with remarkable endurance until late in the summer.

The original cause of this strike was undoubtedly overproduction, though the direct cause assigned was the effort of the operatives to secure an advance in wages, or rather a return to the scale which had obtained in the earlier part of 1893. During 1893 there had been no effort made to restrict the production of coal, notwithstanding the industrial depression and a very restricted demand, but on the other hand the output was increased. In many cases mines were worked simply to give employment to the men, while in others the spirit of competition and an aggressive policy which sought to extend their market into territories naturally tributary to other fields brought about a condition of affairs which could not act otherwise than disastrously. In order to renew contracts for the succeeding year, operators were obliged to meet competitive prices, and necessarily a reduction in cost of production had to be made. A reduction in the rate of wages was agreed to by the miners in a number of districts, and matters drifted along under an amicable understanding between employers and employees until the officers of the United Mine Workers met in Columbus, Ohio, in March, 1894. It was at this meeting that a restoration of the old rate of wages was demanded, with the alternative of a general strike, to go into effect on April 21. The time was unpropitious for such a demand. Operators had continued to mine and ship coal, with docks and storage places at the larger cities and the lake and Atlantic ports stocked to repletion, so that to accede to such a demand would have been suicidal.

It must not be supposed from the above that in all cases, prior to the demand of the leaders, a satisfactory condition prevailed among the miners. The operatives in the Massillon district and in Jackson County (embracing the cities of Jackson, Coalton, and Wellston), Ohio, were on strike in February and March, and there was, of course, some disaffection in other regions. The strike in Ohio was the starting point of the general strike and the nucleus about which it grew. The statement that the time was not propitious for a strike of such dimensions is made from the miners' standpoint. If we except the damage done to property during the outbreaks of lawlessness which always attend such strikes, the result to the operators was rather favorable than otherwise.

The suspension of so many mines soon created a scarcity of coal, and prices rapidly rose. Those who had any coal on hand realized handsome profits, and the comparatively few mines that continued to work were paying investments for the time. In the Upper Monongahela district, West Virginia, for instance, where, by sufficient inducement being offered, the miners' remained at work, the price of coal went up from 70 cents to $1.50 per ton and the output was increased about five-fold. In the Pocahontas Flat Top region, which was exempted from the mine workers' decree, production was so heavy that the Norfolk and Western Railroad had to lease a number of engines from other roads to transport the product to the seaboard. The same favorable conditions existed in other sections, particularly along the New and Kanawha rivers, where the union had not sufficient strength to cause an entire suspension of business. In justice to a large body of miners not personally in sympathy with the strike, it must be said that many of those who quit work did so under persuasion or compulsion.

At the time this report is writing, troubles have again arisen in Ohio, the wage scale being again the cause. The scale for the year has been, for some years past, fixed in the spring, usually in April and May, and this adjustment of the scale is, with somewhat monotonous regularity, attended by a strike of greater or less dimensions. In the Pocahontas Flat Top region a strike is also in progress. This was the one region officially exempted from the strike of 1894. In this case it is a protest against a reduction of wages, and while a difference seemingly exists between the mine owners and their men, it is said to be in reality a fight against the Norfolk and Western Railroad for exacting what are claimed to be exorbitant freight rates, and which in order to ship the coal profitably called for a reduction in wages. This region embraces the county of Tazewell, Va., and McDowell and Mercer counties, W. Va., and employs in the neighborhood of 6,000 men.

A comprehensive understanding of the tendency of trade during 1894 and the effects of the strike upon it at the important centers, and the movement of coal between the producing districts and the principal markets, may be arrived at by consideration of the following contributions from secretaries of boards of trade and other reliable sources. The influences of the strike overshadowed all other items of interest. The conditions of the money market and the timidity of capital have not been favorable to the opening of any new fields—which is doubtless fortunate, since the capacity of our developed mines far exceeds the needs—and there were no special discoveries of any importance. Some promise is made of the development of valuable cannel coal lands in Johnson and Pike counties, Ky., the parties interested believing that the superior qualities claimed for the coal will make the working of it profitable, notwithstanding the already glutted market.

A railroad is building from Chispa Station, on the Southern Pacific Railroad, to the recently discovered coal fields in Presidio County, Tex.

(described in Mineral Resources, 1893), and before the close of the present calendar year this coal will probably be brought in. It is in a region where cheap coal is badly needed, and will doubtless prove remunerative at once.

Following will be found the coal trade reviews at the various important cities:

NEW YORK CITY.

The best report on the movement and prices of coal at New York is contained in Mr. F. E. Saward's annual publication, The Coal Trade. The following review for 1894 is taken from Mr. Saward's report:

New York City is the point where more coal is handled in the course of the year than anywhere else, except the city of London, England. In its vicinity are the shipping ports of millions of tons of every grade and quality of anthracite and bituminous, so that 15,000,000 tons is an underestimate of the sales actually consummated at this point. The several shipping points on the New Jersey shore of the Hudson, the Kill von Kull, and the Raritan Bay, known as South Amboy, Perth Amboy, Port Reading, Elizabethport, Port Johnston, Port Liberty, Jersey City, Hoboken, and Weehawken, are feeders to the trade of the metropolis for local use and for shipment to eastern ports. The docks of the Pennsylvania Coal Company at Newburg, N. Y., the Delaware and Hudson Canal at Rondout, N. Y., the "Erie" at Piermont, N. Y., and the Ontario and Western at Cornwall, N. Y., also furnish tribute to the trade of the parties doing business here.

The quantity used locally is set down at 6,000,000 tons, to which may be added 2,750,000 for Jersey City and Brooklyn, really but part of the metropolis.

Bituminous coal comes in schooners and steam colliers from Norfolk, Newport News, and Baltimore, and in barges from South Amboy, Port Reading, and Port Liberty, N. J., and is used locally for all the purposes to which it is adapted. An approximate statement of the bituminous coal loaded into ocean steamers at this port shows that there are over 1,500,000 long tons so taken; of this perhaps 150,000 tons is the "Pocahontas" coal, and the remainder is "Clearfield."

Prices ranged very low during the year, for the reason, perhaps only too well known, that the tonnage was more of an object in the view of some of the producers than price. There was no attempt to adhere to the agreements made, from time to time, in regard to what would constitute a sufficient amount to meet the requirements of the month next ensuing after the agreement was entered into. As a consequence, the market value of anthracite dropped to figures below what it had sold for in three years, and the carrying companies were very near bedrock in earnings. The nominal opening prices were as below, free on board, at the loading ports, in the beginning of the years named:

Opening prices for free-burning anthracite coal at New York for five years.

Years.	Broken.	Egg.	Stove.	Chestnut.
1890	$3.40	$3.50	$3.50	$3.25
1891	3.50	4.60	3.75	3.50
1892	3.65	3.75	3.90	3.65
1893	3.90	3.90	4.15	4.15
1894	3.50	3.50	3.75	3.75

Figures at the close of the years nominally were:

Closing prices for anthracite coal at New York for seven years.

	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Broken	$3.95	$3.90	$3.75	$3.75	$4.00	$3.75	$3.10
Egg	4.30	4.15	4.00	4.15	4.40	4.00	3.20
Stove	4.65	4.40	4.40	4.40	4.75	4.45	3.35
Chestnut	4.65	4.15	3.95	4.15	4.65	4.45	3.25

The schedules show the decline in value of this magnificent fuel. It is only too evident that the lack of harmony during the year (so far as what may constitute the market requirements) represents a clear loss of many millions of dollars.

In the spring of the year the soft coal producers sending to the seaboard put their prices at $2.25 free on board vessels at all loading points, with say $3.25 at New York alongside; while for tonnage at the loading ports near New York $2.75, $2.80, and $3 per long ton free on board, according to destination, were the agreed-on rates. The market was an uneven one, and except for the time of the strike the above schedule was seldom realized. During the strike coal was brought from many places not usually shipping to the Atlantic seaboard. It came from West Virginia, England and Nova Scotia, selling at $6 per ton at New York to those having contracts with steamship companies. The cheaper grades of domestic coal sold lower free on board at New York and other loading ports than ever before. So much has this been the case that the year closed with the following quotations: $1.80 to $2.25 free on board Norfolk and Newport News; $1.90 to $2.25 free on board, Baltimore; $1.80 to $2.25 free on board, Philadelphia; $2.40 to $2.75 free on board, New York Harbor.

A fair exhibit of the course of prices of the best Georges Creek coal is shown below:

Prices for Georges Creek (Cumberland) coal at New York.

Years.	Per ton.	Years.	Per ton.
1889	$3.50	1892	$3.40
1890	3.50	1893	3.25
1891	3.50	1894	3.00

The growth of the use of the small sizes of anthracite is worthy of note, and it is stated on good authority that with many of the receivers 40 per cent of the tonnage handled is made up of the smaller coals, such as pea, buckwheat, rice, culm, etc. At the electric-light stations, the power houses for the cable roads, and many of the large office buildings in this city they now use the small anthracite sizes. There was 42.88 per cent of the tonnage shipped by the Cross Creek Coal Company represented by these small coals.

The soft coal for "bunker" use—that is, put into the "ocean greyhounds" and other vessels plying to all parts of the world from this port—is a feature that is looked after by the producers of coal in Pennsylvania, Maryland, and the Virginias most earnestly. Competition for this trade brings the prices down to a figure that is much less than it should be to pay a fair recompense to the miner, the carrier, and the producer. The principal lines and their yearly tonnage are given below:

Annual tonnage of coal used by steamship companies out of New York.

Companies.	Tons.	Companies.	Tons.
Anchor Line	50,000	C. H. Mallory & Co	80,000
Atlas Line	30,000	North German Lloyd Co	120,000
Cromwell Line	20,000	Phelps Bros. & Co	30,000
Clyde Steamship Co	30,000	Red Star Line	40,000
Cunard Steamship Co	100,000	National Line	25,000
French Line	70,000	Morgan Line	60,000
Funch, Eyde & Co	40,000	White Star Line	75,000
Hamburg Line	100,000	Spanish Line	20,000
American Line	75,000	Standard Oil Co	30,000
Guion Line	25,000	United States and Brazil Mail Line	20,000
New York and Cuba Mail Steamship Co	40,000	Tramp steamers	200,000
Pacific Mail Steamship Co	20,000	Lines taking 20,000 tons	170,000

The retail exchange had a hard time of it last year; prices were very uneven at retail, and much coal was sold at $4.50 per ton delivered.

It is stated that the amount of wood consumed annually in New York City is 40,000 cords, nearly all of which is sold by coal dealers who purchase their supplies from half a dozen wholesale dealers in wood. The price to dealers is something over $10 per cord, taking the average the year round.

BOSTON, MASS.

Mr. Elwyn G. Preston, secretary of the chamber of commerce of Boston, has prepared the following review of the coal trade of that city:

The receipts of coal at Boston for the past twelve years have been as follows:

Receipts of coal at Boston for twelve years.

Years.	Domestic.			Foreign.	Total.
	By water.		All rail. *a*		
	Anthracite.	Bituminous.			
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
1883					2,273,068
1884					2,225,740
1885					2,221,220
1886				44,464	2,500,000
1887				13,966	2,400,000
1888	2,057,279	1,004,195		10,081	3,071,555
1889	1,647,348	914,966		5,538	2,567,852
1890	1,740,564	964,857		14,072	2,719,493
1891	2,039,443	1,070,088		5,842	3,115,373
1892	2,163,984	919,815		1,416	3,085,215
1893	2,227,086	1,100,384	50,000	17,097	3,394,567
1894	2,237,599	958,701	71,303	41,779	3,309,382

a Largely bituminous.

The figures given above include coal forwarded to interior Massachusetts and New Hampshire points, and for which Boston is merely the discharging port. Coal so forwarded during the year 1894 amounted to 992,639 tons, which would make the local consumption last year

2,316,743 tons. This is a decrease of 131,683 tons compared with the year immediately preceding, caused by the extraordinary industrial depression that prevailed during a great part of the year. The coal trade of the city of Boston during 1894 has been subject to much the same conditions that have prevailed at other large centers. Notwithstanding the fact that the price of all grades has been uniformly low, there has at no time been any activity displayed.

The coal miners' strike during May and June caused a sharp temporary advance in the price of bituminous coal in anticipation of shortage of supplies, but the stocks on hand were sufficiently large to obviate any serious inconvenience to manufacturing plants until the mines were again open and coal began to move freely. In a few cases resort was had to buckwheat and pea sizes of anthracite, which for a time stimulated the market for those grades.

The opening months of the year were remarkably dull, with the demand at the lowest possible point. Stove coal was quoted $3.75 free on board, New York, at which price it remained during the first half of the year. During July and August advances were made to $4 and $4.15, dropping again to $3.75 in September and $3.55 and $3.65 in October, the year closing at $3.75. Georges Creek Cumberland ranged from $3.40 to $3.60 on board cars at Boston until the effects of the strike began to be felt, when advances were made, sales being reported at as high as $5.50 and $6 per ton. In July prices again fell off to $3.50 and $3.60, dropping during September and October to $3.20, the year closing at $3.55.

Carriers have been plenty, and although at times high rates were realized, the year has been on the whole unsatisfactory to vessel owners. The range of rates has been as follows:

Coal freight to Boston, Mass.

	Per ton.
From Philadelphia	$ 0.50 to $1.05
Baltimore	.40 to 1.10
Norfolk	.70 to 1.00
New York	.40 to .75

The highest prices were reached in November and December; the lowest during the summer months, the extremely low rate from Baltimore being quoted in April.

The following table shows the receipts of coal by months for the past year:

Monthly receipts of coal at Boston during 1894.

	Domestic.			Foreign.	Total.
	By water.		All rail.		
	Anthracite.	Bituminous.	Anthracite and bituminous.		
January	122, 371	54, 925	3, 891	114	181, 301
February	93, 448	26, 618	2, 308	548	122, 922
March	128, 095	67, 226	1, 824	88	197, 233
April	164, 968	73, 225	3. 867	....	242, 060
May	253, 217	58, 223	6, 619	1, 508	319, 567
June	257, 917	49, 309	6, 650	8, 455	322, 331
July	245, 362	101, 376	6, 360	11, 383	364, 481
August	187, 175	117, 864	8, 939	4, 517	318, 495
September	165, 452	116, 624	5, 554	2, 849	290, 479
October	175, 995	96, 552	6, 263	1, 740	280, 550
November	211, 661	108, 774	7, 554	7, 882	335, 871
December	231, 938	87, 985	11, 474	2, 695	334, 092
Total	2, 237, 599	958, 701	71, 303	41, 779	3, 309, 382

PHILADELPHIA, PA.

The following interesting contribution in regard to the coal trade of Philadelphia has been prepared by Mr. John S. Arndt, financial editor of the Inquirer:

The developments in the anthracite coal trade in Philadelphia in the year 1894 were perhaps more striking than in any recent year. The mercantile operations of buying and selling presented few changes of importance, but the methods of handling and the substitution of one size or character of fuel for another were altered in such a way as to involve economic considerations of the first order. The processes are revolutionary in their nature, and bid fair to continue for some years to come, but the progress made in 1894 was most marked. The most important of these, from the consumer's standpoint, was the great decrease in the number of small retail yards and the concentration of the distributing business in a smaller number of yards of greatly enlarged capacity. In some instances dealers have retired from business, being unable to meet the competition of others with greater capital, and in other cases additional real estate has been purchased and the plant thereby enlarged, but in either event the result has been the same. The dealer who sold from 1,500 to 3,000 tons a year has realized more forcibly than ever that in addition to paying 10 or 15 cents a ton more for his coal than his strong competitor paid, his charge for yard expenses and personal profit was so much greater that the contest was a most unequal one. The margin between cost and selling price was narrower than ever before, while the aggregate volume of business has not increased sufficiently to compensate for this loss.

There has been a great change, too, in the use of fuel. Five years ago 90 per cent of the pea coal brought into the city was delivered to manufacturers; in 1894 considerably over one-half was delivered to retailers. It comes free from slate and dirt, and uniform as to size, and has been successfully introduced as a domestic range fuel. It sells at retail at $3.50 per ton delivered, as against $5.25 and $5.50 for chestnut or stove, and yields as much profit to the dealer as the so-called prepared sizes. Its use was enormously extended in 1894, and so great was the demand for it that many manufacturers fell back upon buckwheat, which they found could be used to great advantage either separately or when mixed with bituminous. The consumption of this size has grown so steadily that the producing companies were able to advance the price slightly, although the market for anthracite was unsettled and weak during the greater part of the year. The average cost per ton of buckwheat delivered on trucks here was a little over $2, and the demand at times was limited only by the capacity of the companies to produce this size. In the same way, rice and culm, which can be had for $1.50 to $1.60 delivered, have come into favor, and the producing companies are encouraging its use, as so much bituminous is displaced thereby. Of the total production of the Philadelphia and Reading Coal and Iron Company in 1894, 34½ per cent was pea, buckwheat, and smaller coals, and nowhere did these coals meet with greater favor than in Philadelphia.

The quantity of anthracite delivered in Philadelphia in 1894 for local consumption was 3,540,000 tons; in 1893 the quantity was 3,570,000 tons. The market was a dragging one all through the year, and was particularly heavy in the closing months. The maximum prices were reached in June, and in December concessions of 15 and 20 cents were freely granted. The circular prices of the Philadelphia and Reading Coal and Iron Company for 1894 and 1893, were as follows, it being understood that a commission of 10 cents was allowed to agents:

Prices for anthracite coal at Philadelphia in 1893 and 1894.

Kinds of coal.	1894.			1893.		
	January.	April.	June.	January.	April.	July.
Lump and steamboat	$2.50	$2.50	$2.50	$2.35	$2.20	$2.25
Broken	2.25	2.15	2.20	2.40	2.25	2.25
Egg	2.50	2.25	2.30	2.85	2.45	2.50
Stove	2.80	2.50	2.55	2.95	2.60	2.80
Chestnut	2.70	2.40	2.40	2.75	2.50	2.70
Pea	1.35	1.40	1.40	1.25	1.25	1.25
Buckwheat	.75	.85	.85	.75	.75	.75

No change in the circular was made after July in either year. As prices declined the reduced price was accepted without comment. These prices were for coal at the mines. The consignee paid the freight rates in addition, which ruled unchanged throughout the year. They varied according to the region from which the coal came, and were as follows:

Freight rates from anthracite coal regions to Philadelphia, Pa.

Regions.	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

The coal companies controlled by the Pennsylvania Railroad Company sold their coal at a delivered price according to their custom.

The shipments of anthracite coal to consuming centers outside the capes of the Delaware were rather less in 1894 than in 1893. To ports in foreign countries 20,635 tons were shipped as against 26,229 tons in 1893. But the coastwise commerce also fell off to about 1,230,000 tons, as against 1,245,000 tons in 1893. The decrease would have been much greater had it not been for the long strike of bituminous coal miners, which enabled shippers to procure an abundant supply of vessels at the season when the trade was most active, and thus diverted business to this region which, under other circumstances, would probably have gone to New York. The selling price of anthracite in the tide-water market for Philadelphia shipment is always 25 cents below the New York price, the differential being supposed to compensate for the higher water freights that have to be paid here. But during most of June and July vessel freights to Boston ruled as low as 50 cents, because of the bituminous strike, and this induced large shipments. When the strike was over, the freight rates ran up to 80 cents, which was the ruling rate during nearly all of 1893, except for a brief period in the summer, when charters were made as low as 55 and 60.

In spite of the interruption to the bituminous trade through the strike, the business of the city and port in this fuel did not fall off materially for the year. The strike had been anticipated and large shipments had been made prior to April 21, and the movement after the conclusion of the strike in August was very heavy. The exports of bituminous to foreign countries was 362,468 tons, as against 296,625 tons in 1893. The coastwise trade also showed an increase, the shipments to points outside the capes of the Delaware being about 1,735,000 tons, as against about 1,715,000 tons in the year 1893. Prices were in the main satisfactory to the shipper at least, although the railroads realized less from transportation, as rates were reduced.

The local consumption of bituminous coal was less than in 1893, the competition of the more cleanly small sizes of anthracite being severely felt. Early in the year the Baldwin Locomotive Works, whose plant is in the center of the city, changed from bituminous to anthracite for steam fuel, and the use of bituminous was relegated almost exclusively to manufactories in the suburbs, where the smoke does not occasion complaint. The consumption of bituminous steam and gas coal in the city is given at about 845,000 tons, as against 910,000 tons in 1893; but this includes the gas coal consumed in the city gas works, about 250,000 tons, and a very considerable amount of gas coal used in iron and steel mills and other establishments where for certain reasons this fuel is desirable. The use of bituminous coal for steam purposes only is not only small but is certainly not increasing at the present time. The local price of bituminous ranged from $2.60 to $2.70 in 1894, a reduction of 10 or 15 cents from 1893, owing to lower freight rates.

About 200,000 tons of bituminous coal was delivered in 1894 for the use of steamships and steamboats. This bunker fuel is not included in the statistics given above. About the same quantity was delivered in 1893.

Through the courtesy of Mr. Joseph S. Harris, president of the Philadelphia and Reading Railroad Company; Mr. W. H. Joyce, general freight agent of the Pennsylvania Railroad Company, and Mr. C. E. Ways, general freight agent of the Baltimore and Ohio Railroad Company, approximate figures of the coal business of these railroads in Philadelphia have been provided, covering the years 1894 and 1893. The approximation is very close and the figures may be accepted as practically exact. The statement of bunker coal furnished steamships and steamboats is a close estimate. The coal business of Philadelphia for the years 1894 and 1893 may therefore be tabulated as below:

Coal receipts at Philadelphia.

Railroads.	1894.		1893.	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*
Baltimore and Ohio	20, 635	362, 468	26, 229	296, 625
Pennsylvania	1, 230, 000	1, 735, 000	1, 245, 000	1, 715, 000
Philadelphia and Reading	3, 540, 000	845, 000	3, 570, 000	910, 000
Bunker coal		200, 000		200, 000
Total	4, 790, 635	3, 142, 468	4, 841, 229	3, 121, 625

BUFFALO, N. Y.

The following review of the coal trade at Buffalo is extracted from the annual report of Mr. William Thurstone, secretary of the Buffalo Merchants' Exchange:

Special features of the anthracite trade for the year 1894 were the low range of prices and comparatively large shipments from Buffalo via lake. Prices ranged from 50 cents to $1 per ton less than during same periods in 1893. This loss falling wholly upon the producing companies and the railroad companies carrying the product, the result has been very disastrous, the dividend-paying corporations barely earning their dividends. Apparently earnest efforts were made by the managers of the companies to bring about an advance in prices, but their efforts proved failures, either because ill-advised or because the financial conditions of the country made an advance in prices impossible. The falling off in tonnage shipped by lake was in the vicinity of 200,000 tons, and this decrease is remarkably small, in view of the large stocks carried over from last season at western receiving ports and the slowness of the trade and consumers to purchase their supplies. Consumers are still practicing economy in the matter of fuel, as well as in other lines, which kept the supplies above the normal point during the spring of 1895. It may be interesting to note the percentages of lake coal brought from the mines to Buffalo by the various railroad lines in 1894. They were approximately as follows: Delaware, Lackawanna and Western, 35 per cent; Erie, 23 per cent; New York Central, 18 per cent; Lehigh Valley, 15 per cent; Wsetern New York and Pennsylvania, 9 per cent. The last-named line has recovered the tonnage it lost during the period of the Reading ascendancy and absorption of Coxe Bros. tonnage by the great combination. While there are no data at hand for comparison of all-rail tonnage in 1894 with that of 1893, it can be safely stated that the falling off for 1894, as compared with 1893, has been very serious. The local tonnage has also decreased very considerably in consequence of the hard times and the introduction of gas on the East Side from the West Seneca field. There has been no material extension of the natural gas lines on the West Side, and to some extent there has been less natural gas used in furnaces, because of the uncertainty of supply in freezing weather. It is believed that as the pressure at the wells decreases and the obtaining of the supply of natural gas becomes more difficult there will be a material increase in the consumption of anthracite coal for heating purposes all over the city.

The consumers have been favored in the way of low retail prices, but this does not seem to have stimulated buying to any noticeable extent. Neither the trestle men nor the retailers can boast of any large profits in the business, but are, like other tradesmen, living in hope of better times.

In the bituminous trade the year opened with prices ranging very low and the demand fair, but not up to the market of January, 1893. The trade received considerable stimulus later in March, and until the 18th of April prices rapidly advanced and the demand was very heavy, occasioned by the anticipation of the great coal strike in the bituminous regions of the United States, which commenced April 21. Great effort was made on the part of all producers to supply their customers with enough coal to carry them through a strike which, it was thought, would not last longer than thirty days. Much to the surprise of everybody, the strike lasted for two months, with the results that at the end of thirty days the markets all over the country were bare of bituminous coal, and the industries of this section, and also the steamers plying the Great Lakes, resorted to the use of anthracite coal. This entailed considerable expense to the consumers. The strike was finally settled, and the mines resumed work June 18, when for about one month the prices received for coal were good and the demand heavy. Since that time the price has been declining, until now, December 31, 1894, finds the market in about the same condition as it was January 1, 1894, and this with the additional cost paid for mining the coal.

Another feature of the year was the awarding of the Grand Trunk contract in February, 1894. The greater part of this contract was awarded to some of the Pittsburg operators at an extremely low price. This was the first time that the Pittsburg district had captured so large an amount of this contract, and the prices were so low that it was a surprise to the other regions that had been in the habit of furnishing the greater part of this contract. With the awarding of the Grand Trunk contract Pittsburg coal commenced to move very freely in this direction, and it is understood from good authorities that Pittsburg coal for the year 1894 has claimed at least 30 per cent of the bituminous coal tonnage of western New York and Canada.

Buffalo, as a coke market, has taken a great stride forward during 1894, mainly owing to the large consumption of the Buffalo Furnace Company, and an appreciable increase in the use of coke as a fuel, in the effort to reduce the smoke from the consumption of bituminous coal. No accurate figures are obtainable as to the tonnage of coke arriving in Buffalo, but a conservative estimate would be not far from 1,000 tons per working day. The sources of this supply are as follows: The Connellsville region in Fayette and Westmoreland counties, the Walston in Jefferson County, the Reynoldsville in Jefferson County, the Standard Works in Elk County, and the Tyler and Helvetia Works in Clearfield County, all in Pennsylvania. Many of these plants make coke for domestic use, but the consumption is very small as compared with the use of anthracite coal; and, though this fuel has merit, it does not seem to meet the popular fancy.

The following were the circular wholesale prices of anthracite coal, per 2,240 pounds, during 1894:

Anthracite wholesale circular prices at Buffalo in 1894.

Dates.	Free on board vessels at Buffalo.				On cars at Buffalo or Suspension Bridge.			
	Grate.	Egg.	Stove.	Chestnut.	Grate.	Egg.	Stove.	Chestnut.
January 1	$5.20	$5.45	$5.45	$5.45	$4.90	$5.15	$5.15	$5.15
April 2	4.45	4.70	4.70	4.70	4.15	4.40	4.40	4.40
June 1 to close of year	4.70	4.95	4.95	4.95	4.40	4.65	4.65	4.65

The retail prices of anthracite per 2,000 pounds, screened, delivered in the city limits during 1894, were as follows:

Anthracite retail prices at Buffalo in 1894.

Dates.	Grate.	Egg.	Stove.	Nut.	Pea.	Blossburg.
January 1	$5.50	$5.75	$5.75	$5.75	$4.00	$4.00
April 2	4.55	4.80	4.80	4.80	3.75	4.00
April 5	4.75	5.00	5.00	5.00	3.75	4.00
June 1	5.00	5.25	5.25	5.25	3.75	4.00
November 1 to close of year	5.00	5.25	5.25	5.25	4.00	4.00

The range of prices during 1894 for bituminous, delivered to manufacturers, gas works, propeller lines, tugs, etc., was from $1.40 to $2.50 per short ton, in car lots, on track, according to description; the price at retail, for choice for family use, was from $4.50 to $6 per short ton delivered.

The shipping docks and coal pockets at this port are:

Shipping docks and coal pockets at Buffalo.

Names.	Average shipping capacity daily.	Average capacity of pockets.
	Tons.	*Tons.*
Western New York and Pennsylvania R. R	2,500	3,000
Delaware and Hudson Canal Co	3,500	5,000
Delaware, Lackawanna and Western R. R	3,000	4,000
Lehigh docks Nos. 1 and 2	6,000	12,000
Erie docks (New York, Lake Erie and Western R. R.)	2,500	3,000
Pennsylvania Coal Co	3,000	3,300
Reading docks	7,000	6,500
Total	27,500	36,800

The following tables exhibit the receipts and shipments of anthracite, bituminous, and Blossburg (smithing) coal at Buffalo for a series of years:

Coal receipts at Buffalo for several years.

Years.	Anthracite.	Bituminous.	Blossburg.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*
1842				1,800
1852				57,560
1862				239,873
1872				790,876
1882				3,021,791
1886	2,673,778	1,420,956	30,000	4,124,734
1887	3,497,203	1,776,217	25,000	5,298,420
1888	4,549,015	1,892,823	22,500	6,464,338
1889	4,338,570	2,198,327	22,500	6,559,397
1890	4,500,000	2,200,000	25,500	6,725,500
1891	4,800,000	2,450,000	25,500	7,275,000
1892	4,804,760	2,627,441	25,000	7,457,201
1893	4,770,546	2,896,614	25,000	7,692,160
1894	4,272,130	2,280,470	25,000	6,577,600

Lake shipments of anthracite coal from Buffalo.

Years.	Tons.	Years.	Tons.
1883	1,467,778	1889	2,151,670
1884	1,431,081	1890	2,157,810
1885	1,428,086	1891	2,365,895
1886	1,531,210	1892	2,822,230
1887	1,894,060	1893	2,681,173
1888	2,514,906	1894	2,475,255

Lake shipments of bituminous and Blossburg coal from Buffalo.

Years.	Bituminous.	Blossburg.
	Tons.	*Tons.*
1887	8,706	10,000
1888	7,452	5,000
1889	11,673	5,000
1890	25,872	5,000
1891	34,066	5,000
1892	54,216	5,000
1893	15,000	7,500
1894	2,500	7,500

Shipments of bituminous coal by canal.

Years.	Short tons.
1890	25,872
1891	34,060
1892	29,216
1893	19,336
1894	8,840

Outside the city limits at Cheektowaga is the stocking coal trestle of the Delaware, Lackawanna and Western, with a capacity of over 100,000 tons storage. In the same place the Lehigh has its trestles and stocking plant of 175,000 tons storage capacity, with a shipping capacity of 3,000 tons daily; and has a transfer trestle for loading box cars with a capacity of 100 cars daily, and at the same point the Erie has a stocking plant with an average daily capacity of 1,000 tons, and storage capacity of 100,000 tons. The Reading has at the foot of Georgia street, in the city, a large trestle and pocket for the convenience of the retail trade and for use in connection with their docks, with a capacity of 2,000 tons. The Buffalo, Rochester and Pittsburg has terminals on Ganson and Michigan streets fronting on Blackwell Canal, with a water frontage of 1,100 feet; also a town delivery yard, with a hoisting plant for loading and coaling vessels, used by Messrs. Coxe Bros. & Co.

The distribution of exports of coal by lake from this port since 1886, as reported by the custom-house, was as follows:

Clearances of coal at Buffalo since 1886.

Destinations.	1886.	1887.	1888.	1889.	1890.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Chicago	642, 135	784, 462	1, 023, 649	988, 750	952, 280
Milwaukee	376, 615	376, 876	549, 831	497, 895	451, 550
Duluth	157, 420	165, 798	282, 106	160, 430	199, 230
Superior	65, 090	96, 746	120, 000	112, 450	127, 300
Toledo	55, 290	84, 563	83, 850	52, 725	96, 230
Gladstone	....	....	39, 575	36, 520	30, 215
Racine	25, 263	16, 565	29, 695	33, 410	29, 130
Detroit	31, 090	40, 203	35, 330	31, 890	40, 065
Green Bay	23, 870	29, 446	26, 345	25, 050	22, 380
Other places	156, 439	140, 020	179, 525	142, 216	131, 390
Total	1, 531, 212	1, 734, 479	2, 369, 906	2, 081, 336	2, 079, 770

Destinations.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Chicago	957, 805	1, 179, 635	1, 180, 245	1, 119, 187
Milwaukee	508, 140	715, 975	555, 995	551, 264
Duluth	257, 625	318, 580	278, 515	242, 664
Superior	162, 075	200, 680	197, 063	198, 284
Toledo	64, 620	102, 585	101, 970	98, 530
Gladstone	35, 170	52, 500	55, 400	45, 900
Racine	30, 510	34, 020	41, 715	30, 775
Detroit	24, 560	22, 500	15, 075	9, 491
Green Bay	29, 015	35, 300	57, 800	20, 335
Other places	295, 375	190, 555	239, 895	168, 825
Total	2, 365, 895	2, 852, 330	2, 703, 673	2, 485, 255

CLEVELAND, OHIO.

Mr. Charles E. Wheeler, superintendent of the department of transportation, Cleveland Chamber of Commerce, has contributed the following in regard to the coal trade of that city:

So far as the general situation is concerned, there is little to be said. The coal interests of Cleveland have not escaped the general depression and stagnation which has been widespread throughout the country; and added to this they have had to contend with labor troubles which, during a great part of the year, and in the Massillon district practically a whole year, have paralyzed their trade. Prices have been low, and neither operators nor railroads have received satisfactory returns.

Notwithstanding this the output has been large, taking into consideration the embarrassed condition of business. At the opening of 1895 there is little promise of improved condition of things.

The figures of 1893 and 1894, as compiled by this organization, have not included coal in transit, as many other cities do in these reports. Within the Cuyahoga district all coal coming to Lorain, Cleveland, Ashtabula, etc., for reconsignment by rail to other places, does not show as coal received or forwarded except where actually rehandled, as in case of lake coal. The effect of this is a decrease in the showing of the district, while some of the other lake ports credit the coal to themselves. Some steps should be taken to secure uniformity in reporting these items, so that comparisons may be made. For instance, a very large part of the coal which Toledo shows received by the Wheeling and Lake Erie goes to Detroit, Toledo's only interest in the transaction being a switching service from the Wheeling and Lake Erie to the Michigan Central or Lake Shore and Michigan Southern, while of course Detroit would show the coal received at that point, and thus both towns would receive a credit. Considerable of the coal from the Cleveland, Lorain and Wheeling is also Detroit coal, and were this district to adopt the same policy it would be credited first to Cleveland, second to Toledo, and third to Detroit.

It is this unsatisfactory condition of things that led the Cleveland Chamber of Commerce to introduce at the last meeting of the National Board of Trade the resolution calling for the appointment of a committee to take up with various commercial organizations the question of uniform reports.

Coal and coke receipts and shipments at Cleveland since 1887.

	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Receipts:	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Bituminous..	1,454,744	1,737,781	1,600,000	1,506,208	2,838,586	3,651,080	3,603,984	2,715,540
Anthracite ..	176,769	181,551	160,000	205,856	201,927	259,150	262,266	207,604
Coke.........	114,924	124,827	150,000	194,527	189,640	351,527	235,248	298,061
Total	1,746,437	2,044,159	1,910,000	1,960,591	3,230,153	4,261,757	4,101,498	3,221,205
Shipments:								
Anthracite by rail.....	20,296	29,735	25,000	29,056	34,910	50,742	49,497	44,177
Bituminous by rail.... and Bituminous by lake...	703,506	1,000,000	1,100,000	1,200,000	1,525,000	1,728,831		
Bituminous by rail....							24,128	30,000
Bituminous by lake...							1,257,326	1,106,000
Total	723,802	1,029,735	1,125,000	1,229,056	1,559,910	1,779,593	1,330,951	1,180,177

The Cuyahoga customs district includes the ports of Cleveland, Ashtabula, Fairport, and Lorain. The following table shows the clearances from this district for the past seven years:

Clearances of coal from the Cuyahoga, Ohio, district for six years.

Years.	Tons.	Years.	Tons.
1887	1,433,035	1891	2,635,461
1888	1,855,260	1892	2,957,988
1889	2,020,996	1893	3,052,342
1890	2,328,663	1894	2,239,829

As previously explained, the figures for 1893 and 1894 include only the coal actually rehandled.

The following table shows the wholesale prices ruling at Cleveland during 1894:

Wholesale prices of coal at Cleveland, Ohio, in 1894.

Kinds.	Prices per ton.	Kinds.	Prices per ton.
Bituminous:		Bituminous:	
Massillon	$2.20	Coshocton	$1.85
Palmyra	2.55	Hocking	1.80
Pittsburg	1.80	Anthracite:	
Salineville	1.60	Grate	4.24
Kentucky cannel	4.75	Egg	4.46
Goshen	1.65	Stove	4.46
Sherodsville	1.55	Chestnut	4.46
Osnaburg	1.65		

TOLEDO, OHIO.

The following statement in regard to the coal trade of Toledo is taken from the annual report of Mr. Denison B. Smith, secretary of the Toledo Produce Exchange:

The commerce in coal here and elsewhere has not regained the strength and activity which characterized it before the general depression of business and manufacturing of a year or more. The adversities of the times have affected both price and consumption. Of course when the machinery of the country is once more actively employed the movement will increase. Our receipts this year are more than in 1892 and less than in 1893, but cheaper cost of mining, cheaper rail freight, cheaper methods of transfer at the lake ports, and, last of all, cheaper lake freight by the great ships that now transport this coal, have all been supplied by the spirit, enterprise, and capital of our citizens, and will extend the demand to wider fields. Our harbor and the straight channel through our bay, admitting the largest vessels that float on the lakes, and the increase in dock and transfer facilities, justify the expectation of renewed and increased traffic here.

Attention is directed to the table below, giving a summary of receipts for nine years.

Coal receipts at Toledo since 1886.

	1886.	1887.	1888.	1889.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Wabash R. R	12, 598	9, 637	10, 375	8, 586
Lake Shore and Michigan Southern Rwy	165, 382	206, 099	201, 064	35, 693
Cincinnati, Hamilton and Dayton R. R	8, 198	11, 741	37, 831	51, 746
Pennsylvania Co	201, 427	330, 020	339, 750	234, 675
Michigan Central R. R	9, 594	13, 864	16, 504	19, 935
Columbus, Hocking Valley and Toledo Rwy	1, 039, 200	955, 620	1, 358, 025	923, 745
Toledo, Ann Arbor and North Michigan Rwy	1, 910	552	24, 700	96
Toledo, St. Louis and Kansas City R. R	3, 828	....	1, 359	3, 287
Toledo and Ohio Central Rwy	404, 684	590, 000	637, 000	706, 950
Lake	87, 120	117, 921	140, 963	90, 282
Wheeling and Lake Erie Rwy	391, 086	454, 813	755, 155	763, 055
Toledo, Columbus and Cincinnati Rwy	15, 832	5, 446	2, 014	2, 210
Cincinnati, Jackson and Mackinaw R. R	....	....	45	54
Total	2, 340, 859	2, 695, 810	3, 423, 780	2, 838, 314

	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Wabash R. R	3, 620	600	500	....	....
Lake Shore and Michigan Southern Rwy	20, 592	8, 872	43, 252	31, 110	22, 126
Cincinnati, Hamilton and Dayton R. R	25, 753	35, 356	82, 053	100, 000	72, 000
Pennsylvania Co	214, 765	172, 325	92, 894	241, 395	78, 792
Michigan Central R. R	3, 152	524	420	....	....
Columbus, Hocking Valley and Toledo Rwy	931, 716	604, 039	394, 895	854, 740	540, 000
Toledo, St. Louis and Kansas City R. R	8, 420	6, 891	5, 041	....	....
Toledo and Ohio Central Rwy	820, 049	300, 429	450, 000	984, 000	767, 670
Lake	133, 813	83, 800	112, 199	134, 750	116, 000
Wheeling and Lake Erie Rwy	853, 940	1, 007, 042	1, 080, 000	1, 100, 000	914, 220
Toledo, Columbus and Cincinnati Rwy	....	35, 064	30, 000	....	....
Cincinnati, Jackson and Mackinaw R. R	65	....	101	....	....
Total	3, 021, 886	2, 754, 943	2, 291, 355	3, 445, 995	2, 510, 808

CHICAGO, ILL.

The following interesting review of the coal trade at Chicago is taken from the Black Diamond, published in that city:

The tabulation below, giving the receipts of all kinds of coal and coke at Chicago as collected by the Chicago Bureau of Coal Statistics, is an interesting and significant compilation. The method of obtaining these data permits of no inaccuracy, so that the statistics in question are vouched for beyond dispute, being verified by the interests involved. It appears that the trade for 1894 shows an enormous though not an astonishing falling off as compared with that of 1893. This, with one exception, is pretty general in connection with all kinds of coal, both hard and soft. There have been, it is true, a variety of peculiar influences at work during 1894. There was financial depression, there was a money panic, there were great coal strikes, there were great railroad strikes, there was for a time excessive production, and there was a remarkable decline in prices.

Thus we find that the receipts of anthracite coal by lake in 1894 were 1,277,191 tons as compared with 1,424,853 tons in 1893, a decrease in receipts by lake of 147,662 tons from 1893 and a decrease of about 130,000 from the receipts of 1892, showing that the activity in dock coal is considerably less than it has been for some time previous. In the receipts of anthracite by rail we find a total for 1894 of 528,000 tons against 668,000 tons for 1893 and 649,000 tons for 1892, a decrease in this particular of 140,000 tons upon either of the two preceding years. Thus the total falling off in the receipts of hard coal was about 267,000 tons. Beside this is to be placed the fact that the stock on hand is slightly in excess of that held last year, when the total in round numbers was 580,000 tons, and may be figured now at about 600,000 tons. To all intents and purposes this is practically the same amount that was held at the opening of last year. In view of the causes of depression above referred to, it can only be regarded as a satisfactory sign of the conditions of the trade that, despite the curtailment in receipts and the natural decrease in the amount which has gone into distribution, greater stock is not held in first hands. Given the proper conditions, there should not be too much hard coal to meet the demand that might be made upon it during the remainder of the season. We might say in this connection, too, that the general anthracite production was 46,358,144 long tons as against 48,185,306 long tons for last year, showing a decrease of 1,827,162 tons. It will thus be seen that the great loss in consumption has not been at the Western distributing points in anything like the ratio as represented from Eastern sources, especially in view of the fact that the receipts of hard coal at Milwaukee were 765,000 tons as against 754,000 tons last year, and that the amount of hard coal which went through the Sault footed up 533,000 tons. We also find that the shipments from Buffalo westward by lake were about 2,400,000 as compared with 2,600,000 tons in 1893, besides the shipments from Erie and Oswego. It will thus be seen that to all intents and purposes, so far as consumption is concerned, the Western anthracite trade has held its own.

The soft-coal trade yields a showing altogether different. It has been in this line that the disparity in figures has made itself manifest. And here it must be remarked that the displacement of coal in what might appear to be a shifting and fluctuating manner is the natural outcome of the difficulties which have beset the trade in Ohio, Indiana, Illinois, and Pennsylvania. In the first place, the great operating factor which has caused such an alteration in the sum total for the producing regions of the States above mentioned was the great miners' strike, which in many States for the time being absolutely paralyzed the soft-coal industry in the West. The West suffered, too, by the tie up of the railroad systems, which added a second disorganizing factor. During the period of these strikes some sections of the country were comparatively free from their baneful effects, notably West Virginia and Kentucky. The result of this has been that the product of these regions has vastly increased, and it may be safely said that seldom before has there been such activity in West Virginia as during 1894. Taking the Chicago market as a case in point and as an indication of the tonnage of West Virginia coals, it is discovered that the receipts in this connection were 296,000 tons as against 148,000 tons for 1893 and 126,000 tons for 1892. This is practically an increase of about 100 per cent, and illustrates the changing character of the influences affecting the trade. The series of troubles in the Pittsburg and Youghiogheny territory and that embraced in its contiguous neighborhood yields a return of 300,000 tons in round numbers as against 420,000 tons in 1893. Ohio coal has been subjected to one factor and another, especially as regards rates and conditions of competition, and it is therefore not surprising that the figures in this connection should show considerable variation, the total for 1894 being 460,000 tons as against 680,000 tons for 1893. It is, however, in the States of Indiana and Illinois where the greatest decrease becomes apparent; yet, owing to the fact that the receipts of Indiana and Illinois coal for the month of December reach the same total as for the corresponding period of last year, it is evident that these fuels have recovered their standing and are now steadily maintaining their ordinary trade. The great difference in the sum total of the receipts for the year is to be attributed to the causes mentioned above and to the long period of idleness which afflicted the miners. The showing for Illinois is 1,500,000 tons for 1894 as against 1,945,000 tons for 1893, a decrease of nearly 450,000. Indiana makes almost the same showing so far as loss of tonnage is concerned. The sum total for 1894 is 1,165,000 tons as against 1,574,000 tons for 1893, a falling off of about 410,000 tons. Finally, it may be said that neither did coke escape, the great strike in the coke region being greatly responsible for the loss of something like 350,000 tons in the Western trade from this point. Thus the total showing evinces the fact that Western coal has suffered a loss in tonnage of some 850,000 tons and that, taken as a whole, all coal and coke has experienced a loss in trade amounting to 1,800,000 tons, 1,000,000 tons of which may be said to be in the confines of Chicago and the remaining 800,000 tons in shipments to contiguous territory. In the early part of 1895, however, shipments were in excess of those of 1894, which would indicate that the trade is rapidly recovering its former health and vigor. In conclusion, it is only rational to recognize the fact that the conditions which have been experienced in the West have been more operative in the East, in so far as that there has been a large decrease in consumption of all kinds and grades of coal, which has been more pronounced in this section than in others.

The following table shows the receipts of coal at and shipments from Chicago during 1893 and 1894 as collected by the bureau of coal statistics:

Coal receipts at Chicago.

ANTHRACITE.

Months.	Anthracite by lake.		Anthracite by rail.		Total anthracite.		1894.	
	1894.	1893.	1894.	1893.	1894.	1893.	Increase.	Decrease.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January			51, 326	48, 915	51, 326	48, 915	2, 411	
February			34, 893	38, 921	34, 893	38, 921		4, 028
March			26, 998	29, 873	26, 998	29, 873		2, 875
April	18, 449	46, 295	15, 206	26, 418	33, 655	72, 713		39, 058
May	117, 572	257, 122	53, 829	34, 816	171, 401	291, 938		120, 537
June	134, 797	182, 769	53, 512	40, 716	188, 309	223, 485		35, 176
July	180, 350	161, 004	15, 639	40, 929	195, 989	201, 933		5, 944
August	131, 408	87, 316	56, 152	38, 429	187, 560	125, 745	61, 815	
September	134, 205	162, 921	39, 204	77, 389	173, 409	240, 310		66, 901
October	182, 184	174, 624	72, 215	99, 386	254, 399	274, 010		19, 611
November	224, 395	226, 952	58, 492	113, 446	282, 887	340, 398		57, 511
December	153, 831	125, 850	50, 885	79, 529	204, 716	205, 379		663
Total	1, 277, 191	1, 424, 853	528, 351	668, 767	1, 805, 542	2, 093, 620		288, 078

BITUMINOUS.

Months.	Pennsylvania.		1894.		Ohio.		1894.	
	1894.	1893.	Increase.	Decrease.	1894.	1893.	Increase.	Decrease.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January	38, 491	47, 193		8, 702	67, 998	84, 856		16, 858
February	24, 833	31, 816		6, 983	56, 476	63, 419		6, 943
March	26, 116	31, 216		9, 100	43, 448	64, 296		20, 848
April	28, 436	35, 312		6, 876	53, 249	55, 560		2, 311
May	14, 391	24, 353		9, 962	22, 503	38, 777		16, 274
June	21, 219	30, 389		9, 170	25, 772	67, 860		42, 088
July	13, 346	38, 194		24, 848	11, 840	55, 617		4, 377
August	47, 795	31, 214	16, 581		60, 987	42, 966	18, 021	
September	5, 644	31, 416		25, 772	17, 905	58, 226		40, 321
October	27, 321	33, 451		6, 130	40, 583	59, 728		19, 145
November	20, 102	38, 985		18, 883	37, 321	74, 935		37, 614
December	28, 195	48, 284		20, 089	30, 586	89, 557		58, 971
Total	295, 889	421, 823		125, 934	468, 668	755, 797		287, 129

Coal receipts at Chicago—Continued.

BITUMINOUS—continued.

Months.	West Virginia and Kentucky.		1894.		Illinois.		1894.	
	1894.	1893.	Increase.	Decrease.	1894.	1893.	Increase.	Decrease.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January	20,587	17,091	3,496		164,821	182,012		17,191
February	17,369	14,825	2,544		164,334	170,925		6,591
March	12,767	15,541		2,774	117,949	160,358		42,409
April	19,885	17,855	2,030		140,761	135,142	5,619	
May	46,433	13,483	32,950		25,320	115,673		90,353
June	39,225	20,432	18,793		25,385	153,171		127,786
July	4,787	18,541		13,754	21,784	119,563		97,779
August	19,197	12,437	6,760		125,170	132,767		7,597
September	24,524	19,794	4,730		147,164	183,575		36,411
October	30,358	18,426	11,932		163,896	180,466		16,570
November	34,173	22,407	11,766		216,497	208,291	8,206	
December	27,349	25,162	2,187		188,099	203,363		15,264
Total	296,654	215,994	80,660		1,501,280	1,945,306		444,026

Months.	Indiana.		1894.		Coke.		1894.	
	1894.	1893.	Increase.	Decrease.	1894.	1893.	Increase.	Decrease.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January	123,229	141,149		17,920	79,013	79,618		9,605
February	120,683	141,500		20,817	64,566	73,518		8,952
March	110,773	156,833		46,060	66,389	68,221		1,832
April	127,898	127,744	154		60,219	59,328	891	
May	930	99,374		98,444	40,693	51,417		10,724
June		123,699		123,699	41,346	52,673		11,327
July	70,706	122,844		52,138	10,102	56,913		46,811
August	105,757	104,329	1,428		15,300	42,813		27,513
September	78,278	140,557		62,279	14,061	74,186		60,125
October	125,368	147,374		22,006	29,712	72,316		42,604
November	149,259	134,209	15,050		17,161	94,307		77,146
December	152,371	135,363	17,008		30,365	82,333		51,968
Total	1,165,252	1,574,975		409,723	459,927	807,643		347,716

Shipments from Chicago.

Months.	Anthracite.		1894.		Bituminous and coke.		1894.	
	1894.	1893.	Increase.	Decrease.	1894.	1893.	Increase.	Decrease.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January	59,718	54,191	5,527		41,129	70,218		29,089
February	42,981	30,239	12,742		34,576	58,644		24,068
March	28,494	38,024		9,530	23,817	71,312		47,495
April	15,511	21,539		6,028	34,123	60,614		26,491
May	69,453	24,718	44,735		14,209	39,227		25,018
June	34,853	29,456	5,397		11,911	40,309		28,398
July		57,314		57,314		51,966		51,966
August	37,040	61,668		24,628	6,013	52,324		46,311
September	15,780	89,537		73,757	101,247	76,309	24,938	
October	54,886	90,006		35,120	81,578	73,924	7,654	
November	53,355	104,249		50,894	85,262	68,317	16,945	
December	40,896	81,336		40,440	81,300	56,218	25,082	
Total	452,967	682,277		229,310	515,165	719,382		204,217

The following table gives a correct statement of anthracite coal received at this market during the season of 1894, as obtained from custom-house reports and compared with the actual weights as shown on the books of the different consignees:

Received by—	Tons.	Received by—	Tons.
Robert Law	201,417	W. L. Scott Co	57,055
E. L. Hedstrom & Co	186,000	Pennsylvania Coal Co	48,518
Philadelphia and Reading Coal and Iron Co.	162,526	William Drieske	27,036
		J. L. Snydacker & Co	12,000
Lehigh Valley Coal Co	159,897	Drieske & Hinners	8,700
O. S. Richardson & Co	125,265	Otto Scheunemann	5,000
Delaware and Hudson Canal Co	110,076		
Peabody Coal Co	103,701	Total	1,277,191
Coxe Brothers & Co	70,000		

Summary of Chicago coal and coke trade for 1893 and 1894.

	1894.	1893.		1894.	1893.
	Tons.	*Tons.*	Shipments of—	*Tons.*	*Tons.*
Stock of anthracite coal on hand Jan. 1	580,430	559,583	Coke	125,088	193,160
Receipts of—			Local consumption:		
Anthracite by lake	1,277,191	1,424,853	Anthracite	1,328,350	1,394,496
Anthracite by rail	528,351	668,767	Bituminous	3,342,617	4,387,673
Bituminous coal	3,732,694	4,913,895	Coke	334,839	614,483
Coke	459,927	807,643	Stock of anthracite coal on hand Dec. 31	604,655	580,430
Shipments of—					
Anthracite to country	452,967	682,277			
Bituminous coal to country	390,077	526,222			

MILWAUKEE, WIS.

Mr. William J. Langson, secretary of the chamber of commerce, has kindly furnished the following statement of the receipts and shipments of coal at Milwaukee for a series of years:

The volume of trade in 1894, as shown by the receipts, was nearly 90,000 tons greater than in 1893, and within 40,000 tons of that of 1892, which was the largest in the history of the city. The total receipts in 1894 were 1,337,046 tons, and the shipments westward by rail and lake 432,768 tons, making the domestic consumption, approximately, 900,000 tons. The growth of the coal trade of Milwaukee has been very rapid, though somewhat restricted during the last two or three years by a scarcity of railroad cars to supply the Western country reached by the roads extending from this point. This difficulty has been partially overcome, and in view of the constant improvement in railroad equipment shippers will doubtless be accorded more liberal facilities every year. The increase in the coal trade of Milwaukee in the past ten years has been over 100 per cent, notwithstanding the enormous quantities distributed from the head of Lake Superior throughout the far Northwest.

The facilities for handling coal at Milwaukee are of the latest and most approved description. The dock room is ample and easily accessible to vessels of the largest class, having in this respect a great advantage over Chicago. Many vessels engaged in the grain trade of Chicago and ore trade of Escanaba bring return cargoes of coal to Milwaukee. The coal-carrying trade is looked upon as one of the most important factors in building up the commerce of Milwaukee.

Receipts of coal at Milwaukee for ten years.

	1885.	1886.	1887.	1888.	1889.
By lake from—	*Tons.*	*Tons*	*Tons.*	*Tons.*	*Tons.*
Buffalo	392, 003	395, 971	464, 972	631, 263	542, 167
Erie	50, 915	41, 847	61, 222	74, 610	47, 862
Oswego	10, 043		1, 153	1, 348	
Cleveland	126, 741	91, 997	78, 259	98, 631	89, 071
Ashtabula	35, 360	11, 096	38, 881	23, 105	48, 599
Black River	5, 549				
Lorain	19, 452	12, 417	11, 757	13, 533	15, 367
Sandusky	19, 307	57, 412	46, 606	19, 733	51, 816
Toledo	31, 875	69, 079	14, 115	38, 452	71, 516
Charlotte	19, 491	31, 744	2, 781	14, 292	22, 526
Fairport			10, 517	30, 253	5, 552
Ogdensburg				7, 700	4, 953
Huron, Ohio				8, 244	7, 726
Other ports		2, 679	4, 331		588
Total by lake	710, 736	714, 242	724, 594	961, 164	907, 743
By railroad	65, 014	45, 439	118, 385	161, 079	72, 935
Total receipts	775, 750	759 681	842, 979	1, 122, 243	980, 678

	1890.	1891.	1892.	1893.	1894.
By lake from—	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Buffalo	510, 598	659, 388	819, 570	629, 243	658, 978
Erie	46, 378	55, 202	65, 190	78, 947	97, 995
Oswego	2, 408	17, 022	26, 177	46, 065	41, 891
Cleveland	135, 413	143, 776	132, 051	189, 539	105, 800
Ashtabula	24, 671	22, 726	30, 549	38, 317	58, 179
Black River					
Lorain	15, 351	3, 983		18, 406	22, 552
Sandusky	26, 193	10, 692	19, 039	5, 360	7, 250
Toledo	59, 305	53, 644	12, 229	64, 548	90, 357
Charlotte	6, 120	10, 013	55, 909	763	
Fairport	11, 100	5, 775	5, 359	16, 483	122, 573
Ogdensburg	7, 026	5, 179	18, 134	1, 635	2, 065
Huron, Ohio	9, 720	12, 307	12, 173	26, 342	3, 275
Other ports	*a* 49, 375	*a* 6, 949	19, 485	1, 800	18, 395
Total by lake	903, 658	1, 006, 656	1, 210, 865	1, 117, 448	1, 229, 310
By railroad	92, 999	149, 377	163, 549	132, 284	107, 736
Total receipts	996, 657	1, 156, 033	1, 374, 414	1, 249, 732	1, 337, 046

a Including cargoes from all ports not reported at the custom-house.

Shipments of coal from Milwaukee for the past twelve years.

Shipped by—	1883.	1884.	1885.	1886.	1887.	1888.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Chicago, Milwaukee and St. Paul Rwy	146, 295	140, 630	179, 883	177, 286	166, 120	283, 269
Chicago and Northwestern Rwy	41, 746	37, 314	56, 591	70, 420	79, 258	107, 193
Wisconsin Central R. R	6, 725	7, 469	8, 943	11, 745	18, 953	12, 624
Milwaukee, Lake Shore and Western Rwy	30, 575	11, 757	12, 804	13, 072	13, 886	16, 146
Milwaukee and Northern R. R	10, 075	7, 556	10, 872	12, 011	15, 627	34, 480
Lake	355	335	184	269	1, 595	125
Total	235, 771	205, 061	269, 277	284, 803	295, 439	453, 837

Shipments of coal from Milwaukee for the past twelve years—Continued.

Shipped by—	1889.	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Chicago, Milwaukee and St. Paul Rwy	258, 281	378, 090	406, 455	252, 168	321, 960	246, 620
Chicago and Northwestern Rwy	97, 207	103, 279	114, 847	163, 063	199, 457	167, 753
Wisconsin Central R. R	11, 727	15, 929	14, 449	14, 930	10, 967	12, 377
Milwaukee, Lake Shore and Western Rwy	25, 413	5, 884	7, 998	11, 041	....	....
Milwaukee and Northern R. R	20, 556	19, 386	26, 723	27, 185	....	....
Lake	224	50	416	757	609	6, 018
Total	413, 408	522, 618	600, 888	469, 144	532, 993	432, 768

The Milwaukee, Lake Shore and Western Railway became a part of the Chicago and Northwestern Railway system, radiating from Milwaukee, and the Milwaukee and Northern Railroad was in like manner absorbed by the Chicago, Milwaukee and St. Paul Railway, and the traffic of both of these roads for 1893 and 1894 was merged in that of the larger corporations.

Receipts of coal at Milwaukee by lake and rail annually for thirty-three years, from 1862 to 1894, inclusive.

Years.	Tons.	Years.	Tons.
1862	21, 860	1879	350, 840
1863	43, 215	1880	368, 568
1864	44, 503	1881	550, 027
1865	36, 369	1882	593, 842
1866	66, 616	1883	612, 584
1867	74, 568	1884	704, 166
1868	92, 992	1885	775, 750
1869	87, 690	1886	759, 681
1870	122, 865	1887	842, 979
1871	175, 526	1888	1, 122, 243
1872	210, 194	1889	980, 678
1873	229, 784	1890	996, 657
1874	177, 655	1891	1, 156, 033
1875	228, 674	1892	1, 374, 414
1876	188, 444	1893	1, 249, 732
1877	264, 784	1894	1, 337, 046
1878	239, 667		

DULUTH, MINN.

Mr. Frank E. Wyman, secretary of the Duluth board of trade, has furnished the following interesting review of the coal trade of that city.

Receipts of coal at this end of Lake Superior during 1894 show a small increase over the receipts for the year preceding, the difference being about 150,000 tons. The steady increase in the volume of the coal traffic in the Northwest is one of the best indications of the healthy growth and development of this portion of the United States. Records at hand showing the receipts at, and distribution of coal from, the head of Lake Superior date back sixteen years. In 1878 there were received at Duluth 31,000 tons of coal. During 1894 the receipts at Duluth and Superior, about the same quantity being received at either place, were 2,350,000 tons, an increase of seventy-six fold within a period of sixteen years. The building of factories, mills, and various industrial enterprises, as well as the increase in population and the development of the lake marine and railroads of the Northwest, must have naturally brought about an increased consumption of coal, but it is only after carefully considering the facts in relation to the almost marvelous growth of the coal traffic at this point that one can conceive something of the true greatness of the growth and development of that portion of the Northwest which makes Duluth the distributing point for its supplies from the mines of the East. During 1893 the Pennsylvania and Ohio Coal Company became identified with the trade here, by the purchase of dock facilities and the doing of some business on its own account. Last year its business amounted to 150,000 tons. Most of the companies will improve their dock properties here during the year 1895. The Youghiogheny and Lehigh will double the capacity of its dock, and next year the new docks of the Northwestern Rail and Coal Company, on Allouez Bay, Superior, will have become a factor in the receiving of coal at the head of Lake Superior, to swell the volume of the business. One of the new factors in this trade that made its appearance last year was the Duluth and Iron Range Railroad Company, which commenced receiving coal at Two Harbors. The outlook for the future of this great traffic indicates that it will continue to increase from year to year for an indefinite period. At the opening of navigation for 1895 there was probably about 400,000 tons of coal on the docks here. This is because the unusually mild winter, up to January, had not been conducive to a maximum consumption of this fuel product. At the opening of navigation for 1894 the docks were practically empty. The increase in receipts this year over the receipts during 1894, as estimated by the local manager of one of the most prominent coal companies, will be about 200,000 tons, barring any deficit that may be contingent with strikes or kindred labor troubles.

Receipts of coal at Duluth, Minn., in 1894, by companies.

Companies.	Tons.	Companies.	Tons.
Northwestern Fuel Co	700,000	St. Paul and Western Coal Co	255,000
Ohio Coal Co	460,000	Pennsylvania and Ohio Coal Co	120,000
Lehigh Coal and Iron Co	200,000	Duluth and Iron Range Rwy Co. (Two Harbors)	50,000
Pioneer Fuel Co	180,000	Total	2,350,000
Philadelphia and Reading Coal and Iron Co	135,000		
Youghiogheny and Lehigh Coal Co	250,000		

The table below shows the development of the coal trade at the head of the lakes since 1878, and will be found of interest.

Coal receipts at Duluth, Minn., and Superior, Wis.

Years.	Tons.	Years.	Tons.
1878	31,000	1888	1,535,000
1881	163,000	1889	1,205,000
1882	260,000	1890	1,780,995
1883	420,000	1891	1,776,000
1884	372,000	1892	1,965,000
1885	595,000	1893	2,200,000
1886	736,000	1894	2,350,000
1887	912,000		

CINCINNATI, OHIO.

Receipts of coal at Cincinnati during the past fourteen years have been as follows:

Coal receipts at Cincinnati, Ohio.

Years.	Tons.	Years.	Tons.
1881	1,492,817	1888	2,551,415
1882	2,197,407	1889	2,348,055
1883	2,025,859	1890	2,452,253
1884	2,092,551	1891	2,608,923
1885	2,008,850	1892	2,718,809
1886	2,130,354	1893	2,905,071
1887	2,350,026	1894	2,755,137

The Survey is indebted to Mr. Charles B. Murray, superintendent of the chamber of commerce, for the statement of coal receipts at Cincinnati since 1891. Statistics for previous years were furnished by the former superintendent, Col. S. D. Maxwell. Prior to 1892 the statistics in the following table were collected for fiscal years ending August 31. The figures for 1892, 1893, and 1894 are for calendar years. The receipts in 1891 from September 1 to December 31 are stated separately.

Receipts of coal at Cincinnati since September 1, 1871.

Years.	Pittsburg (Youghiogheny.)	Kanawha.	Ohio River.	Canal.	Anthracite.	Other kinds.	Total.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1871-72	19,254,716		*b*10,359,906	1,104,003	72,171		30,790,796
1872-73	24,962,373		*b*11,075,072	1,162,052	75,000		37,274,497
1873-74	24,014,681		*b*10,398,153	710,000	112,000		35,234,834
1874-75	24,225,002	4,476,619	4,277,327	565,352	248,750	1,597,260	35,390,310
1875-76	27,017,592	6,004,675	4,400,792	409,358	282,578	2,068,322	40,183,317
1876-77	28,237,572	3,631,823	5,141,150	322,171	376,125	1,913,793	39,622,634
1877-78	26,743,055	6,386,623	3,288,008	380,768	439,350	1,654,425	38,892,229
1878-79	20,769,027	6,134,039	4,068,452	333,549	768,750	2,136,850	34,210,667
1879-80	31,750,968	8,912,801	4,268,214	202,489	712,075	2,351,699	48,198,246
1880-81	23,202,084	10,715,459	3,151,934	67,684	770,525	2,336,752	40,244,438
1881-82	37,807,961	13,950,802	3,560,881	77,336	779,925	3,090,715	59,267,620
1882-83	33,895,064	13,260,347	3,309,534	180,621	977,250	2,997,216	54,620,032
1883-84	32,239,473	15,926,743	2,956,688	293,010	1,085,350	3,910,795	56,412,059
1884-85	32,286,133	14,588,573	3,007,078	314,774	1,257,900	2,683,864	54,138,322
1885-86	34,933,542	17,329,349	939,746	205,717	1,287,925	2,720,250	57,416,529
1886-87	37,701,094	20,167,875	338,435	129,503	1,314,775	3,693,850	63,345,532
1887-88	41,180,713	20,926,596	1,533,358	26,098	1,328,225	5,710,649	70,705,639
1888-89	36,677,974	23,761,853	544,940	12,129	1,020,525	3,075,000	65,092,421
1889-90	42,601,615	19,221,196	454,385		1,001,175	4,709,775	67,988,146
1890-91	43,254,460	19,115,172	1,479,670	15,111	1,118,671	7,362,698	72,345,782
1891, 4 mos.	13,766,390	6,288,442	234,940		402,528	4,437,139	25,129,439
1892*a*	42,272,348	19,214,704	768,588		1,268,170	13,335,006	76,858,816
1893*a*	28,643,562	24,971,261	405,202		759,626	25,832,374	80,612,025
1894*a*	40,156,667	16,398,039	158,334		661,548	19,083,527	76,458,115

a Calendar years. *b* Including Kanawha coal.

ST. LOUIS, MO.

The following summary of the coal trade of St. Louis for the year 1894 has been furnished by Mr. James Cox, secretary of the Business Men's League of that city:

The consumption of coal in this city in 1893 was the highest on record, financial depression notwithstanding. The feature of 1894 is the heavy falling off in the receipts of soft coal. The manufacturing output for the year just ended exceeded that of 1893, and a greater number of heavy fuel-consuming plants were in operation. Hence the falling off can not be attributed to financial or commercial depression, or to "hard times." The strike in the Illinois coal fields is the direct cause. In the first place this caused a reduction of stocks in every direction, the process of scraping being resorted to in more senses than one. When the coal famine was at its worst all sorts of substitutes had to be burned. Several car loads of coal siftings, which had been used for track ballast, were dug up and made to do duty under boilers. Wood of all kinds, shavings, and almost everything that would burn, were brought into requisition; and the city inspectors, who were attracted by a peculiar blue smoke, found that one enterprising concern was fighting against a shut-down by burning dried apples. The result of this peculiar experiment was far more satisfactory than anyone would have imagined.

There is no doubt that the strike, lasting as it did for some months, taught some very valuable lessons in fuel economizing, and that a good deal more power has been obtained from a given quantity of coal than ever before. The influence of smoke-abating devices on coal consumption has also been tested. The law against smoking chimneys has been enforced with considerable severity and uniformity, and there are very few plants in the business or manufacturing sections of St. Louis which have no abaters. The steam jet is used very extensively. According to some people it increases the consumption of coal to an alarming extent, while others who have made equally careful comparisons do not find the result the same. Scientific tests of some of the higher-priced devices in use show that they reduce the consumption of coal materially, the same power being produced with much less coal. It is to be regretted that there are no statistics available to show exactly to what extent smoke abaters are responsible for the apparent anomaly of an increase in manufacturing activity with a simultaneous decrease in coal consumption.

The reduction in the smoke volume is very apparent. The manager of the Southern Hotel states that the saving in laundry bills in his house runs into the thousands, and one large lithographing house is equally enthusiastic. The latter concern had determined to move out into the country owing to the loss to finished work from soot and smuts while drying. The improvement in the atmospheric conditions is so marked that the idea of moving has been abandoned, and the city retains a valuable wage-paying concern. Another evidence of effective smoke abatement work is to be found in the increased fashionableness of white paint for exterior decoration. This luxury was out of the question until recently, owing to the great quantity of bituminous coal burned and the denseness of the smoke.

As will be seen by the following quotations anthracite coal has ruled $1 a ton lower. This and the smoke-abatement pressure combined have led to an increase in the consumption. Except during the strike, coal generally has ruled very low, and since the year expired some contracts have been made at even lower figures than those of 1894. Very fair steam-producing coal is sold at but a fraction over $1. During the strike a good deal of oil was burned and careful tests were made as to relative cost. There can be no doubt that oil can not be burned in competition with coal at anything like $1 a ton. An iron manufacturer, whose plant is on the Illinois side of the Mississippi, says his experiments proved that his oil cost him as much as $2 coal. Other manufacturers say that coal at $3.50 to $4 comes cheaper.

The following are the receipts of coal and coke during the last five years:

Coal and coke receipts at St. Louis since 1890.

	1890.	1891.	1892.	1893.	1894.
Soft coal....bushels..	69,477,225	72,078,225	82,302,228	87,769,375	74,644,375
Hard coal....tons..	124,335	139,050	187,327	173,653	186,494
Coke....bushels..	9,919,850	6,924,250	8,914,400	7,807,000	6,365,900

The following are the prices per ton of the most used grades of coal in St. Louis in 1894. The prices are for coal in car lots free on board St. Louis.

Prices of coal at St. Louis during 1894.

	Highest.	Closing.		Highest.	Closing.
Standard Illinois....	$1.42½	$1.16¼	Connellsville coke....	$5.75	$4.75
High grade Illinois....	1.67½	1.61¼	New River coke....	4.95	4.45
Anthracite:			Indiana coke....	4.05	3.80
Large egg....	5.80	5.55	Kentucky coke....	4.05	3.80
Small....	6.05	5.80	Gas coke....	4.80	4.20

KANSAS CITY, MO.

Mr. A. J. Vanlandingham, commissioner of the Kansas City transportation bureau, has furnished the following statement regarding the movements of coal in that city:

Kansas City is the wholesale coal market for all the territory east of the Rocky Mountains and west of the Missouri River, and is the largest coal market west of the Mississippi River. The general offices of all the mines in southeastern Kansas, southwestern Missouri, and many of those in the Indian Territory and Arkansas, are in Kansas City, and their coal is sold from this market, although shipped direct from mines to destination. About 75 per cent of the coal sold by Kansas City wholesale dealers is routed via Kansas City.

Kansas City is also the largest consumer of coal of any city west of St. Louis. The steam and commercial coal consumed here is mined in southwestern Missouri and southeastern Kansas. Domestic coal consists of Pennsylvania anthracite, Arkansas semianthracite, Colorado coal, and the better grades of soft coal from the surrounding district. Average prices for 1894 were as follows:

Prices of coal at Kansas City.

Kinds of coal.	Per short ton.
Lump	$2.71
Mine run	2.00
Nut	2.00
Slack	1.25 to $1.40
Anthracite	7.50 to 9.00
Smithing	8.50
Coke	4.20

Owing to some dealers ending their fiscal year with June 30, others with December 31, it has been somewhat difficult to arrive at the correct figure for local consumption the past five years. Figures below, however, are very nearly correct.

Local consumption of coal at Kansas City, 1889 to 1894, inclusive.

Years.	Short tons.
1889	667,190
1890	650,862
1891	613,644
1892	629,997
1893	703,031
1894	640,053

MOBILE, ALA.

Mr. A. C. Danner, president of the Mobile Coal Company, has furnished the following information regarding the coal trade at that port:

As near as can be estimated there were received here during the year 1894 from Alabama mines by the railroads and consigned to dealers and shippers 95,212 tons of bituminous coal, 2,000 pounds to the ton. This does not include the coal used by the railroad shops and on their locomotives, which is estimated to have been about 35,000 tons. There has been received by vessel here from Pennsylvania anthracite coal to the amount of about 3,600 tons.

There is no special change in the coal business at this port except a moderate increase in the business of furnishing bunker coal to steamers.

As the channel is being deepened by the Government, more steamers come here, and more coal is being used by them.

During the latter part of 1894 and the early part of 1895 the U. S. S. *Montgomery* was stationed at this port for the purpose of testing various Southern coals.[1] Sample lots of these coals were also sent to Washington for analysis.

The following table shows the receipts of coal at Mobile since 1883:

Receipts of coal at Mobile, Ala., for twelve years.

Years.	Alabama coal. (*a*)	Anthracite and English.	Total.
	Tons.	*Tons.*	*Tons.*
1883	25, 304	1, 229	26, 533
1884	17, 808	891	18, 699
1885	40, 301	775	41, 076
1886	30, 310	2, 022	32, 332
1887	39, 232	910	40, 142
1888	38, 785	648	39, 433
1889	43, 620	1, 454	45, 074
1890	39, 320	1, 327	40, 647
1891	51, 267	1, 775	53, 042
1892	70, 298	1, 500	71, 798
1893	90, 000	4, 130	94, 130
1894	95, 212	3, 600	98, 812

a This does not include the amount of coal used by the railroads on their locomotives and at their shops.

NORFOLK, VA.

The following statement of coal handled at Lambert's Point coal piers has been furnished this office by the chamber of commerce of Norfolk:

Coal shipments from Lambert's Point piers in five years.

Years.	Foreign.	Bunkers.	Coastwise.	Local.	Total.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
1890	37, 723	102, 755	941, 019	71, 010	1, 152, 507
1891	27, 997	135, 112	1, 215, 028	90, 606	1, 468, 743
1892	25, 653	129, 627	1, 400, 984	98, 034	1, 654, 298
1893	34, 969	125, 688	1, 512, 931	100, 453	1, 774, 041
1894	44, 328	105, 382	1, 810, 480	96, 841	2, 057, 031

SAN FRANCISCO, CAL.

Mr. J. W. Harrison reports the trade for the year as follows:

The uniformity of quotations for cargo lots during the year is unprecedented in the former history of the coal trade, as there was no apparent change at all for the first seven months; and the maximum and minimum values did not show a variance of 5 per cent until the tariff reduction of 40 cents per ton on bituminous grades caused a decline equal to the exact amount of the tariff change. Our large fuel consumers can not complain of the prices they have had to pay this year, as they have been the lowest ever known. Our consumption should have been largely increased on that account, were it not for the stag-

[1] See p. 54.

nancy of trade among our principal manufactories. With the seasonable rainfall we have had locally, the exceedingly low prices of pig iron and coal now ruling, and the gradual return of confidence new visible everywhere—these combined should lead to a revulsion of trade in the near future. There is every indication pointing to a possible 20 per cent increase of fuel to be consumed in 1895 over and above the quantity burned up this year, and there is no article which so forcibly betokens prosperity as an increased coal demand.

The following table of prices will show the monthly fluctuations of foreign coals for "spot" cargoes; the average price is given for each month:

Monthly prices for coal at San Francisco in 1894.

Kinds.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Australian (gas)	$6.25	$6.25	$6.25	$6.25	$6.25	$6.25	$6.25	$6.00	$5.62	$5.62	$5.50	$5.62
English steam	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.25	6.25	6.00	6.00
Scotch splint	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	6.62	6.62	6.00	6.12
West Hartley	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.50	7.25	7.25	6.75	6.75

The various sources from which we have derived our supplies are as follows:

Sources of coal consumed in California.

Sources.	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
British Columbia	441,759	652,657	554,600	588,527	647,110
Australia	194,725	321,197	314,280	202,017	211,733
English and Welsh	35,662	168,586	210,660	151,269	157,562
Scotch	1,610	31,840	24,900	18,809	18,636
Eastern (Cumberland and anthracite)	32,550	42,210	35,720	18,960	16,640
Franklin, Green River, and Cedar River	216,760	178,230	164,930	167,550	153,199
Carbon Hill and South Prairie	191,109	196,750	218,390	261,435	241,974
Mount Diablo and Coos Bay	74,210	90,684	66,150	63,460	65,263
Japan, etc	13,170	20,679	4,220	7,758	15,637
Total	1,204,555	1,702,833	1,593,850	1,479,785	1,527,754

To insure a correct statement of the entire amount consumed all the arrivals by water at San Pedro, Port Los Angeles, and San Diego, aggregating 208,036 tons, have been included.

The total imports of coke (all foreign) last year were 24,492 tons; in 1893, 29,645 tons.

OFFICIAL TESTS OF COAL MINED IN THE UNITED STATES.

Acting under instructions from the honorable the Secretary of the Navy, a number of analyses and tests of coal mined in the United States, and particularly of coal obtained from mines in the Southern States, have been made by officers of the United States Navy. The results of some of these tests are contained in Senate Executive Document No. 82, Fifty-third Congress, third session, and are reproduced below.

This document consists of the reply of the Secretary of the Navy to a Senate resolution, dated February 8, 1895, which was as follows:

Resolved, That the Secretary of the Navy be directed to communicate to the Senate all examinations and tests that have been made within twelve months past of coals taken from any coal mines in the United States, showing the constituents of such coals and their value for steaming purposes in vessels of the Navy and in stationary engines in the gun factories, armories, and yards under the control of the Department of the Navy; and any other information on this subject that will show the economic value of such coals for steaming purposes and the places at which they can be most advantageously shipped aboard the vessels employed in the naval and Coast Survey service, in the Atlantic Ocean, the Gulf of Mexico, the Caribbean Sea, and the Pacific Ocean.

Since the transmittal of the Secretary's reply to this resolution, some other tests have been made, the results of which have been furnished the Geological Survey for publication with this report. The results contained in the Senate document, with the dates of the tests, and, in some cases, analyses of the coal, are as follows:

Report of test of Black Diamond and Eureka coal made on steamer Walcott, Seattle, Wash., March 31, 1894.

	Black Diamond.	Eureka.
Knots per ton of coal	23.59	19.24
Knots per ton of coal at equalized speed and resistance	27.15	23.31
Coal, pounds per hour, main engine stopped	43.5	41.7
Percentage of refuse from coal consumed	9.7	33.7

The following tests were made of Blue Canyon and Fairhaven (State of Washington) coals under the boilers of the steam cutter attached to the U. S. S. *Yorktown*, at Seattle, Wash., April 18, 1894. The tests were made by a board of inquiry composed of C. J. Boush, lieutenant, United States Navy; J. M. Pickrell, past assistant engineer, United States Navy, and Albert Moritz, assistant engineer, United States Navy:

Report of test of Blue Canyon and Fairhaven coals, April 18, 1894.

Coals.	Where mined.	Cubic feet per ton.	Water per pound coal from 54° F.	Refuse.
			Pounds.	*Per cent.*
Blue Canyon	Whatcom County	46	4.18	18
Fairhaven	do	45	4.77	25

The Blue Canyon coal ignites readily, with heavy smoke, which thins out greatly when the coal is coked. It cakes slightly and cokes. There is no slack; the coal is free from dust and contains but a very small proportion of earthy ingredients. No traces of sulphur were observed. The fracture is very black, with little luster, and becomes duller when exposed to the atmosphere, assuming a slightly brownish color.

The Fairhaven coal comes in a mixture of very small lumps and slack, having an oily appearance. It looks as if it crumbled on exposure to the atmosphere. The lumps on being broken present a lustrous black surface. It ignites freely, with a dense black smoke at first, thinning out rapidly as the coal cokes. It has considerable evaporative efficiency after coking. No traces of sulphur were observed.

As far as could be determined, either of the above coals is as safe as the Comox, and show greater evaporative efficiency.

The following test of 12 tons of coal furnished by the Fairhaven Land Company, of Fairhaven, Wash., was made at Mare Island Navy-Yard and reported by George W. Melville, Engineer in Chief, United States Navy.

Report of test of 12 tons of coal delivered in navy-yard, Mare Island, by the Fairhaven Land Company, of Fairhaven, Wash.

Duration of test	hours..	24.5
Water evaporated, calculated from volume and temperature for each hour	pounds..	47,367.49
Coal consumed	do....	6,036
Coal consumed per hour	do....	251.5
Coal consumed per hour per square foot of grate	do....	11.178
Water evaporated per pound of coal	do....	6.853
Equivalent evaporation from and at 212° per pound of coal	do....	8.05
Refuse	per cent..	19.95
Steam pressure in pounds per gauge (average)		50.77
Temperature of—		
Atmosphere (average)		66.25
Fire room (average)		83.92
Feed water (average)		69.25
Uptake, tin and lead melted.		

Pocahontas coal.—The following tests were made of Pocahontas (Virginia and West Virginia) coal at the New York Navy-Yard May 2, 1894:

The coal breaks readily, with an irregular fracture, some portions showing a lustrous black surface, while others resemble slate in appearance. The coal when received was in bags and was practically all lumps. The coal burned freely, with a short yellow flame, when first ignited emitting a small quantity of light-brown smoke. It did not cake, and considerable small coal fell through the bars, most of which was returned to the fires. It required very little labor on the part of the firemen.

An insignificant amount of clinker was formed, and that of a friable nature. The deposit on tubes and front connections was small in amount and of a brown color. Pieces of tin, zinc, and antimony were inserted in the front ends of tubes in row next to top; the tin was partly fused, the zinc and antimony were not. The steam appeared to be dry.

Report of test of Pocahontas coal made at the New York Navy-Yard May 2, 1894.

Duration of test	hours..	24$\frac{5}{6}$
Water evaporated	pounds..	89,729.75
Coal consumed	do....	11,280
Coal consumed per hour per square foot of grate	do....	12.034
Water evaporated per pound of coal	do....	7.9548
Equivalent evaporation from and at 212°	do....	9.38
Refuse	per cent..	8.390
Steam pressure (average)		40.04
Barometer (average)		30.21
Temperature of—		
Atmosphere (average)		63.40
Fire room (average)		66.36
Feed water (average)		62
Uptake (average)		560

Report of test of sample A coal.

[Delivered at New York Navy-Yard by Schriver Steamer Line.]

Duration of test ....hours..	24.5
Water evaporated ....pounds..	80,909
Coal consumed ....do....	11,280
Coal consumed per hour per square foot of grate ....do....	12.116
Water evaporated per pound of coal ....do....	7.7047
Equivalent evaporation from and at 212° ....do....	9.02
Refuse ....per cent..	10.3258
Steam pressure (average)	39.96
Barometer (average)	29.90
Temperature of—	
Atmosphere (average)	75.20
Fire room (average)	87.40
Feed water (average)	70
Uptake (average)	583.2

Report of test of the contract coal, Georges Creek, Cumberland, Md., made at Washington Navy Yard, February 10 and 11, 1895.

Duration of test ....hours..	24.5
Coal burned ....pounds..	11,520
Water evaporated ....do....	71,574
Refuse from coal ....do....	1,697.5
Water evaporated per pound of coal (steam pressure, 39.16 pounds per gauge; temperature of feed water, 42) ....pounds..	6.213
Equivalent evaporation from and at 212° ....do....	7.4501
Ashes ....per cent..	14.735
Coal per square foot of grate per hour ....pounds..	12.373
Temperature of uptake, tin melted.	

Report of test of Standard Victor coal, made at the navy-yard, New York, January 29 and 30, 1895.

Duration of test ....hours..	24.5
Coal burned ....pounds..	11,040
Water evaporated ....do....	72,831
Refuse from coal ....do....	1,294.13
Water evaporated per pound of coal (steam pressure, 39.81 pounds per gauge; temperature of feed water, 40) ....pounds..	6.5971
Equivalent evaporation from and at 212° ....do....	7.9205
Ashes ....per cent..	11.722
Coal per square foot of grate per hour ....pounds..	11.86
Temperature of uptake, zinc melted.	

The following are the results of tests made on the U. S. S. *Montgomery*, cruising in the Gulf of Mexico, off Mobile, Ala.

Trial of Sloss Iron and Steel Company's (Birmingham, Ala.) coal by U. S. S. Montgomery.

[Quantity tested, 75 tons; date of test, beginning December 8, 1894.]

Boilers:
- Kind of boilers: 3 main (A, B, and D), double-ended; 2 auxiliary (C and E) single-ended; cylindrical return fire tubes.
- Total area of grate surface: 336.28 square feet
- Internal diameter of furnaces: 42 inches.
- Length of grates: A and B, 6.02; D, 6.31; C and E, 5.67.
- Grate surface in each furnace: A and B, 21.07 square feet; D, 22.08 square feet; C and E, 19.85 square feet.
- Number of tubes in each boiler: A, B, and D, 632; C and E, 316.
- Length of tubes: A and B, 6 feet 3¼ inches; D, 6 feet 7 inches; C and E, 5 feet 11¼ inches (between tube sheets).
- Diameter of tubes: 2¼ (external).
- Aggregate water-heating surface in each boiler: A and B, 2,734.79 square feet; D, 2,871.20 square feet; C and E, 1,318.65 square feet.
- Size of chimney (2 chimneys): 5 feet 8 inches (internal diameter).
- Height of chimney above grate bars: 60 feet.
- Water contained in each boiler (to steaming level 9 inches above tops of tubes): A and B, 21.67 tons; D, 22.95 tons; C and E, 11.47 tons.

Engines:
Number of main engines: 2.
Number of cylinders for each main engine: 3.
Diameter of cylinders of main engines: H. P., 26½ inches; I. P., 39 inches; L. P., 63 inches.
Stroke of main engines: 26 inches.

	First speed (135 revolutions).	Second speed (120 revolutions).	Third speed (100 revolutions).
Duration of trial	10.65 hours	11.35 hours	19 hours.
Area of grate surface used.	296.58 square feet.	296.58 square feet.	208.26 square feet.
Boilers used	A, B, D, and C	A, B, D, and C	A, B, and C.
Fuel consumed per hour.	5,258 pounds (or 2.35 tons).	4,934 pounds (or 2.2 tons).	2,947 pounds (or 1.3 tons).
Per cent of refuse	11.16 per cent	11.16 per cent	11.16 per cent.
Indicated H. P. of main engines:			
Taken from cords	2,361.66	1,529.12	1,185.89.
Mean number revolutions.	2,109.14	1,491.90	1,183.62
Estimated I. H. P. of auxiliaries in use.	62	62	62.
Fuel burned per H. P. per hour.	2.42 pounds	3.175 pounds	2.366 pound
Miles made per ton of coal.	6.452	6.584	8 604.
Speed	15.15 miles	14.5 miles	11.3 miles
Number of revolutions.	S., 130.1; P., 129.2; mean, 129.65.	S., 119.6; P., 118.3; mean, 118.95.	S., 99.92; P., 99.99; mean, 99.955.
Distance steamed	161.3 miles	164.6 miles	215.1 miles.
Character of smoke	Grayish black	Grayish black	Grayish black.
How often necessary to sweep tubes.	Every 36 hours	Every 36 hours	Every 36 hours.
Condition of ship's bottom.	Good	Good	Good.
How long out of dock	40 days	41 days	41 days.
Force and bearing of wind.	Force, 3 to 4; bearing, 0.66 points.	Force, 3 to 4; bearing, 12 to 8.	Force, 3 to 5; bearing, 15 to 4½.
Sails in use	None	None	None.
Condition of sea	Smooth	Smooth to heavy	Moderate, abeam.
Estimated effect of wind, sails, and condition of sea on speed.	None	None	None.

REMARKS.—Coal is easily stowed. It requires considerable working to make it burn efficiently, as it cakes soon after slicing, and makes a considerable quantity of clinker. Half of the fires would require cleaning every watch, and the tubes would require sweeping every 36 hours. The fires were very dirty in 8 hours from the time they were started. It forms a great quantity of smoke of a grayish-black color. A small quantity of the coal was tried in the forge, and was found to be good for blacksmithing purposes. A careful examination of the boilers has been made since the test, and no injurious effects have been discovered. We were unable to keep speed up to 135 revolutions after the first 3 hours, the fires being dirty. Boiler E, having had steam on it for two weeks preceding the trial, was not in proper condition for use.

The above coal, analyzed under the direction of Commander Theo. F. Jewell, U. S. Navy, superintendent Naval Gun Factory, Washington, D. C., Navy-Yard, shows the following composition:

Analysis of Sloss Iron and Steel Company coal.

Test No. 1:	Per cent.
Moisture	0.33
Nonvolatile combustible matter	2
Volatile combustible matter	24.197
Fixed carbon	70.311
Sulphur	.425
Ash	2.737
Total	100
Phosphorus	.013

Trial of Mingo Mountain Coal and Coke Company's (Middlesboro, Ky.) Mingo Mountain coal by U. S. S. Montgomery.

[Quantity tested, 75 tons; date of test, beginning January 3, 1895; boilers and engines, same as in the preceding test.]

	First speed (135 revolutions).	Second speed (120 revolutions).	Third speed (100 revolutions).
Duration of trial	7.8 hours	11.2 hours	18.5 hours.
Area of grate surface used.	296.58 square feet.	296.58 square feet	208.26 square feet.
Boilers used	A, B, C, and D	A, B, C, and D	A, B, and C.
Fuel consumed per hour	7,179 pounds (or 3.2 tons).	5,000 pounds (or 2.23 tons).	3,027 pounds (or 1.35 tons).
Per cent of refuse	6.01 per cent	6.01 per cent	6.01 per cent.
Indicated H. P. of main engines:			
Taken from cords	2357.42	1662.36	884.48.
Average revolutions	2371.87	1662.36	884.48.
Estimated I. H. P. of auxiliaries in use.	62	62	62.
Fuel burned per H. P. per hour.	2.95 pounds	2.90 pounds	3.20 pounds.
Miles made per ton of coal.	4.88	6.20	8.62.
Speed	15.61 miles	13.83 miles	11.7 miles.
Number of revolutions.	S., 135.07; P., 135.53; mean, 135.30.	S., 120; P., 120; mean, 120.	S., 100; P., 100.05; mean, 100.025.
Distance steamed	121.8 miles	154.9 miles	215.5 miles.
Character of smoke	Grayish-black	Grayish-black	Grayish-black.
How often necessary to sweep tubes.	Every 24 hours	Every 24 hours	Every 24 hours.
Condition of ship's bottom.	Good	Good	Good.
How long out of dock	65 days	66 days	66 days.
Force and bearing of wind.	Light air	Light breeze	Light breeze.
Sails in use	None	None	None.
Condition of sea	Smooth	Smooth	Smooth.
Estimated effect of wind, sails, and condition of sea on speed.	None	None	None.

REMARKS.—Main engines were indicated, coal and ashes carefully weighed, and great care exercised in obtaining all data required by the engine-room log. The coal is easily stowed. It required but little working to make it burn freely, and the specified number of revolutions were easily maintained. It made very little clinker, and that was easily removed. It makes great quantities of smoke of grayish-black color, and during the full-speed test flames issued from both smoke pipes continuously, heating the pipes and uptakes to a dangerous extent. The sparks fell in great quantities on deck, making it necessary to wet decks and boat covers to prevent them from burning. In the 120 and 100 revolution tests it made all the steam required without overheating pipes and uptakes, and neither flame or sparks came from pipes. The tubes would require sweeping every twenty-four hours. Upon examination of boilers they were found to be uninjured, but inner smoke pipes and the uptakes were warped so that two forward dampers could not be closed.

Analysis of Mingo coal from Mingo Mountain Coal and Coke Company, Middlesboro, Ky.

	Per cent.
Moisture	0.949
Noncombustible volatile matter	2.661
Combustible volatile matter	30.226
Fixed carbon	64.368
Sulphur	0.140
Ash	1.656
Total	100.000
Phosphorus	0.008

Trial of Tennessee Coal, Iron and Railroad Company, Birmingham, Ala., Pratt division, coal by U. S. S. Montgomery.

[Quantity tested, 73.46 tons; date of test, beginning December 18, 1894; boilers and engines same as in preceding tests.]

	First speed (135 revolutions).	Second speed (120 revolutions).	Third speed (100 revolutions).
Duration of trial	10.75 hours	12 hours	19.8 hours
Area of grate surface used.	296.58 square feet	296.58 square feet	208.26 square feet.
Boilers used	A, B, D, and C	A, B, D, and C	A, B, and C.
Fuel consumed per hour.	4,887 pounds (or 2.18 tons).	4,667 pounds (or 2.08 tons.	2,828 pounds (or 1.26 tons).
Per cent of refuse	9.46 per cent	9.46 per cent	9.46 per cent.
Indicated H. P. of main engines:			
Taken from cords	2,464.40	1,552.99	918.52.
Mean number revolutions.	2,318.82	1,522.99	936.55.
Estimated I. H. P. of auxiliaries in use.	62	62	62.
Fuel burned per H. P. per hour	2.05	2.89	2.83.
Miles made per ton of coal.	7.216	6.908	9.436.
Speed	15.56 miles	14.4 miles	12.02 miles.
Number of revolutions	S., 132.49; P., 132.43; mean, 132.46.	S., 120.01; P., 120; mean, 120.005.	S., 100.11; P., 100.62; mean, 100.065.
Distance steamed	169.3 miles	172.7 miles	235.9 miles.
Character of smoke	Grayish black	Grayish black	Grayish black.
How often necessary to sweep tubes.	Every 36 hours	Every 36 hours	Every 36 hours.
Conditon of ship's bottom	Good	Good	Good.
How long out of dock	50 days	51 days	51 days.
Force and bearing of wind.	Force, 3 to 2; bearing, 126° to 15½°.	Force, 2 to 4; bearing, 37° to 127°.	Force, 5 to 2; bearing, 107½° to 25½°.
Sails in use	None	None	None.
Condition of sea	Light swell	Light swell	Light swell
Estimated effect of wind, sails, and condition of sea on speed.	None	None	None.

REMARKS.—During trials main engines were indicated, and coal and ashes carefully weighed, and great care was exercised in obtaining all the data required by the engine-room log. We were unable to keep the speed up to 135 revolutions after the first four or five hours, the fires being dirty. It requires a moderate amount of working to make it burn efficiently; the amount of clinker was not excessive, but appeared to stick firmly to the grate bars and was difficult to remove; the tubes would require sweeping in 36 hours from the time the fires were started; it formed great quantities of smoke of grayish-black color. A small quantity of coal was tested by the blacksmith and found to be good for blacksmithing purposes. A careful examination of the boilers has been made since the tests and no injurious effects have been discovered. The test of the first speed was closed when only 23.46 tons had been consumed, due to a mistake made in summing up the total number of buckets of coal burned, toward the end of the test. The error was not detected until after the next test had begun. The coal is easily stowed.

This coal, analyzed at the Washington Navy-Yard under the direction of Commander Jewell, shows:

Analysis of Tennessee Coal, Iron and Railroad Company's "Pratt" coal.

Test No. 2:	Per cent.
Moisture	0.36
Nonvolatile combustible matter	1.74
Volatile combustible matter	25.773
Fixed carbon	68.351
Sulphur	.073
Ash	3.703
Total	100
Phosphorus	.079

Trial of Tennessee Coal, Iron and Railroad Company's (Birmingham, Ala.) "Cahaba" coal by U. S. S. Montgomery.

[Quantity tested, 75 tons; date of test, beginning January 11, 1895; boilers and engines same as in preceding tests.]

	First speed (135 revolutions).	Second speed (120 revolutions).	Third speed (100 revolutions).
Duration of trial	9.5 hours	12.2 hours	18.8 hours.
Area of grate surface used.	296.58 square feet	256.88 square feet	168.56 square feet for 11 hours; 208.26 square feet for 7.8 hours.
Boilers used	A, B, C, D	A, B, D	A and B; A, B, C.
Fuel consumed per hour	5,894.74 pounds	4,590.16 pounds	2,978.73 pounds.
Per cent of refuse	7 per cent	7 per cent	7 per cent.
Indicated H. P. of main engines:			
From cords	2,348.92	1,736.70	864.33.
Average revolutions	2,338.95	1,737.75	864.33.
Estimated I. H. P. of auxiliaries in use.	62	62	62.
Fuel burned per H. P. per hour.	2.445 pounds	2.550 pounds	3.107 pounds.
Miles made per ton of coal.	5.488	7.072	8.988.
Speed	14.44	14.45	11.96.
Number of revolutions	Average, 134.9	Average, 120.02	Average, 100.095.
Distance steamed	137.2	176.8	224.7.
Character of smoke	Dark gray	Dark gray	Dark gray.
How often necessary to sweep tubes.	Once in 48 hours	Once in 48 hours	Once in 48 hours.
Condition of ship's bottom.	Good	Good	Good.
How long out of dock	73 days	74 days	74 days.
Force and bearing of wind.	Force, 4 to 5; bearing, 33°.	Force, 4 to 5; bearing, 33°, 135°.	Force, 2 to 6; bearing, 120°, 55°.
Sails in use	None	None	None.
Condition of sea	Moderate	Moderate	Smooth and moderate.
Estimated effect of wind, sails, and condition of sea on speed.	0.5 knot	None	None.

REMARKS.—The engines were indicated during test. Coal and ashes carefully weighed in accordance with Department letter of November 10, 1894. Thirty tons of "Cahaba" coal were purchased for use before and after the trials. Three main and 1 auxiliary boiler were used in making first test, and there was no difficulty whatever in maintaining 135 revolutions. On its completion the fires in auxiliary boiler were allowed to die out, as the coal was making plenty of steam; also on the completion of the second test fires in boilers were allowed to die out. When third test was about half finished it was found difficult to keep steam up to the required pressure, and the fires were again started in auxiliary boiler, and the remainder of the test was run off with 2 main and 1 auxiliary boiler in use. The coal burns freely with very little working, but if it is necessary to force the fires on account of limited grate surface it burns poorly. It will not stand much working. The percentage of refuse is small; amount of clinker moderate, but adheres to the bars and is removed with difficulty. It forms a moderate amount of smoke of gray color. It is easily handled and stored. The tubes did not require sweeping during test and on arrival in port they were found to be only moderately dirty. Upon examination of the boilers no bad effects were discovered from its use.

This coal, analyzed as the preceding ones shows the following:

Analysis of Cahaba coal from the Tennessee Coal, Iron and Railroad Company.

	Per cent.
Moisture	1.320
Nonvolatile combustible matter	1.900
Volatile combustible matter	25.705
Fixed carbon	64.329
Sulphur	.051
Ash	6.695
Total	100
Phosphorus	.003

No. 5.—Trial of Mobile Coal Company's (Mobile, Ala.) "Milldale" coal by U. S. S. Montgomery.

[Quantity tested, $72\frac{1256}{2240}$ tons; date of test, beginning January 26, 1895; boilers and engines, same as in preceding tests.]

	First speed (135 revolutions).	Second speed (120 revolutions).	Third speed (100 revolutions).
Duration of trial	7.5 hours	12 hours	16.5 hours.
Area of grate surface used.	296.58 square feet	296.58 square feet	208.26 square feet.
Boilers used	A, B, C, D	A, B, C, D	A, B, C, D.
Fuel consumed per hour.	5,895 pounds	4,667 pounds	3,062.8 pounds.
Per cent of refuse	8.94	8.94	8.94.
Indicated H. P. of main engines.	2,199.17	1,744.34	927.46.
Estimated I. H. P. of auxiliaries in use.	62	62	62.
Fuel burned per H. P. per hour.	2.607 pounds	2.584 pounds	3.302 pounds.
Miles made per ton of coal.	5.934	6.536	8.644.
Speed	15.61 knots	13.6 knots	11.8 knots.
Number of revolutions	Average, 135.05	Average, 120.15	Average, 100.
Distance steamed	148.35 knots	163.4 knots	
Character of smoke	Grayish	Grayish	Grayish.
How often necessary to sweep tubes.	60 hours	60 hours	60 hours.
Condition of ship's bottom.	Slightly foul	Slightly foul	Slightly foul.
How long out of dock	88 days	89 days	89 days.
Force and bearing of wind.	Force 3 to 4; bearing, 120° to 140°.	Force 5 to 6; bearing, 11°.	Force, 4 to 6; bearing, 0 to 11° to 180°.
Sails in use	None	None	None.
Condition of sea	Moderate	Moderate	Moderate.
Estimated effect of wind, sails, and condition of sea on speed.	None	Loss, 1 mile per hour.	None.

REMARKS.—This coal is easily handled and stowed; it is mostly fine coal; the amount of lumps does not exceed 15 per cent in run of mine coal. It cokes readily when thrown on fires. Three main and 1 auxiliary boilers were used during the first two tests, viz, 135 revolutions and 120 revolutions, and 2 main and 1 auxiliary were used in the low-speed test. The coal burned freely with a moderate amount of working, and there was no difficulty in keeping up to the required number of revolutions; the amount of clinker is moderate and easily removed, and the percentage of refuse is not excessive. The fires did not require cleaning in the first twelve hours; after that, cleaning one-third of the fires each watch kept them in good steaming condition. It makes a moderate quantity of smoke of gray color; the tubes did not require sweeping during the tests and were only moderately dirty when the ships arrived in port. Upon examination of the boilers and accessories, they were found to be uninjured. The low-speed test was stopped on account of a heavy fog when 22.1256 tons of coal had been burned. The greatest diminution of speed in the tests indicate that the ship's bottom is becoming foul; the local conditions of the port warrant this assumption. The speed during the second test of this trial was greatly reduced by the wind and sea.

The above coal analyzed under the same auspices as the preceding ones gives the following composition:

Analysis of Milldale coal from Mobile Coal Company, Mobile, Ala.

	Per cent.
Moisture	0.080
Nonvolatile combustible matter	1.200
Volatile combustible matter	27.430
Fixed carbon	69.236
Sulphur	.284
Ash	1.770
Total	100.
Phosphorus	.007

Trial of "Pocahontas" (Norfolk, Va.) coal by U. S. S. Montgomery.

[Quantity tested, 50 tons; date of test, November 11 and 15, 1894; boilers and engines, same as in preceding tests.]

	Second speed (120 revolutions.)	Third speed.
Duration of trial	13⅓ hours	20.04 hours.
Area of grate surface used	256.88 square feet	168.56 square feet.
Boilers used	A, B, and D	A and B.
Fuel consumed per hour	4,200 pounds	2,730 pounds.
Per cent of refuse	8.31 per cent	7.19 per cent.
Indicated H. P. of main engines:		
From cord	1,448.31	867.77.
Average revolutions	1,305.15	890.78.
Estimated I. H. P. of auxiliaries in use	62	62.
Fuel burned per H. P. per hour	3.07	2.86.
Miles made per ton of coal	7,624	8,769.
Speed	14,265	10.94.
Number of revolutions	Average, 118.13	Average, 100,535.
Distance steamed	190.2	219.24.
Character of smoke	Grayish black	Grayish black.
How often necessary to sweep tubes	3 days	3 days.
Condition of ship's bottom	Good	Good.
How long out of dock	17 days	13 days.
Force and bearing of wind	Forced, 1 to 4; bearing, 22½° to 101¼°.	Force, 4 to 6; bearing, 39½° to 84⅓°.
Sails in use	None	None.
Condition of sea	Moderate	Moderate.
Estimated effect of wind, sails, and condition of sea on speed.	None	None.

REMARKS.—No data for first test of 135 revolutions. No injurious effects to boilers and appurtenances; a moderate amount of clinker. This data is taken from the Pocahontas coal, received on board at Norfolk, Va., November 1, 1894. Data for second speed test at 120 revolutions was taken from 10 p. m. November 15 to 11 a. m. November 16, 1894. Data for third speed test at 100 revolutions is taken from 4 p. m. November 10 to meridian November 11, 1894. Twenty-five tons were burned at each speed.

The following tests have been made subsequent to the transmittal of the letter of the Secretary of the Navy to the Senate, and are furnished by the chief of the Bureau of Equipment for publication in this report:

Trial of Corona coal, by U. S. S. Montgomery, Mobile Coal Company.

[Quantity tested, 75 tons; date of test beginning February 17, 1895; boilers and engines same as preceding tests.]

	First speed.	Second speed.	Third speed.
Duration of trial	7.5 hours	9.75 hours	14.75 hours.
Area of grate surface used	296.58 square feet.	296.58 square feet.	212.30 square feet.
Boilers used	A, B, C, and D	A, B, C, and D	A, C, and D.
Fuel consumed per hour	7,466.66 pounds	5,743.57 pounds	3,862.07 pounds.
Per cent of refuse	16.69	16.69	16.69.
Indicated H. P. of main engines.	2,113.90	1,689.09	971.80.
Estimated I. H. P. of auxiliaries.	62	62	62.
Fuel burned per H. P. per hour.	3.432 pounds	3.28 pounds	3.736 pounds.
Miles made per ton of coal	4.468	5.468	6.84.
Speed	14.9 knots	14 knots	11.79 knots.
Number of revolutions	S., 133.465; P., 133.955; mean, 133.71.	S., 120.08; P., 120.04; mean, 120.06.	S., 100.312; P., 100; mean, 100.156.
Distance steamed	111.7 knots	136.7 knots	171 knots.
Character of smoke	Grayish black	Grayish black	Grayish black.
How often necessary to sweep tubes.	Every 24 hours	Every 24 hours	Every 24 hours.
Condition of ship's bottom	Slightly foul	Slightly foul	Slightly foul.
How long out of dock	108 days	108 days	109 days.
Force and bearing of wind	Light, 50° to 150°	Light, 150° to 90°	Light, variable.
Sails in use	None	None	None.
Condition of sea	Smooth	Smooth	Smooth to moderate.
Estimated effect of wind, sails, and condition of sea on speed.	No effect	No effect	No effect.

REMARKS.—The Corona coal can be readily handled and stowed in bunkers. As furnished for test it consisted of about 80 per cent lump and 20 per cent fine coal. Three main and 1 auxiliary boilers were in use during first and second test, and 2 main and 1 auxiliary boilers during third or low speed test. During first test it was impossible to make the required number of revolutions after first 5 hours, the fire being very dirty. This coal would not make sufficient steam without working, and when worked formed great quantities of clinker, which was readily removed. It was necessary to commence cleaning fires 4 hours after test began, and one-half of the fires had to be cleaned each watch thereafter. The percentage of refuse is large. It makes a great quantity of smoke of dark gray color, and the tubes were nearly closed at end of test. On arrival in port, the boilers were opened and examined and were found to be uninjured from the use of this coal. Three blades of port and one blade of starboard propellers were bent before this test by coming in contact with sunken trees in river and bay. The ship's bottom is slightly foul.

Draft at beginning of trial, forward, 13 feet 10 inches; aft, 16 feet 2 inches. Draft at end of trial, forward, 12 feet 6 inches; aft, 16 feet 2 inches.

Commander Jewell's report on the analysis of the above coal shows:

Analysis of Corona Alabama coal.

	Per cent.
Moisture	0.72
Nonvolatile combustible matter	0.32
Volatile combustible matter	30.93
Fixed carbon	59.17
Sulphur	0.77
Ash	6.09
Total	100.00
Phosphorus	0.011

Trial of Jellico coal by U. S. S. Montgomery.

[Quantity tested, 66 tons; date of test, beginning February 3, 1895; boilers and engines, same as preceding tests.]

	First speed.	Second speed.	Third speed.
Duration of trial	8.5 hours	9.25 hours	15.05 hours.
Area of grate surface used	296.58 square feet.	256.88 square feet.	168.56 square feet.
Boilers used	A, B, C, and D	A, B, and D	A and B.
Fuel consumed per hour	5,797.65 pounds	5,054.36 pounds	3,277.34 pounds.
Per cent of refuse	5.7	5.7	5.7.
Indicated H. P. of main engines.	2,249.60	1,488.38	928.35.
Estimated I. H. P. of auxiliaries in use.	62	62	62.
Fuel burned per H. P. per hour.	2.508 pounds	3.217 pounds	3.309 pounds.
Miles made per ton of coal	5.879	5.909	8.077.
Speed	15.21 knots	14.05 knots	11.8 knots.
Number of revolutions	S., 135.17; P., 135; average, 135.085	S., 119.955; P., 119.98; average, 119.967.	S., 100.05; P., 100.04; average, 100.027.
Distance steamed	129.3 knots	130 knots	177.7 knots.
Character of smoke	Grayish black	Grayish black	Grayish black.
How often necessary to sweep tubes.	Once in 60 hours	Once in 60 hours	Once in 60 hours.
Condition of ship's bottom	Slightly foul	Slightly foul	Slightly foul.
How long out of dock	94 days	95 days	95 days.
Force and bearing of wind	Light	Light	Light.
Sails in use	None	None	None.
Condition of sea	Smooth	Smooth	Smooth.
Estimated effect of wind, sails, and condition of sea on speed.	None	None	None.

REMARKS.—The Jellico Coal Company furnished 75 short tons of coal, making but 67 long tons; therefore 22 tons were burned in making each test, instead of 25 tons, as directed by the Department's orders. The coal burned very freely, making very little clinker and a small amount of refuse. It required little or no working to keep the steam at a pressure that would produce the required number of revolutions. Three main and 1 auxiliary boilers were used in first test. Three main boilers in second test, and 2 main boilers in third test. It makes a considerable quantity of smoke of grayish-black color. The tubes did not require sweeping during the tests, and were in a fair condition when the ship arrived in port. It can be readily handled and stowed in the bunkers. On arrival in port the ship's diver examined the propellers and reports that all three blades of port and one blade of starboard propellers are bent, caused by coming in contact with sunken logs or trees in the river. Upon examining boilers we have not discovered any bad effects from the use of this coal.

Draft at beginning of trial, forward, 13 feet 9 inches; aft, 16 feet 2 inches. Draft at end of trial, forward, 12 feet 6 inches; aft, 15 feet 11 inches.

Trial of Virginia and Alabama coal by U. S. S. Montgomery.

[Quantity tested, 75 tons; date of test, April 11 to 13, 1895; boilers and engines same as preceding tests.]

Trial.	First speed.	Second speed.	Third speed.
Duration of trial	$7\frac{45}{60}$ hours	9 hours	15 hours.
Area of grate surface used	296.58 square feet	296.58 square feet	168.56 square feet.
Boilers used	A, B, C, and D	A, B, C, and D	A and B.
Fuel consumed per hour	7,225.80 pounds	6,222.22 pounds	3,733.33 pounds.
Per cent of refuse	10.02	10.02	10.02.
Indicated H. P. of main engines.	1,948.30	1,366.42	962.32.
Estimated I. H. P. of auxiliaries in use.	62	62	62.
Fuel burned per H. P. per hour.	3.594 pounds	4.356 pounds	3.645 pounds.
Miles made per ton of coal	4.94	5.06	7.124 knots.
Speed	15.9 knots	14.05 knots	11.87 knots.
Number of revolutions	Average, 130.6	S., 120; P., 120: average, 120.	S., 100; P., 100; average, 100.
Distance steamed	123.5 miles	126.5 miles	178.1 miles.
Character of smoke	Dark gray	Dark gray	Dark gray.
How often necessary to sweep tubes.	Once in 60 hours	Once in 60 hours	Once in 60 hours.
Condition of ship's bottom	Slightly foul	Slightly foul	Slightly foul.
How long out of dock	162 days	163 days	163 days.
Force and bearing of wind	1 to 2, 15½° to 117½°	2 to 4, 29° to 117°	1 to 4, 5½° to 107½°.
Sails in use	None	None	None.
Condition of sea	Smooth	Smooth and moderate.	Smooth and moderate.
Estimated effect of wind, sails, and condition of sea on speed.	None	None	None.

REMARKS.—The Virginia and Alabama coal can be readily handled and stowed in bunkers. As furnished for test it contained about 60 per cent of lumps. Three main and 1 auxiliary boilers were used during the high speed test, and it was impossible to maintain the required number of revolutions. The fires were very dirty after running four hours. By keeping 3 main and 1 auxiliary boilers on during the second test, firing lightly on the auxiliary boiler and cleaning most of the fires each watch, we were able to keep the engines up to the required speed. In order to use this coal efficiently, half the fires would require cleaning each watch. It formed considerable chinker and a large volume of smoke of dark-gray color. The tubes were not swept during the tests; they were moderately dirty when the ship arrived in port. The amount of refuse exceeded 10 per cent. Upon examining the boilers, no bad effects were discovered from the use of this coal.

Draft at beginning of trial, forward, 13 feet 8 inches; aft, 16 feet 8 inches. Draft at end of trial, forward, 12 feet 6 inches; aft, 16 feet 9 inches.

The above coal as analyzed at the Washington Navy-Yard has the following composition:

Analysis of coal from the Virginia and Alabama Coal Company.

	Per cent.
Moisture	1.18
Nonvolatile combustible matter	2.80
Volatile combustible matter	31.22
Fixed carbon	55.75
Sulphur	2.40
Ash	6.65
Total	100
Phosphorus	.034

Trial of Pearson "Warrior" coal by U. S. S. Montgomery.

[Quantity tested, 75 tons; date of test, beginning April 4, 1895; boilers and engines same as preceding tests.]

	First speed.	Second speed.	Third speed.
Duration of trial	9 hours 2 minutes.	11 hours 58 minutes.	15 hours 20 minutes.
Area of grate surface used	296.58 square feet.	256.88 square feet.	172.60 square feet.
Boilers used	A, B, C, and D	A, B, and D	A and D.
Fuel consumed per hour	6,222.22 pounds	4,666.66 pounds	3,733.33 pounds.
Per cent of refuse	9.36	9.36	9.36.
Indicated H. P. of main engines.	2,267.10	1,800.75	933.32.
Estimated I. H. P. of auxiliaries in use.	62	62	62.
Fuel burned per H. P. per hour.	2.676 pounds	2.505 pounds	3.735 pounds.
Miles made per ton of coal	5.64	6.52	7.268.
Speed	15.32	14.5	11.09.
Number of revolutions	S. 135; P. 135; average, 135	S. 120; P. 120; average, 120.	S. 100; P. 100; average, 100.
Distance steamed	141 knots	163 knots	181.7 knots.
Character of smoke	Dark gray	Dark gray	Dark gray.
How often necessary to sweep tubes.	Once in 60 hours	Once in 60 hours	Once in 60 hours.
Condition of ship's bottom	Slightly foul	Slightly foul	Slightly foul.
How long out of dock	155 days	155 days	156 days.
Force and bearing of wind	22½° to 75°, 2	45° to 68°, 3	46½° to 149°, 4.
Sails in use	None	None	None.
Condition of sea	Smooth	Smooth to moderate.	Moderate to smooth.
Estimated effect of wind, sails, and condition of sea on speed.	None	None	None.

REMARKS.—The Pearson "Warrior" coal is mostly fine coal; it does not contain more than 15 per cent of lump. During the first test 3 main and 1 auxiliary boilers were used; second test, 3 main boilers, and third test, 2 main boilers. The coal burned freely with a moderate amount of working and there was no difficulty in keeping the engines up to the required number of revolutions. The amount of clinker was moderate and easily removed. The percentage of refuse was not excessive. There was only a moderate quantity of smoke, dark gray in color. This coal can be readily handled and stored in bunkers. The tubes did not require sweeping during the test and were not very dirty when the ship arrived in port. Upon examination the boilers and accessories were found to be uninjured by the use of the coal.

Draft at beginning of trial, forward, 13 feet 8 inches; aft, 16 feet 8 inches. Draft at end of trial, forward, 12 feet 6 inches; aft, 16 feet 6 inches.

This coal analyzed at the Washington Navy-Yard, under Commander Jewell, shows:

Anaylsis of Pearson "Warrior" coal, Mobile Coal Company, Mobile, Ala.

	Per cent.
Moisture	0.51
Nonvolatile combustible matter	1.84
Volatile combustible matter	23.95
Fixed carbon	72.030
Sulphur	.399
Ash	1.261
Total	100
Phosphorus	.007

The Secretary of the Navy, in his letter, writes:

The points at which vessels can coal most advantageously in the Atlantic Ocean, the Gulf of Mexico, the Caribbean Sea, and the Pacific Ocean are as follows: The Atlantic Ocean: Norfolk and adjacent waters, Port Royal. Gulf of Mexico: Key West, New Orleans, Pensacola, and Mobile (the two last named are limited to vessels of about 21 and 19 feet, respectively). The Caribbean Sea: St. Lucia, St. Thomas, and Cartagena. Pacific Ocean: San Francisco, the ports of Vancouver Island and Puget Sound, Honolulu (for the mid-Pacific Ocean), the Australian and

New Zealand coal ports (where the native supply is abundant and not dear), Nagasaki in Japan, Talcahuano, Chile. Of these, the coal at San Francisco and Honolulu is shipped from points considerably distant, and the prices are a good deal above those at the other points named; they are still, however, very much lower than at many other ports in the Pacific.

PRODUCTION OF COAL, BY STATES.

ALABAMA.

Total product in 1894, 4,397,178 short tons; spot value, $4,085,535.

COAL FIELDS OF ALABAMA.

The great Appalachian coal field, which follows that mountain system and derives its name from it, finds its southern terminus in Alabama. The Alabama fields have been fully described by Prof. Eugene A. Smith, of the University of Alabama, in Mineral Resources, 1892 and need only be briefly mentioned here. Locally they are divided into three regions, named many years ago by Professor Tuomey, from the rivers which drain them, the Cahaba, the Coosa, and the Warrior. The coal field occupies a large part of the northern half of the State. It enters at the northeast corner, extends southeasterly, the eastern or southeastern border reaching to the western central portion of the State near Tuscaloosa. From there its border line extends in a northwesterly direction until it nearly touches the Mississippi State line, thence runs nearly due east about half way across the State, and then northeasterly to the Tennessee State line. The Warrior region is by far the largest, containing 7,810 of the 8,660 square miles underlaid by coal measures. Included in this is the Lookout Mountain region, which runs in a narrow belt from the Georgia line, parallel to the Warrior field proper, and separated from it by a valley drained by branches of the Coosa River at its southern end, and of the Tennessee River at the north.

The Cahaba and Coosa fields, containing 435 and 415 square miles, respectively, extend in nearly parallel, narrow belts along the southeastern border of the Warrior, and are separated from it by the valley in which the city of Birmingham is located, and from each other by the valley of the Cahaba River. Because of the demand created by the war, coal was mined in Alabama during its existence, but the first product of which there is any record from the Alabama fields was obtained in 1870, when 13,200 tons were mined. In 1882, the year covered by the first volume of Mineral Resources, the output was 896,000 short tons. The maximum product in any one year was in 1892, when it reached the remarkable total of 5,529,312 tons, an increase in eleven years of 4,633,312, or 5,171 per cent. The output in 1892 was more than 60 times that of 1882. In 1894 the product had fallen, as a result of hard times and the great strike, to 4,397,178 tons, but even this shows an output nearly 50 times that of 1882, the first year recorded in this series.

DEVELOPMENT OF ALABAMA COAL MINES.

The pioneers in the development of Alabama coal lands after the close of the war were not rewarded with success. The value of the coal had been demonstrated, and those who undertook to work the mines which had supplied the Confederate government with coal, and to open new prospects, looked naturally to a remunerative business. In this they were disappointed. The country was still paralyzed from the effects of the war, and there were no manufacturing industries to encourage the development of the natural resources. They had the goods but no market. Ten years after the close of the war the coal fields of Alabama, which are now yielding from 4,000,000 to 5,000,000 tons annually, did not reach a yearly product of 100,000 tons. From 1876 the industrial development of Birmingham and vicinity began, and coal mining was put on a remunerative basis. In 1883 the product exceeded 1,500,000 tons, the intervening years showing a steadily increasing output. The output in 1884 is given at 2,240,000 short tons, and in 1885 at 2,492,000 short tons. There is little doubt but that these figures are considerably in excess of the actual output. Dr. Ashburner, in his report for 1886, says that they were estimates based on information from various sources, the information being chiefly estimates of other persons.

No satisfactory reason is given for the remarkable increase of nearly 50 per cent in 1884 over that of 1883, nor for the 600,000 tons decrease in 1886 from 1885. More than this, Dr. Ashburner states that the statement for 1886 was compiled from direct returns of producers to the Geological Survey, the Survey being assisted in the work by Professor Smith, State geologist. Since 1886 the annual increase in product up to 1892 is reasonable, and the natural result of industrial activity. In 1888, the year of the great boom at Birmingham, new mines were opened and the capacity of the old ones was increased, so that the product increased in that year nearly 1,000,000 tons, or about 50 per cent over 1887. Although the boom itself collapsed, as most booms will, there were established at Birmingham, Bessemer, and neighboring cities iron and steel and other manufacturing industries, which, encouraged as they are by favorable conditions for cheap production, are permanent. This is shown by the continued increase in the annual production of coal up to 1892 (see table, page 75), by the increase in the production of iron ore from 675,000 long tons in 1887 to 1,742,410 long tons in 1892, by an increase in the manufacture of pig iron in the same period from 292,762 short tons to 1,025,132 short tons, and by a similar progress in other industries. The decreased product in 1893 and 1894 was not due to local disturbance, but to general trade depression throughout the United States, and to the prolonged strike of the latter year, which is treated elsewhere.

The improvements on the Warrior River, conducted by the United States Government, and consisting of a series of dams for slack-water navigation, are expected to do much toward extending the use of Alabama coal. One of the dams (of which there are to be five) is finished and two more are nearing completion, and it is expected that they will be ready for use by September 1. When this means of transportation has been accomplished, it is claimed that coal can be freighted from the Warrior field to Mobile for 50 cents per ton. It is stated that similar improvements will be made on the Coosa River, which will afford water transportation to the Coosa fields.

PRODUCTION.

In 1893 the amount of coal produced in Alabama was 5,136,935 short tons, having a spot value of $5,096,792. The output in 1894 therefore shows a decrease of 739,757 short tons, or 14.4 per cent. In value the decrease was nearly 20 per cent, or $1,011,257. The decrease in product was due to the general strike inaugurated by the United Mine Workers in April, and which continued in force until July in some cases, and in others was prolonged until August. The scarcity of coal occasioned by the strike had the effect for awhile of advancing the market price, but this was not sufficient to offset the prevalent decline in values, and an average reduction in price of 6 cents per ton, or from 99 cents in 1893 to 93 cents in 1894, is shown.

There were some mines not affected by the strike, and in others, where convict labor is employed, the convicts continued to work while the free labor was out. And it must be stated here that in Alabama, as in Kentucky, Tennessee, Maryland, and West Virginia, the strike was, in many instances, not due to any special grievance of the miners in those States, but was a "sympathetic" one, the men being called out by their leaders in order to give strength and encouragement to those who went out "for cause." In many cases some of the men were not only willing, but anxious, to continue their work, but were persuaded, or, worse, intimidated, by others into compliance with the labor leaders' orders. Some of the operating companies have reported to this office the extent to which the strike was carried at their mines, and this information is given below as being of interest:

In Bibb County the Blocton mine of the Tennessee Coal, Iron and Railroad Company, employing nearly 1,100 men, was closed on April 14 and resumed August 17. At the Blue Creek mines, in Jefferson County, operated by the same company, and employing 1,350 men, the strike lasted the same time. At Pratt mines, Jefferson County, owned by same company, 1,500 free miners were on strike, while 1,150 convicts continued to work. At Warrior, in Jefferson County, 50 miners employed by the Watts Coal and Iron Company were on strike from April until July. Two hundred miners at the Gurnee mines of the Tennessee Coal, Iron and Railroad Company, in Shelby County, were out from April 14 to August 17. A three days' strike took place at the Walter Smith mine in Tuscaloosa County. In Walker County the miners employed by the Corona Coal and Coke Company, 350 in number, were on strike from April 20 to July 1. The American Coal Company and the Carbon Hill and Lost Creek Coal Company, employing 114 and 28 men, respectively, were shut down by the strike during May, June, and July. These do not represent all the miners that were on strike, but they are all that have been reported to this office.

Decreased production is observed in all of the three principal counties, Bibb, Jefferson, and Walker. In Bibb County the decrease was over 50 per cent; from 806,214 tons in 1893 to 401,061 tons in 1894. The decrease in Jefferson County exceeded 300,000 tons. In Walker County the decrease was comparatively small, being 35,396 tons from a total production in 1893 of 927,349 tons.

The details of production by counties in 1893 and 1894 may be seen in the following tables:

Coal product of Alabama in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Bibb	688, 846	1, 783	27, 744	87, 841	806, 214	$802, 487	$1.00	216	1, 280
Jefferson	1, 818, 313	28, 391	44, 922	1, 201, 651	3, 093, 277	3, 012, 268	.98	258	7, 033
De Kalb	40	....	....	....	40	40	1.00	20	2
St. Clair	60, 300	1, 200	3, 500	7, 000	72, 000	76, 600	1.06	198	135
Shelby	53, 339	....	2, 000	....	55, 339	101, 028	1.82½	200	255
Tuscaloosa	106, 449	7, 644	2, 260	51, 163	167, 516	175, 997	1.05	247	412
Walker	806, 448	8, 581	15, 986	96, 334	927, 349	907, 172	.98	187	2, 158
Winston	3, 200	....	....	....	3, 200	3, 200	1.00	165	19
Small mines	....	12, 000	....	....	12, 000	18, 000	1.50	....	....
Total	3, 536, 935	59, 599	96, 412	1, 443, 989	5, 136, 935	5, 096, 792	.99	237	11, 294

Coal product of Alabama in 1894, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Bibb	379, 488	4, 250	15, 190	2, 133	401, 061	$401, 061	$1.00	204	1, 089
Blount	....	6, 000	....	2, 000	8, 000	8, 000	1.00	75	45
Jackson	....	6, 011	....	....	6, 011	15, 028	2.50	257	6
Jefferson	1, 805, 269	11, 744	82, 959	866, 330	2, 766, 302	2, 477, 795	.90	272	6, 567
St. Clair	34, 167	950	5, 200	3, 200	43, 517	42, 135	.96	225	98
Shelby	72, 904	350	3, 365	....	76, 619	110, 600	1.44	114	405
Tuscaloosa	129, 999	1, 400	6, 720	52, 962	191, 081	201, 754	1.06	261	363
Walker	843, 227	5, 066	16, 970	26, 690	891, 953	812, 528	.91	180	2, 252
Winston	4, 494	140	....	....	4, 634	4, 634	1.00	140	34
Small mines	....	8, 000	....	....	8, 000	12, 000	....	....	....
Total	3, 269, 548	43, 911	130, 404	953, 315	4, 397, 178	4, 085, 535	.93	238	10, 859

The following table shows the annual output of coal in the State since 1870, with the exception of 1871 and 1872, for which no statistics were obtained:

Annual coal product of Alabama since 1870.

Years.	Short tons.	Value.	Average price per ton.	Average number of days worked.	Number of employees.
1870	13, 200				
1873	44, 800				
1874	50, 400				
1875	67, 200				
1876	112, 000				
1877	196, 000				
1878	224, 000				
1879	280, 000				
1880	380, 800				
1881	420, 000				
1882	896, 000				
1883	1, 568, 000				
1884	2, 240, 000				
1885	2, 492, 000				
1886	1, 800, 000	$2, 574, 000	$1.43		
1887	1, 950, 000	2, 535, 000	1.30		
1888	2, 900, 000	3, 335, 000	1.15		
1889	3, 572, 983	3, 961, 491	1.10	248	6, 975
1890	4, 090, 469	4, 202, 469	1.03	217	10, 642
1891	4, 759, 781	5, 087, 596	1.07	268	9, 302
1892	5, 529, 312	5, 788, 898	1.05	271	10, 075
1893	5, 136, 935	5, 096, 792	.99	237	11, 294
1894	4, 397, 178	4, 085, 535	.93	238	10, 859

It will be seen from the above table that the product in 1894 is the smallest since 1890, and the total value less than in any year since 1889. The average price obtained in 1894 was the lowest in the history of coal mining in the State.

In the following table is shown the coal product in Alabama, by counties, for a period of six years, with the increase or decrease in each county during 1894 as compared with 1893.

Coal product of Alabama, by counties, since 1889.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.	Increase.	Decrease.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*		
Bibb	500, 525	221, 811	619, 809	793, 469	806, 214	401, 061		405, 153
Blount						8, 000	8, 000	
De Kalb					40			40
Jackson						6, 011	6, 011	
Jefferson	2, 437, 446	2, 665, 060	2, 905, 343	3, 399, 274	3, 093, 277	2, 766, 302		326, 975
St. Clair	40, 557	33, 653	66, 096	24, 950	72, 000	43, 517		28, 483
Shelby	84, 333	25, 022	34, 130	27, 968	55, 339	76, 619	21, 280	
Tuscaloosa	16, 141	65, 517	142, 184	168, 039	167, 516	191, 081	23, 565	
Walker	488, 226	767, 346	980, 219	1, 103, 612	927, 349	891, 953		35, 396
Winston					3, 200	4, 634	1, 434	
Small mines	5, 255	12, 000	12, 000	12, 000	12, 000	8, 000		4, 000
Total	3, 572, 983	4, 090, 409	4, 759, 781	5, 529, 312	5, 136, 935	4, 397, 178		*a* 739, 757

a Net decrease.

Previous to 1889 the statistics of coal production in Alabama did not show the value by counties nor the average prices. It is, however, interesting to note the almost uniform decline in values in every county since that year, as is shown in the following table. The seemingly increased price in Shelby County in 1890, 1891, and 1892 was due to the fact that one of the largest mines was shut down during those years. Its resumption in 1893 brought down the average price to some extent, and the increased production in 1894 caused a further decline.

Average prices for Alabama coal at the mines since 1889, by counties.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Bibb	$1.20	$1.10	$1.17	$1.08	$1.00	$1.00
Jefferson	1.07	1.00	1.04	1.03	.98	.90
St. Clair	1.25	1.18	1.14	1.10	1.06	.96
Shelby	1.79	2.50	2.60	2.61	1.82½	1.44
Tuscaloosa	1.23	1.05	1.03	1.07	1.05	1.06
Walker	1.04	1.00	1.03	1.02	.98	.91
General average	1.10	1.03	1.07	1.05	.99	.93

In the above table only those counties are considered whose annual product exceeds 10,000 tons. Instead of discussing each county by itself, the foregoing tables have been given as showing in compact form the essential matters of interest in regard to the product and value for a series of years. Similarly the following table shows the statistics of the number of men employed and the average working time in counties producing more than 10,000 tons in each year. The general averages, including all counties, are shown in the table on page 74.

Statistics of labor employed and working time at Alabama coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.
Bibb	250	1,340	243	1,175	290	1,500	216	1,280	204	1,089
Jefferson	267	6,209	274	5,405	289	5,860	258	7,033	272	6,567
St. Clair	250	1,340	242	180	200	75	198	135	225	98
Shelby	200	150	265	200	225	150	200	255	114	405
Tuscaloosa	157	268	287	298	261	281	247	412	261	363
Walker	210	1,500	219	2,044	217	2,209	187	2,158	180	2,252
The State.	217	10,642	268	9,302	271	10,075	237	11,294	238	10,859

ARKANSAS.

Total product in 1894, 512,626 short tons; spot value, $631.988.

COALS AND COAL FIELDS OF ARKANSAS.

The coal fields of Arkansas are an extension eastward of the Indian Territory areas, which are in turn the southern extension of the great western field. Although the Territory areas have not been definitely outlined, the known outcrops at various places north of developed fields at McAlester, Hartshorne, etc., indicate direct connection with the fields of Kansas and Missouri. The Arkansas Coal Measures containing workable beds are all within the area drained by the Arkansas, and contain, so far as known, 1,620 square miles. The full extent of the Coal Measures, however, is 14,700 square miles, while the total Carboniferous formation covers 19,260 square miles. The Arkansas coals are of great variety, ranging from lignite to semianthracite. The commercial product is divided into bituminous and semianthracite, and these are so adapted for different purposes that careful discrimination in their use is necessary. The semianthracites burn more slowly than the bituminous, have a much shorter flame, and give off very little smoke. They ignite much more readily than true anthracite coals, are softer, and have the cuboidal fracture of bituminous coals. These coals are preferred for domestic purposes, and are not good steam raisers. The bituminous coals burn more rapidly, with a long flame, some with intense heat. They do not coke, and in their use care should be taken to use grates with small spaces between the bars, as otherwise a considerable quantity of unconsumed fuel is lost. The lignites are of little commercial importance, owing to the cheapness of the superior coals.

It is within the period covered by this series that the coal fields of Arkansas have been developed on a commercial scale. There had been some mining done in the State as early as 1870, but not until 1883 did the operations assume any proportions. In that year the product was estimated at 50,000 short tons, and an annual increase of 25,000 tons is shown in the three following years, bringing the product in 1886 up to 125,000 short tons. There were no reliable statistics collected in those years. The business had not settled down to a regularly organized industry, and the estimates were based on the best information available. The first authentic statistics were collected by the survey in 1888, covering the production in the preceding year, when 129,600 tons were obtained. About this time the St. Louis and San Francisco Railroad extension from Fort Smith was completed into the field, and in the following year (1888) the output more than doubled, and had, with one exception (1892), increased annually up to the close of 1893, when it reached 574,763 short tons, more than eleven times the product in 1883.

PRODUCTION.

In 1894 the coal product of Arkansas was 512,626 short tons, a decrease as compared with 1893 of 62,137 short tons, or a little more than 10 per cent. The value decreased from $773,347 in 1893 to $631,988, a loss of $141,359, or about 18 per cent. Most of the mines were shut down for from two to three months by the strike, which in Arkansas was a "sympathetic" one, and this accounts for the decreased production. The effects of the "hard times" are shown even more clearly in the decline in value, the average price for the State falling from $1.34 to $1.22. The year 1893, however, happened to be an unusually remunerative one for the Arkansas mines, due chiefly to an increased demand, which was caused by the closing down of many Kansas mines by a strike from May until September. This naturally opened up a new market for Arkansas coal, and while the output was not increased materially over that of 1892, the value shows a decided advance.

In the tables below the statistics of coal production in Arkansas in 1893 and 1894 are shown, together with the distribution of the product for consumption:

Coal product of Arkansas in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	Total. number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Franklin	9, 629	250		9, 879	$11, 269	$1. 14	77	70
Johnson	90, 702	4, 531	2, 500	97, 733	191, 799	1. 96	114	372
Pope	10, 000	250	2, 000	12, 250	45, 000	3. 67	225	70
Sebastian	439, 173	747	8, 981	448, 901	513, 279	1. 14	164	1, 047
Small mines		6, 000		6, 000	12, 000	2. 00		
Total	549, 504	11, 778	13, 481	574, 763	773, 347	1. 34	151	1, 559

Coal product of Arkansas in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total amount produced.	Total value.	Average price per ton.	Average number of days active	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Franklin / Johnson	3	143, 618	610	3, 500	147, 728	$172, 357	$1. 17	192	372
Pope	2	16, 363	300	1, 125	17, 788	52, 289	2. 94	229	62
Sebastian	8	328, 096	960	12, 054	341, 110	395, 342	1. 16	108	1, 059
Small mines			6, 000		6, 000	12, 000			
Total	13	488, 077	7, 870	16, 679	512, 626	631, 988	1. 22	134	1, 493

According to the Tenth Census of the United States (1880) the coal output of Arkansas was 14,778 short tons, worth at the mines $33,535. No statistics were obtained in 1881. Since 1882 the statistics of production, as far as have been ascertained, have been as follows:

Annual production of coal in Arkansas since 1882.

Years.	Short tons.	Value.	Average price per ton.	Average number of days worked.	Total number of employees.
1882	5, 000				
1883	50, 000				
1884	75, 000				
1885	100, 000				
1886	125, 000	$200, 000	$1. 60		
1887	129, 600	194, 400	1. 50		
1888	276, 871	415, 306	1. 50		978
1889	279, 584	395, 836	1. 42		677
1890	399, 888	514, 595	1. 29	214	938
1891	542, 379	647, 560	1. 19	214	1, 317
1892	535, 558	666, 230	1. 24	199	1, 128
1893	574, 763	773, 347	1. 34	151	1, 559
1894	512, 626	631, 988	1. 22	134	1, 493

In the following table is shown the annual product since 1887, by counties:

Coal product of Arkansas since 1887 by counties.

Counties.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
	Short tons	*Short tons*	*Short tons*	*Short tons*	*Short tons*	*Short tons*	*Short tons*	*Short tons*
Franklin	....	....	....	....	....	....	9,879	} 147,728
Johnson	81,900	106,037	105,998	89,000	80,000	91,960	97,733	
Pope	8,200	10,240	6,014	4,000	5,000	17,500	12,250	17,788
Sebastian	39,500	160,594	165,884	300,888	451,379	420,098	448,901	341,110
Small mines	....	....	*a* 1.688	6,000	6,000	6,000	6,000	6,000
Total	129,600	276,871	279,584	399,888	542.379	535.558	574,763	512,626

a Product of Franklin County according to Eleventh Census.

From the above it will be seen that while the combined product of Franklin and Johnson counties shows an increase of approximately 40 per cent, and that of Pope County, though it is a comparatively unimportant coal producer, also shows an increase, there is a decrease in Sebastian County of 107,791 tons, nearly 25 per cent of its product in 1893. The loss in Sebastian County in 1894 was more than the combined product of Franklin and Johnson counties in 1893.

CALIFORNIA.

Total product in 1894, 67,247 short tons; spot value, $155,620. The decreasing tendency of coal production in California, noted in the preceding volume of Mineral Resources, continued in 1894. The largest product in any one year was obtained in 1889, when it reached 121,820 short tons. In only one other year did it exceed 100,000 tons. This was in 1890. In 1886 the product was estimated at 100,000 short tons, but the figure was in all probability too high. There is little to say in regard to California coal which has not been said before. It is not probable that coal mining in the State will ever develop into an industry of importance, though from changes of temperature and other local causes the product may be increased. California coals are of inferior quality, mostly lignites, and high in moisture or ash, or both. They can, however, and do to some extent, act as a balancing wheel in keeping prices for other coals at a reasonable figure. Consumers are willing to pay higher prices for better coal, but there is a limit beyond which it is found impolitic to go, and California lignites would be the cheaper fuel notwithstanding their inferiority.

This fact should be borne in mind by consumers in San Francisco and other large cities, and encouragement should be given to the development of such mines as the State has. As it is, prices for coal at San Francisco have materially declined in the past few years. In 1890 English coal was selling at from $10 to $13 per ton. At the close of 1894 it brought only from $6 to $6.75 per ton. Such a cheapening in fuel is of great benefit to manufacturers. It is true that the decline in values was originally due to heavy importations, chiefly in

1891, when the total receipts exceeded those of the preceding year by nearly half a million tons, and resulted in a glutted market, but unless there should be other resources for consumers to fall back upon the present low prices will not be apt to continue.

The following tables show the statistics of production in California in 1893 and 1894:

Coal product of California in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Amador	21,546	333	750	22,629	$33,944	$1.50	266	30
Contra Costa	35,016	899	1,064	36,979	97,161	2.63	173	82
Fresno	5,240		720	5,960	20,860	3.50	265	30
Monterey		560		560	2,000	3.57	60	5
San Bernardino, San Diego	2,931	3,544		6,475	13,590	2.10	220	11
Total	64,733	5,336	2,534	72,603	167,555	2.31	208	158

Coal product of California in 1894.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total production.	Total value.	Average price per ton.	Average number days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Contra Costa	2	34,720	112	4,368	39,200	$99,310	$2.53	220	96
Amador, Fresno, San Diego	4	18,016	8,031	2,000	28,047	56,310	2.01	270	29
Total	6	52,736	8,143	6,368	67,247	155,620	2.31	232	125

The following table shows the total output of California since 1883, with the value when it has been reported, and the statistics of the number of employees and the average working time during the past five years:

Coal product of California since 1883.

Years.	Short tons.	Value.	Average price per ton.	Average number of days active.	Total number of employees.
1883	76,162				
1884	77,485				
1885	71,615				
1886	100,000	$300,000	$3.00		
1887	50,000	150,000	3.00		
1888	95,000	380,000	4.00		
1889	121,820	288,232	2.36		
1890	110,711	283,019	2.56	301	364
1891	93,301	204,902	2.20	222	256
1892	85,178	209,711	2.46	204	187
1893	72,603	167,555	2.31	208	158
1894	67,247	155,620	2.31	232	125

COLORADO.

Total product in 1894, 2,843,400 short tons; spot value, $3,516,340.

COAL FIELDS OF COLORADO.

The coal fields of Colorado have been described at length by Mr. R. C. Hills in Mineral Resources of the United States, 1892, and the following has been briefly abstracted from Mr. Hills's report: The fields embrace a total area of about 18,100 square miles, exclusive of those portions of the measures which do not contain coal of workable thickness. The productive measures are divided into six independent fields, known as the Raton, South Platte, North Park, Grand River, Zampa, and La Plata. The first three lie east of the great Continental divide and the last three west of it. In addition to the six fields, there are several smaller districts, among which are the Canyon City and the South Park districts, lying on the east of the divide, and the Tongue Mesa on the west.

The Raton field lies in the southern part of the State, a little east of the center, and extends into New Mexico. The Colorado portion of the field is contained in the counties of Huerfano and Las Animas, and embraces the important Trinidad region. Some of the coals are coking, over 300,000 tons of coal being made into coke in Las Animas County in 1894. Over a million and a half tons of coal have been mined in this field annually since 1890, and in 1893 the product exceeded 2,000,000 tons.

The South Platte field is a continuous strip extending from Franceville, in El Paso County, in a northerly direction, following the eastern base of the Colorado range nearly to the Wyoming line. Mr. Hills places the average width of the workable beds of the field at 40 miles, and estimates the area covered at about 6,800 miles. The actual width of the measures in this field is much greater than 40 miles, and, in fact, they extend over an immense tract in northeastern Colorado, but the change from workable to unworkable or inaccessible areas is so gradual that it is difficult to establish a definite limit. Mr. Hills is the recognized authority on Colorado coal lands and his estimates may be accepted without question. The coals of this field are lignitic, and owing to its slacking upon exposure, it is not adapted for storage or transportation to any great distance. There is, however, a large local market, Denver being directly in the field, and the cheapness of the fuel procures a steady demand. The counties through which this field extends are El Paso, Jefferson, Arapahoe, Boulder, Weld, and a little into Larimer.

The North Park field lies entirely in Larimer County, in the northern part of the State. The coal is lignite, and the region remote from railroad transportation. A small amount is mined for local consumption.

The South Park district is a small area lying in Park County. Its entire length does not exceed 21 miles, and its average width is less than 3. Its total area is not more than 45 square miles, less than half of which is workable. The coal is noncoking bituminous, and is used chiefly by the Denver, Leadville and Gunnison branch of the Union Pacific Railroad.

The Canyon City district is all included within 54 square miles, and is situated near Canyon City, in Fremont County. The coal is noncoking bituminous, makes an excellent fuel, and bears a high reputation in the prairie States For three years prior to 1894 this field produced over half a million tons annually. In 1894 the product was only a little more than half that of 1893.

The La Plata field is located in the southwestern part of the State, and like the Raton field, extends across the southern boundary of the State into New Mexico. In Colorado it lies chiefly in La Plata County, extending eastward into Archuleta County, and a short distance into Montezuma County on the west. Its area within Colorado is about 1,250 square miles. The principal mines are in the vicinity of Durango, La Plata County, and it is only within the past two years that they can be said to have assumed any importance. Up to 1892 the product had barely reached 5,000 tons. In 1893 it rose to 18,100 tons, and in 1894 yielded 53,571 tons.

The Grand River field is in the extreme western part of the State and extends across the line into Utah. The counties in Colorado in which this field lies are Rio Blanco, Garfield, Mesa, Delta, Pitkin, and Gunnison. In this field and in Gunnison County the only anthracite mined in the State is found. The greater part of the field is noncoking bituminous coal, but in the southeastern corner, where there has been the greatest amount of development, considerable coking coals exist and as much as 100,000 tons have been coked in one year in this region. The Grand River field, according to Mr. Hills, embraces about 6,950 square miles, of which 1,116 square miles contain accessible beds and an estimated available tonnage of 26,384,800,000, more than half the entire estimated tonnage for the State.

The Yampa field is without doubt a northeasterly extension of the Grand River field, being separated from it by only a few miles, and was at one time a part of it. The separation has been caused by erosion. The Yampa is itself divided into two parts, separated from each other by only a few miles, one being drained by the Yampa River, the other by the Little Snake, which joins the Yampa farther west. The field has not been thoroughly explored, and what mining is carried on is for local trade. Mr. Hills places the aggregate area of the field at 1,100 square miles. The coals are of superior quality, but there is no railroad communication.

The Tongue Mesa district is a small field lying in the southeastern corner of Montrose County. It is a long, narrow strip running northwest and southeast. It is mined only for local use, the coal being almost a lignite in character, that will not compete with the better fuels which railroad transportation have made available.

PRODUCTION.

The first production of coal in Colorado, of which there is any record, was in 1864. It came from Jefferson and Boulder counties in the South Platte field, and was used, as the product of those counties chiefly is to-day, by the citizens of Denver and vicinity. Weld County, also a part of the South Platte field, began producing in 1872. The total output reported for the State in 1864 was 500 short tons. In 1872 it was 68,540 tons. In the following year the Raton field was opened, as was also the Canyon City district in Fremont County, but the total product was not materially increased in that year. The time had come, however, for the development of Colorado's mineral wealth, and the rapid increase in the production of coal tells the tale. In 1876 the output reached and passed 100,000 tons. In 1882, six years later, it had passed the million-ton mark. The Grand River field became a producer in 1880. The development of Colorado coal mining since 1882, has also been remarkable. In the volume for 1882 it was stated that coal mining was in its first stages, though it had then reached 1,000,000 tons. In 1885 and 1886 there was considerable activity in railroad building, and the product exceeded 1,350,000 short tons in each year. The year 1887 and the four following years were periods of great activity in coal mining, and the product showed an annual increase of from 400,000 to 500,000 tons, until, in 1891, it reached 3,512,632 short tons. The product in 1892 was about the same as in 1891. In 1893 it increased 600,000 tons and reached the maximum production in the history of the State, gave her first place among the coal-producing States west of the Mississippi River, and sixth in the United States. The heretofore almost uninterrupted increase met with a decided check in 1894. The general strike of the spring and summer included Colorado, and its effects were disastrous. The total product shows a decrease of 1,270,980 short tons, or 30 per cent. The decrease in value was in exact proportion, there being no change in the average price per ton.

The following tables exhibit the statistics of coal production in Colorado during 1893 and 1894, with the distribution of the product for consumption:

Coal product of Colorado in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Arapahoe	....	633	....	....	633	$766	$1.21	150	2
Boulder	579,222	15,565	68,433	....	663,220	851,444	1.28	142	1,143
Delta	200	2,380	....	....	2,580	8,310	3.22	167	6
Douglas	....	200	....	....	200	400	2.00	75	3
El Paso	16,385	900	2,200	....	19,415	25,308	1.20	143	88
Fremont	482,649	9,840	44,298	....	536,787	860,182	1.60	182	1,268
Garfield	208,814	608	3,496	....	212,918	253,659	1.19	121	300
Gunnison	168,097	1,465	5,534	83,443	258,539	431,553	1.67	168	576
Huerfano	491,248	2,316	27,641	....	521,205	600,651	1.15	172	999
Jefferson	1,834	61	....	....	1,895	4,738	2.50	250	7
La Plata	95,771	6,476	795	1,950	104,992	152,748	1.45	235	152
Las Animas	1,208,507	18,131	23,965	336,735	1,587,338	1,610,366	1.01½	229	2,243
Mesa	17,000	100	....	1,000	18,100	41,250	2.28	249	23
Montezuma	....	90	....	....	90	450	5.00	75	3
Park	38,692	403	....	....	39,095	97,738	2.50	236	185
Pitkin	8,602	52	1,626	88,931	99,211	110,932	1.12	211	115
Routt	....	816	....	....	816	1,597	1.96	54	10
Weld	29,000	5,350	1,005	....	35,355	52,510	1.49	217	79
Total	3,345,951	65,386	178,993	512,059	4,102,389	5,104,602	1.24	188	7,202

Coal product of Colorado in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total production.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Arapahoe	1	....	539	20	....	559	$839	$1.50	125	2
Boulder	12	377,877	9,087	32,770	....	419,734	536,190	1.28	150	1,091
Delta	3	1,797	1,900	....	....	3,697	5,545	1.50	143	9
El Paso	1	27,668	600	2,000	....	30,268	35,453	1.17	241	70
Fremont	4	226,940	3,334	15,342	....	245,616	409,966	1.67	104	1,580
Garfield	2	73,335	32	2,296	....	75,663	85,767	1.13	142	122
Gunnison	5	125,644	792	5,410	68,479	200,325	330,517	1.65	156	332
Huerfano	6	373,199	1,766	33,080	....	408,045	441,130	1.08	186	753
Jefferson	2	30,000	1,108	3,000	....	34,108	68,216	2.00	162	25
La Plata	6	41,672	8,519	302	3,078	53,571	87,346	1.63	46	349
Las Animas	10	807,772	14,658	14,984	316,449	1,153,863	1,167,174	1.01	199	1,699
Mesa	2	25,000	6,000	250	500	31,750	63,500	2.00	223	46
Montezuma	3	....	235	....	....	235	1,050	4.47	110	6
Montrose	1	....	100	....	....	100	125	1.25	80	1
Park	1	28,094	....	849	....	28,943	91,170	3.15	231	108
Pitkin	1	2,793	67	2,111	92,753	97,724	110,117	1.13	266	135
Rio Blanco	4	....	1,680	....	....	1,680	4,310	2.57	172	10
Routt	12	560	2,150	....	....	2,710	3,853	1.42	75	24
Weld	3	38,697	4,121	....	....	42,818	74,072	1.73	145	145
Total	79	2,181,048	56,688	112,414	481,259	2,831,409	3,516,340	1.24	155	6,507

In the table below is shown the total product of the State, by counties, since 1887, with the increases and decreases in 1894 as compared with 1893.

Coal product of Colorado since 1887, by counties.

[Short tons.]

Counties.	1887	1888.	1889.	1890.	1891.
Arapahoe	16,000	1,700	823	700	1,273
Boulder	297,338	315,155	323,096	425,704	498,494
Dolores	1,000	200	....	800	3,475
El Paso	47,517	44,114	54,212	25,617	34,364
Fremont	417,326	438,789	274,029	397,418	545,789
Garfield	30,000	115,000	239,292	183,884	191,994
Gunnison	243,122	258,374	252,442	229,212	261,350
Huerfano	131,810	159,610	333,717	427,832	494,466
Jefferson	12,000	9,000	10,790	10,984	17,910
Las Animas	506,540	706,455	993,534	1,154,668	1,219,224
La Plata	22,880	33,625	34,971	43,193	72,471
Mesa	....	300	1,100	1,000	5,000
Park	23,421	46,588	41,823	49,594	52,626
Pitkin	4,000	28,113	....	74,362	91,642
Weld	39,281	28,054	28,628	46,417	22,554
Routt	....	....	1,491	705	....
Larimer	....	....	100	1,500	....
Douglas	3,500	400	260	700	....
San Miguel	....	....	1,800	1,500	....
Delta	....	....	1,357	775	....
Montezuma	....	....	816	238	....
Montrose	....	....	....	....	....
Rio Blanco	....	....	2,900	200	....
Total	1,795,735	2,185,477	2,597,181	3,077,003	3,512,632

Counties.	1892.	1893.	1894.	Increase.	Decrease.
Arapahoe	654	633	559	....	74
Boulder	545,563	663,220	419,734	....	243,486
Dolores	....	....	....	....	....
El Paso	23,014	19,415	30,268	10,853	....
Fremont	538,887	536,787	245,616	....	291,171
Garfield	277,794	212,918	75,663	....	137,255
Gunnison	225,260	258,539	200,325	....	58,214
Huerfano	541,733	521,205	408,045	....	113,160
Jefferson	21,219	1,895	34,108	32,213	....
Las Animas	1,171,069	1,587,338	1,153,863	....	433,475
La Plata	81,500	104,992	53,571	....	51,421
Mesa	5,050	18,100	31,750	13,650	....
Park	76,022	39,095	28,943	....	10,152
Pitkin	....	99,211	97,724	....	1,487
Weld	2,205	35,355	42,818	7,463	....
Routt	330	816	2,710	1,894	....
Larimer	....	....	....	....	....
Douglas	200	200	....	....	200
San Miguel	....	....	....	....	....
Delta	200	2,580	3,697	1,117	....
Montezuma	30	90	235	145	....
Montrose	....	....	100	100	....
Rio Blanco	100	....	1,680	1,680	....
Total	3,510,830	4,102,389	2,831,409	....	*a* 1,270,980

a Net decrease.

In connection with the above table it will be of interest to note the variations in the average prices in each county. The statistics of value by counties were not obtained prior to 1889, when the Eleventh Census was taken. Since that year, with the exception of 1891, the statistics have been collected in that way by the Geological Survey, and the average prices for five years are shown in the following table. Only those counties are considered whose product averages 10,000 tons or over.

Average prices for Colorado coal since 1889 in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1892.	1893.	1894.
Boulder	$1.53	$1.32	$1.36	$1.28	$1.28
El Paso	1.27	1.10	1.25	1.20	1.17
Fremont	2.12	1.54	1.92	1.60	1.67
Garfield	1.64	1.46	2.00	1.19	1.13
Gunnison	2.28	1.95	1.84	1.67	1.65
Huerfano	1.37	1.31	2.00	1.15	1.08
Jefferson	2.54	2.99	1.90	2.50	2.00
La Plata	1.91	2.76	1.76	1.45	1.63
Las Animas	1.16	1.16	1.22	1.01½	1.01
Park	2.49	3.00	2.40	2.50	3.15
Pitkin	....	1.45	....	1.12	1.13
Weld	1.51	1.38	2.00	1.49	1.73
The State	1.54	1.40	1.62	1.24	1.24

In the following table is shown the number of men employed during 1890, 1892, 1893, and 1894, in counties producing 10,000 tons or over, together with the average working time, for the past three years:

Statistics of labor employed and working time at Colorado coal mines.

Counties.	1890.	1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.
Boulder	979	193	1,128	142	1,143	150	1,091
El Paso	54	200	40	143	88	241	70
Fremont	1,049	195	1,040	182	1,268	104	1,580
Garfield	334	248	423	121	300	142	122
Gunnison	389	259	368	168	576	156	332
Huerfano	907	253	947	172	999	186	753
Jefferson	79	233	50	250	7	162	25
La Plata	97	288	124	235	152	46	349
Las Animas	1,531	246	1,450	229	2,243	199	1,699
Park	150	266	140	256	185	231	108
Pitkin	96	....	....	211	115	266	135
Weld	118	300	4	217	79	145	145
The State	5,827	229	5,747	188	7,202	155	6,507

The State is divided, for sake of convenience, into four geographical divisions, known, respectively, as the northern, central, southern, and western. The first mentioned contains the counties of Arapahoe, Boulder, Jefferson, Larimer, Routt, and Weld. The central division embraces Douglas, El Paso, Fremont, and Park counties. The southern division contains the counties of Dolores, Huerfano, La Plata, and Las Animas, while Delta, Garfield, Gunnison, Mesa, Montezuma, Pitkin, Rio Blanco, and San Miguel counties lie in the western district.

The following table shows the annual product of coal in Colorado since 1864, that for the years previous to 1867 being given by counties and subsequent to 1878 by districts:

Coal product of Colorado from 1864 to 1894.

Years.	Localities	Product.	
		Short tons.	
1864	Jefferson and Boulder counties		500
1865	do		1,200
1866	do		6,400
1867	do		17,000
1868	do		10,500
1869	do		8,000
1870	do		13,500
1871	do		15,600
1872	do	14,200	
	Weld County	54,340	
			68,540
1873	Jefferson and Boulder counties	14,000	
	Weld County	43,790	
	Las Animas and Fremont counties	12,187	
			69,977
1874	Jefferson and Boulder counties	15,000	
	Weld County	44,280	
	Las Animas and Fremont counties	18,092	
			77,372
1875	Jefferson and Boulder counties	23,700	
	Weld County	59,860	
	Las Animas and Fremont counties	15,278	
			98,838
1876	Jefferson and Boulder counties	28,750	
	Weld County	68,600	
	Las Animas and Fremont counties	20,316	
			117,666
1877			160,000
1878	Northern division	87,825	
	Central division	73,137	
	Southern division	39,668	
			200,630
1879	Northern division	182,630	
	Central division	70,647	
	Southern division	69,455	
			322,732
1880	Northern division	123,518	
	Central division	136,020	
	Southern division	126,403	
	Western division	1,064	
	Unreported mines	50,000	
			437,005
1881	Northern division	156,126	
	Central division	174,882	
	Southern division	269,045	
	Western division	6,691	
	Unreported mines	100,000	
			706,744
1882	Northern division	300,000	
	Central division	243,694	
	Southern division	474,285	
	Western division	43,500	
			1,061,479
1883	Northern division	243,903	
	Central division	396,401	
	Southern division	501,307	
	Western division	87,982	
			1,229,593
1884	Northern division	253,282	
	Central division	296,188	
	Southern division	483,865	
	Western division	96,689	
			1,130,024
1885	Northern division	242,846	
	Central division	416,373	
	Southern division	571,684	
	Western division	125,159	
			1,356,062
1886	Northern division	260,145	
	Central division	408,857	
	Southern division	537,785	
	Western division	161,551	
			1,368,338
1887	Northern division	364,619	
	Central division	491,764	
	Southern division	662,230	
	Western division	273,122	
			1,791,735

Coal product of Colorado from 1864 to 1894—Continued.

Years.	Localities.	Product.	
		Short tons.	
1888	Northern division	353, 909	
	Central division	529, 891	
	Southern division	899, 690	
	Western division	401, 987	
			2, 185, 477
1889	Northern division	364, 928	
	Central division	370, 324	
	Southern division	1, 362, 222	
	Western division	499, 707	
			2, 597, 181
1890	Northern division	486, 010	
	Central division	473, 329	
	Southern division	1, 626, 493	
	Western division	491, 171	
			3, 077, 003
1891	Northern division	540, 231	
	Central division	632, 779	
	Southern division	1, 789, 636	
	Western division	549, 986	
			3, 512, 632
1892	Northern division	569, 971	
	Central division	638 123	
	Southern division	1, 794, 302	
	Western division	508, 434	
			3, 510, 830
1893	Northern division	701, 919	
	Central division	694, 708	
	Southern division	2, 213, 535	
	Western division	492, 227	
			4, 102, 389
1894	Northern division	499, 929	
	Central division	304, 827	
	Southern division	1, 615, 479	
	Western division	411, 174	
			2, 831, 409

GEORGIA.

Total product in 1894, 354,111 short tons; spot value, $299,290. Coal is mined on a commercial scale in but two counties in Georgia, Dade and Walker. The beds from which it is taken are extensions of the Warrior field in Alabama. The Dade County mines are in the northeast end of the Sand Mountain ridge, and the Walker County openings are in the Lookout Mountain vein. This small portion of the Appalachian field (the smallest contained in any one State) occupies an area of about 200 square miles. The Dade County mines have been operated for a number of years. The first reliable statistics of production were obtained in 1886, when a total output of 223,000 short tons was reported. Conservative estimates placed the amount produced in each of the two previous years at 150,000 short tons. There is no record at all antedating 1884. The Walker County mines were opened in 1892 with an output of 37,761 short tons. During 1893 and 1894 the total product of the State was nearly evenly divided between the two counties. In the following table are shown the statistics of production during the past six years:

Coal product of Georgia since 1889.

Years.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total amount produced.	Total value.	Average price per ton.	Average number of days worked.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
1889	46, 131	158	15, 000	164, 645	225, 934	$338, 901	$1. 50	....	....
1890	57, 949	....	....	170, 388	228, 337	238, 315	1. 04	313	425
1891	15, 000	1, 000	5, 000	159, 000	171, 000	256, 500	1. 50	312	850
1892	52, 614	250	3, 756	158, 878	215, 498	212, 761	. 99	277	467
1893	196, 227	....	4, 869	171, 644	372, 740	365, 972	. 98	342	736
1894	178, 610	....	8, 978	166, 523	354, 111	299, 290	. 85	304	729

The following table exhibits the total annual product since 1884:

Coal product of Georgia since 1884.

Years.	Short tons.	Years.	Short tons.
1884	150, 000	1890	228, 337
1885	150, 000	1891	171, 000
1886	223, 000	1892	215, 498
1887	313, 715	1893	372, 740
1888	180, 000	1894	354, 111
1889	225, 934		

ILLINOIS.[1]

Total product in 1894, 17,113,576 short tons; spot value, $15,282,111.

COAL FIELD OF ILLINOIS.

The Illinois coal field occupies the greater part of the Central coal field of the United States, the smaller portions constituting the Indiana field and the western Kentucky field. The area in Illinois embraces about 36,800 square miles, about three and one-half times the area in Indiana and Kentucky combined. The product has been for several years in about the same proportion, that of Illinois being something more than three-fourths of the total output of the Central field. The coal area of Illinois is larger than that of any other State. It is about four times as large as the bituminous area in Pennsylvania, more than twice as large as that of West Virginia, and more than half the area of the entire Appalachian coal field.

A line drawn from Hampton, in Rock Island County, to the junction of the Kankakee and Iroquois rivers would define approximately the northern line of the Illinois coal field; but from the junction of these streams the boundary line deflects south to the vicinity of Chatsworth, in Livingston County, and thence eastwardly to the Indiana line. All

[1]The statistical portion of this report is abstracted from advance sheets of the report of Mr. Geo. A. Schilling, secretary of the bureau of labor statistics of Illinois, and compiled by Mr. J. D. Roper, Statistician.

the area south of the line above designated, except a narrow belt along the Mississippi to the mouth of the Ohio and up the latter stream to Battery Rock, is underlaid by the Coal Measures, and nearly all the counties within the above-described boundary have afforded some coal, although in several of them the coal lies too deep below the surface to be available without a heavier expenditure of capital than the present demand for fuel would seem to warrant.

The Coal Measures attain an aggregate thickness of about 1,400 feet, and may be properly divided into upper and lower measures, taking as a line of demarcation the limestone of Shoal Creek and Carlinville, a tough brownish-gray rock that is so persistent in its lithological characters and development as to make it a conspicuous horizon in tracing the detailed stratification of the Coal Measures. This limestone overlays a thin coal, often only 3 or 4 inches in thickness, but locally increasing to 18 inches to 2 feet or more, as in the vicinity of Highland, in Madison County, where it has been worked in a limited way for many years. Above this limestone there is some 700 feet of strata belonging to the upper measures, inclosing six or seven seams of coal that range in thickness from 6 inches to 3 feet, but none of them attaining to the thickness of those in the lower measures.

The extensive area of the Illinois coal field and the liberal expenditure of capital and labor in it has resulted in placing Illinois in the second place on the list of coal producing States. No other mineral resource within its border is at all comparable in intrinsic value with the coal deposits. The abundance of coal, the wide extent of its area, the facility with which it can be mined, and the low price at which it can be sold, have been important factors in the development of railroad facilities and manufacturing enterprises.

For the purposes of inspection and the collection of statistics, the State is divided into five inspection districts. The first district embraces the northeastern corner of the State as far south as and including Iroquois County, on the Indiana line. There are but five coal-producing counties in the district, Grundy, Kankakee, Lasalle, Livingston, and Will, but the fact that the city of Chicago is within the limits of the district, in close proximity to the coal fields, makes it one of the most important. Lasalle County in 1894 was foremost in rank for production. The second district occupies the northwest corner of the State, extending south as far as Adams County, which it includes. The coal-producing counties are Bureau, Hancock, Henry, Knox, McDonough, Marshall, Mercer, Rock Island, Schuyler, Stark, and Warren. The third district contains the counties of Cass, Fulton, Logan, McLean, Menard, Peoria, Tazewell, Vermilion, and Woodford, and extends nearly across the State from the eastern border a little north of the center. The fourth district stretches entirely across, and occupies the northern half of the southern portion of the State. It embraces the coal-producing counties of Bond, Calhoun, Christian, Coles, Greene, Jersey, Macoupin, Madison, Mason, Montgomery, Morgan, Sangamon, Scott, Shelby, Effingham, Jasper, Pike, and Richland. The fifth district embraces all of the southern portion of the State, from a line drawn east of a point opposite St. Louis, Mo. The coal-producing counties are Clinton, Franklin, Gallatin, Hardin, Hamilton, Jackson, Jefferson, Johnson, Marion, Perry, Randolph, Saline, St. Clair, Washington, and Williamson.

PRODUCTION.

The thirteenth annual report of the statistics of coal in Illinois is here presented, being for the year ended July 1, 1894. These reports are made continuous and uniform in every particular, thus enabling the formation of parallel statistics of the coal business for the whole State. In this distinct manner the bureau of labor statistics of Illinois has preserved in the published reports a permanent, uninterrupted, and uniform record of the mine-inspection service and of the resources of the coal industry in this State. The foundation of all conclusions and summaries is derived from the reports of the several State inspectors; the exactness of these reports is based upon the returns made by the companies or operators owning or controlling the mines, on specially prepared blanks provided by the bureau; therefore these reports of the inspectors present the most definite data extant concerning each mine.

The statement that the total product of the mines for the past year is less than the year preceding will not be a matter of astonishment to anyone at all versed in the traffic of coal. However, the tonnage of the State has had a steady yearly increase since 1889. In that year the output was 14,017,298 tons; last year the total product was 19,949,564 tons, showing an increase of 5,932,266 tons, or over 42 per cent, during the four years. For the year 1894 the reports gave the output as 17,113,576 tons, being a falling off from last year of 2,835,988 tons, or about 14 per cent. Considering the general depression of business throughout the entire country, affecting very seriously two of the greatest fuel consumers in the land—manufacturing and transporting, the decrease in the output for the year proves to be much less than was predicted by those supposed to be best informed. Another cause of general inactivity is recognized in the great strike during the year. From data carefully procured by the State inspectors under direction of the bureau, it was found that 277 of the mines of the State became involved by the strike, and that over 25,000 men employed at these mines suspended work. The duration of the suspension from work by the mines was 61 days and of the miners 73. Of the mines involved, 249, or 90 per cent, were of the class known as shipping mines, and these comprise 78 per cent of the shipping mines of the State.

The following general summaries of the activity in the coal business and other facts closely allied to it are presented:

Counties in which coal has been mined	56
Mines and openings of all kinds	836
Shipping mines	319
Mines in local trade	517
Coal of all grades mined ....tons..	17, 113, 576
Lump coal (2,000 pounds) ....do...	13, 865, 284
Other grades of coal ....do...	3, 248, 292
Nut coal included in other grades ....do...	479, 595
Acres worked out (estimated)	2, 818
Employees of all kinds	38, 477
Miners	31, 595
Other employees, including boys	6, 882
Boys over 14 years of age under ground	701
Employees under ground	32, 046
Employees above ground	6, 431
Average days of active operations, shipping mines	183. 1
Aggregate home value of total product	$15, 282, 111
Aggregate home value of lump coal	$13, 998, 588
Aggregate home value of other grades of coal	$1, 283, 523
Average value of lump coal per ton at the mines	$1. 01
Average value of other grades of coal per ton at the mines	$0. 40
Average price per ton for hand mining	$0. 67
Average price paid for hand mining (summer)	$0. 64
Average price paid per ton for hand mining (winter)	$0. 685
Lump coal mined by hand ....tons..	7, 368, 850
Mined by hand and paid for by the day ....do...	988, 153
Mined by hand and paid gross weight ....do...	2, 727, 331
Mining machines in use	296
All grades mined by machines ....tons..	3, 396, 139
Lump coal mined by machines ....do...	2, 496, 793
Other grades mined by machines ....do...	758, 781
Kegs of powder used	318, 263
Men killed	72
Wives made widows	41
Children made fatherless	114
Men injured so as to lose time	521
Coal mined for each life lost ....tons..	237, 689
Coal mined for each man injured ....do...	32, 847
Employees for each life lost	534
Employees for each man injured	74
New mines opened and old mines reopened	156
Mines closed or abandoned	108

These totals are a condensation of the experience in the coal fields of the State for the past year. The number of counties yielding the product is 56, the same number as reported last year. Nine of the counties reported have been carried on the list of coal-producing counties, while their aggregate tonnage would scarcely be perceptible in the total for the State—6,060 tons is their total for the year. Six of these counties are in the fourth district, and 3 in the fifth. This leaves 47 as the number of coal-producing counties. The number of mines or openings reported is 836, or 48 more than last year, the additions being in the second, third, and fourth districts, the first adding but one. In the fifth district the number has decreased by 11, of which 4 are shipping mines. This class of mines has had a total increase of 13 during the year, 1 in the first district, 5 in the second, and 7 in the fourth, the total for the State being 319, a gain of 9 over last year.

This grouping, as formerly, continues to represent almost the entire volume of the production of the State. For the past five years their yield has been 95 per cent of the whole output; this year it was 94 per cent.

It has already been stated that the product of the State for this year, compared with the year 1893, shows a falling off of 2,835,988 tons, or 14.22 per cent. Reviewed by districts, it is found the greater shrinkage is in the first and fourth, being 20.9 per cent in the former and 16.7 in the latter; the second shows a decline of 14.8 per cent, the third 9.4, and the fourth 10.6.

It is found that the trend of the shipments of the product from the commercial collieries of the northern field—namely, first, second, and third districts—are to the markets of the north, northwest, and east, while that of the southern field, or the fourth and fifth districts, inclines to the trade of the South and West. With such division the falling off of the northern field is found to be 15 per cent and of the southern field 14 per cent, thus showing a quite uniform decline all over the State. In this connection, also, attention is directed to the notable increase in coal production of the State during the past fourteen years. In 1880 the national census showed that Illinois produced 6,089,514 tons of lump or marketable coal; the past year the tonnage of the same grade is reported as 13,865,284 tons, showing an increase of 7,775,770 tons, or 127.7 per cent during the period named. In the last decade the increase in the same grade of coal was over 37 per cent, and in the past five years about 20 per cent.

The standard grade, lump coal, for the year averages in value at the mines 1.6 cents per ton less than last year. Approximating a valuation of $1.01 per ton, this is the lowest point touched at any time in the record for the State, excepting the year 1891, when the value was found to be $1.008; for the year 1890 the value was a shade higher, being $1.02.

The average price paid for hand mining for the past year, computed exclusively on tons of screened coal, was 67.1 cents. This is 4.35 cents less than obtained the year before, and is the lowest average rate ever reached. It must be understood that this average is deduced by computations on the different quantities of coal mined at all the various rates, both in summer and winter, and at every mine.

The price paid for hand mining this year is founded on 7,368,850 tons of screened coal. This exceeds by over a million and a quarter tons the quantity wrought out last year by hand and paid for by the ton. Con sidering this subject further, it is noted here that in mining coal, employees and employers, in making all computations or reckonings as to wages, howsoever to be earned or paid, seem to depend largely, if not exclusively, on the rate paid per ton for hand mining.

The number of men reported as employed in and around the mines of the State during the year is 38,477. This is the aggregate of the highest number employed at each individual mine at any one time. The number is largely in excess of any previous year, and is 3,087 more than reported last year. Perhaps no better explanation can be given of the employment of this large number of men during the year, so notable in its lack of opportunity for work, than the urgent appeals by men having dependents, and a corresponding sympathetic feeling on the part of mine operators.

The number of days of active operation of the mines during the past year is found to be 183.1. This is 46 days less than the preceding year, and is the lowest number of days ever reported. The falling off in demand, the labor troubles, and the exceedingly large number of men employed, have had their inevitable influence in causing this decrease in the possible working days.

Machine mining is now virtually confined to the fourth and fifth districts. The whole number of machines in use in all the mines during the year was 296. Last year the number was 310. The total tons cut by machines was 3,396,139, a falling off of 1,198,991 tons from last year.

The number of kegs of powder used during the year in all mines was 318,263, which is 35,509 kegs less than reported last year, but is 18,796 kegs more than recorded for 1892. Of the total number of kegs 204,543 were used in hand mining and 33,060 in mines using machinery, leaving 80,660 kegs which were used in blasting at other mines in the various ways incident to the industry.

The number of accidents is deplorably larger than for any previous year, reaching a total of 593. By these 72 men were killed or died from the effects of the injury, and 521 men met with accidents causing a loss of time of a week or more. The fatal accidents are 3 in excess of last year, and 12, or nearly 26 per cent, more than the average for twelve years. The non-fatal accidents exceed the number of last year by 118, or about 30 per cent, and is 274, or 90 per cent more than the average for the past twelve years. This grewsome record is susceptible of no other explanation except that an excessively increased number of men were employed, and that a very large per cent of these were inexperienced in the skill necessary for the undertaking.

NUMBER AND RANK OF MINES.

In the summary preceding, the number of coal mines operated in the State during the past year is given as 836, which is 48 more than reported last year. Without some further explanation a wrong impression is likely to be formed regarding this large number of mines. As a matter of fact the greater proportion are unimportant in significance as to their product or value, and as to employment of either capital or labor.

In order better to illustrate or characterize the mines of the State, and to discern the important from the insignificant, a table is presented giving the number of shipping and local mines for the past eight years by districts and for the State:

Number of shipping coal mines in Illinois, 1887 to 1894, by districts.

Years.	First.		Second.		Third.		Fourth.		Fifth.		Total.	
	Shipping.	Local.	Shipping.	Local.	Shipping.	Local.	Shipping.	Local.	Shipping.	Local.	Shipping.	Local.
1887	44	24	30	245	77	159	58	53	83	35	292	516
1888	37	33	32	235	81	156	57	51	106	45	313	520
1889	36	36	31	233	89	157	57	41	119	55	332	522
1890	37	42	32	222	93	180	55	82	110	83	327	609
1891	38	32	31	233	90	183	56	70	112	73	327	591
1892	37	33	30	210	85	171	57	52	101	63	310	529
1893	38	33	27	197	84	152	59	45	102	51	310	478
1894	39	33	32	209	84	167	66	64	98	44	319	517
Averages	38	33	31	223	85	166	58	57	104	56	316	535
Increase	......	9	2	......	7	8	8	11	15	9	32	37
Decrease	5	......	......	36	......	......	......	......	......	......	5	36

This demonstrates that the increase in the larger and more important mines has been gradual and permanent. While, of course, some of these extensive plants have been closed from various causes, permanently abandoned, or consolidated, still it is found that their number has been increased and that 49 costly and durable workings have been opened and established, making an average of 316 during the eight years. On the other hand, it is found that during the same period the number of smaller or local mines has been inconstant, reaching a maximum number of 609 in 1890 and a minimum of 478 in 1893, presenting an average of 535, but an increase of only 1.

The amount of both capital and labor employed in the development of these enterprises can scarcely be estimated. It is shown, however, in the former statement, that 49 shipping mines were opened during these years, and these alone would perhaps involve an investment or outlay of over $2,000,000. The others are smaller mines, and though costing much less to develop the coal, yet the greater number, in their aggregate cost, would augment the outlay by many thousand dollars. It is further shown that 816 mines have been closed or permanently abandoned, so that the net gain is only 21.

Classifying the mines of the State on the basis of their output of lump coal for the year, the following table is presented, also including the two previous years:

Classification of Illinois coal mines according to output.

Districts.	Number of mines producing— Less than 1,000 tons.			From 1,000 to 10,000 tons.			From 10,000 to 50,000 tons.			From 50,000 to 100,000 tons.			Over 100,000 tons.			Total number of mines.		
	1892	1893	1894	1892	1893	1894	1892	1893	1894	1892	1893	1894	1892	1893	1894	1892	1893	1894
First	11	12	11	21	23	24	13	15	17	12	10	11	13	11	9	70	71	72
Second	148	131	133	72	71	88	12	12	11	3	4	4	5	6	5	240	224	241
Third	108	96	103	82	74	89	49	52	44	13	11	12	4	3	3	256	236	251
Fourth	27	21	50	28	29	21	20	14	28	22	26	20	12	14	11	109	104	130
Fifth	41	25	18	39	40	32	60	53	69	19	29	19	5	6	4	164	153	142
The State	335	285	315	242	237	254	154	146	169	69	80	66	39	40	32	839	788	836
Increase			30			17			23	14	11		8	1				*a*48
Decrease	70	50		21	5		10	8				14			8	*a*79	*a*51	
Per cent of increase			10.5			7.2			15.8	25.6	15.9		25.8	2.6				6.09
Per cent of decrease	17.3	14.9		8	2.1		6.1	5.2				17.5			20	*a*8.6	*a*6.8	

*a*Net increase.

It is shown here that the number of smaller mines, or those showing an output of less than 50,000 tons, has increased 70 over last year, while those producing over 50,000 tons have decreased 22. This falling off in the number of these more important mines is the natural consequence of the depressed condition of trade during the year.

Three of the districts show a decrease in the two higher classes, the first and second 1 each, the fourth 9, the fifth 12, and the third adds 1. Another classified table presents the number of mines in the State, according to tonnage, for the past twelve years :

Classification of Illinois coal mines by annual output since 1883.

Years.	Number of mines producing— Less than 1,000 tons.	From 1,000 to 10,000 tons.	From 10,000 to 50,000 tons.	From 50,000 to 100,000 tons.	Over 100,000 tons.	Total number of mines.	Increase.	Decrease.
1883	209	233	133	39	25	639		
1884	262	273	148	38	20	741	102	
1885	286	290	143	40	19	778	37	
1886	316	280	135	44	14	789	11	
1887	320	278	141	42	20	801	12	
1888	327	271	151	47	25	822	21	
1889	321	316	139	55	23	854	32	
1890	398	301	155	54	28	936	82	
1891	405	263	164	55	31	918		18
1892	335	242	154	69	39	839		79
1893	285	237	146	80	40	788		51
1894	315	254	169	66	32	836	48	
Increase	106	21	36	27	7	197	345	148
Per cent of increase	50.7	9	27.1	69.2	28		30.8	

The number this year producing over 50,000 tons is 98. This is a less number than reported for either of the past two years, but is more than is recorded for any previous year. The decrease in the two more important classes notably increases those of the subordinate classes.

The proportion of the product of these mines is made clear in the following table:

Classification of the lump-coal product of Illinois in 1894.

Districts.	Mines producing—								Total number of mines and tons.	
	Over 100,000 tons lump coal.		From 50,000 to 100,000 tons.		From 10,000 to 50,000 tons.		Less than 10,000 tons.			
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
First	9	1, 050, 679	11	770, 094	17	455. 200	35	91, 325	72	2, 367, 298
Second	5	692, 462	4	256, 228	11	220, 239	221	280, 427	241	1, 449, 356
Third	3	467, 132	12	812. 420	44	951, 154	192	338, 562	251	2, 569, 268
Fourth	11	1, 550, 520	20	1, 390, 142	28	850, 625	71	85, 823	130	3, 877, 110
Fifth	4	487, 768	19	1, 308, 463	69	1, 680. 075	50	125, 946	142	3, 602, 252
The State	32	4, 248, 561	66	4, 537, 347	169	4, 157, 293	569	922, 083	836	13, 865, 284
Percentages:										
1894	3. 8	30. 6	7. 9	32. 7	20. 2	30	68. 1	6. 7	....	....
1893	5. 1	37. 3	10. 2	34. 5	18. 5	22. 8	66. 2	5. 4	....	....
1892	4. 6	37. 6	8. 2	31. 8	18. 4	24. 3	68. 8	6. 3	....	....
1891	3. 4	33	6	29. 6	17. 9	29. 1	72. 8	8. 3	....	....
Mines and averages:										
1894	32	132, 768	66	68, 748	169	24, 599	569	1, 621	836	16, 585
1893	40	150, 287	80	69, 443	146	25, 200	522	1, 667	788	20, 448
1892	39	142, 077	69	67, 787	154	23, 272	577	1, 610	839	17, 558
1891	31	137, 855	55	69, 745	164	23, 015	668	1, 564	918	14, 118

Separating these mines into two classes, we have one group of 267, each producing 10,000 tons and over for the year, these comprising less than 32 per cent of the whole number, but contributing 93 per cent of the output; while the other group of 569 mines, producing less than 10,000 tons, represent 68 per cent of the whole number, yet yield only 7 per cent of the product. Of this last class 55 per cent produced less than 1,000 tons for the year.

Percentages and averages for the past four years are given for comparison and information.

Another division of the mines into two classes, those producing over 50,000 tons and those producing less than 50,000 tons, is presented in the following table:

Annual lump-coal product of Illinois since 1887.

Years.	Mines producing over 50,000 tons of lump coal.					Mines producing less than 50,000 tons of lump coal.				
	No.	Short tons.	Average number of tons per mine.	Per cent of whole number of mines.	Per cent of total product.	No.	Short tons.	Average number of tons per mine.	Per cent of whole number of mines.	Per cent of total product.
1887	62	5,949,894	95,966	7.74	57.90	739	4,328,996	5,858	92.26	42.10
1888	72	7,188,507	99,840	8.76	60.64	750	4,666,681	6,222	91.25	39.36
1889	78	7,235,577	92,764	9.13	62.39	776	4,362,386	5,622	90.87	37.61
1890	81	8,011,777	98,911	8.65	63.39	855	4,626,587	5,411	91.35	36.61
1891	86	8,109,485	94,296	9.37	62.57	832	4,850,739	5,883	90.63	37.43
1892	108	10,218.279	94,614	12.87	69.37	731	4,512,684	6,173	87.13	30.63
1893	120	11,563,728	96,364	15.23	71.77	668	4,549,171	6,810	84.77	28.23
1894	98	8,785.908	89,652	11.72	63.37	738	5,079,376	6,883	88.28	36.63
Average 8 years	88	8,382,894	95,125			786	4,622,078	6,073		
Percentage 8 years				10.38	64.46				89.62	35.54
Average 7 years	87	8,325,321	96,009			764	4,556,749	6,148		
Percentage 7 years				10.19	64.63				89.81	35.37
Average 6 years	81	7,785,587	95,921			781	4,558,012	5,840		
Percentage 6 years				9.42	63.07				90.58	36.93

This is a record for eight years of the output of lump coal. The number of the higher class of mines, their total output, and the average and percentages bear out the evidence already presented of the depression experienced in the traffic of this class of mines during the past year when compared with the two previous years.

The decline for the year, however, was not sufficient to reduce the average number of mines and tons, and the percentages for the eight years, below those shown for the seven and six years, although the average number of tons per mine for the former proves to be somewhat less.

The mines rendering less than 50,000 tons have increased in number, tonnage, average, and percentages over the two previous years. For the past year they represent 88 per cent of the mines, but furnished only 37 per cent of the output.

The number of shipping mines returned this year is 319. This is 9 more than returned for last year, and 10 more than the year before. The following table presents the record by districts:

Statistics of coal production in Illinois by shipping mines in 1894.

Districts.	No.	Total output, all grades.	Total lump coal.	Per cent of whole number of mines.	Per cent of total tonnage.	Per cent of total lump.	Average number of tons of lump coal per mine.	Average number of days worked.
		Tons.	*Tons.*			*Tons.*		
First	39	2, 517, 733	2, 211, 166	54. 2	93. 8	93. 4	64, 557	153
Second	32	1, 458, 715	1, 209, 947	13. 3	83. 0	83. 5	37, 811	149
Third	84	2, 821, 084	2, 321, 756	33. 5	91. 7	90. 4	27, 640	180
Fourth	66	5, 117, 187	3, 821, 194	50. 8	98. 8	98. 6	57, 882	190
Fifth	98	4, 191, 894	3, 328, 518	69. 0	93. 7	92. 4	33, 975	175
The State.	319	16, 106, 613	12, 892, 581	38. 2	94. 1	93. 0	40, 416	174

The class comprises only 38 per cent of the mines of the State, but furnished 94 per cent of the total product, and 93 per cent of the lump coal. The average tons per mine is over 9,000 less than last year, and the average number of running days is 51, or 23 per cent less.

A parallel table of the local mines is presented:

Statistics of coal production in Illinois by local mines in 1894.

Districts.	No.	Total output, all grades.	Total lump coal.	Per cent of whole number of mines.	Per cent of total tonnage.	Per cent of total lump.	Average number of tons of lump coal per mine.	Average number of days worked.
		Tons.	*Tons.*			*Tons.*		
First	33	167, 511	156, 132	45. 8	6. 2	6. 6	4, 731	169
Second	209	244, 908	239, 409	86. 7	14. 0	16. 5	1, 146	144
Third	167	256, 834	247, 512	66. 5	8. 3	9. 6	1, 482	162
Fourth	64	56, 116	55, 916	49. 2	1. 2	1. 4	874	150
Fifth	44	281, 594	273, 734	31. 0	6. 3	7. 6	6, 221	198
The State.	517	1, 006, 963	972, 703	61. 8	5. 9	7. 0	1, 881	157

This class has 517, or 62 per cent of all the mines, yet these only supplied 6 per cent of the coal. It is to be observed, however, that the aggregate tons of these mines is 315,081, or 45 per cent more than last year, and the average per mine nearly 32 per cent more.

For comparison both classes are presented in condensed form, for five years, in the following table:

Percentage of coal product, by shipping and local mines in Illinois, for five years.

Years.	Shipping mines.					Local mines.				
	No.	Per cent of whole number of mines.	Per cent of total product.	Per cent of lump tons.	Average number of lump tons per mine.	No.	Per cent of whole number of mines.	Per cent of total product.	Per cent of lump tons.	Average number of lump tons per mine.
			Tons.					*Tons.*		
1890	327	34. 9	93. 6	....	34, 176	609	65. 1	6. 4	....	1, 328
1891	327	35. 6	95. 5	92. 0	37, 850	591	64. 4	4. 5	8. 0	987
1892	309	36. 8	95. 1	94. 0	45, 356	530	63. 2	4. 9	6. 0	1, 295
1893	310	39. 3	96. 5	96. 0	49, 776	478	60. 7	3. 5	4. 0	1, 427
1894	319	38. 2	94. 1	93. 0	40, 416	517	61. 8	5. 9	7. 0	1, 881

This affords a view of the number of mines in the State, with percentages and averages as to the working capacity and activity of each class. The percentages of lump tons of both groups are given for four years, and it will be noticed that in the group of shipping mines these percentages are slightly below those for the total output, and a like degree of increase in the same percentages of the local mines.

A further classification of the mines in respect to number and output is shown for the past four years in the following table, by districts:

Coal mines in Illinois having a total output, all grades, of 100,000 tons and over.

Districts.	1894.		1893.		1892.		1891.		Averages for 4 years.	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
First	11	1,397,480	12	1,985,937	15	2,305,796	12	1,809,008	12	1,874,555
Second	6	954,255	7	1,240,175	6	1,015,949	5	742,365	6	988,186
Third	5	781,531	6	849,791	4	690,634	5	673,553	5	760,127
Fourth	19	3,085,399	20	3,661,177	17	2,993,734	13	2,329,251	17	3,017,390
Fifth	9	1,289,969	14	2,011,663	10	1,322,579	8	1,096,662	10	1,430,218
The State	50	7,508,634	59	9,793,743	52	8,328,692	43	6,650,839	51	8,070,477
Averages	....	150,173	....	165,996	....	160,167	....	154,671	....	....
Percentage of whole number of mines and of total product	6.0	43.9	7.5	49.1	6.2	46.6	4.7	42.57	6.0	46.36

Here is presented the continued vigor and significance of these large collieries. The largest number and greatest output appears for 1893; also the largest average tonnage per mine. The previous year follows next in this regard. The year 1891 has the smallest number of these mines and the lowest aggregate output. The past year is third in rank as to number of mines and tons, but discloses the lowest average tonnage per mine.

Regarding these extensive mines as to numbers and tonnage and comparing them with the whole number of mines in the State, it is found that for this year they represent only 6 per cent of the mines, yet they produced about 44 per cent of the coal; last year they were 7.5 per cent of the mines; still they furnished 49 per cent of the product; the year before only 6.2 per cent of the mines and 46.6 per cent of the output; for 1891, 4.7 per cent of the mines, but 42.5 per cent of the tonnage. Combining the four years gives a result of 6 per cent of the mines producing 46.36 per cent of the output.

OUTPUT FOR THE YEAR.

The aggregate production for the year as reported is 13,865,284 tons of lump coal out of a total tonnage of 17,113,576 of all grades; the other grades less than lump appear as 3,248,292 tons, the latter for the greater part is of merchantable quality.

The comparative output of lump coal is continued from year to year and is shown in the following table by districts for the past five years:

Total tonnage of lump coal, with gains and losses, for five years by districts.

Districts.	Output of lump coal by districts.								
	1890.	1891.	1892.	1893.	1894.	1892–93.		1893–94.	
						Gain.	Loss.	Gain.	Loss.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
First	2,303,326	3,701,652	2,965,067	2,913,144	2,367,298	....	51,923	......	545,846
Second	1,002,600	1,215,883	1,461,224	1,708,909	1,449,356	247,685	......	......	259,553
Third	2,375,970	2,336,500	2,711,574	2,860,299	2,569,268	148,725	......	......	291,031
Fourth	3,716,464	3,532,233	4,090,921	4,508,382	3,877,110	417,461	......	......	631,272
Fifth	3,240,004	3,173,956	3,502,177	4,122,165	3,602,252	619,988	......	......	519,913
Total	12,638.346	12,960,224	14,730,963	16,112,899	13,865,284	1,433,859	......	......	2,247,615
Net gain	*a* 1.040,401	321,860	1,770,739	1,381,936	....	1,381,936	......	......	....
Net loss	....	....	....	....	2,247,615	....	......	......	2,247,615

a Gain over 1889.

Here is disclosed the loss and gain in the tonnage of lump coal for five years. This year shows a shrinkage of 2,247,615 tons compared with the year before. The fourth district shows the largest decrease; the first district is next, the fifth next, the second next, the smallest being in the third.

This year is the fourth showing a record of decrease in output; the other years were 1885, 1886, and 1889. However, the decrease this year exceeds the aggregate of the former years by 1,135,820 tons, and it also exceeds the gain of any former year by 476,876 tons.

The percentages of gains and losses of tonnage of lump coal for six years is given by districts and for the State in the following table:

Percentages of increase and decrease in tonnage of lump coal for six years, 1889–1894, by districts.

Years.	First.		Second.		Third.		Fourth.		Fifth.		The State.	
	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.
1889	......	13.73	......	18.14	......	6.91	10.88	......	4.81	......	......	2.22
1890	......	9.86	......	8.50	15.88	......	17.43	......	17.20	......	8.97	....
1891	17.29	......	21.27	......	......	1.26	......	5.22	......	2.08	2.55	....
1892	9.75	......	18.53	......	16.05	......	15.82	......	10.34	......	13.51	....
1893	......	1.78	16.95	......	5.48	......	10.20	......	17.70	......	9.38	....
1894	......	18.74	......	15.19	......	10.18	......	14.00	......	12.61	......	13.95
Six years	......	17.74	31.74	......	17.20	......	35.82	......	36.58	......	16.96	....
Five years	1.23	......	32.15	......	30.57	......	57.94	......	56.28	......	35.93	....
Four years	3.03	......	12.99	......	23.70	......	43.31	......	32.78	......	24.26	....

The decrease for the State from last year is nearly 14 per cent. Noting also the gradations in percentages of decrease by districts, the first shows the highest, 18.74; the second, 15.19; the fourth, 14.0; the fifth, 12.61; and the third, 10.18, the lowest. The percentages of gain and loss by districts and for the State, for four, five, and six years, are also set forth. The first district, after slight gains for two previous years, suffers a contraction of 17.74 per cent from its output six years ago. The other districts, for the same period, show quite large percentages of increase. However, for the State, the gain since 1888 is only 16.96 per cent, while for last year it was 35.93 and the year before 24.26.

The total product, all grades of coal with percentages of lump tons, is presented in the following table:

Total product and percentage of lump coal for four years.

Districts.	1891.		1892.		1893.		1894.	
	Total product.	Percentage of lump grade.	Total product.	Percentage of lump grade.	Total product.	Percentage of lump grade.	Total product.	Percentage of lump grade.
	Tons.		*Tons.*		*Tons.*		*Tons.*	
First	3, 082, 915	87. 63	3, 458, 066	85. 74	3, 394, 686	85. 81	2, 685, 244	88. 16
Second	1, 440, 266	82. 73	1, 733, 608	84. 29	2, 000, 664	85. 42	1, 703, 623	85. 07
Third	2, 794, 004	83. 54	3, 260, 951	83. 15	3, 397, 433	84. 19	3, 077, 918	83. 47
Fourth	4, 428, 109	79. 61	5, 117, 600	79. 94	5, 784, 866	77. 93	5, 173, 303	74. 95
Fifth	3, 915, 404	81. 06	4, 292, 051	81. 60	5, 371, 915	76. 73	4, 473, 488	80. 52
The State	15, 660, 698	82. 76	17, 862, 276	82. 47	19, 949, 564	80. 77	17, 113, 576	81. 02

The slight variations observed in the percentages of the lump grade of coal in each district, and for the State during the four years, give significance and marked importance to the correctness and reliability of the returns secured by the State inspectors. The first district shows a gain over previous years; the second, third, and fourth fall slightly below last year; while the fifth gives an increase. For the State the per cent this year is a trifle above last year, and a little below the two former years, leaving 18.98 per cent for the past year of nut and other grades.

The total tonnage, all grades, with the whole number of mines and men for thirteen years, is shown in the following table:

Total number of mines, men, and product, lump, and other grades, since 1882.

Years.	Whole number of mines.	Whole number of men employed.	Total product in tons (2,000 pounds).	Total tons of lump coal.	Total tons of other grades.
1882	704	20, 290	11, 017, 069	9, 115, 653	1, 901, 506
1883	639	23, 939	12, 123, 456	10, 030, 991	2, 092, 465
1884	741	25, 575	12, 208, 075	10, 101, 005	2, 107, 070
1885	778	25, 946	11, 834, 459	9, 791, 874	2, 402, 585
1886	787	25, 846	11, 175, 241	9, 246, 435	1, 928, 806
1887	801	26, 804	12, 423, 066	10, 278, 890	2, 144, 176
1888	822	29, 410	14, 328, 181	11, 855, 188	2, 472, 993
1889	854	30, 076	14, 017, 298	11, 597, 963	2, 419, 335
1890	936	28, 574	15, 274, 727	12, 638, 364	2, 636, 363
1891	918	32, 951	15, 660, 698	12, 960, 224	2, 700, 474
1892	839	33, 632	17, 062, 276	14, 730, 963	3, 131, 313
1893	788	35, 390	19, 949, 564	16, 112, 899	3, 836, 655
1894	836	38, 477	17, 113, 576	13, 865, 284	3, 248, 292

The prominent coal-producing counties, each of which nas contributed annually over 200,000 tons during the past four years, are presented in the following tables:

Counties which have produced more than 200,000 tons of coal, arranged in order of their rank, for the years 1891, 1892, 1893, and 1894.

Districts.	1891. Counties.	Rank.	Total product.	Districts.	1892. Counties.	Rank.	Total. product.
			Tons.				*Tons.*
5	St. Clair	1	1,595,839	4	Macoupin	1	1,823,136
4	Macoupin	2	1,461,344	5	St. Clair	2	1,759,822
1	Lasalle	3	1,378,168	1	Lasalle	3	1,544,311
4	Sangamon	4	1,051,604	1	Grundy	4	1,175,084
1	Grundy	5	921,907	4	Sangamon	5	1,091,014
3	Vermilion	6	880,466	3	Vermilion	6	972,589
4	Madison	7	719,308	2	Bureau	7	943,496
4	Christian	8	718,326	4	Madison	8	873,770
2	Bureau	9	701,064	5	Jackson	9	869,514
5	Jackson	10	681,859	4	Christian	10	767,354
5	Perry	11	604,152	3	Fulton	11	666,473
3	Peoria	12	564,119	3	Peoria	12	632,939
3	Fulton	13	484,117	1	Livingston	13	532,667
1	Livingston	14	458,329	5	Perry	14	461,068
5	Marion	15	321,652	5	Marion	15	376,519
2	Mercer'	16	314,360	2	Mercer	16	328,542
1	Will	17	233,603	5	Williamson	17	322,486
3	McLean	18	230,129	3	Menard	18	285,695
4	Macon	19	207,286	4	Macon	19	227,020
5	Williamson	20	206,452	3	McLean	20	222,372
3	Menard	21	204,583		Total	....	15,875,871
	Total	....	13,938,667				

Districts.	1893. Counties.	Rank.	Total product.	Districts.	1894. Counties.	Rank.	Total product.
			Tons.				*Tons.*
5	St. Clair	1	2,133,870	5	St. Clair	1	1,623,684
4	Macoupin	2	1,983,069	4	Macoupin	2	1,575,045
1	Lasalle	3	1,494,826	4	Sangamon	3	1,142,299
4	Sangamon	4	1,410,346	1	Lasalle	4	1,134,097
1	Grundy	5	1,186,919	1	Grundy	5	1,130,420
2	Bureau	6	1,143,270	4	Christian	6	1,005,500
3	Vermilion	7	996,768	3	Vermilion	7	989,813
4	Madison	8	951,894	4	Madison	8	889,768
5	Jackson	9	926,242	2	Bureau	9	878,937
5	Perry	10	860,151	5	Jackson	10	766,514
4	Christian	11	839,650	3	Peoria	11	611,792
3	Fulton	12	772,497	3	Fulton	12	557,703
3	Peoria	13	620,149	5	Perry	13	530,490
1	Livingston	14	542,516	5	Marion	14	478,757
5	Marion	15	480,529	5	Williamson	15	437,157
5	Williamson	16	418,426	2	Mercer	16	374,003
2	Mercer	17	363,206	1	Livingston	17	342,127
3	Menard	18	281,635	3	Menard	18	295,852
4	Macon	19	280,233	4	Macon	19	227,820
5	Clinton	20	255,095	5	Clinton	20	200,920
3	McLean	21	204,827		Total	....	15,192,698
	Total	....	18,151,117				

For this year twenty counties appear in the list. They produced 15,192,698 tons, which is 88.78 per cent of the total output of the State, leaving to the thirty-six other counties 1,920,878 tons, or 11.22 per cent of the output.

For this year St. Clair County again heads the list, but with over a half million tons less than last year; Macoupin retains the second place, while Sangamon ranks third for the first time; Lasalle takes fourth place after holding third for three years; Grundy County holds fifth place; Christian ranks as sixth, while Bureau, holding sixth place last year, goes to ninth. Will County has now been out of the list for three successive years, and McLean is dropped out for the first time.

The following table gives all the counties with their total product for the past eight years:

Output of coal in Illinois, by counties, for eight years.

Districts.	Output of lump coal.					1891—Output, all grades.
	1887.	1888.	1889.	1890.	1891.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
First district	2,686,829	2,877,794	2,530,453	2,303,326	2,701,652	3,082,915
Counties:						
Grundy	792,954	862,866	698,033	654,017	861,507	921,907
Kankakee	97,000	82,000	67,380	62,460	84,808	90,908
Lasalle	1,125,235	1,090,435	1,039,703	926,214	1,174,961	1,378,168
Livingston	387,600	495,388	382,965	372,504	355,800	458,329
Will	284,040	347,105	342,372	288,131	224,576	233,603
Second district	1,069,027	1,293,187	1,087,818	1,002,600	1,215,883	1,440,266
Counties:						
Bureau	459,580	635,097	493,730	372,701	612,292	701,064
Hancock	6,208	6,515	6,028	6,948	6,740	6,740
Henry	117,533	108,831	101,716	98,734	116,173	131,986
Knox	64,324	57,013	57,588	51,653	44,974	44,974
Marshall	73,928	87,013	59,784	56,574	53,319	65,219
McDonough	110,103	104,274	98,386	83,401	73,596	81,732
Mercer	127,708	167,931	175,690	238,290	222,237	314,360
Rock Island	85,282	57,872	47,363	39,696	38,654	41,540
Schuyler	22,686	34,403	16,243	21,836	15,369	20,122
Stark	17,865	18,690	19,171	18,672	20,157	20,157
Warren	13,810	15,518	12,149	14,095	12,372	12,372
Third district	1,781,395	2,192,121	2,050,349	2,375,970	2,336,500	2,794,004
Counties:						
Cass	2,325	7,300	4,414	4,650	5,680	6,466
Fulton	337,215	461,589	366,577	404,417	391,721	484,117
Logan	159,000	174,330	138,700	164,650	155,048	176,052
McLean	141,700	117,110	129,322	173,492	184,629	230,129
Menard	155,621	181,075	181,621	230,662	171,784	204,583
Peoria	452,123	533,817	454,731	482,725	498,601	564,119
Tazewell	51,847	59,324	67,973	81,141	85,692	107,252
Vermilion	359,119	499,076	537,411	704,509	728,156	880,466
Woodford	122,445	158,500	169,600	129,724	115,189	140,820
Fourth district	2,568,291	2,854,540	3,164,835	3,716,464	3,532,233	4,428,109
Counties:						
Bond	36,076	38,200	59,724	66,746	76,067	102,535
Calhoun	....	1,036	1,078	1,468	2,773	2,773
Christian	149,973	147,030	249,774	439,451	513,315	718,326
Coles	34,612	27,210	....	....	....	....
Effingham	....	....	....	796	*a* 487	*a* 487
Greene	12,578	14,494	19,048	11,714	16,442	16,442
Jasper	....	....	....	152	(*b*)	(*b*)
Jersey	2,684	3,949	4,040	7,500	4,252	4,252
Macon	118,183	280,805	233,309	179,050	126,569	207,286
Macoupin	926,588	1,016,624	1,202,187	1,369,919	1,149,380	1,461,344
Madison	521,705	512,948	490,181	646,228	600,294	719,308
Montgomery	10,220	14,295	24,425	58,617	94,975	107,190
Morgan	6,669	12,545	13,019	16,601	6,584	7,610
Pike	....	....	....	135	(*b*)	(*b*)
Richland	....	....	....	154	(*b*)	(*b*)
Sangamon	730,391	764,970	846,012	879,888	912,643	1,051,604
Scott	9,802	12,491	15,028	20,022	14,255	14,755
Shelby	8,810	7,943	7,010	18,023	14,197	14,197
Fifth district	2,173,348	2,637,546	2,764,478	3,240,004	3,173,956	3,915,404
Counties:						
Clinton	55,238	66,463	121,557	170,416	146,903	174,166
Franklin	....	....	....	700	200	200
Gallatin	31,437	45,374	30,044	52,383	31,119	34,462
Hardin	....	....	....	40	24	24
Hamilton	....	....	....	450	280	280
Johnson	28,000	28,210	3,000	12,110	424	424
Jackson	375,718	445,575	477,474	580,521	477,330	681,859
Jefferson	....	....	....	2,100	1,104	1,104
Marion	98,915	156,975	180,777	218,499	251,283	321,652
Perry	319,552	306,235	381,347	497,768	457,431	604,152
Randolph	74,263	167,321	98,202	134,699	162,717	172,321
Saline	19,518	32,550	35,496	45,845	38,729	54,269
St. Clair	1,018,149	1,184,579	1,198,100	1,332,978	1,389,429	1,595,839
Washington	40,220	43,600	36,220	25,160	56,500	68,200
Williamson	112,338	160,664	202,261	166,335	160,483	206,452
State totals	10,278,890	11,855,188	11,597,963	12,638,364	12,960,224	15,660,698

a Includes Jasper, Pike, and Richland counties. *b* Included in Effingham County.

Output of coal in Illinois, by counties, for eight years—Continued.

Districts.	1892—Output.			1893.		
	Lump coal.	Other grades.	All grades.	Lump coal.	Other grades.	All grades.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
First district	2, 965, 067	492, 999	3, 458, 066	2, 913, 144	481, 542	3, 394, 686
Counties:						
Grundy	1, 108, 419	66, 665	1, 108, 419	1, 106, 574	80, 345	1, 186, 919
Kankakee	81, 793	10, 365	92, 158	83, 700	5, 000	88, 700
Lasalle	1, 261, 467	282, 844	1, 544, 311	1, 242, 566	252, 260	1, 494, 826
Livingston	404, 491	128, 176	532, 667	402, 370	140, 146	542, 516
Will	108, 897	4, 949	113, 846	77, 934	3, 791	81, 725
Second district	1, 461, 224	272, 384	1, 733, 608	1, 708, 909	291, 755	2, 000, 664
Counties:						
Bureau	809, 009	134, 487	943, 496	976, 572	166, 698	1, 143, 270
Hancock	5, 380		5, 380	5, 060		5, 060
Henry	142, 762	13, 974	156, 736	148, 324	7, 937	156, 261
Knox	43, 137		43, 137	49, 808		49, 808
Marshall	64, 276	14, 300	78, 576	78, 700	13, 444	92, 144
McDonough	82, 001	9, 126	91, 127	92, 096	10, 830	102, 926
Mercer	233, 244	95, 298	328, 542	273, 390	89, 816	363, 206
Rock Island	34, 017	2, 092	36, 109	34, 058	250	34, 308
Schuyler	13, 685	3, 107	16, 792	15, 955	2, 780	18, 735
Stark	22, 349		22, 349	23, 070		23, 070
Warren	11, 364		11, 364	11, 876		11, 876
Third district	2, 711, 574	549, 377	3, 260, 951	2, 860, 299	537, 134	3, 397, 433
Counties:						
Cass	13, 270	2, 060	15, 330	21, 370	1, 780	23, 150
Fulton	535, 288	131, 185	666, 473	610, 854	161, 643	772, 497
Logan	163, 002	24, 354	187, 356	157, 699	31, 620	189, 319
McLean	170, 912	51, 460	222, 372	153, 027	51, 800	204, 827
Menard	237, 419	48, 276	285, 695	230, 296	51, 339	281, 635
Peoria	541, 659	91, 280	632, 939	537, 928	82, 221	620, 149
Tazewell	94, 190	25, 966	120, 156	113, 597	15, 360	128, 957
Vermilion	827, 893	144, 696	972, 589	873, 597	123, 171	996, 768
Woodford	127, 941	30, 100	158, 041	161, 931	18, 200	180, 131
Fourth district	4, 090, 921	1, 026, 679	5, 117, 600	4, 508, 382	1, 276, 484	5, 784, 866
Counties:						
Bond	92, 308	29, 504	121, 812	56, 120	22, 480	78, 600
Calhoun	4, 637		4, 637	4, 584		4, 584
Christian	525, 746	241, 608	767, 354	593, 602	246, 048	839, 650
Coles						
Effingham	*a* 302		302	520		520
Greene	19, 870		19, 870	10, 995		10, 995
Jasper	(*b*)			(*b*)	(*b*)	(*b*)
Jersey	3, 378		3, 378	5, 904		5, 904
Macon	198, 375	28, 645	227, 020	237, 442	42, 791	280, 233
Macoupin	1, 434, 021	389, 115	1, 823, 136	1, 509, 594	478, 475	1, 988, 069
Madison	703, 980	169, 790	873, 770	758, 288	193, 606	951, 894
Montgomery	119, 850	28, 020	147, 870	123, 920	51, 792	175. 712
Morgan	4, 266		4, 266	2, 142		2, 142
Pike	(*b*)			(*b*)	(*b*)	(*b*)
Richland	(*b*)			(*b*)	(*b*)	(*b*)
Sangamon	951, 517	139, 497	1, 091, 014	1, 170, 854	239, 492	1, 410, 346
Scott	17, 006	500	17, 506	22, 157	600	22, 757
Shelby	15, 665		15, 665	12, 260	1, 200	13, 460
Fifth district	3, 502, 177	789, 874	4, 292, 051	4, 122, 165	1, 249, 750	5, 371, 915
Counties:						
Clinton	156, 376	35, 497	191, 873	174, 994	80, 101	255, 095
Franklin	200		200	120		120
Gallatin	13, 782	720	14, 502	14, 972	2, 485	17, 457
Hardin						
Hamilton	220		220	244		244
Johnson	2, 200		2, 200			
Jackson	674, 161	195, 353	869, 514	674, 943	251, 299	926, 242
Jefferson	100		100	90		90
Marion	306, 019	70, 500	376, 519	352, 793	127, 736	480, 529
Perry	362, 926	98, 142	461, 068	620, 502	239, 649	860, 151
Randolph	160, 532	8, 447	168, 979	161, 565	9, 490	171, 055
Saline	41, 992	19, 610	61, 602	24, 929	11, 507	36, 436
St. Clair	1, 519, 472	240, 350	1, 759, 822	1, 778, 787	355, 083	2, 133, 870
Washington	54, 183	8, 783	62, 966	63, 500	8, 700	72, 200
Williamson	210, 014	112, 472	322, 486	254, 726	163, 700	418, 426
State totals	14, 730, 963	3, 131, 313	17, 862, 276	16, 112, 899	3, 836, 665	19, 949, 564

a Includes Jasper, Pike, and Richland counties. *b* Included in Effingham County.

Output of coal in Illinois, by counties, for eight years—Continued.

Districts.	1894.		
	Lump coal.	Other grades.	All grades.
	Short tons.	*Short tons.*	*Short tons.*
First district	2,367,298	317,946	2,685,244
Counties:			
Grundy	1,052,233	78,187	1,130,420
Kankakee	50,883	7,000	57,883
Lasalle	968,243	165,854	1,134,097
Livingston	276,654	65,473	342,127
Will	19,285	1,432	20,717
Second district	1,449,356	254,267	1,703,623
Counties:			
Bureau	743,764	135,173	878,937
Hancock	10,290	25	10,315
Henry	105,453	6,187	111,640
Knox	50,581	949	51,530
Marshall	117,612	17,084	134,696
McDonough	50,223	3,144	53,367
Mercer	286,445	87,558	374,003
Rock Island	40,041	1,600	41,641
Schuyler	11,774	2,054	13,828
Stark	22,182	443	22,625
Warren	10,991	50	11,041
Third district	2,569,268	508,650	3,077,918
Counties:			
Cass	13,300	5,600	18,900
Fulton	444,896	112,807	557,703
Logan	154,025	32,275	186,300
McLean	125,053	42,241	167,294
Menard	235,873	59,979	295,852
Peoria	517,957	93,835	611,792
Tazewell	85,399	8,200	93,599
Vermilion	842,615	147,198	989,813
Woodford	150,150	6,515	156,665
Fourth district	3,877,110	1,296,193	5,173,303
Counties:			
Bond	54,091	25,500	79,591
Calhoun	3,478		3,478
Christian	671,278	334,222	1,005,500
Coles			
Effingham	5,440		*a* 5,440
Greene	18,400	200	18,600
Jasper			
Jersey	2,238		2,238
Macon	190,388	37,432	227,820
Macoupin	1,173,392	401,653	1,575,045
Madison	682,520	207,248	889,768
Montgomery	122,742	55,298	178,040
Morgan			
Pike			
Richland			
Sangamon	912,700	229,599	1,142,299
Scott	18,525	500	19,025
Shelby	21,909	4,541	26,450
Fifth district	3,602,252	871,236	4,473,488
Counties:			
Clinton	150,159	50,761	200,920
Franklin			
Gallatin	153,116	2,235	155,351
Hardin			
Hamilton	620		*b* 620
Johnson			
Jackson	566,540	199,974	766,514
Jefferson			
Marion	354,670	124,087	478,757
Perry	394,702	135,788	530,490
Randolph	180,971	12,276	193,247
Saline	24,864	12,049	36,913
St. Clair	1,427,714	195,970	1,623,684
Washington	48,435	1,400	49,835
Williamson	300,461	136,696	437,157
State totals	13,865,284	3,248,292	17,113,576

a Includes Cumberland, Jasper, Morgan, Pike, and Richland counties.
b Includes Franklin and Jefferson counties.

This table is supplemented by the following, giving the totals of the State, mines, men, and product for twelve years:

Number of mines, employees, and tons raised, in each district and the State, for each of the twelve years, on the basis of all grades of product.

Years.	First.			Second.			Third.		
	Mines.	Employees	Coal.	Mines.	Employees	Coal.	Mines.	Employees	Coal.
			Tons.			*Tons.*			*Tons.*
1883	93	7, 566	3, 015, 544	229	3, 211	1, 004, 977	92	4, 070	2, 036, 662
1884	84	8, 013	3, 030, 407	264	3, 616	890, 273	171	5, 018	2, 336. 080
1885	74	7, 463	3, 044, 943	236	3, 391	873, 911	209	5, 213	2, 189. 264
1886	69	7, 613	2, 812, 100	262	3, 599	851, 728	223	4, 870	1. 835, 193
1887	68	7, 915	3, 247, 302	275	4, 068	1, 292, 026	236	4, 903	2, 152, 994
1888	70	8, 623	3, 478, 106	267	4, 914	1, 562. 946	237	5, 250	2, 649, 397
1889	72	9, 018	3, 058, 305	264	4, 498	1, 314, 773	246	5, 117	2, 478, 052
1890	79	8, 258	2, 783, 700	254	4. 099	1, 211, 742	273	5, 171	2, 871, 597
1891	70	9, 128	3, 082, 915	264	5, 089	1, 440, 266	273	6, 458	2, 794, 004
1892	70	9, 572	3, 458, 066	240	4, 865	1, 733, 608	256	6, 453	3, 260. 951
1893	71	8, 831	3, 394, 686	224	5, 794	2, 000, 664	236	6, 964	3, 397, 433
1894	72	10, 280	2, 685, 244	241	6, 714	1, 703, 623	251	7, 112	3, 077, 918

Years.	Fourth.			Fifth.			The State.		
	Mines.	Employees.	Coal.	Mines.	Employees.	Coal.	Mines.	Employees.	Coal.
			Tons.			*Tons.*			*Tons.*
1883	95	4, 417	3, 660, 086	130	4, 695	2, 406, 227	639	23, 939	12, 123, 456
1884	104	3, 781	3, 389, 136	118	4, 147	2, 572, 262	741	25, 575	12, 208, 075
1885	104	4, 950	3, 161, 808	126	4, 429	2, 564, 653	778	25, 946	11, 834, 459
1886	109	5, 197	3, 323, 424	126	4, 567	2 352, 794	787	25, 846	11, 175, 241
1887	111	4, 934	3, 104, 520	118	4, 984	2, 626, 708	801	26. 804	12, 423, 066
1888	108	5, 086	3, 449, 997	151	5, 537	3, 187, 738	822	29, 410	14, 328, 181
1889	98	5, 679	2, 825, 020	174	5, 764	3, 341, 148	854	30, 076	14, 017, 298
1890	137	5, 685	4, 491, 718	193	5, 361	3, 915, 869	936	28, 574	15, 274, 727
1891	126	5, 881	4, 428, 109	185	6, 395	3, 915, 404	918	32, 951	15, 660, 698
1892	109	6, 542	5, 117, 600	164	6, 200	4, 292, 051	839	33, 632	17, 862, 276
1893	104	7, 021	5, 784, 866	153	6, 780	5, 371, 915	788	35, 390	19, 949, 564
1894	130	7, 750	5, 173. 303	142	6, 621	4, 473, 488	836	38, 477	17, 113, 576

NUMBER OF EMPLOYEES.

The record this year of the total number employed in and about the coal mines of the State is 38,477. Of these 32,046 are given as miners, or those employed under ground, and 6,431 above ground. The number under ground includes 701 boys over 14 years of age, over 150 boys less than reported for any previous year, and nearly 300 less than the highest number recorded, which was 995 in 1891.

It is certainly gratifying to note the lessening of the number of boys employed in our coal mines, for it is significant of a betterment of their condition and that, instead of being continued in this underground employment, limited in the development of both mind and body, they are possibly to be found in schools or seeking a livelihood in some of the various industries of our great Commonwealth.

The following table gives the distribution of employees by districts for twelve years:

Total number of employees in and about the mines by districts for twelve years.

Years.	First.	Second.	Third.	Fourth.	Fifth.	The State.
1883	7,566	3,211	4,079	4,417	4,675	23,939
1884	8,013	3,616	5,018	4,781	4,147	25,575
1885	7,463	3,391	5,213	4,950	4,429	25,446
1886	7,613	3,599	4,870	5,197	4,567	25,846
1887	7,915	4,068	4,903	4,934	4,984	26,804
1888	8,623	4,914	5,250	5,086	5,537	29,410
1889	9,014	4,498	5,117	5,679	5,764	30,076
1890	8,258	4,099	5,171	5,685	5,361	28,574
1891	9,128	5,089	6,458	5,881	6,395	32,951
1892	9,572	4,865	6,453	6,542	6,200	33,632
1893	8,831	5,794	6,964	7,021	6,780	35,390
1894	10,280	6,714	7,112	7,750	6,621	38,477
Net increase	2,714	3,503	3,042	3,333	1,946	14,538
Per cent increase	35.89	112.21	74.74	75.46	41.63	60.73

The second district shows very much the largest per cent of gain; the third and fourth are about equal, and there is only a slight difference between the first and fifth, making for the State an increase in the twelve years of over 60 per cent.

DAYS OF ACTIVE OPERATION.

The general depression of business in manufacturing industries, as indicated by the decline in output and prices, the suspension of work during the labor troubles, and the increased number of employees have, as a natural consequence, reduced the average working time for all the mines for the year to a less number of days than ever before. The average active days of operation of the mines of the State has been for years founded on the given running time of the large and important plants. Last year 301 of these mines, which produced 96 per cent of the coal and employed 91 per cent of the men, had an average of 230 days. For this year the number of mines is 295, yielding 92 per cent of the tonnage and employing 81 per cent of the men, but showing an average of only 183 days. The mines considered in these computations are designated as shipping mines. The following table presents their record by districts for four years:

Shipping mines producing 1,000 tons or more, and working one hundred days or more, with average number of days and average number of total tons produced by districts for four years.

Districts.	1894.			1893.			1892.			1891.		
	Mines.	Average number of days.	Average number of tons, all grades.	Mines.	Average number of days.	Average number of tons, all grades.	Mines.	Average number of days.	Average number of tons, all grades.	Mines.	Average number of days.	Average number of tons, all grades.
First	35	161.5	69,019	38	220	86,860	35	218.3	81,026	36	207.6	82,961
Second	26	171	51,794	26	228	65,214	29	214.8	43,734	28	214.6	43,710
Third	81	182.9	33,735	80	215	39,316	84	203.8	29,241	88	193	28,524
Fourth	63	194.7	81,195	56	251	102,027	55	239.9	72,771	53	238.8	80,275
Fifth	90	186.9	45,762	101	233	52,366	96	221.8	35,204	106	225	36,096
The State	295	183.1	53,318	301	229.6	63,818	299	219.5	46,630	311	215.6	47,593

To more clearly illustrate the accuracy of the calculations presented, a corresponding table follows, including all mines producing 1,000 tons or over and running one hundred days or more:

All mines producing 1,000 tons or more, and working one hundred days or more, with average number of days and average number of total tons produced, for four years, by districts.

Districts.	1894.			1893.			1892.			1891.		
	Mines.	Average number of days.	Average number of tons, all grades.	Mines.	Average number of days.	Average number of tons, all grades.	Mines.	Average number of days.	Average number of tons, all grades.	Mines.	Average number of days.	Average number of tons, all grades.
First	56	177. 7	46.067	60	213	56, 459	59	207. 5	57, 777	53	200. 9	57, 570
Second	107	187	14, 371	93	225	20, 794	91	268	17, 132	93	215. 4	14, 901
Third	145	187. 8	20, 264	136	213	24, 508	144	239. 9	22, 152	146	201	18, 483
Fourth	80	191	64, 404	80	249	72, 132	81	240	62, 592	85	233. 5	51, 236
Fifth	119	195. 6	36, 751	128	223	41, 843	120	227. 7	35, 477	127	227. 8	30, 727
The State	507	188. 9	32, 703	497	225. 5	39, 801	495	217. 7	35, 523	504	215. 8	30, 506

A condensed table of all the mines included in the foregoing statements, for four years, with the average tonnage, is presented:

Years.	Shipping mines.			Mines in local trade.			Both classes of mines.		
	Mines.	Average number of days.	Average number of tons, all grades.	Mines.	Average number of days.	Average number of tons, all grades.	Mines.	Average number of days.	Average number of tons, all grades.
1891	311	215. 6	47, 593	193	216. 1	2, 829	504	215. 8	30, 506
1892	299	219. 5	46, 630	196	215. 2	3, 042	495	217. 7	35, 523
1893	301	229. 6	63, 818	196	219. 5	2, 881	497	225. 5	40, 287
1894	295	183	53, 318	212	196. 9	4, 018	507	188. 9	32, 703

AVERAGE VALUE OF COAL.

The proper valuation of the coal production of the State in its aggregate and per ton is considered of the highest importance. The statement has been repeatedly made in these reports that the detailed valuations published are as given by each operator to the inspectors as the average value of the coal at the mine. These returns therefore form the basis upon which this value is computed; first on the number of tons at the given price for each mine; then successively for counties, for districts, and for the State. Very careful and methodical computations are wrought out, so that the results present the most reliable figures possible to be obtained. These methods have been adhered to in these reports for each of the several years. The values given are not, however, to be taken as governing in any market nor for any contracts, but represent only the statement of each owner of the average he receives for the product during the year.

Results of these estimates are shown in lump tons, by districts, for a series of thirteen years:

Average value of lump coal per ton, 2,000 pounds, at the mines.

Years.	Total lump coal.	First district.	Second district.	Third district.	Fourth district.	Fifth district.	The State.	Increase.	Decrease.
	Tons.							*Cents.*	*Cents.*
1882	9, 115, 653	$1. 75	$1. 87	$1. 42	$1. 33	$1. 31	$1. 51		
1883	10, 030, 991	1. 59	1. 97	1. 45	1. 32	1. 26	1. 48		3
1884	10, 101, 005	1. 49	1. 75	1. 31	1. 09	. 961	1. 26		22
1885	9, 791, 874	1. 41	1. 71	1. 25	. 985	. 894	1. 17		9
1886	9, 246, 435	1. 32	1. 57	1. 16	. 969	. 862	1. 10		7
1887	10, 278, 890	1. 316	1. 497	1. 095	. 887	. 823	1. 085		1. 5
1888	11, 855, 188	1. 369	1. 473	1. 138	. 947	. 857	1. 123	3. 8	
1889	11, 597, 963	1. 355	1. 432	1. 104	. 965	. 867	1. 078		4. 5
1890	12, 638, 364	1. 302	1. 477	1. 065	. 873	. 811	1. 019		5. 9
1891	12, 960, 224	1. 208	1. 426	1. 032	. 853	. 757	1. 008		1. 1
1892	14, 730, 963	1. 323	1. 432	1. 053	. 836	. 817	1. 029	2. 1	
1893	16, 112, 899	1. 333	1. 455	1. 074	. 836	. 803	1. 025		. 4
1894	13, 865, 284	1. 316	1. 416	1. 043	. 821	. 826	1. 009		1. 6
Net decrease	*a* 4, 749, 631	. 434	. 454	. 387	. 509	. 484	. 501		50. 10
Per cent of decrease	*a* 52. 1	24. 1	24. 3	27.	38. 3	37.	33. 2		

a Increase.

In order to gain information as to the wide range in values resultant from diversified conditions and localities, reference must be had to the individual tables of mines. In St. Clair, the banner county in point of production for a number of years, the value is found at some mines to be as low as 50 cents per ton, and in many others it ranges but a few cents higher; in all, making the average for the county only 66.5 cents per ton. This is the minimum price in that district and in the State. The maximum value is reached in Grundy County, at $2.25 per ton. This value, however, obtains only for an inconsiderable tonnage. The mines in Bureau and other counties of the second district realize a higher uniformity of values per ton than elsewhere in the State, making the yearly average of this district the highest.

The average value found for the State is $1.009 per ton. This is the mean between $1.416 in the second district and 82.1 cents in the fourth. The fourth district for the first time shows the lowest average value per ton, and is only five-tenths of a cent below the fifth district. These two districts represent about 54 per cent of the tonnage of the State, on which this minimum value is based.

The total product for the past six years, with the average value per ton and the aggregate value of the total output, is presented in the following table, and concludes the consideration of the value of the product:

Total amount and value of lump coal produced in Illinois for six years.

Year.	Total product of lump coal.	Average value of lump coal per ton at the mine.	Aggregate value of total product of lump coal at the mine.	Aggregate value of the total product, all grades, at the mine.
	Tons.			
1889	11, 597, 963	$1. 0775	$12, 496, 885	
1890	12, 638, 361	1. 0194	12, 882, 936	
1891	12, 960, 224	1. 0084	13, 068, 854	$14, 237, 094
1892	14, 730, 963	1. 0291	15, 158, 430	16, 243, 645
1893	16, 112, 899	1. 025	16, 517, 960	17, 827, 595
1894	13, 865, 284	1. 009	13, 998, 588	15, 282, 111

INDIANA.

Total product in 1894, 3,423,921 short tons; spot value, $3,295,034.

COAL FIELDS OF INDIANA.

The southwestern part of Indiana contains the southeastern end of the Central or Illinois coal basin. The northern limit of the field in Indiana is in Warren County, where it crosses the State line from Illinois. Its border line passes from Warren through the eastern part of Fountain County, the northeastern corner of Parke County, and on slightly east of south, near and a little west of Greencastle, in Putnam County, and Spencer, in Owen County. It takes in something more than half of Greene County, where an extension juts out into Monroe County, crosses along the western part of Martin County into the eastern part of Dubois, extends eastward into Crawford County, takes in the western third of Perry County, and crosses the Ohio River into Kentucky near Cannelton. The coal-bearing rocks occur altogether in nineteen counties, and have an area of about 6,500 square miles. The most important coal in the State, from a manufacturing point of view, is the well-known "block" coal, peculiar to this State and a part of Illinois. Block coal is described as having a laminated structure, and is composed of alternate thin layers of vitreous, dull, black coal and fibrous mineral charcoal. It splits readily into sheets, and is with difficulty broken in the opposite direction. In burning it swells so little that its expansion is scarcely perceptible, does not change form, and never cakes or runs together. It is as pure as splint coal, free from sulphur, and has the softness and combustibility of wood. Its effects in the iron furnace are said to exceed those of charcoal in the quantity and quality of iron produced. In addition to the block coal, there are four other varieties in the State, known as semiblock, coking, semicoking, and cannel.

PRODUCTION.

Indiana has held sixth place in the rank of coal-producing States, but not since 1886. In 1887 she fell to seventh; in 1888, 1889, and 1890 she was eighth; in 1891 and 1892 ninth, and rose again to eighth in 1893 and 1894. The output in 1894 was 367,930 short tons, or nearly 10 per cent, less than in 1893, the decrease being due, as in other States, partly to the strike and partly to the business depression. The effects of the latter are more clearly shown in the greater proportionate decrease in value, which fell from $4,055,372 in 1893 to $3,295,034 in 1894, a decline of $760,338, or 18.7 per cent. The average price per ton declined from $1.07 in 1893 to 96 cents in 1894.

In the following tables will be seen the statistics of production in Indiana in 1893 and 1894, with the distribution of the product for consumption:

Coal product of Indiana in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Clay	1,163,142	17,626	28,935	....	1,209,703	$1,559,339	$1.29	196	2,976
Daviess	313,312	4,110	2,365	....	319,787	310,692	.97	213	553
Dubois	....	9,172	970	....	50,142	13,691	1.35	300	18
Fountain	3,500	200	300	....	4,000	4,000	1.00	150	18
Greene	251,730	2,000	6,200	....	259,930	215,666	.83	203	391
Knox	13,357	....	....	....	13,357	14,693	1.10	183	37
Owen	5,785	....	....	....	5,785	5,258	.91	135	27
Parke	478,086	6,307	7,454	....	491,847	563,930	1.16	202	1,091
Pike	238,372	1,181	4,000	....	243,353	185,482	.76	211	365
Perry	28,512	7,400	340	....	36,252	42,758	1.13	198	100
Spencer	6 834	613	200	....	7,647	6,398	.84	170	29
Sullivan	252,840	22,578	7,719	7,345	290,482	254,284	.88	221½	460
Vanderburg	55,372	121,412	9,269	....	186,053	200,705	1.08	250	357
Vermilion	262,179	500	1,545	....	264,224	253,219	.96	158	507
Vigo	339,643	10,500	....	....	350,143	332,859	.95	217	579
Warrick	49,166	9,280	500	....	58,946	52,398	.89	129	136
Small mines	....	40,000	....	....	40,000	40,000	1.00	....	....
Total	3,461,830	252,879	69,797	7,345	3,791,851	4,055,372	1.07	201	7,644

Coal product of Indiana in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total production.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Clay	25	865,950	7,020	8,919	8,825	890,714	$1,008,293	$1.13	131	3,114
Daviess	5	100,233	550	50	....	100,833	104,021	1.03	116	350
Fountain and Owen	2	25,789	492	225	....	26,506	29,535	1.11	146	105
Gibson	2	15,521	3,000	500	....	19,021	14,865	.78	143	36
Greene	5	292,606	858	7,010	....	300,474	287,498	.96	141	576
Knox	2	18,076	9,641	1,145	....	28,862	24,133	.84	153	64
Parke	15	327,011	21,992	7,262	....	356,265	370,419	1.07	135	1,065
Pike	5	158,749	1,183	4,935	8,689	173,556	134,007	.77	148	348
Perry	2	22,668	7,492	536	....	30,696	34,657	1.12½	168	93
Spencer	5	6,711	3,187	285	....	10,183	10,513	1.03	170	40
Sullivan	12	496,495	18,589	17,193	4,800	537,077	440,410	.82	152	885
Vanderburg	5	55,286	108,923	11,672	....	175,881	168,987	.96	215	330
Vermilion	4	289,791	2,060	4,371	....	296,222	243,354	.82	165	710
Vigo	10	309,593	10,666	1,280	....	321,539	301,555	.95	196	740
Warrick	8	101,185	16,745	2,162	....	120,092	86,787	.72	199	147
Small mines	....	....	36,000	....	....	36,000	36,000	....	....	....
Total	107	3,085,664	248,398	67,545	22,314	3,423,921	3,295,034	.96	149	8,603

Previous to 1889 the statistics of production by counties were not obtained. The following table shows the annual product by counties since that year, with a statement of the increase or decrease in each county in 1894 as compared with 1893:

Coal product of Indiana since 1889, by counties.

[Short tons.]

Counties.	1889.	1890.	1891.	1892.	1893.	1894.	Increase in 1894.	Decrease in 1894.
Clay	695, 649	1, 161, 730	980, 921	1, 146, 897	1, 209, 703	890, 714		318, 989
Daviess	191, 585	189, 696	155, 358	174, 560	319, 787	100, 833		218, 954
Dubois	15, 848	13, 994	7, 700		10, 142			10, 142
Fountain	41, 141	24, 000	23, 700	13, 888	4, 000	18, 931	14, 931	
Gibson	1, 267					19, 021	19, 021	
Greene	185, 849	197, 338	164, 965	228, 574	259, 930	300, 474	40, 544	
Knox	9, 040			14, 314	13, 357	28, 862	15, 505	
Martin	710							
Owen	3, 958		12, 600	8, 200	5, 785	7, 575	1, 790	
Parke	357, 434	345, 460	307, 382	394, 335	491, 847	356, 265		135, 582
Perry	40, 050	40, 201	35, 400	37, 796	36, 252	30, 696		5, 556
Pike	154, 524	115, 836	122, 066	78, 760	243, 553	173, 556		69, 997
Spencer	18, 456	11, 656	15, 340	8, 426	7, 647	10, 183	2, 536	
Sullivan	317, 252	286, 323	181, 434	316, 893	290, 482	537, 077	246, 595	
Vanderburg	183, 942	192, 284	205, 731	190, 346	186, 053	175, 881		10, 172
Vermilion	187, 651	173, 000	228, 488	301, 063	264, 224	296, 222	31, 998	
Vigo	371, 903	429, 160	400, 255	307, 113	350, 143	321, 539		28, 604
Warren	2, 160							
Warrick	66, 638	89, 059	96, 134	84, 009	58, 946	120, 092	61, 146	
Small mines		36, 000	36, 000	40, 000	40, 000	36, 000		4, 000
Total	2, 845, 057	3, 305, 737	2, 973, 474	3, 345, 174	3, 791, 851	3, 423, 921		a367,930

a Net decrease.

The following table is of interest as showing the total amount and value of coal produced in the State from 1886 to 1894, and the total number of employees and average number of working days in each year since 1889:

Statistics of coal production in Indiana since 1886.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employees.
1886	3, 000, 000	$3, 450, 000	$1. 15		
1887	3, 217, 711	4, 324, 604	1. 03		
1888	3, 140, 979	4, 397, 370	1. 40		
1889	2, 845, 057	2, 887, 852	1. 02		6, 448
1890	3, 305, 737	3, 259, 233	. 99	220	5, 489
1891	2, 973, 474	3, 070, 918	1. 03	190	5, 879
1892	3, 345, 174	3, 620, 582	1. 08	225	6, 436
1893	3, 791, 851	4, 055, 372	1. 07	201	7, 644
1894	3, 423, 921	3, 295, 034	. 96	149	8, 603

In the following table is shown the total annual product of coal in the State since 1873:

Product of coal in Indiana from 1873 to 1894.

Years.	Short tons.	Years.	Short tons.
1873	1, 000, 000	1884	2, 260, 000
1874	812, 000	1885	2, 375, 000
1875	800, 000	1886	3, 000, 000
1876	950, 000	1887	3, 217, 711
1877	1, 000, 000	1888	3, 140, 979
1878	1, 000, 000	1889	2, 845, 057
1879	1, 196, 490	1890	3, 305, 737
1880	1, 500, 000	1891	2, 973, 474
1881	1, 771, 536	1892	3, 345, 174
1882	1, 976, 470	1893	3, 791, 851
1883	2, 560, 000	1894	3, 423, 921

In accordance with the plan adopted in discussing the production in other States, the following tables are given to show the tendency in prices and the statistics of labor employed and average working time by counties for such years as they have been obtained. They include only those counties whose annual product averages 10,000 tons or over.

Average prices for Indiana coal since 1889, in counties averaging 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Clay	$1.14	$1.01	$1.15	$1.25	$1.29	$1.13
Daviess	1.02	1.04	1.12	1.11	.97	1.03
Fountain	1.29	1.00	.99	.89	1.00	1.08
Gibson						.78
Greene	.91	.94	.91	.84	.83	.96
Knox				.84	1.10	.84
Parke	1.05	1.09	1.13	1.09	1.16	1.07
Perry	1.18	1.05	1.10	.86	1.13	1.12½
Pike	.83	.98	.90	.87	.76	.77
Spencer	1.15	.96	.88	.80	.84	1.03
Sullivan	.94	.94	1.01	.89	.88	.82
Vanderburg	1.16	1.02	1.09	1.06	1.08	.96
Vermilion	.89	1.17	.98	.96	.96	.82
Vigo	.88	.80	.80	1.14	.95	.95
Warrick			.77	.81	.89	.72
The State	1.02	.99	1.03	1.08	1.07	.96

Statistics of labor employed in Indiana coal mines.

Counties.	1889.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average number employed.	Average number of days worked.	Average number employed.	Average number of days worked.	Average number employed.	Average number of days worked.	Average number employed.	Average number of days worked.	Average number employed.	Average number of days worked.
Clay	2,592	2,179	218	2,346	181	2,797	239	2,976	196	3,114	131
Daviess	455	280	231	359	217	403	224	553	213	350	116
Fountain	41	48	260	252	40	30	315	18	150	75	160
Gibson	7									36	143
Greene	296	250	218	154	300	335	227	391	203	576	141
Knox	22					28	138	37	183	64	153
Parke	591	558	254	510	255	639	228	1,091	202	1,065	135
Perry	109	100	250	95	190	88	227	100	198	93	168
Pike	340	235	170	230	198½	160	163	365	211	348	148
Spencer	29	39	261	46	204	13	310	29	170	40	170
Sullivan	556	588	181	544	130½	522	242	460	221½	885	152
Vanderburg	318	454	262	338	228½	282	262	357	250	330	215
Vermilion	276	307	244	380	147	545	164	507	158	710	165
Vigo	629	280	161	487	244	491	217	579	217	740	196
Warrick	85	131	222	161	199	171	141	136	129	147	199
The State	6,448	5,489	220	5,879	190	6,436	225	7,644	201	8,603	149

INDIAN TERRITORY.

Total product in 1894, 969,606 short tons; spot value, $1,541,293.

COAL MEASURES OF THE INDIAN TERRITORY.

The Ouachita Mountain system extends east and west through the Indian Territory south of the Arkansas and Canadian rivers.

The Coal Measures of the Territory are excessively folded along the immediate axes of this system. To the northward the coal-bearing beds dip away toward the Kansas measures. West of the ninety-eighth meridian they are overlapped by the Red beds of Oklahoma; south of the system, except in a limited region near Ardmore, the Carboniferous rocks are overlapped by the Red beds and the Cretaceous of the Texas region.

By this geologic arrangement the area containing available Coal Measures is mostly exposed on the north side of the Ouachita Mountains and in the prairie region of the northeast portion of the Territory adjacent to Kansas. Local outcrops may be preserved in patches in the area of excessive folding, but little is known concerning them.

By these mountainous conditions it will be seen that the coal fields of the Indian Territory are not continuous with those of Texas, as is frequently and erroneously asserted. Their relations by direct continuity are with the Arkansas and Kansas coal fields. Little reconnoissance, to say nothing of detailed exploration, has been made of the coal fields of the Indian Territory. The outcrop of the measures of the Carboniferous formation containing them is approximately delineated on the latest edition of the geological map of the United States, published by the United States Geological Survey. The only portion of the coal fields of the Territory which has been accurately defined is what is known as the Choctaw field. The survey of this field was made by Mr. H. M. Chance, and his report has been published in the Transactions of the American Institute of Mining Engineers, Volume XVIII, page 653, and in Mineral Resources, 1889–90, page 208.

PRODUCTION.

No record of the production of coal in the Indian Territory prior to 1885 is in existence. During 1885 an output of 500,000 short tons was obtained. From that time the output increased annually, except in one year, until 1893, when it reached 1,252,110 short tons, more than five times the product nine years before. In 1894, owing to the general strike, which extended its influences to the Territory, the product fell off about 22 per cent, to 969,606 short tons. There was only one company whose mines were not closed. The others suspended operations from two to four months. The exception was the Choctaw, Oklahoma and Gulf Railroad Company (formerly the Choctaw Coal and Railway

Company), and the product at these mines showed a slight increase over 1893. The Choctaw Coal and Railway Company was reorganized in 1894, and the name changed to the Choctaw, Oklahoma and Gulf Railroad Company. By the reorganization the company is placed upon a better financial basis, and the railroad will be extended westward into Colorado, to furnish a new outlet for the Colorado Fuel and Iron Company's mines. Contracts for 15,000 tons of steel rails, necessary to complete the extension, were made in August, 1894.

The product of the Territory in 1894 was less than in any year since 1890. In 1891 it passed the million-ton mark, and increased further both in 1892 and in 1893, the latter year recording the largest product in the history of coal mining in the Territory. The following table shows the statistics of production in the past four years:

Coal product of the Indian Territory in 1891, 1892, 1893, and 1894.

Distribution.	1891.	1892.	1893.	1894.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
Loaded at mines for shipment	1,026,932	1,156,603	1,197,468	923,581
Sold to local trade and used by employees	9,405	10,840	9,234	4,632
Used at mines for steam and heat	22,163	18,089	21,663	30,878
Made into coke	32,532	7,189	23,745	10,515
Total	1,091,032	1,192,721	1,252,110	969,606
Total value	$1,897,037	$2,043,479	$2,235,209	$1,541,293
Total number of employees	2,891	3,257	3,446	3,101
Average number of days worked	222	211	171	157

The value of the product in 1894 decreased in greater proportion than the amount, from $2,235,209 to $1,541,293, the difference being $693,916, or about 31 per cent, against a decrease of 22 per cent in the amount. The value in 1893 was somewhat enhanced by the long strike in the Kansas mines, which created an unusual demand for Territory coal, and was an important factor in the increased product for that year. The trade depression in 1894 brought the average price down to $1.59, the lowest on record, and 20 cents below that of 1893.

The developed coal fields of the Indian Territory are mostly in the Choctaw Nation, and are reached by four lines of railroad, the Missouri, Kansas and Texas, the St. Louis and San Francisco, the Denison and Washita Valley, and the Choctaw Coal and Railroad Company's railroads. The last mentioned, however, acts really as a feeder to the Missouri, Kansas and Texas and the St. Louis and San Francisco lines, though its own line is now being completed to marketing points. The Denison and Washita has also acted principally as a feeder to the Missouri, Kansas and Texas, but is now completing its line through to Denison, Tex., and will soon be independent of the other roads for reaching points of consumption. The Territory coals are bituminous, of excellent quality. They are consumed largely in Texas, going as far south as Houston and San Antonio. The output has shown an almost steady increase since 1885, the only exceptions being in 1889 and 1894. The following table shows the annual production since 1885:

Product of coal in the Indian Territory from 1885 to 1894, inclusive.

Years.	Short tons.	Value.	Average price per ton.	Number of employees.	Number of days active.
1885	500, 000	....	....	....	....
1886	534, 580	$855, 328	$1. 60	....	....
1887	685, 911	1, 286, 692	1. 88	....	....
1888	761, 986	1, 432, 072	1. 89	....	....
1889	752, 832	1, 323, 807	1. 76	....	1, 862
1890	869, 229	1, 579, 188	1. 82	238	2, 571
1891	1, 091, 032	1, 897, 037	1. 71	222	2, 891
1892	1, 192, 721	2, 043, 479	1. 71	211	3, 257
1893	1, 252, 110	2, 235, 209	1. 79	171	3, 446
1894	969, 606	1, 541, 293	1. 59	157	3, 101

IOWA.

Total product in 1895, 3,967,253 short tons; spot value, $4,997,939.

IOWA COAL FIELDS.

The coal-bearing area of Iowa covers a little more than one-third of the entire surface of the State. It is the northernmost extension of the great Western field, which, as previously described, includes all the coal area west of the Mississippi River, east of the Rocky Mountains, and south of the forty-third parallel. The northern limit in Iowa occurs in Humboldt County, a little northwest of the central point of the State. From here its eastern border runs in an irregular line to the southeastern corner of the State. The western border has not been well defined on account of the deep deposits of glacial-drift material, but it is approximately along a sinuous line to Council Bluffs on the Missouri River, which, with the entire southern boundary line of the State, completes the limits of the field in Iowa. Beyond these boundaries, particularly to the east, small outlying basins occur, some of which afford seams of coal sufficiently thick for profitable working.[1]

The strata of the Iowa region have suffered but little deformation since their deposition. Folds are almost entirely absent, and the few that occur are so slight as to offer no difficulties in practical mining, their influence being felt rather in prospecting, and there only to a limited extent.

In no case is any seam of coal more than 13 feet thick known to be worked in Iowa, and seams of this thickness are quite rare. A considerable number are profitably worked which have a thickness of $1\frac{1}{4}$ to 4 feet, but the very great majority of the seams worked have thicknesses of from 4 to 6 feet. This factor alone greatly simplifies the problems of mining, as the complex methods of timbering in use in working thicker beds have no use here at all.

[1] See paper on the Iowa coal deposits, by Charles R. Keyes, Mineral Resources, 1892.

At present no mine operates at a depth much exceeding 250 feet, though some have been worked at a lower level. A majority are from 100 to 200 feet deep, and a considerable amount of coal is reached by drifts and shallow slopes. It is probable that the greater portion of the coal of this territory may be won by shafts not exceeding 500 feet in depth. The difficulties and dangers of deep mining are at present nowhere encountered; and while in the future it is not improbable that considerable deep mining will be carried on in the southwestern counties, even here the amount of coal finally won will not be apt to exceed that taken from the shallow shafts.

One of the greatest difficulties encountered in coal mining has always been the presence of inflammable gas. The mines of Iowa are practically free from that danger.

The physical properties of Iowa coals show great variation. The consideration of hardness, crushing strength, presence of joints, and other physical characteristics must all enter into the estimates of the cost of their mining. If the coal be hard, it must be blasted; if soft, it may be cut and wedged; if it have a low crushing strength, allowance must be made for the fact in estimating the size of pillars. The joints and cleavages may help or hinder in the cutting of the coal.

Probably the most far-reaching in effect of any one condition present is that the coal here is not found in a few continuous seams of constant thickness and definite stratigraphic position, as is more usual in other fields, but that it is instead found in numerous distinct interlocking basins of limited extent.

The Coal Measures of Iowa have been exposed to very heavy erosion, and the effects of this action are to be seen in weak roofs, "cut-outs," washes, and other similar "troubles" so often encountered in the mines. There was also an erosion period preceding the deposition of the coal measures which has profoundly influenced the distribution of the productive beds.[1]

COAL MINING IN IOWA.[2]

The developed coal field of Iowa lies in 24 counties, and some of these have produced only small amounts. A district lying southeast and northwest from Lee County to Hamilton, along the Des Moines River, embraces 19 of the 24 counties. Four others lie in the southwestern corner of the State along the Nodaway River, and Scott County shows a small outskirt of the Illinois field. Of the entire field, Mahaska is the banner county, producing 1,172,530 tons in the year ending June 30, 1893. Most of this coal is a good quality of steaming and fuel coal, easy of access and workable. Many of the mines are developed by drift or slope entries. Of the shaft mines none are over 250 feet deep, while the principal ones are 125 feet or less. The thickness of the

[1] Mr. H. Foster Bain, Iowa Geological Survey.

[2] Abstract from a paper by Mr. G. A. Davis, read before the Iowa Society of Civil Engineers and Surveyors.

veins run from 3 to 8 feet, and even more. The coal is worked by both the room-and-pillar and the long-wall systems, the former plan being the most used, because it requires a peculiar roof for the long-wall system, and where it can be used it is considered the best, being safer, requiring less timbering, and removing a larger per cent of coal. A good roof of slate or stone is a great advantage in working a mine; indeed, may be said to be a necessity, as there are some veins unworkable from the fact there is not enough hard material overlying them to make safe work.

In Keokuk the first large mines opened had excellent roof and no faults to make waste piles, but the later ones have poorer roofing and large waste piles from the faults and bottom that must come up on account of thin veins. This makes these mines much more expensive to work. In general the dip of the coal vein somewhat conforms to the surface of the ground above, and, for convenience in working, the hoisting shaft is sunk in low ground, so the coal will haul downhill and the water run to the sump to be pumped out. The dip of the vein and the whole lease should be prospected thoroughly by numerous holes bored through the coal, and especially where it is proposed to sink the shaft, in order to avoid quicksand and to ascertain the lowest point for location. The size of the shaft is usually 7 by 15 feet, to provide for two cages and the necessary room for pipes for compressed air, water, or electricity when required. It is mostly lined with 4-inch timbers in Keokuk County, but cases occur where even 12-inch timbers are not heavy enough. One shaft encountered a soft, bluish mud called "sea mud." This shaft is about 15 feet deep, is said to have cost $10,000, and was soon abandoned not only because it gave trouble but because it was not in the best location. The average cost of sinking a shaft is about $12 per foot in depth; the cost to timber with 4-inch stuff is $3 to $3.50 per foot in depth; air shaft, 5 by 10, costs about $10 per foot in depth. Main entries are about 7 feet wide at the bottom and 6 feet at the top, not less than 5 feet high or as high as the coal vein is thick. When the vein is less than 5 feet in thickness, top or bottom is removed to give this height. Side entries may be less. In long-wall working enough of the entry roof is removed to make gobbing or packing on the sides, and the settling of the roof causes it to lock or key itself before it has settled more than half the height it was excavated. The timber used for mine props is an item of expense that varies with the conditions met with in each mine. They cost 1 cent per linear foot, delivered at the mine, for 4-inch diameter at small end. They should be straight, seasoned thoroughly, and have both ends sawed square. They are not used as plentifully and carefully as they should be, the mine inspectors' records for the last biennial report showing that of 7,000 miners working in Iowa, 31 were killed and 48 were injured by falling coal and slate during the years 1892 and 1893.

The miners usually work in pairs, two men per room. They load the coal into pit cars, which the company hauls out and empties on screens of diamond-shaped bars set $1\frac{1}{4}$ inches apart and 12 feet long, set at an angle of 26°, or $\frac{1}{2}$ to 1. Accompanying each car is a numbered brass check, which is credited with the weight of lump coal sent with it. As an incentive to good work, the nut and slack are not paid for. Some men shoot the coal to pieces more than others, and good judgment in digging coal counts in dollars and cents here, as well as in other trades. The method of digging coal is about the same in all mines where the vein lies horizontal or nearly so. A room is simply enlarging branch entries. The miner with pick cuts under the face of the coal as far as he can reach, usually about 4 feet, then drills a hole about the same depth up near the roof, then puts in powder and shoots the coal down. Formerly the powder holes were drilled with the ordinary hand drill, but now they are all bored with a miner's patent auger, with which a hole 6 feet deep can be bored in twenty minutes. In What Cheer iron men (picks worked by compressed air) have been introduced. With this machine (the Harrison) a man can cut under about 40 feet face, 4 feet deep, in a day. He will have one or two assistants, whom he pays a stipulated price per day, and he gets credit for all the coal he sends out. The company furnishes the machines and the compressed air and pays all expenses connected with them. Entry work, on an average, costs by hand pick \$1.80 per linear yard, and 75 cents per ton of coal removed. With machine it costs \$1.50 per linear yard and 40 cents per ton. The proportion of nut and slack to lump in Keokuk County is about as follows: Slack, 10 per cent; nut, 15 per cent, and lump, 75 per cent. Ventilation is by fan in the large mines and by steam jet or furnace in the smaller ones. The fan forces air into the mine, which is carried around through the various side entries and rooms by a system of stoppings in the entries until it reaches the upcast shaft. The furnace or steam jet is placed at bottom of the upcast shaft to create a draft from the workings. The coal is usually hauled to the bottom of the hoisting shaft by small chunky mules, but in some cases the endless rope and tail-rope methods are used. Pit cars usually hold about 1,500 to 2,000 pounds each, and run on track of 2 foot 8 inch to 3 foot gauge, laid with 12 to 18 pounds per yard T-rail, laid on $2\frac{1}{2}$ by 4 inch oak cross-ties placed 2 feet apart.

The cost of a first-class plant for operating a mine of say 500 to 800 tons per day capacity is approximately as follows: Main shaft, 7 by 15, per foot depth, \$15; air shaft, 5 by 10, per foot depth, \$10; top works, tower, screens, cages, tipples, etc., \$4,500; two boilers in place, \$2,000; boiler house, \$300; engine, \$2,000; engine house, \$300; track scales, \$800; pump, pipes, etc., \$500; sixty pit cars, \$20 each, \$1,200; blacksmith shop, \$200; oil house, \$100; powder house, \$100; fan, \$200; fan engine, \$250; house, \$150; rails, spikes, etc., \$500; hardware, tools, and sundries, \$2,500; total, \$15,625. If machine picks are used, add for air compressor, \$4,000, and for eight machine picks, \$3,200.

This plant will require about 13 topmen at a cost of $25 per day, and 16 to 18 men, including mule drivers, underground, at a cost of $30 to $40 per day, and from 150 to 250 miners. Patent loaders cost about $1,500, and if the coal is clean and requires but little picking over, they are a good investment, as they save the work of from 4 to 6 men, chunking in box cars, where the mine loads 400 tons or more per day. Besides, they place the load over the car trucks instead of leaving the bulk of it piled in the center of the car. The railroad tracks at the mine should have a grade of 1.5 per 100 feet from a point 100 feet below scales, to the end of empty storage tracks. From this point, 100 feet below scales, it should have 300 feet of 1 per 100 feet, and lesser grade from there on, or even level it the ground will admit of it. Steeper grades than 1.5 per 100 feet are liable to cause trouble in bad weather, while less grades on the empty track and over the scales cause cars to move hard in cold weather; and the availability of these grades should be kept in view when locating the hoisting shaft.

PRODUCTION.

The coal deposits of Iowa were first brought to public notice by Dr. David Dale Owen of the United States General Land Office, who was sent out to survey the mineral lands of the Northwest. In his report, which was published in 1852, he pointed out a number of localities where good coal could be obtained. Mr. A. H. Worthen subsequently pointed out some additional places where coal was being mined for local use. The Eighth United States Census (1860) contains the results of the first attempt made to gather authentic information of coal mining in Iowa. Statistics were collected for the preceding year (1859), and showed a total output of 48,263 short tons, valued at $92,180. The State census taken in 1865 showed a total tonnage of 69,574 tons. The Ninth United States Census, taken in 1870, reported a product of 283,467 short tons, valued at something over $500,000. At the State census of 1875 the tonnage was 1,231,547, having a valuation of $2,500,140, showing a five-fold increase in both amount and value in five years. During the next five years little increase was noted, the product at the Tenth Census, 1880, being 1,461,166 short tons, worth $2,507,453.[1]

In 1882, Mr. Albert Williams, jr., in Mineral Resources for that year, placed the total product at 3,920,000 short tons. This was merely an estimate, but may be assumed as approximately correct, as in the following year, 1883, the product reported by the mine inspectors was 4,457,540 short tons, more than three times the product in 1880. From 1883 to 1890 the product was between 4,000,000 and 5,000,000 tons annually, reaching a maximum in 1888, when a total of 4,952,440 tons was obtained. For the past four years the total has not reached 4,000,000 tons, and from the practically stationary output for the past

[1] Iowa Geological Survey, Vol. II, pp. 521 to 523.

decade it appears that the mines of the State are producing all the coal the market for it demands. That is to say, the coal mining industry has reached a point where its further development will depend upon the growth of other industrial enterprises in the State and the creation of an increased local demand.

The output in 1894 was 3,967,253 short tons, valued at $4,997,939, against 3,972,229 short tons in 1893, worth $5,110,460. The decrease in tonnage, less than 5,000 tons, is so little as to be scarcely worth mentioning. The noticeable feature of the year was the decline in value of over $100,000, and this would have been more noticeable still but for the mild winter of 1892–93, which, added to the business depression, caused a decline in the value of the product of 1893 as compared with that of the preceding year. The strike of 1894 affected Iowa's product to some extent, but even if the strike had not occurred it is doubtful whether the output would have been substantially increased, as the market, restricted by the stringency of the times, would not have absorbed much more than the amount taken out during the year. The difference would have been in distributed periods of idleness for the miners throughout the year, instead of in one protracted spell. Naturally, if the strike had occurred as it did in other States, and not extended to Iowa, the mines of the State would have been benefited temporarily, but the new markets would not have been held upon the resumption of work in other sections.

The statistics of production by counties in 1893 and 1894 are shown in the following tables, together with the distribution of the product for consumption:

Coal product of Iowa in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Appanoose	470,842	12,611	6,467	489,920	$737,949	$1.51	151	1,793
Boone	140,101	29,936	2,033	172,070	321,137	1.87	208	577
Dallas	11,186	2,275	....	13,461	24,509	1.82	159	55
Greene	15,000	2,800	200	18,000	36,000	2.00	150	60
Jasper	151,836	10,736	67	162,639	208,909	1.28	253	284
Jefferson	120	360	2	482	723	1.50	120	3
Keokuk	126,848	14,186	11,063	152,097	104,375	1.21	155	528
Mahaska	1,306,536	71,071	42,323	1,419,930	1,570,537	1.11	258	2,209
Marion	101,933	8,932	280	111,145	134,304	1.21	193	292
Monroe	554,350	10,948	5,607	570,905	638,085	1.12	214	1,103
Polk	170,261	95,454	6,016	271,731	468,933	1.73	211	697
Taylor	7,530	3,445	15	10,990	22,279	2.02	228	29
Van Buren	19,295	3,337	335	22,867	31,021	1.36	178	69
Wapello	215,911	11,139	3,410	230,460	293,683	1.27	174	603
Warren	1,000	2,000	....	3,000	5,250	1.75	100	15
Wayne	43,195	21,416	825	65,436	95,940	1.47	205	155
Webster	106,640	9,093	1,363	117,096	196,826	1.67	194	391
Small mines	....	140,000	....	140,000	140,000	1.00	....	....
Total	3,442,584	449,639	80,006	3,972,229	5,110,460	1.30	204	8,863

Coal product of Iowa in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total production.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Appanoose	44	638, 804	18, 912	9, 555	667, 271	$852, 124	$1. 30	153	2, 254
Boone	14	215, 641	24, 771	1, 110	241, 522	386, 393	1. 60	169	842
Dallas, Davis, Greene	4	10, 147	4, 132	1, 142	15, 421	26, 104	1. 65	186	62
Jasper	6	115, 104	4, 257	2, 443	121, 804	213, 156	1. 75	204	177
Jefferson	2	300	815	12	1, 127	1, 542	1. 37	101	7
Keokuk	13	129, 694	10, 837	2, 219	142, 750	162, 786	1. 14	128	551
Mahaska	14	1, 053, 142	84, 301	15, 545	1, 152, 988	1, 357, 448	1. 18	199	2, 396
Marion	12	99, 088	8, 942	665	108, 695	114, 623	1. 05	121	329
Monroe	8	482, 156	9, 656	13, 352	505, 164	559, 017	1. 09	172	1, 212
Polk	19	247, 902	132, 706	15, 039	395, 647	577, 058	1. 50	184	944
Taylor	2	13, 880	900	....	14, 780	27, 343	1. 85	212	52
Van Buren	5	21, 658	1, 859	102	23, 619	32, 257	1. 37	174	78
Wapello	8	228, 228	48, 403	1, 952	278, 583	304, 661	1. 09	167	541
Warren	5	5, 409	7, 232	8	12, 649	20, 015	1. 58	177	32
Wayne	2	39, 981	1, 787	456	42, 224	63, 432	1. 50	121	140
Webster	16	89, 617	12, 173	1, 219	103, 009	168, 980	1. 64	155	378
Small mines	....	....	140, 000	....	140, 000	140, 000	....	....	....
Total	174	3, 390, 751	511, 683	64, 819	3, 967, 253	4, 997, 939	1. 26	170	9, 995

The State is divided into three inspection districts, known, respectively, as the first or southern, the second or northeastern, and the third or northwestern. The following table shows the annual production according to districts since 1883:

Total production of coal in Iowa, by districts, from 1883 to 1894, inclusive.

Districts.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
First	1, 231, 444	1, 165, 803	1, 294, 971	1, 416, 165	1, 598, 062	1, 712, 443	1, 497, 685
Second	1, 654, 267	1, 583, 468	1, 379, 799	1, 890, 784	1, 989, 095	2, 211, 274	1, 720, 727
Third	1, 571, 829	1, 621, 295	1, 337, 805	1, 008, 830	886, 671	1, 028, 723	876, 946
Total	4, 457, 540	4, 370, 566	4, 012, 575	4, 315, 779	4, 473, 828	4, 952, 440	4, 095, 358

Districts.	1890.	1891.	1892.	1893.	1894.	Increase in 1894.	Decrease in 1894.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
First	1, 536, 978	1, 229, 512	1, 398, 793	1, 505, 205	1, 654, 112	148, 907	....
Second	1, 626, 193	1, 814, 910	1, 656, 224	1, 734, 666	1, 417, 542	....	317, 124
Third	718, 568	641, 073	713, 474	592, 358	755, 599	163, 241	....
Small mines	140, 000	140, 000	140, 000	140, 000	140, 000	....	....
Total	4, 021, 739	3, 825, 495	3, 918, 491	3, 972, 229	3, 967, 253	....	*a* 4, 976

a Net increase.

The counties composed in each district and the product of each county since 1883 are shown in the following table:

Product of coal in the first inspection district of Iowa from 1883 to 1894, inclusive.

Counties.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Appanoose	144, 364	178, 064	275, 404	168, 000	179, 593	235, 495	285, 194
Adams	4, 358	4, 459	4, 364	10, 731	22, 233	21, 075	13, 457
Cass	....	....	....	....	....	....	280
Davis	590	1, 358	37, 694	1, 120	2, 016	2, 016	3, 825
Jefferson	43, 553	9, 153	1, 250	1, 213	11, 645	10, 514	8, 123
Lucas	546, 360	460, 017	492, 750	594, 450	529, 758	408, 765	339, 229
Marion	101, 903	108, 735	112, 012	158, 697	238, 218	258, 330	145, 180
Monroe	104, 647	110, 238	113, 699	131, 824	205, 525	261, 964	258, 401
Montgomery	....	....	....	....	....	....	1, 040
Page	838	1, 130	2, 037	1, 736	1, 993	3, 842	2, 768
Taylor	105	142	691	9, 615	13, 642	8, 962	9, 736
Van Buren	1, 880	1, 991	1, 336	9, 003	29, 491	29, 075	39, 258
Wapello	266, 360	269, 607	210, 461	265, 564	304, 722	426, 042	359, 199
Warren	14, 367	15, 374	14, 364	26, 132	27, 772	19, 155	14, 515
Wayne	2, 119	5, 541	28, 909	38, 080	31, 454	27, 208	17, 480
Total	1, 231, 444	1, 165, 803	1, 294, 971	1, 416, 165	1, 598, 062	1, 712, 443	1,497,685

Counties.	1890.	1891.	1892.	1893.	1894.	Increase.	Decrease.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Appanoose	284, 560	409, 725	411, 984	489, 920	667, 271	177, 351	....
Adams	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	....	....
Cass	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	....	....
Davis	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	....	....
Jefferson, Lucas	351, 600	800	1, 000	482	1, 127	645	....
Marion	153, 506	165, 867	134, 400	111, 145	108, 695	....	2, 450
Monroe	324, 031	393, 227	507, 106	570, 905	505, 164	....	65, 741
Montgomery	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	....	....
Page	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	....	....
Taylor	(*a*)	10, 500	15, 204	10, 990	14, 780	3, 790	....
Van Buren	47, 464	36, 166	28, 946	22, 867	23, 619	752	....
Wapello	341, 932	165, 827	231, 472	230, 460	278, 583	48, 123	....
Warren	8, 470	2, 000	3, 600	3, 000	12, 649	9, 649	....
Wayne	25, 415	45, 000	62, 078	65, 436	42, 224	....	23, 212
Total	*b* 1,536,978	*b* 1,229,512	*b* 1,398,793	*b* 1,505,205	*b* 1, 654, 112	*c* 148. 907	....

a Included in product of small mines.
b Exclusive of product of small mines.
c Net increase.

Product of coal in the second inspection district of Iowa from 1883 to 1894.

Counties.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Mahaska	1, 038, 673	1, 044, 640	854, 319	953, 525	1, 148, 614	936, 299	1, 056, 477
Keokuk	560, 045	482, 652	417, 554	610, 741	670, 888	607, 002	455, 162
Jasper	51, 389	51, 896	101, 276	320, 358	159, 083	308, 200	199, 152
Scott	4, 160	4, 280	6, 650	3, 360	9, 670	10, 170	9, 446
Marshall	....	....	....	448	224	....	....
Hardin	....	....	....	2, 240	504	1, 120	490
Muscatine	....	....	....	112	112	....	....
Total	1, 654, 267	1, 583, 468	1, 379, 799	1, 890, 784	1, 989, 096	*a* 2, 211, 274	1, 720, 727

Counties.	1890.	1891.	1892.	1893.	1894.	Increase.	Decrease.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Mahaska	1, 103, 831	1, 231, 405	1, 141, 131	1, 419, 930	1, 152, 988	....	266, 942
Keokuk	349, 318	316, 303	361, 233	152, 097	142, 750	....	9, 347
Jasper	173, 044	267, 202	163, 860	162, 639	121, 804	....	40, 835
Scott	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)	....	....
Marshall	....	....	....	....	....	....	....
Hardin	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)	....	....
Total	*c* 1, 626, 193	*c* 1, 814, 910	*c* 1, 666, 224	*c* 1, 734, 666	*c* 1, 417, 542	....	317. 124

a Includes 348,483 tons nut coal not included in county distribution.
b Included in product of small mines.
c Exclusive of product of small mines.

Product of coal in the third inspection district of Iowa from 1883 to 1894.

Counties.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Boone	523, 019	529, 842	513, 174	330, 366	187, 116	156, 959	174, 392
Dallas	42, 793	41, 647	36, 944	24, 624	45, 270	54, 457	67, 055
Greene	99, 513	107, 886	100, 337	131, 643	118, 601	122, 127	51, 438
Guthrie	....	5, 809	5, 148	19, 257	20, 502	20, 922	12, 275
Hamilton	2, 238	2, 103	1, 028	3, 710	7, 469	7, 257	....
Polk	625, 879	694, 312	518, 442	378, 520	341, 705	336, 749	434, 047
Webster	278, 387	239, 696	162, 732	120, 710	163, 768	178, 881	137, 739
Story	....	....	....	....	2, 240	2, 240	....
Total	1, 571, 829	1, 621, 295	1, 337, 805	1, 008, 830	886, 671	*a* 1,028,723	876, 946

Counties.	1890.	1891.	1892.	1893.	1894.	Increase.	Decrease.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Boone	153, 229	151, 659	139, 820	172, 070	241, 522	69, 452	....
Dallas	33, 466	48, 710	26, 550	13, 461	10, 201	....	3, 260
Greene	45, 192	53, 215	43, 360	18, 000	5, 220	....	12, 780
Guthrie	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)	....	....
Hamilton	....	....	....	....	....	....	....
Polk	367, 852	309, 467	388, 590	271, 731	395, 647	123, 916	....
Webster	118, 829	78, 022	115, 154	117, 096	103, 009	....	14, 087
Story	....	....	....	....	....	....	....
Total	*c* 718, 568	*c* 641, 073	*c* 713, 474	*c* 592, 358	*c* 755, 599	*d* 163, 241	....

a Includes 149,131 tons nut coal not included in county distribution.
b Included in product of small mines.
c Exclusive of product of small mines.
d Net increase.

The product in some of the earlier years in the history of coal mining has already been referred to. Below is given in tabular form the output in all the years for which figures are obtainable, with the value and average price per ton when known, and the statistics of labor employed during the past six years.

Product of coal in Iowa from 1860 to 1894, inclusive.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employees.
1860	48, 263	$92, 180	$1. 91	....	....
1865	69, 574	....	....	....	....
1866	99, 320	....	....	....	....
1868	241, 453	....	....	....	....
1870	283, 467	....	....	....	....
1875	1, 231, 547	2, 500, 140	2. 03	....	....
1880	1, 461, 166	2, 507, 453	1. 72	....	....
1882	3, 920, 000	....	....	....	....
1883	4, 457, 540	....	....	....	....
1884	4, 370, 566	....	....	....	....
1885	4, 012, 575	....	....	....	....
1886	4, 315, 779	5, 391, 151	1. 25	....	....
1887	4, 473, 828	5, 991, 735	1. 34	....	....
1888	4, 952, 440	6, 438, 172	1. 30	....	....
1889	4, 095, 358	5, 426, 509	1. 33	....	9, 247
1890	4, 021, 739	4, 995, 739	1. 24	213	8, 130
1891	3, 812, 495	4, 807, 999	1. 27	224	8, 124
1892	3, 918, 491	5, 175, 060	1. 32	236	8, 170
1893	3, 972, 229	5, 110, 460	1. 30	204	8, 863
1894	3, 967, 253	4, 997, 939	1. 26	170	9, 995

It will be seen from the above table that the greatest range in the average price per ton during the past nine years has been 10 cents; the highest $1.34, in 1887, and the lowest $1.24, in 1890.

In the preceding tables the product for a series of years, by counties, has been given. In the following tables will be found the average price per ton for a period of six years, and the statistics of labor and working time in counties producing 10,000 tons or over:

Average prices for Iowa coal since 1889, in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Appanoose	$1.32	$1.38	$1.39	$1.51	$1.51	$1.30
Boone	1.86	1.82	1.86	1.80	1.87	1.60
Dallas	1.66	1.70	1.60	1.71	1.82	1.60
Greene	1.74	1.63	1.40	1.76	2.00	2.00
Jasper	1.42	1.11	1.44	1.28	1.28	1.75
Keokuk	1.25	1.31	1.32	1.28	1.21	1.14
Lucas	1.23	1.25				
Mahaska	1.16	1.06	1.06	1.15	1.11	1.18
Marion	1.28	1.26	1.16	1.17	1.21	1.05
Monroe	1.16	1.21	1.21	1.26	1.12	1.09
Polk	1.59	1.49	1.50	1.57	1.73	1.50
Taylor	2.07		2.15	2.00	2.02	1.85
Van Buren	1.39	1.29	1.29	1.32	1.36	1.37
Wapello	1.13	1.10	1.24	1.29	1.27	1.09
Wayne	1.47	1.25	1.52	1.49	1.47	1.50
Webster	1.63	1.54	1.71	1.61	1.67	1.64
The State	1.33	1.24	1.27	1.32	1.30	1.26

Statistics of labor employed and working time at Iowa coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.
Appanoose	1,080	165	1,419	207	1,213	184	1,793	151	2,254	153
Boone	465	191	484	196	534	189	577	208	842	169
Dallas	130	207	140	210	89	242	55	159	43	172
Greene	121	209	120	185	120	214	60	150	19	213
Jasper	335	246	416	256	426	274	284	253	177	204
Keokuk	1,018	184	795	204	610	285	528	155	551	128
Lucas	324	298								
Mahaska	1,673	258	1,815	263	1,818	238	2,209	258	2,396	199
Marion	269	265	394	222	267	244	292	193	329	121
Monroe	735	197	806	203	1,112	233	1,103	214	1,212	172
Polk	700	243	779	239	938	268	697	211	944	184
Taylor			35	241	54	223	29	228	52	212
Van Buren	108	280	85	207	92	226	69	178	78	174
Wapello	773	159	421	214	445	260	603	174	541	167
Wayne	60	180	130	205	140	232	155	205	140	121
Webster	307	182	273	182	302	247	391	194	378	155
The State	8,130	213	8,124	224	8,170	236	8,863	204	9,995	170

KANSAS.

Total product in 1894, 3,388,251 short tons; spot value, $4,178,998.

KANSAS COAL FIELDS.

The Kansas Coal Measures have never been accurately defined. They form a part of the great Western field which passes through the eastern half of the State from Iowa and Missouri into the Indian Territory, with an outlying area of Cretaceous lignite to the west and in the northern central part of the State. The main portion of the field occupies, approximately, one-fourth the area of the State. What little is known geologically of the Kansas Coal Measures is contained in the Eighth Biennial Report of the State Board of Agriculture, which says:

The Coal Measures consist of three kinds of rock formations—sandstones, limestones, and shales. In these are inclosed the beds of coal, which do not occupy anywhere more than one-twentieth of the thickness assigned to the Coal Measures, and over large parts of the area there is no coal at all. Still, a few square miles, with one bed of coal 30 inches thick, would be a rich district, and there are several such districts in eastern Kansas. The bottom of the Lower Coal Measures is the richest horizon of the formations. It is in this horizon, not far from the Spring River boundary, that we have the Weir City and Scammon coal field, of Cherokee County, and the neighboring coal fields of Frontenac and Pittsburg, in Crawford County. The Fort Scott or Mound coal, of Bourbon County, is higher in the same division. A thin seam in northwestern Bourbon County should be placed near the top of the Lower Coal Measures. A thick bed of limestone in western Bourbon, which slopes down to the Neosho River, in Allen and Neosho counties, and passes into Montgomery, may possibly be regarded as the top of the Lower Coal Measures. The Thayer coal seam and one at Howard and Stockton, which latter is possibly near the horizon of the coal of Osage and Shawnee counties, may all be called in the Upper Coal Measures, whose upper limit may be found in the strata which cross the Kaw Valley west of Wamego. Still, some seams of coal are found at higher horizons, though they are thin and of little use. Examples are found in the north of Pottawatomie County and in the strata of the Fort Riley section, on Humboldt Creek, in Geary County. The Leavenworth coal, found over 700 feet deep, is in the Lower Coal Measures. The recent borings at Alma, McFarland, and Cherryvale, though revealing no seams of thickness workable at the depths reached, also illustrate the fact that the best place for coal is at the bottom of the Coal Measures.

The Coal Measures contain more persistent beds of sandstone than are found in any other group in Kansas except the Dakota. Sandstones are more variable, where of any great extent, than limestones, and often change into arenaceous shales, and these again to clay shales or back to sandstone. This is also true of their thickness. If beds have considerable vertical extent, they are frequently separated by partings of arenaceous shale, which in places are several feet thick. The Coal Measures of southeast Kansas are, however, characterized by three very persistent sandstone horizons, and they probably also extend north of the Kaw River, though there more hidden by Quaternary formations. * * * One fact as to the coal beds should be borne in mind. None of them has a very great extension at right angles (nearly east and west) to the Spring River trend. The Cherokee seam, on which the Pittsburg and Weir City fields are situate, extends north by east into Missouri, and in the opposite direction into the Indian Territory, but it is only 3 or 4 miles wide. The Stockton coal is probably carried through Osage County and north of the Kaw River, in Jefferson County, but the greatest width of the coal field in Osage County is only 8 or 10 miles.

In the First Biennial Report of the Board of Education, covering the years 1877 and 1878, Prof. B. F. Mudge says: "The thickest and best seam of coal in Kansas is the Cherokee bed, found in Cherokee, Crawford, and Labette counties. It extends from the Indian Territory, entering the State near Chetopa, and runs across the southeast part of Labette County, the west and northwest parts of Cherokee, and southeast part of Crawford, and enters Missouri." This description of position is practically correct to-day, though on part of this area it was another seam that was probably known at that time. On the eastern edge of this line there is, however, only the one seam that is worked. Its workable area has largely been increased within the limits formerly known. At a few miles north of Columbus the coal-mining region begins, and we have a series of mining towns—Scammon, Weir City, Cherokee, Fleming, Frontenac, Pittsburg, Arcadia, Minden—around which the coal seam, whose average thickness is over 40 inches, is worked. In the northeastern part it is worked in "strip" banks and drifts; in the southern part by shafts, the deepest of which is 140 feet. In part of the district there is a workable seam above this. The widest part of this area is said to be 8 miles, but it is not more than about 4 on the average. Recently Mr. John Marchant reports having made a "prospect" drill hole 1¾ miles east of the railway station at Scammon, and found coal 33 inches thick. This would extend the width of the field at that place more than a mile, as Scammon has been considered on the east edge of the field.

The foregoing takes no account of the lignite coal of north central Kansas. It is not coal of the Coal-Measures epoch. It is found in that series of Cretaceous formations which we call the Dakota group. As a fuel, it is mostly an inferior material, but as it is more than 200 miles from the Carboniferous coal fields, and a still greater distance from the lignites of superior quality found in still higher horizons in Colorado and Wyoming, it is used locally to a limited extent.

PRODUCTION.

There has been some coal mined in Kansas from the early days of settlement. Seams outcrop in Cherokee, Crawford, Bourbon, Linn, Neosho, and Labette counties, and these outcrops have been worked by drifts into the hillside and in places by "stripping" off superincumbent earths, and even limestone, when the thickness has not exceeded a few feet. The earliest record of coal mining in Kansas is for the year 1869, reported by the Ninth United States Census. In that year the product was 32,938 short tons. There is then a lapse of eleven years, during which no statistics were obtained. Mineral Resources for 1883–84 gives the output in 1880 at 550,000 short tons, 17 times as much as it was eleven years before. Through the series of Mineral Resources the product shows an annual increase up to 1892, when an output of a little over 3,000,000 tons was obtained. At this time the coal production had reached a point collateral with the industrial conditions of the territory tributary to the coal field, and the increases and decreases in coal production from now on in Kansas may be taken as fairly indicative of trade conditions. Unusual climatic conditions—that is, extraordinarily severe or exceedingly mild winter seasons—will affect the output somewhat, but such changes are of minor importance.

The product in 1894 was the largest in the history of the State, exceeding that of 1893 by 735,705 short tons, or nearly 28 per cent.

The value increased $803,252, or nearly 20 per cent. The increase in Kansas was due to two causes. In the first place, the coal mining industry in 1893 was seriously upset by a strike local to the State, but bitterly contested from the middle of May until September 1. This caused a decrease in the production of 354,730 tons, as compared with 1892. In the second place, while some of the miners went out in sympathy with the general strike in 1894, the disaffection did not extend over the entire State, and the mines which kept going found, temporarily, new markets for their product, and the results are shown in the increased output. It is remarkable that under these circumstances there should have been a comparative decrease in valuation. It may in reality be taken as showing in a more radical manner the widespread business depression, the decline in values throughout the year being more than enough to offset the temporary advantage gained by the shutting out of other sources of supply.

In the following tables the production of coal in Kansas during 1893 and 1894 is shown by counties, together with the distribution of the product for consumption:

Coal product of Kansas in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	To number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Cherokee	673, 810	10, 257	13, 454	....	697, 521	$805, 525	$1. 15	106	1, 978
Coffey	....	1, 720	....	....	1, 720	3, 765	2. 19	150	6
Crawford	1, 160, 601	14, 151	15, 716	....	1, 195, 868	1, 321, 489	1. 10	163	2, 883
Franklin	7, 084	4, 684	....	....	11, 768	21, 650	1. 84	162	57
Labette	....	800	....	....	800	2, 000	2. 50	250	5
Leavenworth	216, 678	62, 160	30, 396	3	309, 237	477, 914	1. 55	208	1, 145
Linn	43, 512	2, 602	350	....	46, 464	56, 853	1. 22	194	136
Osage	257, 725	20, 947	496	....	279, 168	526, 544	1. 85	145	1, 100
Small mines	....	110, 000	....	....	110, 000	160, 000	1. 45	......	....
Total	2, 364, 810	227, 321	60, 412	3	2, 652, 546	3, 375, 740	1. 27	147	7, 310

Coal product of Kansas in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total production.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Cherokee	26	914, 056	24, 878	8, 551	657	948, 142	$1, 075, 480	$1. 13	143	1, 834
Crawford	25	1, 520, 953	14, 547	18, 753	......	1, 554, 253	1, 669, 789	1. 07	167	2, 723
Franklin	9	4, 024	13, 378	16	......	17, 418	32, 799	1. 88	147	87
Leavenworth	4	301, 421	77, 272	17, 166	108	395, 967	591, 661	1. 49	197	1, 406
Linn	6	22, 408	3, 185	274	......	25, 867	31, 088	1. 20	91	132
Osage	39	300, 036	21, 390	763	......	322, 189	609, 324	1. 89	159	1, 129
Atchison, Coffey, and Labette	4	3, 500	915	....	......	4, 415	8, 857	2. 01	266	28
Total	113	3, 066, 398	275, 565	45, 523	765	3, 388, 251	4, 178, 998	1. 23	164	7, 339

The following table shows in condensed form the statistics of coal production in Kansas since 1880. It will be noted that the first decrease in the amount of coal produced as compared with former years occurred in 1893.

Coal product of Kansas since 1880.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1880	550, 000				
1881	750, 000				
1882	750, 000				
1883	900, 000				
1884	1, 100, 000				
1885	1, 212, 057	$1, 485, 002	$1. 23		
1886	1, 400, 000	1, 680, 000	1. 20		
1887	1, 596, 879	2, 235, 631	1. 40		
1888	1, 850, 000	2, 775, 000	1. 50		
1889	2, 221, 043	3, 296, 888	1. 48		5, 956
1890	2, 259, 922	2, 947, 517	1. 30	210	4, 523
1891	2, 716, 705	3, 557, 305	1. 31	222	6, 201
1892	3, 007, 276	3, 955, 595	1. 31½	208	6, 559
1893	2, 652, 546	3, 375, 740	1. 27	147	7, 310
1894	3, 388, 251	4, 178, 998	1. 23	164	7, 339

In the following table is shown the total product of the State since 1885, by counties, with the increases and decreases during 1894 as compared with 1893:

Coal product of Kansas since 1885, by counties.

[Short tons.]

Counties.	1885.	1886.	1887.	1888.	1889.	1890.
Atchison						
Cherokee	371, 930	375, 000	385, 262	450, 000	549, 873	724, 861
Coffey					18, 272	12, 200
Crawford	221, 741	250, 000	298, 049	425, 000	827, 159	900, 464
Franklin	14, 518	15, 000	18, 080	25, 000	37, 771	9, 045
Labette					2, 541	4, 000
Leavenworth	120, 561	160, 000	195, 480	210, 000	245, 616	319, 866
Linn	5, 556	8, 900	12, 400	17, 500	25, 345	10, 474
Osage	370, 552	380, 000	393, 608	415, 000	446, 018	179, 012
Small mines	107, 199	211, 100	294, 000	307, 500	68, 448	100, 000
Total	1, 212, 057	1, 400, 000	1, 596, 879	1, 850, 000	2, 221, 043	2, 259, 922

Counties.	1891.	1892.	1893.	1894.	Increases in 1894.	Decreases in 1894.
Atchison				3, 500	3, 500	
Cherokee	832, 289	825, 531	697, 521	948 142	250, 621	
Coffey	1, 218	3, 664	1, 720	475		1, 245
Crawford	997, 759	1, 309, 246	1, 195, 868	1, 554, 253	358, 385	
Franklin	10, 277	11, 150	11, 768	17, 418	5, 650	
Labette	800	800	800	440		360
Leavenworth	380, 142	330, 166	309. 237	395, 967	86, 730	
Linn	38, 934	43, 913	46, 464	25, 867		20, 597
Osage	355, 286	372, 806	279, 168	322, 189	43, 021	
Small mines	100, 000	110, 000	110, 000	120, 000	10, 000	
Total	2, 716, 705	3, 007, 276	2, 652, 546	3, 388, 251	*a* 735, 705	

a Net increase.

In the preceding table the output by counties has been shown. The following tables indicate the tendency of prices for such years as they have been obtained, and the statistics of labor employed, together with the average working time:

Average prices for Kansas coal since 1889 in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Cherokee	$1.20	$1.22	$1.19	$1.22	$1.15	$1.13
Crawford	1.20	1.24	1.09	1.08	1.10	1.07
Franklin	2.18	2.00	1.90	1.85	1.84	1.88
Leavenworth	1.69	1.60	1.40	1.60	1.55	1.49
Linn	1.32	1.34	1.23	1.27	1.22	1.20
Osage	2.03	1.35	2.04	2.04	1.85	1.89
The State	1.48	1.30	1.31	1.31½	1.27	1.23

Statistics of labor employed and working time at Kansas coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.
Cherokee	1,413	186	1,609	180	1,777	183	1,978	106	1,834	143
Crawford	1,447	198	1,785	202	2,234	213	2,883	163	2,723	167
Franklin	47	224	48	207	57	180	57	162	87	147
Leavenworth	745	273	1,073	245	1,020	247	1,145	208	1,406	197
Linn	60	164	94	236	115	237	136	194	132	91
Osage	804	209	1,581	270	1,312	202	1,100	145	1,129	159
The State	4,523	210	6,201	222	6,559	208	7,310	147	7,339	164

KENTUCKY.

Total product in 1894, 3,111,192 short tons; spot value $2,749,932.

KENTUCKY COAL FIELDS.

Kentucky is the only State having within its borders parts of two great coal fields, the Appalachian and the Central. In the State they are known as the eastern and the western fields. The eastern field has an area of 11,180 square miles, and contains coals of superior excellence. Within its borders are found some excellent cannel coals, some superior coking coals, and a part of the famous Jellico steam and domestic coal, which extends from Anderson and Campbell counties, Tenn., into Whitley County, Ky. The discovery of the coals in eastern Kentucky capable of producing a high grade coke is one of great importance in its bearing upon the future development of the Appalachian region. Some of these coking coals are nearer Chicago and the Bessemer ores of Lake Superior than Connellsville coke, and they are the nearest coking coals to Cincinnati and Louisville. But their greatest value is in their proximity to the great ore deposits of the South. The conditions in the neighborhood are favorable to the manufacture of cheap iron and steel, and a local market may be built up capable of absorbing a large output of high grade coke.

The western field forms the southeastern extremity of the Central or Illinois field. It has an area of 4,500 square miles. It is penetrated throughout its entire length by the Green River, which is navigable at all seasons, and which exposes in its course outcrops of all of the twelve seams in the field. The western part of the field is convenient to the Ohio River, so that all of the coal is accessible to cheap water transportation. Some coke of excellent physical structure is made from one of the coals in the Upper Measures. There is an abundant supply of cheap iron ores convenient to the field. Should the contemplated ship canal connecting Lake Michigan with the Mississippi River be completed the high grade ores of Lake Superior could be brought to Kentucky to mix with these cheap ores, and a profitable iron industry built up, in addition to affording an outlet by water for these coals to the lakes.[1]

PRODUCTION.

The first record at hand of the production of coal in Kentucky is for the year 1873, when a total of 300,000 tons was reported. The statistics were not collected accurately, and the statement for that year and from 1873 to 1886 were estimated upon the best information obtainable. They are fairly indicative, however, of the growth of the coal mining industry in the State. In 1883 the product was estimated at 1,650,000 tons, five and a half times the output a decade previous. In 1887, according to the report of Mr. C. J. Norwood, chief inspector of mines, the product was 1,933,185 short tons. The Eleventh United States Census showed a product in 1889 of 2,399,755 short tons. From 1889 to 1893 the statistics were collected by the Survey. In 1892 and 1893 the totals have differed somewhat from the mine inspector's reports, the difference being due, doubtless, to the exclusion by some of the operators of the item of slack coal in their reports to the Survey. For 1894 arrangements were made with Mr. C. J. Norwood, State mine inspector, to collect the information for the Survey and thus to obtain uniformity and at the same time relieve the operators of making two sets of reports. Mr. Norwood also undertook to collect the statistics of the production at small mines, of which there are a great number in the State. The total product from this source in 1894 was found after a careful investigation to have been 153,999 short tons. The estimated product in 1893 was placed at 150,000 short tons. The following tables show the statistics of production by counties, in 1893, as collected by the

[1] Abstract from a paper by Prof. John R. Proctor, State geologist. (Mineral Resources, 1892, p. 415.)

Survey, and in 1894, as collected by Mr. Norwood, with the distribution of the product for consumption:

Coal product of Kentucky in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Bell	16, 829	2, 001	242	24, 599	43, 671	$38, 006	$0. 87	177	194
Boyd	161, 706	1, 000			162, 706	134, 144	. 82	225	275
Butler	14, 134	8, 585			22, 719	28, 399	1. 25	224	45
Carter	102, 605	2, 623	616		105, 844	131, 315	1. 24	222	476
Christian	31, 560	1, 800	1, 200		34, 560	33, 550	. 97	182	143
Daviess		7, 546			7, 546	10, 994	1. 46	188	18
Greenup	1, 964				1, 964	6, 004	3. 05	100	12
Hancock	5, 000				5, 000	12, 500	2. 50	150	25
Henderson	77, 624	23, 683	2, 332		103, 639	87, 594	. 85	185	194
Hopkins	619, 618	23, 491	13, 849	56, 851	713, 809	468, 519	. 66	232	1, 264
Johnson	6, 073	132			6, 205	16, 357	2. 64	281	27
Knox	160, 286	1, 200	500		161, 986	137, 097	. 85	240	275
Laurel	183, 133	9, 717	772		193, 622	173, 114	. 89	223	654
Lawrence	93, 807	550	875		95, 232	131, 096	1. 38	244	380
McLean									
Muhlenberg	283, 181	4, 173	2, 916		290, 270	218, 303	. 75	173	597
Ohio	304, 422	5, 011	3, 225		312, 658	243, 120	. 78	170	590
Pike									
Pulaski	31, 000	21, 897			52, 897	56, 292	1. 06	180	108
Rockcastle	9, 010				9, 010	9, 032	1. 00	114	70
Union	141, 782	13, 170	3, 242		158, 194	150, 835	. 95	181	332
Webster	34, 953	2, 646	400		37, 999	28, 095	. 74	215	52
Whitley	334, 958	1, 890	800		337, 648	349, 203	1. 03	163	850
Small mines		150, 000			150, 000	150, 000	1. 00		
Total	2, 613, 645	281, 115	30, 969	81, 450	3, 007, 179	2, 613, 569	. 86	202	6, 581

Coal product of Kentucky in 1894, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Bell	61,384	1,100	538	....	63,022	$79,715	$1.27	208	192
Carter	77,581	6,705	980	....	85,266	116,199	1.37	110	516
Daviess	3,541	6,808	4	....	10,353	8,986	.87	142	33
Hancock	34,641	900	30	....	35,571	35,297	1.00	129	111
Henderson	53,505	25,660	909	....	80,074	70,601	.88	164	215
Hopkins	725,278	24,618	17,597	44,266	811,759	607,250	.75	182	1,535
Johnson	16,402	500	....	....	16,902	40,596	2.40	284	.98
Laurel	249,446	10,357	1,374	....	261,177	209,981	.80	108	927
Lee	48,367	460	700	....	49,527	57,827	1.17	246	152
Muhlenberg	253,861	7,688	8,031	....	269,580	205,513	.76	105	642
Ohio	339,105	5,726	4,106	....	348,937	248,480	.70	147	673
Pulaski	49,421	747	1,497	....	51,665	51,813	1.00	90	339
Rockcastle	800	....	....	....	800	800	1.00	20	38
Union	103,072	24,196	3,817	3,500	134,585	117,497	.87	168	260
Webster	39,220	2,029	685	....	41,934	27,505	.66	98	89
Butler, Christian, and McLean	72,157	1,040	975	....	74,172	84,478	1.14	180	204
Boyd, Greenup, and Lawrence	195,049	2,364	2,316	....	199,729	178,386	.89	188	517
Knox and Whitley	412,017	6,338	3,785	....	422,140	414,391	.98	125	1,542
Small mines	....	153,999	....	....	153,999	194,617	1.27	....	....
Total	2,734,847	281,235	47,344	47,766	3,111,192	2,749,932	.88	145	8,083

The following table exhibits the annual product of the State since 1873:

Annual coal product of Kentucky since 1873.

Years.	Short tons.	Years.	Short tons.
1873	300,000	1884	1,550,000
1874	360,000	1885	1,600,000
1875	500,000	1886	1,550,000
1876	650,000	1887	1,933,185
1877	850,000	1888	2,570,000
1878	900,000	1889	2,399,755
1879	1,000,000	1890	2,701,496
1880	1,000,000	1891	2,916,069
1881	1,100,000	1892	3,025,313
1882	1,300,000	1893	3,007,179
1883	1,650,000	1894	3,111,192

Since 1889 the product, by counties, has been as follows:

Coal product of Kentucky since 1889, by counties.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.	Increase 1894.	Decrease 1894.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Bell	20,095	....	15,693	7,971	43,671	63,022	19,351	....
Boyd	163,124	*a* 191,600	179,350	194,470	162,706	111,659	....	51,047
Butler	6,489	*b* 44,931	12,871	18,951	22,719	19,982	....	2,737
Carter	172,776	179,379	145,937	139,351	105,844	85,266	....	20,578
Christian	27,281	(*b*)	34,060	47,895	34,560	38,836	4,276	....
Daviess	30,870	(*b*)	6,711	8,064	7,546	10,353	2,807	....
Greenup	632	....	....	....	1,964	1,573	....	391
Hancock	21,588	(*c*)	16,815	13,393	5,000	35,571	30,571	....
Henderson	65,682	*c* 126,640	124,021	80,661	103,639	80,074	....	23,565
Hopkins	555,119	604,307	680,386	730,879	713,809	811,759	97,950	....
Johnson	32,347	21,222	21,522	24,543	6,205	16,902	10,697	....
Knox	48,703	90,000	100,000	106,031	161,986	72,858	....	89,128
Laurel	280,451	291,178	308,242	241,129	193,622	261,177	67,555	....
Lawrence	79,787	(*d*)	80,848	97,000	95,232	86,497	....	8,735
Lee	....	....	....	....	....	49,527	49,527	....
McLean	35,177	(*c*)	25,000	....	....	15,354	15,354	....
Muhlenberg	206,855	240,983	260,315	277,865	290,270	269,580	....	20,690
Ohio	246,253	267.736	322,411	310,289	312,658	348,937	36,279	....
Pulaski	84,363	(*a*)	15,810	10,990	52,897	51,665	....	1,232
Rockcastle	1,432	....	....	9,774	9,010	800	....	8,210
Union	56,556	67,763	86,678	127,225	158,194	134,585	....	23,609
Webster	32,729	*d* 133,216	33,883	38,207	37,999	41,934	3,935	....
Whitley	184,874	262,541	265,516	340,615	337,648	349,282	11,634	....
Small mines	46,572	180,000	180,000	200,000	150,000	153,999	3,999	....
Total	2,399,755	2,701,496	2,916,069	3,025,313	3,007,179	3,111,192	*e* 104,013	....

a Includes Pulaski.
b Includes Christian, Crittenden, and Daviess.
c Includes Hancock and McLean.
d Includes Lawrence.
e Net increase.

The following tables exhibit the average price per ton received for coal at the mines in counties producing 10,000 tons or over, the number of employees, and the average number of days worked:

Average prices for Kentucky coal since 1889 in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Bell	$1.40	....	$1.25	$1.50	$0.87	$1.27
Boyd	1.10	$0.84	.81	.74	.82	.80
Butler	1.24	....	1.00	2.00	1.25	1.25
Carter	1.14	1.10	1.04	1.29	1.24	1.37
Christian	1.26	.86	1.16	.95	.97	1.25
Hancock	1.58	....	1.84	2.50	2.50	1.00
Henderson	1.26	.89	.92	.86	.85	.88
Hopkins	.78	.76	.73	.70	.66	.75
Johnson	1.67	2.13	2.28	2.37	2.64	2.40
Knox	.84	.77	1.00	.79	.85	.80
Laurel	.90	.95	1.00	.94	.89	.80
Lawrence	1.34	1.25	1.00	1.15	1.38	.98
Lee	....	....	....	....	....	1.17
Muhlenberg	.87	.80	.84	.89	.75	.76
Ohio	.81	.78	.79	.83	.78	.70
Pulaski	1.30	1.00	1.39	1.20	1.06	1.00
Union	1.13	1.08	1.26	1.01	.95	.87
Webster	.80	.78	.88	.86	.74	.66
Whitley	1.10	1.09	1.19	1.05	1.03	1.01
The State	.99	.92	.93	.92	.86	.88

Statistics of labor employed and working time at Kentucky coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Avarage working days.	Average number employed.	Average working days.
Bell	......	......	75	130	30	136	194	177	192	208
Boyd	......	......	300	287	300	285	275	225	287	183
Butler	......	......	45	200	65	192	45	224	64	195
Carter	459	237	437	227½	375	276	476	222	516	110
Christian	......	......	125	187	135	210	143	182	88	194
Hancock	......	......	100	80	100	275	25	150	111	129
Henderson	......	......	231	249	150	231	194	185	215	164
Hopkins	1,104	231	1,203	244	1,292	228	1,264	232	1,535	182
Johnson	110	267	153	280	157	291	27	281	98	284
Knox	200	240	215	200	225	185	275	240	255	113
Laurel	680	225	798	233	775	177	654	223	927	108
Lawrence	......	......	300	289	325	295	380	244	226	194
Lee	......	......	......	......	......	......	......	......	152	246
Muhlenberg	495	213	586	215	555	219	597	173	642	105
Ohio	520	236	625	225	818	169	590	170	673	147
Pulaski	......	......	74	170	45	135	108	180	339	90
Union	131	189	289	161	313	191	332	181	260	168
Webster	......	......	67	226	64	194	52	215	89	98
Whitley	625	204	680	190	890	216	850	163	1,287	125
The State	5,259	219	6,355	225	6,724	217	6,581	202	8,083	145

MARYLAND.

Total product in 1894, 3,501,428 short tons; spot value, $2,687,270.

ELK GARDEN AND UPPER POTOMAC COAL FIELDS.[1]

On the extreme fringe of the great Appalachian coal-basin is a long, narrow, detached coal field, which is, in some respects, one of the most important in the United States. This field, about 90 miles long by 2½ to 16 miles wide, extends from the southwest corner of Somerset County, Pa., through Allegany and Garrett counties, Md., Mineral, Grant, and Tucker counties, W. Va., into Randolph County, W. Va. In this distance four distinct subdistricts are recognized, the Wellersburg in Pennsylvania, the Cumberland-Georges Creek in Maryland, and the Elk Garden and the Upper Potomac in West Virginia. The output of coal from the whole field, including steam, domestic, smithing, and coking coal of the best quality, is about 4,500,000 tons annually. It is the nearest to tide water of all the bituminous coal fields which supply the great coal markets of the Northern Atlantic seaboard, and its coal beds are so situated as to permit a well-nigh unlimited increase of production should the trade of these markets demand it.

This great coal field has sometimes been termed the Cumberland coal field, from the fact that the Cumberland field proper, which, about half a century ago, began sending its high-grade steam coal into market, was for a long time the only one of the sub-basins which produced coal; but as the name "Cumberland" is now more appropriately applied to a coal (that of the Big Vein) which is not mined throughout the entire district, and as the amount of coal in the beds below the Big Vein is vastly greater than that remaining in it, some other name would be more appropriate and less misleading. As the district is watered chiefly by the Potomac River and its tributaries, and as most of the mining is along the banks of that stream, the name "Potomac Basin" has been suggested for this entire coal field; the distinctive and well known names of the several subbasins, however, being still retained.

The general course of this basin is northeast and southwest. It is hemmed in by the Allegheny Front Mountains on the east and the Backbone Mountains on the west. Its general shape from Pennsylvania to near the southern border of Tucker County, W. Va., where it abuts on several parallel mountain ranges, is that of a wedge, very narrow in Pennsylvania, only 2½ miles wide at the State line, and widening as the mountains draw away from each other, until, at the point named in Tucker County, it is some 16 miles wide.

The northern end of this field passes through the western part of Allegany County and a portion of the eastern part of Garrett County, Maryland, and from it the entire coal product of Maryland is obtained.

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[1] Abstract from a paper by Mr. Joseph D. Weeks, read before the American Institute of Mining Engineers, Virginia Beach, February, 1894 (Trans. A. I. M. E.).

The main field of the Appalachian range touches the western part of Garrett County, but no coal is mined from it on a commercial scale in this State. Coal from the Cumberland region in Maryland is shipped over the Cumberland and Pennsylvania Railroad, the Cumberland Coal and Iron Company's railroad, and the Georges Creek and Cumberland Railroad as initial lines, to the Pennsylvania Railroad at Cumberland, and the Baltimore and Ohio Railroad and the Chesapeake and Ohio Canal at Piedmont, whence it is transported to Atlantic coast points. A comparatively small amount goes west for smithing purposes.

PRODUCTION.

With the possible exception of the shipments of Pennsylvania anthracite, the records of the Cumberland coal trade, which includes the shipments also from the West Virginia portion of the field, are the most perfect we have. The record of anthracite shipments dates back to 1820; that of the Cumberland field to 1842. The advantage possessed by the anthracite is twenty-two years of anteriority in mining. The Cumberland region began with 1,708 long tons in 1842. In 1852, ten years later, it produced 334,178 long tons. In the following decade it reached as high as 788,909 long tons in one year, 1860; but at the outbreak of the war, in 1861 and 1862, it declined to 269,674 and 317,634 long tons, respectively, but recovered in 1863 to 748,345 long tons. At the end of the next decade, in 1872, the output exceeded two million tons, the actual product being 2,355,471 long tons. At this time the product seems to have reached the limit of demand temporarily, for the tonnage during the following ten years averaged about 2,000,000. The industrial activity from 1882 to 1892 is shown in the increased coal product from this field, the maximum being reached in 1891, with a total shipment of 4,382,096 long tons, of which more than three-fourths, or 3,420,670 long tons, were from the Maryland mines. In 1892 the product was decreased by the decision of the operators to curtail production rather than cut prices. The total shipments in that year were 4,029,564 long tons, of which Maryland shipped 3,016,393, or almost exactly 75 per cent. In 1893 the output increased somewhat to 4,347,807 long tons, Maryland's quota being 3,316,010. During 1894 the shipments were decreased by the strike and by trade depression to less than 4,000,000 long tons, of which Maryland furnished 3,065,707. The operators were unable to maintain prices in the face of the unfavorable conditions and the value declined from $3,267,317 in 1893 (an average of 98 cents per long ton, or 88 cents per short ton) to $2,687,270 in 1894, the average price being 86 cents per long ton, or 77 cents per short ton.

The following table shows the statistics of production in Maryland since 1889. The figures are reduced to short tons for the sake of uniformity throughout the report.

Coal product of Maryland since 1889.

Years.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
1889	2, 885, 336	44, 217	10, 162	2, 939, 715	$2, 517, 474	$0. 86	....	3, 702
1890	3, 296, 393	52, 621	8, 799	3, 357, 813	2, 899, 572	. 86	244	3, 842
1891	3, 771, 584	36, 959	11, 696	3, 820, 239	3, 082, 515	. 80	244	3, 891
1892	3, 385, 384	30, 955	3, 623	3, 419, 962	3, 063, 580	. 89	225	3, 886
1893	3, 676, 137	26, 833	13, 071	3, 716, 041	3, 267, 317	. 88	240	3, 935
1894	3, 435, 600	51, 750	14, 078	3, 501, 428	2, 687, 270	. 77	215	3, 974

The following table shows the annual output of coal in Maryland since 1883:

Product of coal in Maryland from 1883 to 1894.

Years.	Short tons.	Value.	Average price per ton.	Average number of days active.	Average number of men employed.
1883	2, 476, 075	....	....	....	....
1884	2, 765, 617	....	....	....	....
1885	2, 833, 337	....	....	....	....
1886	2, 517, 577	$2, 391, 698	$0. 95	....	....
1887	3, 278, 023	3, 114, 122	. 95	....	....
1888	3, 479, 470	3, 293, 070	. 95	....	....
1889	2, 939, 715	2, 517, 474	. 86	....	3, 702
1890	3, 357, 813	2, 899, 572	. 86	244	3, 842
1891	3, 820, 239	3, 082, 515	. 80	244	3, 891
1892	3, 419, 962	3, 063, 580	. 89	225	3, 886
1893	3, 716, 041	3, 267, 317	. 88	240	3, 935
1894	3, 501, 428	2, 687, 270	. 77	215	3, 974

The following tables, showing the shipments from the various mines in Maryland since 1883 and the total shipments from the Cumberland field (including the West Virginia mines in the field) since 1842, are obtained from the official reports of the Cumberland coal trade. The Maryland mining laws compel the use of the long ton as a basis of measurement, and the quantities in these tables are so expressed:

Shipments of coal from Maryland mines from 1883 to 1894.

[Long tons.]

Companies.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Consolidation Coal Co	456,238	689,212	710,064	675,652	936,799	1,023,349	871,463
New Central Coal Co	210,850	210,140	203.814	149,561	181,906	169,484	118,885
Georges Creek Coal and Iron Co	257,490	266,042	257,343	265,942	394,012	437,992	311,258
Maryland Union Coal Co.	137,105	117,180	98,095	116,771	148,523	106,620	....
Borden Mining Co	151,665	162,057	179,537	137,747	192,636	212,520	206,549
Maryland Coal Co	235,854	295,736	365,319	288,742	316,518	340,866	268,438
American Coal Co	190,055	194,330	220,339	211,305	259,632	287,058	297,537
Potomac Coal Co	139,723	169,463	196,280	156,757	209,793	208,777	205,212
Hampshire and Baltimore Coal Co	194,534	36,416	....	....	....	....	....
Atlantic and Georges Creek Coal Co. (Pekin mine)	69,000	75,467	64,938	7,321	....	6,375	3,884
Swanton Mining Co	34,905	28,620	52,862	42,688	61,610	58,383	40,748
Blæn Avon Coal Co	84,721	100,961	69,192	65,830	11,934	....	....
Piedmont Coal and Iron Co	4,619	1,250	32	1,678	....	....	....
Union Mining Co	5,024	5,310	5,641	6,824	7,500	6,396	3,734
National Coal Co	38,998	42,680	48,307	62,637	117,775	76,592	72,571
Davis and Elkins mine	....	74,437	58,002	58,382	82,667	98,443	18,089
James Ryan	....	....	....	....	3,608	....	....
George M. Hansel	....	....	....	....	1,989	3,559	113
Barton and Georges Creek Valley Co	....	....	....	....	....	69,857	123,429
Enterprise mine	....	....	....	....	....	399	288
Franklin Consolidated Coal Co *a*	....	....	....	....	....	....	71,837
Big Vein Coal Co	....	....	....	....	....	....	21,310
Piedmont-Cumberland Coal Co	....	....	....	....	....	....	2,493
Total	2,210,781	2,469,301	2,529,765	2,247,837	2,926,902	3,106,670	2,637,838

Companies.	1890.	1891.	1892.	1893.	1894.	Increase in 1894.	Decrease in 1894.
Consolidation Coal Co	956,031	910,977	912,787	907,559	892,502	....	15,057
New Central Coal Co	218,169	206,813	201,428	223,504	151,002	....	72,502
Georges Creek Coal and Iron Co	351,310	356,927	297,632	345,791	364,668	18,877	....
Borden Mining Co	290,055	300,268	253,629	367,725	265,548	....	102,177
Maryland Coal Co	366,839	406,464	280,946	356,820	351,542	....	5,278
American Coal Co	386,731	449,631	384,681	443,963	453,680	9,717	....
Potomac Coal Co	217,232	184,706	137,738	121,258	108,977	....	12,281
Atlantic and Georges Creek Coal Co. (Pekin mine)	752	....	....	....	....	....	....
Swanton Mining Co	41,401	33,029	5,162	....	2,465	2,465	....
Union Mining Co	17,933	179,232	176,996	205,210	173,548	....	31,662
National Coal Co	60,206	....	....	....	....	....	....
Barton and Georges Creek Valley Co	175,838	201,124	201,365	193,545	165,886	....	27,659
Enterprise mine	11	....	....	....	....	....	....
Franklin Consolidated Coal Co *a*	66,644	76,593	72,117	57,598	64,766	7,168	....
Big Vein Coal Co	52,917	62,832	66,683	63,940	47,023	....	16,917
Piedmont - Cumberland Coal Co	29,003	42,439	14,564	17,869	6,483	....	11,386
Anthony Mining Co	115	9,725	10,665	11,228	17,617	6,389	....
Total	3,231,187	3,420,760	3,016,393	3,316,010	3,065,707	....	*b* 250,303

a Succeeded by Davis Coal and Coke Co. in 1894.
b Net decrease.

Total shipments from the Cumberland coal field in

Years.	Frostburg region.						
	Cumberland and Pennsylvania R. R.				Cumberland Coal and Iron Company's railroad.		
	By Baltimore and Ohio R. R.	By Chesapeake and Ohio canal.	By Pennsylvania R. R.	Total.	By Baltimore and Ohio R. R.	By Chesapeake and Ohio canal.	Total.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
1842	757			757	951		951
1843	3, 661			3, 661	6, 421		6, 421
1844	5, 156			5, 156	9, 734		9, 734
1845	13, 738			13, 738	10, 915		10, 915
1846	11, 240			11, 240	18, 555		18, 555
1847	20, 615			20, 615	32, 325		32, 325
1848	36, 571			36, 571	43, 000		43, 000
1849	63, 676			63, 676	78, 773		78, 773
1850	73, 783	3, 167		76, 950	119, 023	875	119, 898
1851	70, 893	51, 438		122, 331	103, 808	31, 540	135, 348
1852	128, 554	46, 357		174, 891	139, 925	19, 362	159, 287
1853	150, 381	84, 060		234, 441	155, 278	70, 535	225, 813
1854	148, 953	63, 731		212, 684	173, 580	92, 114	265, 694
1855	93, 691	77, 095		170, 786	97, 710	100, 691	198, 401
1856	86, 994	80, 387		167, 381	121, 945	105, 149	227, 094
1857	80, 743	55, 174		135, 917	88, 573	54, 000	142, 573
1858	48, 018	166, 712		214, 730	66, 009	87, 539	153, 548
1859	48, 415	211, 639		260, 054	72, 423	86, 203	158, 626
1860	70, 699	232, 278		302, 947	80, 500	63, 600	144, 100
1861	23, 878	68, 303		92, 181	25, 983	29, 296	55, 279
1862	71, 745	75, 206		146, 951	41, 096	23, 478	64, 574
1863	117, 796	173, 269		291, 065	111, 087	43, 523	154, 610
1864	287, 126	194, 120		481, 246	67, 676	64, 520	132, 198
1865	384, 297	285, 295		669, 592	104, 651	57, 907	162, 558
1866	592, 938	291, 019		883, 957	52, 251	52, 159	104, 410
1867	623, 031	385, 249		1, 008, 280	40, 106	72, 904	113, 010
1868	659, 115	424, 406		1, 083, 521	100, 345	57, 919	158, 264
1869	1, 016, 777	573, 243		1, 590, 020	130, 017	78, 908	208, 925
					2, 092, 660	1, 192, 224	3, 284, 884
					Eckhart Branch R. R.		
1870	909, 511	520, 196		1, 429, 707	114, 404	83, 941	198, 345
1871	1, 247, 279	656, 085		1, 903, 364	69, 864	194, 254	264, 118
1872	1, 283, 956	612, 537	22, 021	1, 918, 514	26, 586	203, 666	230, 252
1873	1, 509, 570	641, 220	114, 589	2, 265, 379	89, 765	137, 582	227, 347
1874	1, 295, 804	631, 882	67, 671	1, 995, 357	113, 670	135, 182	248, 852
1875	1, 095, 880	715, 673	160, 213	1, 971, 766	52, 505	164, 165	216, 670
1876	939, 262	443, 435	131, 866	1, 514, 563	15, 285	189, 005	204, 290
1877	755, 278	473, 646	170, 884	1, 399, 808	63, 181	111, 350	174, 531
1878	823, 801	486, 038	145, 864	1, 455, 703	99, 455	123, 166	222, 621
1879	933, 240	397, 009	154, 264	1, 484, 513	141, 907	104, 238	146, 145
1880	1, 055, 491	471, 800	213, 446	1, 740, 737	197, 525	131, 325	328, 850
1881	1, 113, 263	270, 156	153, 501	1, 536, 920	271, 570	151, 526	423, 096
1882	576, 701	115, 344	91, 574	783, 619	199, 183	76, 140	275, 323
1883	851, 985	302, 678	217, 065	1, 371, 728	197, 235	141, 390	338, 625
1884	1, 193, 780	150, 471	199, 138	1, 543, 389	299, 884	124, 718	414, 602
1885	1, 091, 904	171, 460	206, 227	1, 469, 591	289, 407	117, 829	407, 236
1886	1, 131, 949	115, 531	141, 520	1, 389, 000	243, 321	113, 791	357, 112
1887	1, 584, 114	132, 177	176, 241	1, 892, 532	332, 798	125, 305	458, 103
1888	1, 660, 406	155, 216	193, 046	2, 208, 668	374, 888	95, 191	470, 079
1889	1, 430, 381	26, 886	177, 152	1, 634, 419	368, 497	26, 407	394, 904
1890	1, 511, 418		291, 704	1, 803, 122	522, 334		522, 334
1891	1, 628, 574	9, 070	289, 235	1, 926, 876	463, 142	39, 294	502, 436
1892	1, 426, 994	93, 705	214, 012	1, 734, 710	349, 207	170, 116	519, 323
1893	1, 332, 634	135, 409	360, 801	1, 828, 850	341, 321	201, 947	543, 268
1894	1, 068, 739	95, 523	372, 207	1, 536, 467	436, 216	208, 914	645, 130
Total	34, 383, 375	11, 365, 295	4, 264, 231	50, 012, 901	5, 663, 150	3, 170, 342	8, 833, 492

a Includes 103,834 tons used on line of Cumberland and Pennsylvania Railroad and its branches
pany in locomotives, rolling mills, etc.

Maryland and West Virginia from 1842 to 1894.

Frostburg region. Georges Creek and Cumberland R. R. By Chesapeake and Ohio canal.	Frostburg region. Georges Creek and Cumberland R. R. By Pennsylvania R. R.	Frostburg region. Georges Creek and Cumberland R. R. Local and Baltimore and Ohio.	Frostburg region. Georges Creek and Cumberland R. R. Total.	Piedmont region. Georges Creek R. R.	Piedmont region. Hampshire R. R. by Baltimore and Ohio R. R.	Total. Baltimore and Ohio R. R. and local.	Total. Chesapeake and Ohio canal.	Total. Pennsylvania R. R.	Aggregate.
Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
......	....	....	....	....	....	1, 708	....	....	1, 708
......	....	....	....	....	....	10, 082	....	....	10. 082
......	....	....	....	....	....	14, 890	....	....	14, 890
......	....	....	....	....	....	24. 653	....	....	24, 653
......	....	....	....	....	....	29, 795	....	....	29, 795
......	....	....	....	....	....	52, 940	....	....	52, 940
......	....	....	....	....	....	79, 571	....	....	79, 571
......	....	....	....	....	....	142, 449	....	....	142, 449
......	....	....	....	....	....	192, 806	4, 042	....	196. 848
......	....	....	....	....	....	174, 701	82, 978	....	257, 679
......	....	....	....	....	....	268, 459	65, 719	....	334, 178
......	....	....	....	73, 725	....	376, 219	157, 760	....	533, 979
......	....	....	....	181, 303	....	503, 836	155, 845	....	659, 681
......	....	....	....	227, 245	65, 570	478, 486	183, 786	....	662. 272
......	....	....	....	269, 210	42, 765	502, 330	204. 120	....	706, 450
......	....	....	....	252, 368	51, 628	465, 912	116, 574	....	582. 486
......	....	....	....	218, 318	63, 060	395, 405	254, 251	....	649, 656
......	....	....	....	257, 740	47, 934	426, 512	297, 842	....	724, 354
......	....	....	....	289, 298	52, 564	493, 031	295, 878	....	788, 909
......	....	....	....	85, 554	36, 660	172, 075	97, 599	....	269, 674
......	....	....	....	69, 482	36, 627	218, 950	98. 684	....	317, 634
......	....	....	....	266, 430	36, 240	531, 553	216, 792	....	748, 345
......	....	....	....	....	44, 552	399, 354	258. 642	....	657, 996
......	....	....	....	....	71, 345	560, 293	343. 202	....	903. 495
......	....	....	....	....	90, 964	736, 153	343, 178	....	1, 079, 331
......	....	....	....	....	72, 532	735, 669	458, 153	....	1, 193, 822
......	....	....	....	....	88, 658	848, 118	482, 325	....	1, 330, 443
......	....	....	....	....	83, 724	1, 230, 518	652, 151	....	1, 882. 669
				2, 190, 673					
				Empire and West Virginia mines.					
......	....	....	....	28, 035	60, 988	1, 112, 938	604, 137	....	1, 717, 075
......	....	....	....	81, 218	96, 453	1, 494, 814	850, 339	....	2, 345, 153
......	....	....	....	85, 441	121, 364	1, 517, 347	816, 103	22, 021	2, 355, 471
......	....	....	....	77, 582	103, 793	1, 780, 710	778, 802	114, 589	2, 674, 101
......	....	....	....	57, 492	109, 194	1, 576, 160	767, 064	67, 671	2, 410. 895
......	....	....	....	63, 537	90, 800	1, 302, 237	879, 838	160, 698	2, 342, 773
......	....	....	....	108, 723	7, 505	1, 070, 775	632, 440	131, 866	1, 835, 081
......	....	....	....	....	....	818, 450	584, 996	170, 884	1, 574, 339
......	....	....	....	....	998	924, 254	609, 204	145, 864	1, 679, 322
......	....	....	....	....	51	1, 075. 198	501, 247	154, 264	1, 730, 709
......	....	....	....	66, 573	....	1, 319, 589	603, 125	213, 446	2, 136, 160
83, 136	125, 097	4, 947	213, 180	88. 722	....	1, 478, 502	504, 818	278, 598	2, 261, 918
78, 298	93, 861	31, 436	203, 595	277, 929	....	1, 085, 249	269, 782	185. 435	1, 540, 466
215, 767	202, 223	77, 829	495, 819	338, 001	....	1, 444, 766	680, 119	419, 288	2, 544, 173
69, 765	156, 959	283, 336	510, 060	466, 928	....	2, 233, 928	344, 954	356, 097	2, 934, 979
79, 455	214, 518	291, 685	585, 658	403, 489	....	2, 076, 485	368, 744	420, 745	2, 865, 974
53, 480	98, 371	348, 196	500, 047	346, 308	....	2, 069, 774	282, 802	239, 891	2, 592, 467
4, 863	153, 230	418, 057	576, 150	449, 011	....	2, 724, 347	262, 345	389, 104	3, 375, 796
112	286, 787	341, 024	627, 923	564, 397	....	2, 669, 216	286, 700	715, 151	3, 671, 067
......	365, 029	243, 487	608, 516	576, 047	....	2, 357, 585	57, 459	798, 842	3, 213, 886
......	677, 593	228, 138	905, 731	774, 904	....	2, 723, 341	....	1, 282, 748	4, 006, 091
......	763, 845	229, 766	993, 111	959, 673	....	2, 855, 225	51, 121	1, 474, 087	4, 380, 433
......	568, 003	236, 314	804, 317	971, 214	....	2, 557, 177	266, 901	1, 205, 486	4, 029, 564
......	741, 954	201, 938	943, 892	1, 031, 797	....	2, 423, 159	338, 107	1, 586, 541	4, 347, 807
......	773, 074	111, 036	884, 110	900, 399	....	*a* 2, 084, 265	304, 437	1, 577, 404	3, 966, 106
584, 876	5, 220, 544	3, 046, 689	8, 852, 109	8, 043, 595	1, 475. 969	54, 843, 633	16 415. 105	12, 110, 720	83, 369, 458

and at Cumberland and Piedmont; also 266,830 tons used by the Baltimore and Ohio Railroad Com-

MICHIGAN.

Total product in 1894, 70,022 short tons; spot value, $103,049.

MICHIGAN COAL FIELD.

The coal deposits of Michigan are detached from those of any other State, and form what is known as the Northern field. The area is about 6,700 square miles, the central point being near the town of St. Louis, in Gratiot County, and the southern boundary passing a few miles south of Jackson, in Jackson County. Beyond this to the south there are several detached patches of productive Coal Measures. The greatest thickness of the measures is found along a line extending from Ionia County to Saginaw, the thickest coal beds lying along Six Mile Creek. The principal operations are carried on near the city of Jackson, in Jackson County, but these are small when compared with other States.

The Michigan coals are of inferior quality when compared to those shipped by lake and rail into the State, and the imported coals are sold so cheap that there is little encouragement for the development of the Michigan field. The basins in which the coal deposits were laid down were unprotected by later deposits prior to the period of Glacial movement, and were exposed to the action of that time. The exposure to the forces of nature before the time of the glaciers seriously affected the qualities of the coal formation, and much of it was worn away and destroyed by moving glaciers, what was left being buried under the débris of the Glacial drift. These conditions have left the rock formation of Michigan with but few exposures, and actual boring is necessary to determine whatever of mineral value lies below the surface. This requires considerable trouble and expense, and is not resorted to unless for some specific purpose. Considering all these disadvantages there is little wonder that the coal fields have not been more fully exploited.

PRODUCTION.

Coal production in Michigan has never reached as much as 150,000 tons in any one year, the highest point attained being in 1882, when the product was 135,339 short tons. The first record of production was obtained in 1877, when an output of 69,197 short tons was reported. It increased each year but one from then until 1882, the product in 1880, 1881, and 1882 having exceeded 100,000 tons. But the attempts made in those years to stimulate coal mining in the State were not attended with much success. Two mines closed down in the following year and the product decreased nearly one-half in 1883, and in about the same proportion in 1884. Since then the output has fluctuated between 40,000 and 80,000 tons, varying to some extent with the rise and fall of the thermometer, the largest product being 81,407 tons in 1888, the year of exceptional activity in coal mining throughout the United States.

The following tables show the statistics of production during the past three years, and the total output since 1887. The amount produced previous to 1877 is estimated to have been 350,000 short tons, so that the total tonnage from the Michigan coal fields to the close of 1894 has been approximately 1,764,250 tons.

Coal product of Michigan in 1892, 1893, and 1894.

Years.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons	*Short tons*	*Short tons*	*Short tons*				
1892	27, 200	45, 180	5, 610	77, 990	$121, 314	$1. 56	230	195
1893	27, 787	16, 367	1, 825	45, 979	82, 462	1. 79	154	162
1894	60, 817	7, 055	2, 150	70, 022	103, 049	1. 47	224	223

Product of coal in Michigan from 1877 to 1893.

Years.	Short tons.	Years.	Short tons.
Previous to 1877	350, 000	1886	60, 434
1877	69, 197	1887	71, 461
1878	85, 322	1888	81, 407
1879	82, 015	1889	67, 431
1880	129, 053	1890	74, 977
1881	130, 130	1891	80, 307
1882	135, 339	1892	77, 990
1883	71, 296	1893	45, 979
1884	36, 712	1894	70, 022
1885	45, 178		

MISSOURI.

Total product in 1894, 2,245,039 short tons; spot value, $2,634,564.

MISSOURI COAL FIELDS.

A line drawn from the junction of the Des Moines River with the Mississippi, in the northeast corner of the State, diagonally across to the southwest corner, will have northwest of it nearly all the coal territory of Missouri. An arm of this territory, however, follows the course of the Missouri River eastward for a short distance in the central part of the State, and some coal is also found in the vicinity of St. Louis. The total area included is estimated at about 25,000 square miles, distributed over fifty-seven counties in whole or in part. All of the coals are of the bituminous variety, with the exception of some limited deposits which approach cannel coal in character. The bituminous coals have, as a rule, a high percentage of ash compared with the best coals of this character. They are comparatively soft, and deteriorate by exposure or much handling. They also usually carry considerable sulphur in the form of pyrite, which, though some of the coals are rich in hydrocarbons of high candle power, unfits them for the manufacture of illuminating gas. The mines are not troubled much by excess of water. In fact, many of them are so dry as to be dusty.

The separation of the Western coal field, of which Missouri forms an important part, from the Illinois or Central field is made by the Mississippi River and its immediate valley. At one place near the northern border of the Illinois field the present course of the Mississippi cuts through it, a small portion of the Central field being found across the river in Iowa. The two fields are really the same, the barren valley being a narrow one, and in it isolated bodies of coal are found both in Iowa and Missouri. It has been customary, however, to consider them separately, and they are so considered in this report. The principal users of Missouri coal are the railways of the State. The manufacturing industries come next, after which comes the domestic consumption in grates, stoves, and furnaces. As before stated, they are not adapted for gas making, the expense of purifying from sulphur being too great to be practicable.

PRODUCTION.

The total product of coal in Missouri in 1894 was 2,245,039 short tons, valued at $2,634,564. In 1893 the output was 2,897,442 short tons, worth $3,562,757. The decrease, therefore, in 1894 was 652,403 short tons, or a little more than 22 per cent in amount, and $928,193, or more than 25 per cent in value. The strike of the spring of 1894 was pretty general throughout the State, varying at different places from three to six months. In some cases operators stated that the product had been curtailed about 40 per cent by the strike. The effects of the business depression is shown in the greater comparative decrease in value, the average price per ton declining from $1.23 in 1893 to $1.17 in 1894. The production by counties during the past two years, with the distribution and value, is shown in the following tables:

Coal product of Missouri in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Adair	20 358	192	343	20, 893	$31, 180	$1. 49	188	81
Audrain	9. 297	27, 739	950	37, 986	53, 028	1. 40	184	101
Barton	41, 600	300	460	42, 360	47, 530	1. 12	116	207
Bates	396, 476	8, 893	4, 450	409, 819	414, 806	1. 01	162	771
Boone	9. 000	2, 550	100	11, 650	18, 925	1. 62	203	32
Caldwell	14, 325	3, 078	699	18, 102	35, 849	1. 98	223	74
Callaway	1. 000	23, 240	26	24, 266	37, 333	1. 54	218	127
Clay	11. 523	315	886	12, 724	20, 995	1. 65	240	55
Cooper	1, 461	91	80	1, 632	3, 264	2. 00	204	5
Grundy	403	35, 230	2, 000	37, 633	77, 148	2. 05	300	130
Henry	91, 700	7, 709	1, 006	100, 415	145, 754	1. 45	225	279
Jasper	....	604	....	604	1, 098	1. 82	60	7
Johnson	10, 100	797	112	11, 009	15, 872	1. 44	285	26
Lafayette	321, 948	13, 550	4, 170	339, 668	516, 573	1. 52	226	1, 148
Linn	80, 084	12, 039	1. 084	93, 207	151, 442	1. 62	233	290
Macon	664, 461	8, 621	15, 397	688, 479	728, 900	1. 06	232	1, 833
Moniteau	20	450	50	520	1, 000	1. 96	125	3
Montgomery	....	12, 000	....	12, 000	16, 200	1. 35	200	48
Morgan	....	....	....	....	....	....	....	....
Putnam	134, 267	1, 581	3, 734	139, 582	189, 273	1. 36	236	460
Randolph	209, 808	2, 942	1, 740	214, 490	236, 571	1. 10	191	523
Ray	212, 559	6, 390	1, 469	220, 418	333, 563	1. 51	196	636
St. Clair	336	....	....	336	525	1. 56	150	2
Vernon	294, 501	4, 443	10, 705	309, 649	310, 928	1. 01	126	537
Small mines	....	150, 000	....	150, 000	175, 000	....	....	....
Total	2, 525, 227	322, 754	49, 461	2, 897, 442	3, 562. 757	1. 23	206	7, 375

Coal product of Missouri in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Adair and Audrain	6	15, 922	9, 049	100	25, 071	$41, 517	$1. 66	199	87
Bates	17	260, 044	14, 476	5, 186	279, 706	289, 665	1. 04	83	919
Barton	5	131, 977	6, 675	1, 325	139, 977	147, 712	1. 06	195	412
Boone	3	10, 000	7, 860	300	18, 160	28, 200	1. 55	200	50
Caldwell	3	23, 343	2, 155	806	26, 304	46, 301	1. 76	228	115
Callaway	14	2, 000	15, 734	953	18, 687	29, 884	1. 60	156	81
Cooper	2	2, 155	48	40	2, 243	5, 236	2. 33	90	20
Henry	14	152, 945	4, 841	623	158, 409	179, 413	1. 13	156	327
Johnson	2	6, 235	263	....	6, 498	9, 313	1. 43	240	25
Lafayette	30	179, 691	18, 410	5, 322	203. 423	348, 153	1. 68	119	1, 305
Linn	5	66, 495	10, 167	610	77, 272	122, 984	1. 59	233	264
Macon	10	469, 529	3, 832	16, 218	489, 579	467, 751	. 96	183	1, 387
Morgan	3	....	745	....	745	1, 500	2. 01	95	6
Putnam	3	111, 415	2, 180	3, 060	116, 655	141, 262	1. 21	146	486
Randolph	11	192, 832	4, 893	3, 672	201, 397	220, 418	1. 09	144	566
Ray	6	95, 316	3, 277	2, 093	100, 686	145, 443	1. 44	78	690
Vernon	10	234, 636	2, 662	6, 915	244, 213	241, 938	. 99	90	666
Chariton, Moniteau, Jackson, Montgomery, St. Clair	5	720	15, 234	60	16, 014	27, 874	1. 28	147	117
Small mines	....	....	120, 000	....	120, 000	140, 000	....	....	....
Total	149	1, 955, 255	242, 501	47, 283	2, 245, 039	2, 634, 564	1. 17	138	7, 523

Prior to 1887 the records of the production of coal in Missouri are simply estimates. They are, however, the best information we have, and are given below as such. In the later years the statistics have been collected with a certain degree of accuracy. The figures in the following table for 1887 and 1888 were reported by the mine inspectors; those for 1889 were collected by the Eleventh United States Census, and since then by the Geological Survey. The maximum product was attained in 1888, a year of unusual activity in the coal mining industry, the output reaching a total of 3,909,967 short tons. The following year it dropped to 2,557,823 short tons, and has not since reached 3,000,000 tons in any one year. As in the cases of Iowa and Kansas, the production of coal in Missouri has for several years been on a par with the industrial development of the State. The markets are necessarily restricted to a comparatively local region. On the east it meets competition with Illinois, Indiana, Ohio, and West Virginia coals, brought by cheap vater transportation to the Mississippi River towns (St. Louis drawing nearly all of its supply from Illinois); on the west where its chief market is, outside of the State, it soon strikes the Colorado and other Rocky Mountain coals; Iowa stands as a bar to the north, and the Indian Territory and Arkansas, with coals of superior quality, lie to the south. Any radical changes in the production of coal may then be taken as indicative of the general condition of industrial enterprises in the State. The following table exhibits the annual production of coal in Missouri since 1873:

Coal product of Missouri since 1873.

Years.	Short tons.	Years.	Short tons.
1873	784, 000	1884	2, 800, 000
1874	789, 680	1885	3, 080, 000
1875	840. 000	1886	1, 800, 000
1876	1, 008, 000	1887	3, 209, 916
1877	1, 008, 000	1888	3, 909, 967
1878	1, 008, 000	1889	2. 557, 823
1879	1, 008, 000	1890	2, 735, 221
1880	1, 680, 000	1891	2, 674, 606
1881	1, 960, 000	1892	2, 773, 949
1882	2, 240, 000	1893	2. 897, 442
1883	2, 520, 000	1894	2, 245, 039

The following table contains the statistics of production by counties since 1889, with the increases and decreases in 1894 as compared with 1893:

Coal product of Missouri since 1889, by counties.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.	Increase in 1894.	Decrease in 1894.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Adair	18,592	16,000	10,940	11,138	20,893	10,150		10,743
Audrain	26.194	20,261	8,772	23,012	37,986	14,921		23,065
Barton	61,167	28,500	85,002	50,561	42,360	139,977	97,617	
Bates	755,989	751,702	628,580	572,730	409,819	279,706		130,113
Boone	31,405	17,000	16,340	15,636	11,650	18,160	6,510	
Caldwell	13,594	21,599	51,065	30,806	18,102	26,304	8,202	
Callaway	16,053	5,331	22,458	21,710	24,266	18,687		5,579
Chariton						100	100	
Clay					12,724			12,724
Cooper	996			1,720	1,632	2,243	611	
Grundy	23,401	24,000	30,000	27,300	37,633			37,633
Henry	180,118	109,768	102,866	89,769	100,415	158,409	57,994	
Jackson						6,000	6,000	
Jasper	720				604			604
Johnson	12.841	5,950	4,500	5,680	11,009	6,498		4,511
Lafayette	348,670	347,688	277,393	324,848	339,668	203,423		136,245
Linn	6.992	1,300	26,994	40,622	93,207	77,272		15,935
Macon	446,396	540,061	592,105	668,146	688,479	489,579		198,900
Moniteau					520	364		156
Montgomery	12,300	13,584	16,129	16,689	12,000	8,871		3,129
Morgan	2,000	650	220	48		745	745	
Putnam	83,774	108,514	122,666	137,058	139,582	116,655		22,927
Randolph	221,463	269,372	274,520	149,608	214,490	201,397		13,093
Ray	220.530	278,118	213,539	235,298	220,418	100,686		119,732
St. Clair	6,880	5,050	2,500	6,500	336	679	343	
Vernon	39,420	13,385	48,017	155,070	309,649	244,213		65,436
Other counties and small mines	28,328	157,388	140,000	150,000	150,000	120,000		30,000
Total	2,557,823	2,735,221	2,674,606	2,773,949	2,897,442	2,245,039		*a*652,403

a Net decrease.

The following tables are worthy of attention, as showing the tendency of prices during a series of years and the statistics of labor employed at Missouri coal mines during the same period:

Average prices for Missouri coal since 1889, in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Adair	\$1.66	\$1.70	\$1.75	\$1.75	\$1.49	\$1.48
Audrain	1.47	1.61	1.57	1.50	1.40	1.50
Barton	1.35	1.06	1.22	1.29	1.12	1.06
Bates	1.14	1.02	1.04	1.00	1.01	1.04
Boone	1.54	1.50	1.50	1.53	1.62	1.55
Caldwell	1.97	1.98	2.15	2.20	1.98	1.76
Callaway	1.79	1.50	1.42	1.56	1.54	1.60
Grundy	2.05	2.05	2.05	2.05	2.05	
Henry	1.55	1.48	1.33	1.41	1.45	1.13
Lafayette	1.60	1.55	1.55	1.60	1.52	1.68
Linn	1.88		1.19	1.56	1.62	1.59
Macon	1.23	1.11	1.02	1.04	1.06	.96
Montgomery	1.42	1.35	1.35	1.36	1.35	1.25
Putnam	1.34	1.31	1.31	1.37	1.36	1.21
Randolph	1.29	1.14	1.06	1.07	1.10	1.09
Ray	1.57	1.52	1.62	1.54	1.51	1.44
Vernon	1.18	1.20	1.04	1.02	1.01	.99
The State	1.36	1.24	1.23	1.23	1.23	1.17

Statistics of labor employed and working time at Missouri coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.
Adair	48	280	40	300	40	300	81	188	28	226
Audrain	70	205	33	180	60	224	101	184	59	186
Barton	90	231	263	221	149	179	207	116	412	195
Bates	1,315	215	1,077	235	663	207	771	162	919	83
Boone	46	290	53	257	38	273	32	203	50	200
Caldwell	77	294	194	230	158	244	74	223	115	228
Callaway	11	218	90	230	97	243	127	218	81	156
Grundy	50	200	90	297	140	275	130	300	......	......
Henry	311	207	286	218	246	219	279	225	327	156
Lafayette	1,056	217	850	206	949	233	1,148	226	1,305	119
Linn	......	......	90	240	135	249	290	233	264	233
Macon	1,027	259	1,198	228	1,489	252	1,833	232	1,387	183
Montgomery	33	200	37	260	40	195	48	200	35	156
Putnam	355	234	430	196	393	242	460	236	486	146
Randolph	635	229	535	249	371	227	523	191	566	144
Ray	687	241	753	178	694	206	636	196	690	78
Vernon	44	118	139	131	186	166	537	126	666	90
The State	5,971	229	6,199	218	5,893	230	7,375	206	7,523	138

MONTANA.

Total product in 1894, 927,395 short tons; spot value, $1,887,390.

MONTANA COAL FIELDS.[1]

The coals of Montana, like those of the Rocky Mountain region generally, are all of Cretaceous age, and, though often the equal as fuels of the Carboniferous coals of the Eastern part of the country, differ wholly from them in their mode of occurrence. The coals of the State embrace a wide variety of true bituminous coals, found only in or near the mountains, and the inferior lignites whose seams form prominent parts of the series of rocks that underlie the Great Plains country. Although formerly supposed to belong to but one geological formation, the coals of the Rocky Mountain region are now known to belong to four very different horizons. The oldest, known as the Kootanie group of rocks, is a series of sandstones and shales of fresh-water origin. The coals so extensively mined in the Rocky Mountains of Canada belong to this series of strata, and the seam of coal that underlies the Great Falls coal field is also of this age. Separated from the Kootanie rocks by a thickness of several thousand feet of black shales, the Belly River beds, as they have been termed, form the next coal-bearing horizon. The coal seam at the top of this series of light-colored sandstone beds is extensively mined at Lethbridge, Canada, and shipped into Montana. The coal seams opened during the past year in the Sweet Grass Hills belong to this group of rocks. The Laramie rocks, which everywhere

[1] By W. H. Weed, United States Geological Survey.

throughout the Rocky Mountain region, from Mexico to Canada, have proved to be coal bearing, overlie several thousand feet of gray shales and clays, capping the Belly River series, and the rocks of this group, with those of the overlying lignite-bearing Fort Union beds, are the only coal-bearing horizons in the southern and eastern parts of the State.

The true bituminous coals are found only in the vicinity of the mountains. Throughout the broken plains country of the eastern part of the State the coals are all lignitic. These lignites have been mined at a few localities in past years, but their low heating power and rapid crumbling unfit them for general use, and the bituminous coals have occupied the market. The lignites are very generally exposed in the bluffs and steeper hillsides of eastern Montana, and form a supply of fuel for local consumption that will be used more and more as this tree less country is settled. The lignites differ from the true coals in two important particulars: they contain a large amount of moisture and they crumble upon exposure soon after mining. The moisture makes them of low heating power, and their rapid crumbling unfits them for transportation and is a serious detriment in burning. These qualities render them commercially valueless at present, except for local consumption, notwithstanding the thickness of the seams and the purity of the fuel. An average analysis of the lignites of eastern Montana shows:

Average analysis of Montana lignites.

	Per cent.
Water	12-15
Volatile carbon	40-45
Fixed carbon	30-35
Ash	5-10

Small quantities of lignite are mined at Chinook and Havre and near Miles City. The best fuels of this class occur in the chain of hills known as the Bull Mountains, north of Billings.

BITUMINOUS COAL.

The bituminous coals of Montana occur in small isolated fields within the mountain region and in a great belt of coal land that extends along the eastern front of the Rocky Mountains.

With the exception of the intermontane field just north of the Yellowstone Park, the producing coal mines of the State are all situated in this foothill coal belt.

The character of the coals varies widely in different seams and at different fields. Long and short flamed, coking and noncoking coals occur sometimes in adjoining seams of the same mine. As a whole the coals contain a high percentage of ash, and would not rank high in more favored localities. Some of the coals, however, are as pure as the best of Wyoming or Colorado fuels. It is a characteristic of the seams that they thin out rapidly within a few miles, and they lose their individuality at any distance. This is particularly true of the Laramie beds. But one workable seam is known in the Belly River, and one in the Kootanie formations of the Great Falls field, but the Laramie rocks often hold a great number of seams of workable thickness, good quality, and considerable extent. The seams are usually covered by a hard sand-rock roof, separated from the coal by but a few inches of shale, and the mines are free from gases and but little troubled by water. The mines depend very largely upon the railroads as consumers, and the cities take comparatively small amounts of coal.

The coal fields of the great belt of coal land east of the mountains are but portions of this continuous strip in which the seams have proven workable, and the fields take their name from the nearest large town or stream.

The most easterly field is that known as the Rocky Fork, and embraces the coal lands lying at the base of the mountains south of the Yellowstone River, near Billings.

During 1894 the coal fields of Montana show an increase of production over all preceding years. The only mines of importance opened during the year are those of Belt Creek, part of the Great Falls field, but the seams of the Flathead country and those found in the Sweet Grass Hills have attracted much attention and will probably soon be opened. The opening of the Pacific Coast line of the Great Northern Railway has brought these fields closer to railroad transportation, and has also stimulated the opening up of the lignite seams near Chinook and Havre.

The total average of coal land claimed and recorded by the Land Office does not represent the actual amount of land held, as very few of the claimants possess the means to pay the Government price of $10 or $20 an acre at the end of the year allowed after filing.

PRODUCTION.

Montana was one of the few States whose product in 1894 exceeded that of 1893. Owing to the remoteness of the region, it was not included in the general strike that upset the industry in the Appalachian, Central, and Western fields; but, on the other hand, derived some benefit from the scarcity of coal in the other regions. Owing to the business depression, and particularly to the injury to her silver industries occasioned by adverse legislation, a decrease in coal production would have been looked for. The increase was not much, about 4 per cent, but it was an increase. The value moreover shows comparatively a little larger increase, something over 6 per cent, the average price per ton advancing from $1.99 to $2.04.

The production by counties for the two years is shown in the following tables:

Coal product of Montana in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Cascade	493, 355	15, 105	8, 000	....	516, 460	$907, 640	$1. 76	247	634
Choteau	1, 596	3, 529	170	....	5, 295	20, 953	3. 96	93	36
Dawson	....	440	....	....	440	1, 320	3. 00	96	5
Fergus	....	200	....	....	200	1, 200	6. 00	50	3
Gallatin	61, 209	564	1, 390	....	63, 163	148, 021	2. 34	278	151
Lewis and Clarke	....	125	....	....	125	666	5. 33	150	2
Meagher	....	100	....	....	100	500	5. 00	140	2
Park	233, 356	7, 000	8, 400	57, 770	306, 526	691, 816	2. 31	240	568
Total	789, 516	27, 063	17, 960	57, 770	892, 309	1, 772, 116	1. 99	242	1, 401

Coal product of Montana in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total production.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Cascade	6	623, 295	4, 210	11, 455	....	638, 960	$1, 238, 001	$1. 94	184	1, 165
Choteau	6	705	2, 177	10	....	2, 892	11, 089	3. 83	92	28
Dawson	2	....	545	....	....	545	1, 635	3. 00	89	6
Fergus, Granite, Lewis, Clarke, and Meagher	5	900	563	25	....	1, 488	4, 840	3. 25	50	22
Gallatin	3	66, 648	975	1, 634	....	69, 257	168, 431	2. 43	265	153
Park	4	169, 623	4, 430	4, 200	36, 000	214, 253	463, 394	2. 16	198	408
Total	26	861, 171	12, 900	17, 324	36, 000	927, 395	1, 887, 390	2. 04	192	1, 782

The following table shows the total output of coal in Montana since 1883, and the value of the product in the past five years:

Product of coal in Montana since 1883.

Years.	Short tons.	Value.	Years.	Short tons.	Value.
1883	19, 795	....	1889	363, 301	....
1884	80, 376	....	1890	517, 477	$1, 252, 492
1885	86, 440	....	1891	541, 861	1, 228, 630
1886	49, 846	....	1892	564, 648	1, 330, 847
1887	10, 202	....	1893	892, 309	1, 772, 116
1888	41, 467	....	1894	927, 395	1, 887, 390

The development of the Montana coal fields on a commercial scale dates from 1889. Previous to that year the largest output was in 1885, when the product was 86,440 short tons. During 1893 extensive improvements were made at the Sandcoulee mines, in Cascade County; mining machines were introduced and the output of the county was increased over 100 per cent—from 242,120 short tons in 1892 to 516,460 short tons in 1893. The increase in this county in 1894 was more than three times the total increase in the State, the gain in Cascade County being in part offset by a decrease of over 90,000 tons, or about 45 per cent, in Park County.

The following tables show the product and value, by counties, since 1889, and the average price per ton and the statistics of labor and working time in the important producing counties:

Product and value of Montana coal since 1889, by counties.

Counties.	1889.		1890.		1891.		1892.	
	Product.	Value.	Product.	Value.	Product.	Value.	Product	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Cascade	166, 480	$339, 226	200, 435	$406, 748	198, 107	$396, 219	242, 120	$484, 320
Choteau	820	2, 160	800	2, 000	478	1, 723	1, 574	6, 338
Custer	3, 470	9, 129	10, 228	26, 417				
Dawson	733	1, 900	450	1, 350	250	625	335	1, 000
Fergus	460	1, 380	1, 260	5, 740	250	1, 400	400	2, 100
Gallatin	43, 838	104, 377	51, 452	119, 084	56, 981	135, 893	61, 198	152, 496
Lewis and Clarke	50	200	115	283				
Meagher					50	200	30	120
Missoula	150	450						
Park	147, 300	421, 950	252, 737	690, 870	285, 745	692, 570	258, 991	684, 473
Total	363, 301	880, 773	517, 477	1, 252, 492	541, 861	1, 228, 630	564, 648	1, 330, 847

Counties.	1893.		1894.		Increase, 1894.		Decrease, 1894.	
	Product.	Value.	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Cascade	516, 460	$907, 640	638, 960	$1.238.001	122, 500	$320, 361		
Choteau	5, 295	20, 953	2, 892	11, 089			2, 403	$9, 864
Dawson	440	1, 320	545	1, 635	105	315		
Fergus	200	1, 200	325	1, 625	125	425		
Gallatin	63, 163	148, 021	69, 257	168, 431	6, 094	20, 410		
Granite			600	600	600	600		
Lewis and Clarke	125	666	60	300			65	366
Meagher	100	500	503	2, 315	403	1, 815		
Park	306, 526	691, 816	214, 253	463, 394			92, 273	228, 422
Total	892, 309	1, 772, 116	927, 395	1, 887, 390	*a* 35, 086	*a* 116, 274		

a Net increase.

Average prices for Montana coal since 1889 in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Cascade	$2. 04	$2. 03	$2. 00	$2. 00	$1. 76	$1. 94
Gallatin	2. 38	2. 31	2. 38	2. 50	2. 34	2. 43
Park	2. 86	2. 73	2. 43	2. 64	2. 31	2. 16
The State	2. 42	2. 42	2. 27	2. 36	1. 99	2. 04

Statistics of labor employed and working time at Montana coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.
Cascade	379		401		426	275	634	247	1, 165	184
Gallatin	120		139		146	298	151	278	153	265
Park	705		562		565	241	568	240	408	198
The State	1, 251		1, 119		1, 158	258	1, 401	242	1, 782	192

NEBRASKA.

The southwestern corner of Nebraska contains a portion of the Western coal field, but the veins of coal being on the edge of the field are pinched to thin seams, varying from 6 to 22 inches. Some coal has been taken out in past years for local consumption, but with the development of the fields of Iowa, Kansas, and Missouri, more favored both as to quality and conditions for economical mining, and with the operators of these mines seeking a market for their surplus product, such little work as had been done on Nebraska coal deposits has been practically abandoned.

NEVADA.

The production of even a small amount of coal in Nevada is of importance. In 1894, 150 short tons were mined in this State by Mr. William Groezinger, of Columbus, Esmeralda County, and was sold to and used by the Columbus Borax Works. It brought $475. Mr. Groezinger writes that a coal field of considerable extent has been discovered about 20 miles from Candelaria. He states there are twelve different veins, varying in thickness from 4 to 12 feet, of semibituminous coal, some of which will make coke. The outcrops are badly weathered and decomposed, but the quality improves at greater depth. At present all the silver mines in the vicinity are shut down and there is no demand for the fuel. With a return to prosperity for the silver-mining industry, attention will be given to any properties promising an adequate and cheap supply of fuel.

Coal is also reported in the vicinity of Carlin, in Elko County, and a company of Nevada citizens has been organized, under the name of the Humboldt Coal Company, to exploit the deposits. No output was obtained in 1894.

NEW MEXICO.

Total product in 1894, 597,196 short tons; spot value, $935,857.

NEW MEXICO COAL FIELDS.

The coal fields of this Territory have not been even approximately defined, and only a sketch of the developed regions can be given. It is taken from the official report of the bureau of immigration of the Territory. Coal is found in Bernalillo, Colfax, Grant, Lincoln, Rio Arriba, San Juan, Santa Fe, and Socorro counties, in beds from 1.5 to 16 feet in thickness and ranging from brown coal, or lignite, to anthracite.

Colfax County contains the southern extension of the Raton field in Colorado. This field in New Mexico covers an area of about 600,000 acres of the best bituminous coal, possessing excellent coking qualities. The mines are from 4 to 6 miles distant from the town of Raton. The veins are from 3.5 feet thick at Blossburg to 9 feet thick at Leconte.

The capacity of the mines is about 500 tons per day. The coal has a red ash and carries very little sulphur. The Raton is one of the most important fields in the State. In 1891 it produced nearly two-thirds the total output of the Territory, but this seemingly large proportion was due to a decreased product in that year in Bernalillo County. The product in 1892 was the largest in any one year, reaching 297,911 short tons. The depression in trade, and particularly the unhealthy condition of the silver-mining industry, was seriously felt in this region during 1894, the product falling off to 114,925 short tons.

The Bernalillo fields cover almost the entire western portion of the county of that name. It is also one of the important fields, rivaling the Raton field in amount of production, and owing to the decrease in that field in 1894 produced nearly two and a half times as much coal as the Raton field during the year. In only two years since 1887 (1890 and 1891) has the product fallen below 200,000 tons. The principal mines are worked at Gallup, on the Atlantic and Pacific Railroad. The coal mined is bituminous. Some lignite occurs in the northern part of the county, along the Rio Puerco.

Grant County contains some semianthracite coal, which is found near Silver City, but no product has been reported for several years.

In Lincoln County coal is found near White Oaks and Fort Stanton. Some coal is mined at both places, the product at the former being consumed in operating the Homestake gold mine.

The Rio Arriba coal fields are the southern extension of the La Plata fields of southwestern Colorado. They underlie nearly all the northern part of Rio Arriba County. The coal is bituminous in character and extends over about 5,000 acres in New Mexico.

The San Juan fields are very extensive, covering at least 30,000 acres, but they have been worked only to a limited extent and for a purely local market. The product in each of the past three years has been about 200 short tons.

The Santa Fe County fields cover about 15,000 acres and contain four distinct veins 4 to 5 feet thick. In this field are found both anthracite and bituminous coal. The former is hard, dense, and of a brilliant luster, containing 87.71 per cent fixed carbon and 5 per cent ash. The bituminous coals are free burning and are also good coking coals, the coke made from them being used by the copper smelters in the vicinity. In some places both anthracite and bituminous coal occur in the same mines, the heat of the porphyritic dikes which traverse the country undoubtedly having caused the transformation from one species into another. Natural coal has also been frequently found. The output from this field has increased largely in the past two years, from 36,780 short tons in 1892 to 118,892 tons in 1893 and 187,923 tons in 1894.

The Socorro County fields contain about 23,000 acres of coal, bituminous in character and having excellent coking qualities. No product has been reported during the past two years, though in 1889, 1891, and 1892 the mines yielded over 50,000 tons.

PRODUCTION.

No product was reported from New Mexico at the Tenth United States Census in 1880, the first record of production in the Territory being contained in Mineral Resources for 1882. In this volume it was given at 163,992 short tons, but corrected by more complete returns in the volume for 1883–84 to 157,092 short tons. From 1882 to 1888 the product increased annually, except in 1886, amounting in 1888 to 626,665 short tons. In 1889 and 1890 the output decreased, falling off in the latter year to 375,777 short tons. During the three succeeding years it recovered its former proportions, reaching the maximum output in 1893. The output in 1894 was about 10 per cent less than in 1893, while the value decreased less than 5 per cent. A rather contradictory statement is shown when the average prices for 1893 and 1894 are considered comparatively. In only one county of any importance was there an increase in price. This was Bernalillo County, and the advance was but 2 cents per ton, from $1.42 to $1.44. In all the other counties (leaving out the insignificant product of 200 tons in San Juan County) the price shows a decrease of from 5 cents to 27 cents per ton, and yet the average for the Territory shows an advance of 10 cents per ton, from $1.47 in 1893 to $1.57 in 1894. This paradoxical effect was caused by the increased output in Santa Fe County, where, although the average price declined from $2.13 to $1.96, the increased product was sufficient to raise the general average for the Territory.

The following tables exhibit the statistics of production in 1893 and 1894, by counties, with the distribution of the product for consumption:

Coal product of New Mexico in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Bernalillo	275, 993	808	1, 890		278, 691	$396, 106	$1. 42	196	370
Colfax	246, 936	1, 339	1, 508		249, 783	301, 503	1. 31	248	272
Lincoln		1, 962			1, 962	7, 698	3. 92	78	12
Rio Arriba	15, 000	100	400		15, 500	20, 150	1. 30	250	25
San Juan		210			210	245	1. 17	60	3
Santa Fe	98, 073	1, 143	4, 978	14, 698	118, 892	253, 242	2. 13	257	328
Socorro									
Union		56			56	100	1. 79	50	1
Total	636, 002	5, 618	8, 776	14, 698	665, 094	979, 044	1. 47	229	1, 011

Coal product of New Mexico in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Bernalillo	3	267, 314	869	2, 230	....	270, 413	$388, 103	$1. 44	192	460
Colfax	3	109, 989	3, 501	1, 495	....	114. 985	143, 925	1. 25	111	136
Lincoln	6	220	2, 405	30	....	2, 655	9, 680	3. 65	104	16
Rio Arriba and Union	2	18, 000	20	3, 000	....	21, 020	26, 290	1. 25	289	26
San Juan	2	....	200	....	....	200	250	1. 25	24	4
Santa Fe	4	,166, 000	1, 271	7, 610	13, 042	187, 923	367, 609	1. 96	193	343
Total	20	561, 523	8, 266	14, 365	13, 042	597, 196	935, 857	1. 57	182	985

The following table shows the annual output of the Territory since 1882, with the value of the product since 1885. It is probable, however, that the values given for years prior to 1889 are too high. They were estimated on a basis of $3 per ton, which was evidently excessive.

Coal product of New Mexico since 1882.

Years.	Short tons.	Value.	Years.	Short tons.	Value.
1882	157, 092	....	1889	486, 943	$872, 628
1883	211, 347	....	1890	375, 777	504, 390
1884	220, 557	....	1891	462, 328	779, 018
1885	306, 202	$918, 606	1892	661, 330	1, 074, 251
1886	271, 285	813, 855	1893	665, 094	979, 044
1887	508, 034	1, 524, 102	1894	597, 196	935, 857
1888	626, 665	1, 879, 995			

In the following table the product since 1882 is shown by counties, together with the increases and decreases in 1894 as compared with 1893:

Coal products of New Mexico since 1882, by counties.

Counties.	1882.	1883.	1884.	1885.	1886.	1887.	1888.
Bernalillo	33, 373	42, 000	62, 802	97, 755	106, 530	275, 952	300, 000
Colfax	91, 798	112, 089	102, 513	135, 833	87, 708	154, 875	227, 427
Lincoln	....	....	....	....	....	....	....
Rio Arriba	12, 000	17, 240	11, 203	14, 958	7, 000	11, 000	12, 000
Santa Fe	3, 600	3, 000	3, 000	1, 000	1. 000	7, 500	25, 200
Socorro	16, 321	37, 018	41, 039	56, 656	69, 047	58. 707	62, 038
Other counties	....	....	....	....	....	....	....
Total	157, 092	211, 347	220, 557	306, 202	271, 285	508, 034	626. 665

Counties.	1889.	1890.	1891.	1892.	1893.	1894.	Increase, 1894.	Decrease, 1894.
Bernalillo	233, 059	181, 647	76, 515	248, 911	278, 691	270, 413	....	8, 278
Colfax	151, 464	151, 400	295, 089	297, 911	249, 783	114, 985	....	134, 798
Lincoln	1, 255	1, 175	1, 000	3, 145	1, 962	2, 655	693	....
Rio Arriba	13, 650	12, 175	7, 350	20, 600	15, 500	*a* 21, 020	5, 520	....
Santa Fe	34, 870	22, 770	16, 500	36, 780	118, 892	187, 923	69, 031	....
Socorro	52, 205	....	65, 574	53, 783	....	....	....	....
Other counties	449	6, 610	300	200	266	200	....	66
Total	486, 943	375. 777	462. 328	661, 330	665, 094	597, 196	....	*b* 67. 898

a Including Union County. *b* Net decrease.

The average price per ton and the statistics of labor and average working time in the more important counties for a series of years are shown in the following table:

Average prices for New Mexico coal since 1889 in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Bernalillo	$1.70	$1.14	$1.47	$1.45	$1.42	$1.44
Colfax	1.33	1.31	1.35	1.33	1.31	1.25
Rio Arriba	1.82	1.72	1.95	1.50	1.30	1.25
Santa Fe	2.14	2.29	2.13	2.63	2.13	1.96
Socorro	3.29	....	3.22	3.43	....	....
The Territory	1.79	1.34	1.68	1.62	1.47	1.57

Statistics of labor employed and working time at New Mexico coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.
Bernalillo	375	......	187	......	449	179	370	196	460	192
Colfax	360	......	384	......	370	261	272	248	136	111
Rio Arriba	20	......	20	......	35	270	25	250	25	300
Santa Fe	55	......	36	......	30	267	328	257	343	193
Socorro	......	......	175	......	180	253	......	......	......	......
The Territory.	827	......	806	......	1,083	223	1,011	229	985	182

NORTH CAROLINA.

Total product in 1894, 16,900 short tons; spot value, $29,675.

NORTH CAROLINA COAL DEPOSITS.

Coal deposits exist in this State in Stokes and Rockingham counties, along the Dan River, and in Chatham and Moore counties in the valley of the Deep River. They are in two isolated areas occurring in the Triassic formation, and are therefore of the same geologic age as the coals of the Richmond basin. The census investigation of 1889 (Eleventh United States Census), carried on by Mr. John H. Jones, failed to find any operations in the Dan River region, except a few unimportant country banks, and the output from these was so small and uncertain that no definite information could be obtained. In December of that year the Egypt Coal Company began mining in the Deep River field, near Egypt Depot, Chatham County, and has been prosecuting work there continually since that time, but was reorganized in 1894 under the title of Langdon-Henzey Coal Mining Company. In 1894 the Kohinoor Coal and Iron Company opened a mine near Carbonton, in the same county, and the Gulf and Glendon Mining and Manufacturing

Company opened up a mine in Moore County. The history of coal mining in the State therefore dates from 1889, since when the product has been as follows:

Coal product of North Carolina since 1889.

Years.	Short tons.	Value.
1889	192	$451
1890	10,262	17,864
1891	20,355	39,635
1892	6,679	9,599
1893	17,000	25,500
1894	16,900	29,675

The statistics of production for the past four years and the total product since 1889 are shown in the following tables:

Coal product of North Carolina in 1891, 1892, 1893, and 1894.

Distribution.	1891.	1892.	1893.	1894.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
Loaded at mines for shipment	18,780	6,679	15,000	13,500
Sold to local trade and used by employees	600			1,000
Used at mines for steam and heat	975		2,000	2,400
Total product	20,355	6,679	17,000	16,900
Total value	$39,635	$9,599	$25,500	$29,675
Total number of men employed	80	90	70	95

NORTH DAKOTA.

Total product in 1894, 42,015 short tons; spot value, $47,049.

Very little development has been made of the coal fields in this State, and very little information is available as to the extent or value of the coal deposits.

The Mouse River coal field, which lies from 80 to 150 miles or more to the north and northwest from Bismarck, has been reported on by Mr. George H. Eldridge. Mr. Eldridge's report was given in Mineral Resources for 1886, and is repeated here as the latest information of value.

The strata carrying the coals of this region may all be referred to the lower part of the Laramie group, upon both lithological and paleontological evidence. They consist, in ascending order, of heavily bedded, coarse-grained sandstones, of gray color, and often ferruginous, containing thin, paper-like seams of lignite, the whole weathering easily. These are overlaid by other gray and yellow sandstones intercalated with clays, the former somewhat argillaceous, the latter arenaceous. Above these last come other purer drab clays, with some beds of sandstone, the latter being very variable in texture and in their ability to withstand the weather. Many of the strata have a strong tendency to a concretionary structure. In the uppermost series of strata just mentioned, the coal seams are larger and the underlying clays thicker, and invariably of a leaden gray color, except where, here and there, they are tinged chocolate from the lignitic matter contained in them. All the clays form bold and steep bluffs, and are a noticeable feature of the landscape where they occur.

The Lower Laramie of this region contains only comparatively unimportant lignite beds, the more important ones occurring higher up in the series and to the southwest of our area of exploration, on the Missouri River, near Fort Stevenson and elsewhere, there being a dip of very slight amount toward a common center at Fort Union, forming there a great but very shallow synclinal basin.

The localities of the exposures of lignite are: 8 miles below the Big Bend of Mouse River; 25 miles above the Big Bend, where the lignite is of comparatively fair quality, taken with the other lignite beds of this locality; another exposure of this seam a mile farther up the river; 1 mile below the mouth of Lake River, a 6-inch seam not figured; on Lake River, 40 miles above its entrance into Mouse River, a 30-inch and a 36-inch seam, the former very dirty, the latter much cleaner, with numerous thin seams of an inch or two scattered all along through the series. While, therefore, we may have seams of lignite from one-half inch to 8 inches thick outcropping along the bluffs between the Big Bend of Mouse River and the source of Lake River, and also two of a thickness of over 2 feet, but one workable bed of 3 feet was met with. The coal of this bed exhibits the usual characteristics of the poorer classes of lignites, layers of the fibrous structure being intercalated with those of homogeneous appearance, and conchoidal fracture and a jetty luster. The entire seam contains much gypsum in the crystalline and powdered forms. The coal is by far the poorest observed during our exploration, and has no resistance whatever to the influences of weathering. It will therefore, in all probability, never be used for other than domestic purposes by the future settlers of this river. Owing to the lay of the country, boring is the only means of determining the extent of any of the beds of lignite.

The inferiority of the North Dakota lignites as compared with the true coals which are brought into the State, principally from Montana, limits their consumption to a local market. The production by counties in 1893 and 1894, and the total product since 1884, is shown in the following tables:

Coal product of North Dakota in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total amount produced.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Morton	19, 000	....	....	19, 000	$20, 900	$1. 10	169	35
Stark	23, 968	1, 112	....	25, 080	24, 250	. 97	227	41
Ward	5, 000	500	50	5, 550	11, 100	2. 00	150	12
Total	47, 968	1, 612	50	49, 630	56, 250	1. 13	193	88

Coal product of North Dakota in 1894, by counties.

Counties.	Number of mines, 1894.	Loaded at mines for shipment.	Sold to localtrade and used by employees.	Used at mines for steam and heat.	Total production.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Morton	2	8, 851	100	....	8, 951	$10, 294	$1. 15	110	30
Stark	4	25, 100	2, 924	....	28, 024	30, 055	1. 07	211	31
Ward and McLean	2	3, 360	1, 456	224	5, 040	6, 700	1. 34	135	16
Total	8	37, 311	4, 480	224	42, 015	47, 049	1. 12	156	77

Coal product of North Dakota since 1884.

Years.	Short tons.	Years.	Short tons.
1884	35,000	1890	30,000
1885	25,000	1891	30,000
1886	25,955	1892	40,725
1887	21,470	1893	49,630
1888	34,000	1894	42,015
1889	28,907		

OHIO.

Total product in 1894, 11,909,856 short tons; spot value, $9,841,723.

COAL FIELDS OF OHIO.

The Coal Measures of Ohio are a part of the great Appalachian system whose northwestern prolongation extends over the eastern and southeastern portion of the State. They occupy between one fourth and one-third the entire area of the entire State, and between 10,000 and 12,000 square miles. The coals are all of the bituminous variety, are known in general terms as block coal, gas coal, cannel coal, etc., and by many special names, as Mahoning Valley, Hocking Valley, Salineville, etc., according to the producing localities. The best furnace coal is the block coal of the Mahoning Valley; the best coke is made from the coals of Columbiana County in the region about Coalton, Jackson, and Wellston. Jackson County yields the best domestic coal, and Belmont County produces a high grade of gas coal.

In the Mahoning Valley raw coal is used with a little Connellsville coke in the blast furnaces of the district. Raw coal is also used in the Hocking Valley. In Jackson County raw coal from two seams—the Jackson and Wellston—is used. At Leetonia coke is used, some of which is made on the spot and mixed with Connellsville. Gas is made from the coals of the Mahoning and Hocking valleys, Steubenville, and the Ohio River coals at Bellaire, Pomeroy, and Ironton.[1]

PRODUCTION.

The coal product of Ohio has been reported since 1872, in which year the output was 5,315,294 short tons. This was followed by several years of less activity, the product not reaching as high a figure again until 1878, when 5,500,000 tons were mined. From 1878 to 1882, the output increased at an average of about a million tons annually, reaching 9,450,000 tons in the latter year. It declined again in 1883 and 1884, and then for four years increased annually until 1888, when the total output was 10,910,951 short tons. A million-ton decrease was noted in 1889, after which it advanced again, reaching 13,562,927 short

[1] For a more detailed description of the coals and coal fields of Ohio see Mineral Resources 1882, p. 65, and 1883–84, p. 59.

tons in 1892. In 1893 it was 300,000 tons less, and it dropped still further in 1894, to 11,909,856 short tons. The decrease from 1893 was 1,343,790 short tons, a little over 10 per cent. The value fell off more than 20 per cent; the average price declining from 92 cents to 83 cents per ton, and evincing in a marked degree the trade depression.

Ohio has the distinction of inaugurating the great strike of 1894. The meeting at which the strike was decided upon was held in Columbus, and the Ohio miners were the first ones to quit work. From here it spread to Pennsylvania, Maryland, part of West Virginia, and the Western States. The conditions in Ohio were very adverse to the coal interests of the State. The completion of the Norfolk and Western Railroad to Kenova, on the Ohio River, opened an outlet for the Pocahontas coal into the State. The Kanawha River coals were already in the markets of Cincinnati, and other Ohio River points by water transportation, and had also an outlet to other points in the State by the Chesapeake and Ohio Railroad. Active competition on the part of these two regions necessarily cut into the business of Ohio operators, who had either to meet the competition or close down their mines. New markets for Ohio coal were not to be had.

During the latter part of 1893 and early part of 1894 wages had been reduced in order to meet the competitive business, and the strike was inaugurated for the purpose of restoring the old rates, or of adopting the scale for 1894, which amounted to the same thing. The effects of the strike have been discussed in another portion of this report.

During 1894 one large combination of operators was effected, all of the mines in the Massillon district, 21 in number, having formed a pool and placed themselves under the control of the Massillon Consolidated Coal Company.

A similar organization exists among the Hocking Valley producers, known as the Hocking Fuel Company. The object is to restrict production to the market demands, to distribute the business among the operators in equitable ratio, and to prevent competition. The ultimate result of these associations will be looked for with interest, as there is evidently an inclination among operators in other sections to organize in a similar manner.

In the following tables will be found the statistics of production in 1893 and 1894, with the distribution of the product for consumption:

Coal product of Ohio in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Athens	1, 528, 894	18, 563	26, 811	23, 417	1, 597, 685	$1, 321, 841	$0. 83	162	3, 203
Belmont	825, 834	145, 331	2, 878		974, 043	787, 419	. 81	199	1, 684
Carroll	261, 169		158		261, 327	227, 337	. 87	166	652
Columbiana	460, 075	4, 459	2, 780		467, 314	412, 599	. 88	210	964
Coshocton	236, 069	6, 136	2, 400		244, 605	243, 920	1. 00	233	398
Gallia	11, 109	284			11, 393	10, 399	. 91	176	36
Guernsey	365, 641	39, 986	6, 768		412, 395	294, 738	. 71	176	993
Harrison		2, 640			2, 640	2, 840	1. 08	124	10
Hocking	1, 601, 109	18, 940	17, 003		1, 637, 052	1, 343, 231	. 82	193	2, 072
Jackson	1, 704, 601	96, 546	25, 425		1, 826, 572	1, 933, 116	1. 06	201	3, 188
Jefferson	955, 914	116, 810	3, 891	1, 164	1, 077, 779	848, 449	. 79	194	2, 033
Lawrence	23, 238	13, 274			36, 512	34, 290	. 94	143	142
Mahoning	157, 503	14, 603	1, 598		173, 704	249, 903	1. 44	196	419
Medina	146, 700	5, 200	1, 200		153, 100	191, 725	1. 25	228	349
Meigs	127, 999	93, 478	7, 057		228, 534	250, 919	1. 10	142	601
Morgan		10, 000			10, 000	7, 500	. 75	204	30
Muskingum	174, 772	31, 194			205, 966	171, 082	. 83	214	388
Perry	1, 389, 250	27, 591	21, 282		1, 438, 123	1, 218, 789	. 85	178	2, 585
Stark	861, 708	24, 107	40, 385		926, 200	1, 149, 243	1. 24	161	2, 105
Summit	21, 403	7, 580	6		28, 989	50, 244	1. 73	256	90
Trumbull	15, 116	565			15, 681	24, 153	1. 54	128	53
Portage	84, 269	3, 202	1, 960		89, 431	138, 561	1. 55	217	252
Tuscarawas	639, 209	56, 604	2, 510	204	698, 527	588, 458	. 84	234	1, 329
Vinton	61, 374	10, 902	700		72, 976	70, 562	. 97	200	179
Washington		646			646	571	. 88	61	8
Wayne	60, 160	102	2, 190		62, 452	79, 251	1. 27	167	168
Small mines		600, 000			600, 000	700, 000	1. 17		
Total	11, 713, 116	1, 348, 743	167, 002	24, 785	13, 253, 646	12, 351, 139	. 92	188	23, 931

Coal product of Ohio in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Athens	33	1, 439, 949	28, 377	25, 517	15, 057	1, 508, 900	$1, 123, 887	$0. 74	124	3, 445
Belmont	31	797, 687	105, 312	3, 285		906, 284	640, 110	. 71	157	1, 947
Carroll	7	258, 648	2, 800	1, 845		263, 293	204, 099	. 78	133	466
Columbiana	23	537, 967	16, 507	3, 806		558, 280	431, 251	. 77	161	1, 417
Coshocton	10	156, 295	9, 948	184		166, 427	151, 136	. 91	168	451
Guernsey	14	874, 342	9, 653	7, 864		891, 859	559, 879	. 63	165	1, 880
Hocking	18	1, 476, 356	23, 607	8, 548	12, 357	1, 520, 868	1, 172, 684	. 77	122	2, 549
Jackson	35	1, 441, 243	40, 546	30, 161		1, 511, 950	1, 469, 802	. 97	142	3, 803
Jefferson	32	745, 706	84, 897	2, 920	17, 677	851, 290	607, 880	. 71	153	2, 093
Lawrence	7	25, 319	31, 860			57, 179	58, 567	1. 03	134	198
Mahoning	8	32, 156	10, 077	515		42, 748	59, 722	1. 40	138	206
Medina	5	105, 587	1, 000	4, 200		110, 787	125, 569	1. 13	150	351
Meigs	11	59, 509	109, 834	1, 250		170, 593	179, 771	1. 05	146	584
Muskingum	15	95, 636	13, 683	15		109, 334	97, 171	. 89	112	458
Perry	56	1, 523, 996	62, 184	12, 845		1, 599, 025	1, 240, 084	. 78	139	3, 597
Portage	3	85, 413	2, 593	2, 088		90, 094	137, 343	1. 52	182	249
Stark	25	424, 193	13, 575	15, 182		452, 950	539, 121	1. 19	81	2, 250
Summit	3	8, 258	6, 144	108		14, 510	24, 187	1. 67	126	80
Trumbull	2	1, 303	975			2, 278	4, 261	1. 87	76	14
Tuscarawas	24	458, 202	23, 922	2, 874	26	485, 024	319, 653	. 66	120	646
Vinton	6	41, 307	1, 093	1, 000		43, 400	40, 600	. 94	115	155
Wayne	3	25, 178	2, 674	2, 190		30, 042	36, 520	1. 22	83	184
Gallia, Harrison, and Morgan	3	22, 152	679			22, 831	18, 426	. 81	185	82
Small mines			500, 000			500, 000	600, 000			
Total	374	10, 636, 402	1, 101, 940	126, 397	45, 117	11, 909, 856	9, 841, 723	. 83	136	27, 105

The following table shows the annual output of the State since 1884, by counties:

Coal product of Ohio since 1884, by counties.

Counties.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Athens	627, 944	823, 139	899, 046	1, 083, 543	1, 336, 698	1, 224, 186	1, 205, 455
Belmont	643, 129	744, 446	573, 779	721, 767	1, 108, 106	641, 862	774, 110
Carroll	102, 531	150, 695	216, 630	293, 328	355, 097	351, 782	328, 967
Columbiana	469, 708	462, 733	336, 063	516, 057	466, 191	596, 824	567, 595
Coshocton	56, 562	99, 609	52, 934	124, 791	167, 903	166, 599	177, 700
Gallia	20, 372	16, 383	17, 424	15, 365	16, 722	23, 208	16, 512
Guernsey	375, 427	297, 267	433, 800	553, 613	383, 728	362, 168	413, 739
Harrison	....	....	5, 509	4, 032	2, 865	33, 724	8, 600
Hocking	372, 694	656, 441	741, 571	853, 063	1, 086, 538	845, 049	1, 319, 427
Holmes	12, 052	11, 459	12, 670	10, 526	8, 121	9, 423	....
Jackson	831, 720	791, 608	856, 740	1, 134, 705	1, 088, 761	926, 874	970, 878
Jefferson	316, 777	271, 329	275, 666	293, 875	243, 178	271, 830	491, 172
Lawrence	176, 412	145, 916	166, 933	143, 559	137, 806	102, 656	77, 004
Mahoning	241, 599	275, 944	313, 040	272, 349	231, 035	240, 563	256, 319
Medina	77, 160	152, 721	252, 411	225, 487	198, 452	136, 061	139, 742
Meigs	248, 436	234, 756	192, 263	185, 205	242, 483	220, 277	255, 365
Monroe	....	....	....	....	....	20, 725	1, 000
Morgan	7, 636	5, 536	4, 370	4, 100	....	8, 060	....
Muskingum	84, 398	86, 846	96, 601	171, 928	211, 861	214, 005	229, 719
Noble	....	....	3, 342	6, 320	6, 200	38, 400	6, 850
Perry	1, 379, 100	1, 259, 592	1, 607, 666	1, 870, 840	1, 736, 805	1, 565, 786	1, 921, 417
Portage	65, 647	77, 071	70, 339	65, 163	70, 923	78, 117	70, 666
Sciota	3, 650	2, 440	....	....	....	....	....
Stark	513, 225	391, 418	593, 422	784, 164	793, 227	851, 994	836, 449
Summit	253, 148	145, 134	82, 225	95, 815	112, 024	50, 726	112, 997
Trumbull	257, 683	264, 517	188, 531	167, 989	157, 826	108, 120	47, 714
Tuscarawas	317, 141	285, 545	267, 666	506, 466	546, 117	683, 505	589, 875
Vinton	69, 740	77, 127	60, 013	89, 727	108, 695	102, 040	80, 716
Washington	5, 600	5, 000	5, 500	1, 880	2, 432	18, 045	5, 990
Wayne	120, 571	81, 507	109, 057	105, 150	91, 157	84, 178	38, 528
Small mines	....	....	....	....	....	....	550, 000
Total	7, 640, 062	7, 816, 179	8, 435, 211	10, 300, 807	10, 910, 951	9, 976, 787	11, 494, 506

Counties.	1891.	1892.	1893.	1894.	Increase in 1894.	Decrease in 1894.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Athens	1, 482, 294	1, 400, 865	1, 597, 685	1, 508, 900	....	88, 785
Belmont	819, 236	1, 037, 700	974, 043	906, 284	....	67, 759
Carroll	313, 543	367, 055	261, 327	263, 293	1, 966	....
Columbiana	621, 726	520, 755	467, 314	558. 280	90, 966	....
Coshocton	189, 469	228, 727	244, 605	166, 427	....	78, 178
Gallia	17. 493	19, 000	11, 393	12, 894	1, 501	....
Guernsey	390, 418	455, 997	412, 395	891, 859	479, 464	....
Harrison	3, 960	3, 220	2, 640	1, 701	....	939
Hocking	1, 515, 719	1, 786, 803	1, 637, 052	1, 520, 868	....	116, 184
Holmes	....	....	....	....	....	....
Jackson	1, 475, 939	1, 833, 910	1, 826, 572	1, 511, 950	....	314, 622
Jefferson	697, 193	932, 477	1, 077, 779	851, 200	....	226, 579
Lawrence	76, 235	71, 376	36, 512	57, 179	20, 667	....
Mahoning	200, 734	205, 105	173, 704	42, 748	....	130, 956
Medina	160, 184	101, 440	153, 100	110, 787	....	42, 313
Meigs	282, 094	266, 044	228, 534	170, 593	....	57, 941
Monroe	....	....	....	....	....	....
Morgan	....	12, 000	10. 000	8, 236	....	1, 764
Muskingum	160, 154	177, 488	205, 966	109, 334	....	96, 632
Noble	3, 800	300	....	....	....	....
Perry	1, 785, 626	1, 452, 979	1, 438, 123	1, 599, 025	160, 902	....
Portage	69, 058	76, 398	89, 431	90, 094	663	....
Stark	917, 995	856, 607	926, 200	452, 950	....	473, 250
Summit	140, 079	147, 847	28, 989	14, 510	....	14, 479
Trumbull	83, 950	30, 187	15, 681	2, 278	....	13, 403
Tuscarawas	736, 297	777, 215	698, 527	485, 024	....	213, 503
Vinton	98, 166	83, 113	72, 976	43, 400	....	29, 576
Washington	5, 950	44, 720	646	....	....	646
Wayne	21, 371	73, 599	62, 452	30, 042	....	32, 410
Small mines	600, 000	600, 000	600, 000	500, 000	....	100, 000
Total	12, 868, 683	13, 562, 927	13, 253, 646	11, 909, 856	....	*a* 1, 343, 790

a Net decrease.

Records of the total production of coal in Ohio extend only as far back as 1872, since which time the annual output has been as follows:

Annual coal product of Ohio since 1872.

Years.	Short tons.	Years.	Short tons.
1872	5,315,294	1884	7,640,062
1873	4,550,028	1885	7,816,179
1874	3,267,585	1886	8,435,211
1875	4,864,259	1887	10,300,708
1876	3,500,000	1888	10,910,951
1877	5,250,000	1889	9,976,787
1878	5,500,000	1890	11,494,506
1879	6,000,000	1891	12,868,683
1880	7,000,000	1892	13,562,927
1881	8,225,000	1893	13,253,646
1882	9,450,000	1894	11,909,856
1883	8,229,429		

Mr. R. M. Hazeltine, State inspector of mines, reports the total output for the State as obtained by him at 11,910,219 short tons. The difference between Mr. Hazeltine's figures and those reported to the Survey is 363 tons out of a total of nearly 12,000,000. The statistics were collected entirely independently, Mr. Hazeltine obtaining the output by grades of coal, separating the lump and nut from pea and slack. In the Survey schedules no inquiry is made as to the amount of the different sizes taken out. Uniform with the plan adopted for all the States the reports to the Survey show the shipments, local and mine consumption, and the amount made into coke. That two separate offices and methods should show totals so nearly identical is, to say the least, remarkable.

Taken in connection with the preceding tables of production, the following tables, exhibiting the average prices and the statistics of labor for a series of years, will be found of interest:

Average prices for Ohio coal since 1889 in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Athens	$0.81	$0.83	$0.85	$0.85	$0.83	$0.74
Belmont	.87	.78	.84	.84	.81	.71
Carroll	.74	.85	81	.83	.87	.78
Columbiana	.79	.91	.96	.90	.88	.77
Coshocton	.98	.90	1.00	1.01	1.00	.91
Gallia	1.04	.90	.92	.92	.91	.85
Guernsey	.87	.68	.79	.72	.71	.63
Hocking	.80	.81	.81	.85	.82	.77
Jackson	1.03	1.00	1.06	.99	1.06	.97
Jefferson	1.00	.83	.85	.92	.79	.71
Lawrence	1.04	1.08	1.04	1.06	.94	1.03
Mahoning	1.12	1.20	1.25	1.41	1.44	1.40
Medina	1.16	1.20	1.16	1.23	1.25	1.13
Meigs	1.02	1.24	.96	1.13	1.10	1.05
Muskingum	.99	.86	.82	.91	.83	.89
Perry	.84	.85	.84	.85	.85	.78
Portage	1.27	1.59	1.52	1.52	1.55	1.52
Stark	1.26	1.30	1.25	1.22	1.24	1.19
Summit	1.83	1.50	1.38	1.43	1.73	1.67
Trumbull	1.64	1.20	1.41	1.54	1.54	1.87
Tuscarawas	.80	.85	.79	.85	.84	.66
Vinton	1.03	1.07	1.05	1.02	.97	.94
Wayne	1.23	1.07	1.15	1.30	1.27	1.22
The State	.94	.94	.94	.94	.92	.83

Statistics of labor employed and working time at Ohio coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.
Athens	2,122	198	2,702	193	2,536	193	3,203	162	3,445	124
Belmont	1,401	201	1,276	238½	1,713	224	1,684	199	1,947	157
Carroll	642	188	589	200	595	214	652	166	466	133
Columbiana	987	219	1,031	251	932	223	964	210	1,417	161
Coshocton	327	237	284	265	386	229	398	233	451	168
Gallia	33	205	35	218	38	220	36	176	40	160
Guernsey	788	225	810	188	800	229	993	176	1,880	165
Hocking	1,625	240	1,674	241	2,099	216	2,072	193	2,549	122
Jackson	2,654	180	3,097	189	3,347	214	3,188	201	3,803	142
Jefferson	944	203	1,237	235	1,544	208	2,033	194	2,093	153
Lawrence	242	198	232	223	247	263	142	143	198	134
Mahoning	537	220	525	233½	484	206	419	196	206	138
Medina	310	219	314	221	175	255	349	228	351	150
Meigs	616	202	623	190	636	190	601	142	584	146
Muskingum	366	250	338	213	356	192	388	214	458	112
Perry	2,977	188	3,284	170	2,380	187	2,585	178	3,597	139
Portage	155	236	149	225	204	207	252	217	249	182
Stark	1,930	182	1,952	190	1,776	199	2,105	161	2,250	81
Summit	389	173	376	194	406	221	90	256	80	126
Trumbull	102	243	176	226	86	205	53	128	14	76
Tuscarawas	1,082	196	1,161	232	1,300	224	1,329	234	646	120
Vinton	186	241	197	206	197	198	179	200	155	115
Wayne	87	178	65	200	196	166	168	167	184	83
The State	20,576	201	22,182	206	22,576	212	23,931	188	27,105	136

OREGON.

Total product in 1894, 47,521 short tons; spot value, $183,914.

Very little is known of the economic geology of the State, or of the exact distribution of the coal-bearing formation within its borders. The developments are confined to the coal basin in Coos County, though other lignite discoveries have been reported. The Coos County basin covers several hundred square miles, and extends from the Umpqua River north into Douglas County, south to the Coquille River, and back from the Pacific coast from 15 to 20 miles. The mines at Marshfield continue to furnish the entire output. The coal is loaded direct from the mines to Pacific Ocean steamers and sold principally in San Francisco. While the coal is classed as lignite, it is black and of very excellent appearance when first mined. It will not coke, and the principal use is for domestic purposes.

The following tables show the statistics of production for the past three years and the total output since 1885:

Coal product in Oregon in 1892, 1893, and 1894.

Distribution.	1892.	1893.	1894.
Loaded at the mines for shipment........short tons..	31,760	37,835	45,068
Sold to local trade and used by employees.......do....	2,353	3,594	2,171
Used at mines for steam and heat................do....	548	254	282
Total product..................................do....	34,661	41,683	47,521
Total value..	$148,546	$164,500	$183,914
Total number of employees............................	90	110	88
Average number of days worked........................	120	192	243

Coal product of Oregon from 1885 to 1894.

Years.	Short tons.	Years.	Short tons.
1885	50,000	1890	61,514
1886	45,000	1891	51,826
1887	31,696	1892	34,661
1888	75,000	1893	41,683
1889	64,359	1894	47,521

PENNSYLVANIA.

Total product in 1894, 81,994,271 long tons, or 91,833,584 short tons; spot value, $107,967,883.

Pennsylvania, as is well known, is by far the most important of the coal-producing States. It is so prominently ahead of every other producing State, having in the combined product of anthracite and bituminous coal more than five times the output of Illinois, which ranks second, that comparisons are only of interest when drawn with reference to the ratio of Pennsylvania's output to that of the total in the United States or of the combined product of the other States. It is not possible to carry such comparisons back to an earlier date than 1880, owing to incomplete statistics in a number of the States. During 1880 the total output of coal in the United States was 63,822,830 long tons, or 71,481,569 short tons, of which Pennsylvania produced 42,437,242 long tons, or 47,529,711 short tons, or practically two-thirds of the total.

The product of Pennsylvania coal has always exceeded 50 per cent of the total product of the United States, the lowest percentage being 52, in 1884 and 1888. The average percentage for the fifteen years from 1880 to 1894, inclusive, was 56. In the following table is shown the total product of Pennsylvania and the United States since 1880, with the percentage of the total produced by Pennsylvania in each year:

Product of Pennsylvania coal compared with total United States since 1880.

Years.	Total United States.	Pennsylvania.	Per cent of Pennsylvania to total.
	Short tons.	*Short tons.*	
1880	71,481,569	46,529,711	65
1881	85,881,030	54,320,018	63
1882	103,285,789	57,254,507	55
1883	115,212,125	62,488,190	54
1884	119,735,051	62,404,488	52
1885	110,957,522	62,137,271	56
1886	112,743,403	62,857,210	56
1887	129,975,557	70,372,857	54
1888	148,659,402	77,719,624	52
1889	141,229,514	81,719,059	58
1890	157,788,657	88,770,814	56
1891	168,566,668	93,453,921	55
1892	179,329,071	99,167,080	55
1893	182,352,774	98,038,267	54
1894	170,741,526	91,833,584	54
Total for 15 years	1,997,939,658	1,109,066,601	56

In 1893 the total output of coal in Pennsylvania was 87,534,167 long tons, equivalent to 98,038,267 short tons, worth $120,947,752. The product in 1894 shows, by comparison, a decrease of 5,539,896 long tons, or 6,204,683 short tons, and a loss in value of $12,979,869. The percentage of loss in product was something over 6, and in value a little more than 10. The decrease was divided between the anthracite and bituminous fields as follows: Anthracite, decrease in output, 1,827,162 long tons (equivalent to 2,046,422 short tons), or a little less than 4 per cent; decrease in value, $7,199,015, or about 9 per cent. Bituminous, decrease in output, 3,712,734 long tons (equivalent to 4,158,261 short tons), or not quite 10 per cent; decrease in value, $5,780,854, or about 16 per cent.

The statistics of production of anthracite and bituminous coal in Pennsylvania are discussed separately in the following pages. The article on anthracite production has been prepared by Mr. John H. Jones from statistics compiled by Mr. William W. Ruley, chief of the Bureau of Anthracite Coal Statistics of Philadelphia. The statistics of bituminous production have as usual been compiled in the office of the Geological Survey.

PENNSYLVANIA ANTHRACITE.

[By John H. Jones.]

The production of anthracite coal in 1894 showed a considerable falling off as compared with the previous year, a result naturally to be expected from the generally bad trade conditions continuing from 1893. In the latter year, notwithstanding the general depression, there was a large increase over the production of 1892, this increase, however, being in the first half of the year, the last six months' production showing a decrease.

In 1894, however, the case was reversed, there being a large reduction in the first four months of 1894 compared with 1893, while the production of the remaining months, taken in the aggregate, increased over that of the corresponding period of 1893, although the comparisons by months indicate great variations from this general result.

A good comparison can be made of the varying conditions spoken of above by an examination of the table given in the body of this report, showing the shipments by months for the last three years.

As practically all the anthracite coal mined in the United States comes from Pennsylvania, and furthermore from an extremely small area in that State, it has been the custom in these reports to go into some detail as to the division and classifications of these fields, the territory they comprise, and how they are reached.

The entire anthracite fields cover an area of something over 480 square miles, and are situated in the eastern middle part of the State, extending about equal distances north and south of a line drawn through the middle of the State from east to west in the counties of Carbon, Columbia, Dauphin, Lackawanna, Luzerne, Northumberland, Schuylkill, and Susquehanna, and are known under three general divisions, viz: Wyoming, Lehigh, and Schuylkill regions. Geologically they are divided into well-defined fields or basins, which are again subdivided for convenience of identification into districts.

The Bernice basin, in Sullivan County, formerly classed as the western northern field, is now not considered strictly anthracite. In the tabular arrangement indicating the divisions of the fields, given below, the western northern is therefore omitted.

Geological fields or basins.	*Local districts.*	*Trade regions.*
Northern	Carbondale	Wyoming.
	Scranton	
	Pittston	
	Wilkesbarre	
	Plymouth	
	Kingston	
Eastern Middle	Green Mountain	Lehigh.
	Black Creek	
	Hazleton	
	Beaver Meadow	
Southern	Panther Creek	
	East Schuylkill	Schuylkill.
	West Schuylkill	
	Lorberry	
	Lykens Valley	
Western Middle	East Mahanoy	
	West Mahanoy	
	Shamokin	

The above territory is reached by twelve so-called initial railroads, as follows:

Philadelphia and Reading Railroad Company.
Lehigh Valley Railroad Company.
Central Railroad Company of New Jersey.

Delaware, Lackawanna and Western Railroad Company
Delaware and Hudson Canal Company's Railroad.
Pennsylvania Railroad Company.
Erie and Wyoming Valley Railroad Company.
New York, Lake Erie and Western Railroad Company.
New York, Ontario and Western Railroad Company.
Delaware, Susquehanna and Schuylkill Railroad Company.
New York, Susquehanna and Western Railroad Company.
Wilkesbarre and Eastern Railroad Company.

The above roads carry all coal shipped from the regions, and their tonnage as compiled by the Bureau of Anthracite Coal Statistics constitutes the official source from which the figures showing the shipments from the several trade regions from the commencement of the industry to the present time are taken. The table presented further on in the report gives in concise form an idea of the growth and importance of anthracite coal mining.

The total product in 1894 was 46,358,144 tons, of which 41,391,200 tons were carried to market, 1,034,780 tons sold to local trade at or a short distance from the mines, and 3,932,164 tons used at the mines for steam and heating purposes.

This last item is to a considerable extent estimated, as a large amount of it is culm and dirt, of which no accurate account is kept by the operators, and they can only give a fair approximation of its amount in their report.

It is also to be noted that on account of the comparatively unmarketable nature of this part of the product, the value given pertains only to coal shipped and that sold to local trade, and the average price per ton is computed accordingly.

The following table shows the total product in 1894 as compared with 1893, with other details as to the value, persons employed, etc.:

Total product of anthracite coal in 1893 and 1894.

Years.	Total product.	Value at mines.	Average per ton.	Number of persons employed.	Number of days worked.
1893	48,185,306	$85,687,078	$1.94	132,944	197
1894	46,358,144	78,488,063	1.85	131,603	190

In the table following, the detailed production by counties is given for the years 1893 and 1894, showing not only the total product, but also the shipments, local and colliery consumption, for each county separately for the two years.

Distribution of the anthracite product of Pennsylvania in 1893.

Counties.	Total product of coal of all grades.	Distribution of total product.		
		Loaded at mines for shipment on railroad cars.	Used by employees and sold to local trade at mines.	Used for steam and heat at mines.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*
Susquehanna	435, 000	375, 000	25, 000	35, 000
Lackawanna	11, 550, 005	10, 548, 629	318, 545	682, 831
Luzerne	19, 108, 135	17, 049, 072	466, 503	1, 592, 560
Carbon	1, 365, 663	1, 207, 204	18, 421	140, 038
Schuylkill	10, 533, 245	9, 256, 310	132, 777	1, 144, 158
Columbia	687, 334	591, 421	13, 842	82, 071
Northumberland	3, 827, 651	3, 462, 889	72, 711	292, 051
Dauphin	678, 273	604, 273	26, 000	48, 000
Total	48, 185, 306	43, 094, 798	1, 073, 799	4, 016, 709

Distribution of the anthracite product of Pennsylvania in 1894.

Counties.	Distribution of total product.			
	Total product of all grades.	Loaded at mines for shipment on railroad cars.	Used by employees and sold to local trade at mines.	Used for steam and heat at mines.
Susquehanna	418, 375	368, 375	20, 000	30, 000
Lackawanna	11, 466, 301	10, 500, 947	302, 523	662, 831
Luzerne	17, 508, 032	15, 558, 959	440, 973	1, 508, 100
Carbon	1, 584, 268	1, 394, 883	23, 872	165, 513
Schuylkill	10, 234, 624	8, 994, 308	125, 857	1, 114, 459
Columbia	593, 569	504, 973	12, 624	75, 972
Northumberland	3, 944, 713	3, 526, 530	88, 163	330, 020
Dauphin	608, 262	542. 225	20, 768	45, 269
Total	46, 358, 144	41, 391, 200	1, 034, 780	3, 932, 164

From the above tables a complete comparison may be made of the anthracite business for these years, the decrease in 1894, and the proportion of this decrease for each county.

The following statement shows the shipments by months for the last three years, and from it can be seen the variations in shipment for the different parts of the year, as noted in the commencement of this article:

Monthly shipments of anthracite in 1892, 1893, and 1894.

Months.	1892.	1893.	1894.
January	2, 851, 487	3, 069, 579	2, 688, 021
February	3, 172, 022	3, 084, 156	2, 344, 511
March	3, 070, 527	3, 761, 744	2, 565. 061
April	2, 939, 157	3, 284, 659	2, 799, 307
May	3, 524, 728	3, 707, 083	3, 884, 277
June	3, 821, 807	4, 115. 633	5, 116, 844
July	3, 648, 583	3, 275, 863	3, 868, 216
August	3, 691, 839	3, 308, 768	3, 089. 844
September	3, 754, 482	3, 614, 496	3, 270, 612
October	4, 052, 897	4, 525, 663	4, 137, 085
November	3, 769, 711	3, 905, 487	4, 522, 232
December	3, 596, 081	3, 436, 406	3, 105, 190
Total	41, 893, 321	43, 089, 537	41, 391, 200

As was also noted in the preface of this report, below is given table showing the shipments by regions from 1820 to the close of 1894.

It must be remembered in regard to this table that it shows only shipments, the amount sold to local trade and used at mines not being included.

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions from 1820 to 1894.

Years.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Long tons.	*Per ct.*	*Long tons.*	*Per ct.*	*Long tons.*	*Per ct.*	*Long tons.*
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
1881	9,253,958	32.46	5,294,676	18.58	13,951,383	48.96	28,500,017
1882	9,459,288	32.48	5,689,437	19.54	13,971,371	47.98	29,120,096
1883	10,074,726	31.69	6,113,809	19.23	15,604,492	49.08	31,793,027
1884	9,478,314	30.85	5,562,226	18.11	*a* 15,677,753	51.04	30,718,293
1885	9,488,426	30.01	5,898,634	18.65	*a* 16,236,470	51.34	31,623,530
1886	9,381,407	29.19	5,723,129	17.89	*a* 17,031,826	52.82	32,136,362
1887	10,609,028	30.63	4,347,061	12.55	*a* 19,684,929	56.82	34,641,018
1888	10,654,116	27.93	5,639,236	14.78	*a* 21,852,366	57.29	38,145,718
1889	10,486,185	29.28	6,294,073	17.57	*a* 19,036,835	53.15	35,817,093
1890	10,867,822	29.68	6,329,658	17.28	*a* 19,417,979	53.04	36,615,459
1891	12,741,258	31.50	6,381,838	15.78	*a* 21,325,240	52.72	40,448,336
1892	12,626,784	30.14	6,451,076	15.40	*a* 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
Total 75 years	314,124,187	34.67	161,259,094	17.80	430,630,122	47.53	906,013,403

a Includes Loyalsock field.

In the following pages is given a directory of the anthracite mines in Pennsylvania, with names of operators, post-office addresses, etc.

Directory of anthracite coal mines in Pennsylvania.

NORTHERN COAL FIELD.

Map Nos.	Names of mines.	Locations. Local districts.	Inspectors' districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping station.	Operators. Names.	Post-office addresses.
15	Erie	Carbondale	1	Carbondale Twp	Lackawanna	D. and H. C. Co. R. R.	Glenwood	Hillside Coal and Iron Co	Scranton.
16	Glenwood	do	1	do	do	do	do	do	Do.
17	Keystone	do	1	do	do	do	Archbald	do	Do.
21	Eaton	do	1	Blakely Twp	do	do	do	Jones, Simpson & Co	Archbald.
23	Pierce	do	1	do	do	D., L. and W. R. R.	Winton	Pierce Coal Co., Limited	Winton.
18	Edgerton	do	1	do	do	N.Y.,L.E. and W.R. R	Jermyn	Edgerton Coal Co., Limited	Jermyn.
25	Sterrick Creek	do	1	do	do	do	Winton	Sterrick Creek Coal Co	Peckville.
36	Jermyn No. 3	do	1	do	do	N.Y., S. and W. R. R. and N. Y., O. and W. R. R.	Dickson	John Jermyn	Scranton.
35	Jermyn No. 4	do	1	do	do	do	do	do	Do.
28	Marshwood	do	1	do	do	N.Y.,L.E. and W.R.R.	Peckville	Moosic Mountain Coal Co.	Marshwood.
43	Murray	do	1	Dunmore Twp	do	N. Y., S. and W. R. R. and D. L and W. R. R.	Scranton	Murray, Carney & Co	Dunmore.
5	Northwest	do	1	Fell Twp	do	N.Y.,L.E. and W.R. R.	Carbondale	Northwest Coal Co	Scranton.
27	White	do	1	Blakely Twp	do	N. Y., S. and W. R. R	Winton	Winton Coal Co., Limited	Do.
24	Mount Jessup	do	1	do	do	D., L. and W. R.R. and N.Y., O. and W. R.R.	do	Mt. Jessup Coal Co., Lim.	Peckville.
8	Boyer	do	1	Fell Twp	do	D. and H. C. Co. R. R	Carbondale	Boyer Coal Co	Scranton.
33	Olyphant No. 2	do	1	Blakely Twp	do	do	Olyphant	D. and H. Canal Co	Providence.
34	Eddy Creek	do	1	do	do	do	do	do	Do.
21	Grassy Island	do	1	do	do	do	do	do	Do.
20	White Oak	do	1	do	do	do	Archbald	do	Do.
19	Jermyn Shaft	do	1	Carbondale Twp	do	do	Jermyn	do	Do.
11	Coal Brook	do	1	do	do	do	Carbondale	do	Do.
12	No. 1 Shaft	do	1	do	do	do	do	do	Do.
13	No. 3 Shaft	do	1	do	do	do	do	do	Do.
10	Racket Brook	do	1	do	do	do	do	do	Do.
14	Powderly	do	1	do	do	do	do	do	Do.
3	Clinton Tunnel	do	1	Fell Twp	do	N.Y.,L.E. and W.R.R.	Forest City	do	Do.
9	Fall Brook	do	1	do	do	D. and H. C. Co. R. R.	Carbondale	John Murrin	Carbondale.
26	Dolph	do	1	Blakely Twp	do	N. Y., S. and W. R. R.	Jessup	Dolph Coal Co., Limited	Scranton.
32	Lackawanna	do	1	do	do	do	Olyphant	Lackawanna Coal Co., Lim.	Do.
31	Ontario No. 1, and Stg's.	do	1	do	do	N. Y., O. and W. R. R.	Peckville	N. Y. and Scranton Coal Co.	Peckville.
2	Forest City	do	1	Forest City	Susquehanna	N.Y.,L.E. and W.R.R.	Forest City	Hillside Coal and Iron Co	Scranton.
1	Clifford	do	1	do	do	do	do	do	Do.

	Riverside	....do	1	Archbald	Lackawanna	N. Y., O. and W. R. R.	Winton	Riverside Coal Co	Do.
69	Archbald	Scranton	2	Lackawanna Twp	....do	D., L. and W. R. R	Scranton	D., L. and W. R. R. Co	Do.
63	Bellevue	....do	2	....do	....do	....do	Bellevue	....do	Do.
60	Brisbin	....do	2	3d W., Scranton	....do	....do	Scranton	....do	Do.
59	Cayuga	....do	2	....do	....do	....do	....do	....do	Do.
66	Central	....do	2	15th W., Scranton	....do	....do	....do	....do	Do.
68	Continental	....do	2	Lackawanna Twp	....do	....do	....do	....do	Do.
64	Dodge	....do	2	....do	....do	....do	Bellevue	....do	Do.
67	Hampton	....do	2	....do	....do	....do	Scranton	....do	Do.
71	Holden	....do	2	....do	....do	....do	Taylorville	....do	Do.
65	Hyde Park	....do	2	5th W., Scranton	....do	....do	Scranton	....do	Do.
62	Oxford	....do	2	....do	....do	....do	....do	....do	Do.
73	Pyne	....do	2	Lackawanna Twp	....do	....do	Taylorville	....do	Do.
70	Sloan	....do	2	....do	....do	....do	Scranton	....do	Do.
44	Storrs	....do	2	Blakely Twp	....do	....do	Priceville	....do	Do.
72	Taylor	....do	2	Lackawanna Twp	....do	....do	Taylorville	....do	Do.
61	{Diamond No. 1	....do	2	21st W., Scranton	....do	....do	Scranton	....do	Do.
	{Diamond No. 2	....do	2	....do	....do	....do	....do	....do	Do.
	{Tripp Shaft	....do	2	....do	....do	....do	....do	....do	Do.
38	Dunmore, No. 1	....do	1	Dunmore Twp	....do	E. and W. V. R. R	Dunmore	Pennsylvania Coal Co	Dunmore.
41	Dunmore, No. 5	....do	2	....do	....do	....do	....do	....do	Do.
	Bunker Hill	....do	2	....do	....do	....do	....do	....do	Do.
30	Rushbrook	....do	1	....do	....do	N. Y., O. and W. R. R.	Peckville	Blue Ridge Coal Co	Peckville.
	Austin	....do	2	Old Forge Twp	....do	L. V. R. R	Lackawanna	Austin Coal Co	Scranton.
40	{Gypsy Grove No. 3	....do	1	Dunmore Twp	....do	E. and W. V. RR	Dunmore	Pennsylvania Coal Co	Dunmore.
	{Gypsy Grove No. 4	....do	1	....do	....do	....do	....do	....do	Do.
52	Pine Brook	....do	2	7th ward, Scranton	....do	D., L. and W. R. R	Scranton	Lackawanna Iron and Coal Co.	Scranton.
53	Capouse	....do	2	21st ward, Scranton	....do	....do	....do	....do	Do.
54	Clark Tunnel	....do	2	3d ward, Scranton	....do	....do	....do	James Flynn	Do.
76	Greenwood No. 1	....do	2	Lackawanna Twp	....do	N. Y. S. and W. R. R	Peckville	Greenwood Coal Co., limited.	Do.
77	Greenwood No. 2	....do	2	....do	....do	....do	Minooka	....do	Do.
80	Jermyn, Nos. 1-2	....do	2	Old Forge Twp	....do	....do	Taylorville	Jermyn & Co	Do.
37	Pancoast	....do	1	Blakely Twp	....do	D., L. and W. R. R	Dickson City	Pancoast Coal Co	Do.
56	Providence	....do	2	2d ward, Scranton	....do	....do	Green Ridge	Providence Coal Co., limited.	Do.
79	Sibley	....do	2	Old Forge Twp	....do	....do	Lackawanna	Elliott, McClure & Co	Do.
42	Spencer	....do	2	Dunmore Twp	....do	....do	Dunmore	A. D. and F. M. Spencer	Dunmore.
	Tripp	....do	2	21st ward, Scranton	....do	....do	Providence	Tripp & Co	Scranton.
74	Meadow Brook	....do	2	20th ward, Scranton	....do	....do	Taylorville	William Connell & Co	Do.
75	National	....do	2	....do	....do	....do	....do	....do	Do.
	Stafford	....do	2	Lackawanna Twp	....do	....do	....do	....do	Do.
49	Manville *a*	....do	2	13th ward, Scranton	....do	D. and H. C. Co. R. R.	Green Ridge	Delaware and Hudson Canal Co.	Providence.
46	Leggitts Creek	....do	1	1st ward, Scranton	....do	....do	Providence	....do	Do.
45	Marvine	....do	1	....do	....do	....do	....do	....do	Do.
48	Von Storch	....do	2	2d ward, Scranton	....do	....do	....do	....do	Do.
47	Dickson	....do	2	....do	....do	....do	Green Ridge	....do	Do.
50	Green Ridge	....do	2	Dunmore Twp	....do	N. Y., L. E. and W. R. R	....do	O. S. Johnson	Scranton.

a Operated jointly with Delaware, Lackawanna and Western Railroad Co.

Directory of anthracite coal mines in Pennsylvania—Continued.

NORTHERN COAL FIELD—Continued.

Map Nos.	Names of mines.	Location.						Operators.	
		Local districts.	Inspectors' districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping station.	Names.	Post-office addresses.
	Richmond, Nos. 3-4	Scranton	1	Scranton Twp	Lackawanna	N. Y., O. and W. R. R.	Providence	Elk Hill Coal and Iron Co.	Scranton.
57	Mt. Pleasant	do	2	14th ward, Scranton	do	D., L. and W. R. R	Scranton	Wm. T. Smith	Do.
81	William A	Pittston	2	Old Forge Twp	do	L. V. R. R	Lackawanna	Connell Coal Co	Do.
88	Katy-Did	do	3	do	do	E. and W. V. R. R	Moosic	Robertson & Co	Moosic.
87	{Central No. 13	do	3	do	do	do	Pleasant Valley	Pennsylvania Coal Co	Dunmore
	{Law Shaft	do	3	Pittston Twp	do	do	do	do	Do.
86	Old Forge	do	2	Old Forge Twp	do	do	Lackawanna	do	Do.
109	{Ewen Breaker	do	3	Jenkins Twp	Luzerne	do	Pittston	do	Do.
	{Shaft No. 4	do	3	do	do	do	do	do	Do.
110	Breaker No. 6	do	3		do	do	Port Blanchard	do	Do.
	Breaker No. 8	do	3	Hughestown boro	do	do	Pittston	do	Do.
99	Breaker No. 10	do	3	do	do	do	do	do	Do.
111	Breaker No. 14	do	3	Jenkins Twp	do	do	Port Blanchard	do	Do.
100	Barnum	do	3	Marcy Twp	do	do	Pittston Junction	do	Do.
112	Annora	do	3	Jenkins Twp	do	C. R. R. of New Jersey and L. V. R. R.	Laflin	Annora Coal Co	Wilkesbarre.
91	Avoca	do	3	Pittston Twp	do	L. V. R. R. and N. Y., L. E. and W. R. R.	Avoca	Avoca Coal Co., limited	Avoca.
90	Langcliffe	do	3	Pittston	do	L. V. R. R. and N. Y. S. and W. R. R.	do	Langcliffe Coal Co	Do.
101	Twin	do	3	do	do	L. V. R. R	Pittston	Newton Coal Mining Co	Pittston.
	Ravine	do	3	do	do	do	do	do	Do.
102	Seneca	do	3	do	do	do	do	do	Do.
98	Mosier	do	3	Marcy Twp	do	do	do	do	Do.
108	Hunt	do	3	Kingston Twp	do	D., L. and W. R. R	Wyoming	Delaware, Lackawanna and Western Railroad Co.	Scranton
83	Hallstead	do	3	Marcy Twp	do	do	Duryea	do	Do.
95	Butler	do	3	Pittston Twp	do	N. Y. S. and W. R. R	Pittston	Butler Mine Co., limited	Pittston.
97	Fernwood	do	3	Jenkins Twp	do	do	Yatesville	do	Do.
106	Schooley	do	3	Exeter Twp	do	do	West Pittston	do	Do.
84	Columbia	do	3	Marcy Twp	do	D., L. and W. and L. V. R. R.	Duryea	Old Forge Coal Mining Co.	Do.
85	Phœnix	do	3	do	do	do	do	do	Do.
82	Babylon	do	3	do	do	L. V. R. R	Coxton	Babylon Coal Co	Scranton.
89	Consolidated	do	3	Pittston Twp	do	E. and W. V. R. R	Moosic	Hillside Coal and Iron Co.	Do.
103	Clear Spring	do	3	West Pittston	do	D., L. and W. R. R	West Pittston	Clear Spring Coal Co	Pittston.

94	Elmwood	do	3	Pittston Twp	do	L. V. R. R. and N. Y., L. E. and W. R. R.	Avoca	Florence Coal Co., limited.	Dupont.
96	Fairmount	do	3	do	do	C. R. R. of New Jersey.	Pittston	Abbott Coal Co	Pittston.
113	Ridgewood	do	3	Plains Twp	do	N. Y. S. and W. R. R	Mill Creek	Keystone Coal Co	Wilkesbarre.
104	Stevens	do	3	Exeter Twp	do	L. V. R. R.	Exeter	Stevens Coal Co	Scranton.
107	Mount Lookout	do	3	do	do	D., L. and W. and L. V. R. R.	do	Mount Lookout Coal Co	Do.
	Morning Star	do	3	do	do	L. V. R. R.	Wyoming	J. A. Hutchins	Wyoming.
105	Exeter	do	3	do	do	do	West Pittston	Lehigh Valley Coal Co	Wilkesbarre.
92	Heidelberg No. 1	do	3	Pittston Twp	do	do	do	do	Do.
93	Heidelberg No. 2	do	3	do	do	do	do	do	Do.
	Spring Brook	do	3	Old Forge Twp	do	D. and H. C. Co. R. R.	Moosic	Whitney & Kemmerer	Philadelphia.
133	Diamond No. 1	Wilkesbarre	4	Wilkesbarre	do	C. R. R. of New Jersey.	Ashley	Lehigh and Wilkesbarre Coal Co.	Wilkesbarre.
132	Hollenback No. 2	do	4	do	do	do	Wilkesbarre	do	Do.
134	Empire No. 4	do	4	do	do	do	Ashley	do	Do.
137	S. Wilkesbarre No. 5	do	4	do	do	do	S. Wilkesbarre	do	Do.
135	Stanton No. 7	do	4	do	do	do	Ashley	do	Do.
138	Jersey No. 8	do	4	Hanover Twp	do	do	do	do	Do.
139	Sugar Notch No. 9	do	4	do	do	do	Sugar Notch	do	Do.
	Maxwell No. 20	do	4	do	do	do	do	do	Do.
143	Wanamie No. 18	do	4	Newport Twp	do	do	Wanamie	do	Do.
142	Alden	do	4	do	do	do	Alden	Alden Coal Co	Alden.
148	Newport No. 1	do	4	do	do	do	Lee	Newport Coal Co	Wilkesbarre.
130	Red Ash No. 1	do	4	Wilkesbarre Twp	do	do	Ashley	Red Ash Coal Co	Do.
131	Red Ash No. 2	do	4	do	do	do	do	do	Do.
144	Colliery No. 1	do	4	Hanover Twp	do	P. R. R.	Nanticoke	Susquehanna Coal Co	Do.
145	Colliery No. 2	do	4	do	do	do	do	do	Do.
146	Colliery No. 5	do	4	do	do	do	do	do	Do.
147	Colliery No. 6	do	4	Newport Twp	do	do	Glen Lyon	do	Do.
117	Bennett	do	3	Plains Twp	do	C. R. R. of New Jersey	Mill Creek	Thomas Waddell Estate	Pittston.
141	Warrior Run	do	4	Hanover Twp	do	L. V. R. R.	Warrior Run	A. J. Davis	Wilkesbarre.
149	West End No. 1	do	4	Conyngham Twp	do	P. R. R. and C. R. R. of New Jersey.	Mocanaqua	West End Coal Co	Shickshinny.
140	Maffet	do	4	Hanover Twp	do	C. R. R. of New Jersey	Sugar Notch	Hanover Coal Co	Wilkesbarre.
118	Abbott	do	3	Plains Twp	do	L. V. R. R.	Miners Mills	Lehigh Valley Coal Co	Do.
129	Hillman Vein	do	4	Wilkesbarre Twp	do	do	Wilkesbarre	Hillman Vein Coal Co	Do.
136	Franklin	do	4	do	do	do	Ashley	Lehigh Valley Coal Co	Do.
119	Enterprise	do	3	Plains Twp	do	do	Port Bowkley	do	Do.
120	Henry	do	3	do	do	do	do	do	Do.
	Midvale	do	3	do	do	do	do	do	Do.
124	Mineral Spring	do	3	do	do	do	Wilkesbarre	do	Do.
122	Prospect	do	3	do	do	do	do	do	Do.
123	Dorrance	do	3	Wilkesbarre Twp	do	do	do	do	Do.
121	Wyoming	do	3	Plains Twp	do	do	Port Bowkley	do	Do.
115	Mill Creek	do	3	do	do	D. & H. C. Co. R. R.	Mill Creek	Delaware and Hudson Canal Co.	Providence.
116	Pine Ridge	do	3	do	do	do	Miners Mills	do	Do.
125	Laurel Run	do	3	do	do	do	Parsons	do	Do.
126	Baltimore Slope	do	4	Wilkesbarre Twp	do	do	do	do	Do.
	Bal. Red Ash No. 2	do	4	do	do	do	do	do	Do.
127	Baltimore Tunnel	do	4	do	do	do	Wilkesbarre	do	Do.

Directory of anthracite coal mines in Pennsylvania—Continued.

NORTHERN COAL FIELD—Continued.

Map Nos.	Names of mines.	Location. Local districts.	Inspectors' districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping station.	Operators. Names.	Post-office addresses.
128	Conyngham	Wilkesbarre	4	Wilkesbarre	Luzerne	D. & H. C. Co. R. R.	Wilkesbarre	Delaware and Hudson Canal Co.	Providence.
114	Delaware	do	3	Plains Twp	do	do	Mill Creek	do	Do.
	Algonquin	Wilkesbarre	3	do	do	N. Y. S. and W. R. R.		Algonquin Coal Co	Wilkesbarre.
168	Lance No. 11	Plymouth	4	Plymouth	do	D., L. and W. R. R.	Plymouth	Lehigh and Wilkesbarre Coal Co.	Do.
169	Nottingham No. 15	do	4	do	do	do	do	do	Do.
170	Reynolds No. 16	do	4	do	do	do	do	do	Do.
172	Avondale	do	4	Plymouth Twp	do	do	Avondale	Delaware, Lackawanna and Western R. R. Co.	Scranton.
160	Woodward	do	4	do	do	do	Kingston	do	Do.
166	Dodson	do	4	do	do	do	Plymouth	John C. Haddock	Wilkesbarre.
155	East Boston	do	3	Kingston	do	D., L. and W. and P. R. R.	Kingston	W. G. Payne & Co	Kingston.
171	Parrish	do	4	Plymouth	do	D., L, and W. and C. R. R. of New Jersey	Plymouth	Parrish Coal Co	Plymouth.
173	Colliery No. 3	do	4	West Nanticoke	do	D., L. and W. R. R.	West Nanticoke.	Susquehanna Coal Co	Wilkesbarre.
	Salem	do	4	Shickshinny	do	do	Shickshinny	E. S. Stackhouse	Shickshinny.
161	Boston	do	4	Plymouth Twp	do	D. and H. C. Co. R. R.	Plymouth	Delaware and Hudson Canal Co.	Providence.
162	Plymouth No. 2	do	4	do	do	do	do	do	Do.
163	Plymouth No. 3	do	4	do	do	do	do	do	Do.
164	Plymouth No. 4	do	4	do	do	do	do	do	Do.
165	Plymouth No. 5	do	4	do	do	do	do	do	Do.
159	Pettebone	Kingston	3	Kingston	do	D., L. and W. R. R.	do	Delaware, Lackawanna and Western R. R. Co.	Do.
156	Kingston No. 1	do	3	Kingston Twp	do	do	do	Kingston Coal Co.	Kingston.
158	{ Kingston No. 2	do	3	Plymouth	do	do	do	do	Do.
	{ Kingston No. 3	do	3	do	do	do	do	do	Do.
	Kingston No. 4	do	3	Kingston Twp	do	do	do	do	Do.
157	Gaylord	do	4	Plymouth Twp	do	do	Plymouth	do	Do.
167	Harry E	do	3	Kingston Twp	do	do	Bennett	Wyoming Valley Coal Co.	Wilkesbarre.
152	Forty Fort	do	3	do	do	D., L. and W. and L. V. R. R.	Maltby	do	Do.
151									
154	Black Diamond	do	3	do	do	do	Kingston	John C. Haddock	Do.
153	Mill Hollow	do	3	do	do	do	Bennett	Thomas Waddell estate	Pittston.
150	Maltby	do	3	do	do	do	Maltby	Lehigh Valley Coal Co.	Wilkesbarre.

EASTERN MIDDLE COAL FIELD.

175	Upper Lehigh No. 2	Green Mountain	5	Butler Twp	Luzerne	C. R. R. of New Jersey	Upper Lehigh	Upper Lehigh Coal Co	Upper Lehigh.
176	Upper Lehigh No. 4	do	5	do	do	do	do	do	Do.
191	Milnesville	Black Creek	5	Hazle Twp	do	L. V. R. R	Hazleton	A. S. Van Wickle & Co	Milnesville.
188	Lattimer No. 1								
189	Lattimer No. 2	do	5	do	do	do	do	Pardee Bros. & Co	Hazleton.
190	Lattimer No. 3								
192	Hollywood	do	5	do	do	do	do	Calvin Pardee & Co	Do.
177	Sandy Run	do	5	Foster Twp	do	C. R. R. of New Jersey	Sandy Run	M. S. Kemmerer & Co	Sandy Run.
178	Highland No. 1	do	5	do	do	L. V. R. R	Highland	G. B. Markle & Co	Jeddo.
179	Highland No. 2	do	5	do	do	do	do	do	Do.
184	Jeddo No. 3	do	5	Hazle Twp	do	do	Jeddo	do	Do.
185	Jeddo No. 4	do	5	do	do	do	do	do	Do.
195	Derringer	do	5	Black Creek Twp	do	D., S and S. R. R	Derringer	Coxe Bros. & Co	Drifton
180	Drifton No. 1	do	5	Foster Twp	do	do	Drifton	do	Do.
181	Drifton No. 2	do	5	do	do	do	do	do	Do.
	Drifton No. 3	do	5	Hazle Twp	do	do	do	do	Do.
183	Eckley No. 5	do	5	Foster Twp	do	do	Eckley	do	Do.
182	Eckley No. 10	do	5	do	do	do	do	do	Do.
196	Gowen	do	5	Black Creek Twp	do	do	Gowen	do	Do.
194	Tombicken	do	5	Sugar Loaf Twp	do	do	Tomhicken	do	Do.
	Oneida, Nos. 1, 2, and 3	do	6	North Union	Schuylkill	do	Oneida	do	Do.
197	Hazlebrook	Hazleton	5	Foster Twp	Luzerne	L. V. R. R	Hazlebrook	J. S. Wentz & Co	Mauch Chunk
209	Humboldt	do	5	Hazle Twp	do	do	Hazleton	Linderman, Skeer & Co	South Bethlehem.
201	East Sugar Loaf No. 1.	do	5	do	do	do	Stockton	do	Do.
200	East Sugar Loaf, Nos. 2 and 4.	do	5	do	do	do	do	do	Do.
199	East Sugar Loaf, Nos. 5 and 6.	do	5	do	do	do	do	do	Do.
208	Harwood	do	5	do	do	D., S. and S. R. R	Hazleton	Pardee Sons & Co	Harwood Mines.
198	Stockton	do	5	do	do	do	Stockton	Coxe Bros. & Co	Drifton.
207	Cranberry	do	5	do	do	L. V. R. R	Hazleton	A. Pardee & Co	Hazleton.
205	Hazleton No. 1	do	5	Hazleton	do	do	do	do	Do.
204	Hazleton No. 3	do	5	do	do	do	do	do	Do.
206	Hazleton No. 6	do	5	do	do	do	do	do	Do.
203	Laurel Hill	do	5	do	do	do	do	do	Do.
202	South Sugar Loaf	do	5	Hazle Twp	do	do	do	do	Do.
	Crystal Ridge	do	5	do	do	do	do	do	Do.
217	Beaver Brook	Beaver Meadow	5	do	do	L. V. R. R. and C. R. R. of New Jersey.	Audenried	C. M. Dodson & Co	Audenried.
211	Beaver Meadow	do	5	Banks Twp	Carbon	D. S. and S. R. R. and L. V. R. R.	Beaver Meadow	Coxe Bros. & Co	Drifton.
218	Honeybrook No. 2	do	5	do	do	C. R. R. of New Jersey	Treskow	Lehigh and Wilkesbarre Coal Co.	Wilkesbarre.
219	Honeybrook No. 4	do	6	Klein Twp	Schuylkill	do	Audenried	do	Do.

Directory of anthracite coal mines in Pennsylvania—Continued.

EASTERN MIDDLE COAL FIELD—Continued.

Map Nos.	Names of mines.	Location.						Operators.	
		Local districts.	Inspectors' districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping station.	Names.	Post-office addresses.
220	Honeybrook No. 5	Beaver Meadow	6	Klein Twp	Schuylkill	C. R. R. of New Jersey	Audenried	Lehigh and Wilkesbarre Coal Co.	Wilkesbarre.
	Washery No. 1	do	6	do	do	do	do	do	Do.
	Washery No. 2	do	5	Banks Twp	Carbon	do	Treskow	do	Do.
221	Silver Brook No. 1	do	6	Klein Twp	Schuylkill	L. V. R. R	Silver Brook	Silver Brook Coal Co	Mauch Chunk.
	Silver Brook No. 2	do	6	do	do	do	do	do	Do.
212	Coleraine	do	5	Banks Twp	Carbon	do	Beaver Meadow	A. S. Van Wickle & Co	Milnesville.
210	Evans	do	5	do	do	do	do	Evans Mining Co	Beaver Meadow.
216	Spring Brook	do	5	do	do	do	Audenried	Lehigh Valley Coal Co	Wilkesbarre.
213	Spring Mount No. 1	do	5	Jeanesville	do	do	Jeanesville	J. C. Haydon & Co	Jeanesville.
214	Spring Mount No. 4	do	5	do	Luzerne	do	do	do	Do.

WESTERN MIDDLE COAL FIELD.

Map Nos.	Names of mines.	Local districts.	Inspectors' districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping station.	Names.	Post-office addresses.
235	Ellangowan	East Mahanoy	6	Mahanoy Twp	Schuylkill	P. and R. R. R	St. Nicholas	Philadelphia and Reading Coal and Iron Co.	Pottsville.
230	Elmwood	do	6	do	do	do	Mahanoy City	do	Do.
236	Knickerbocker	do	6	do	do	do	Yatesville	do	Do.
229	Mahanoy City	do	6	Mahanoy City	do	do	Mahanoy City	do	Do.
228	North Mahanoy	do	6	Mahanoy Twp	do	do	do	do	Do.
227	Schuylkill	do	6	do	do	do	do	do	Do.
233	Suffolk	do	6	do	do	do	St. Nicholas	do	Do.
232	St. Nicholas	do	6	do	do	do	do	do	Do.
231	Tunnel Ridge	do	6	do	do	do	Mahanoy City	do	Do.
225	Glendon	do	6	do	do	L. V. R. R	do	Delano Land Co	Wilkesbarre.
330	Middle Lehigh	do	7	do	do	do	New Boston	Mill Creek Coal Co	New Boston.
223	Buck Mountain	do	6	do	do	do	Buck Mountain	do	Do.
331	Morea	do	8	do	do	P. R. R. and L. V. R. R.	Morea	Dodson Coal Co	Morea Colliery.
222	Park No. 2	do	6	do	do	L. V. R. R	Park Place	Lentz, Lilly & Co	Park Place.
226	Springdale	do	6	do	do	do	do	do	Do.
224	Primrose	do	6	do	do	do	Mahanoy City	Primrose Coal Co	New York City.

234	Maple Hill	do	6	do	do	P. and R. R. R	St. Nicholas	Philadelphia and Reading Coal and Iron Co.	Pottsville.
284	Alaska	West Mahanoy	7	Mount Carmel Twp	Northum'land	do	Alaska	do	Do.
283	Locust Gap	do	7	do	do	do	Locust Gap	do	Do.
282	Locust Spring	do	7	do	do	do	do	do	Do.
279	Merriam	do	7	do	do	do	Locust Summit	do	Do.
280	Monitor	do	7	do	do	do	Locust Gap	do	Do.
281	Reliance	do	7	do	do	do	Mount Carmel	do	Do.
285	Fernvale	do	7	do	do	L. V. and N. C. Rwy	do	Phillips, Nagle & Co	Mount Carmel.
276	Mount Carmel	do	7	do	do	P. and R., N. C., and L. V. R. R.	do	Thomas M. Righter & Co	Do.
274	Columbus, Nos. 1, 2	do	7	N. Conyngham Twp	Columbia	L. V. R. R	do	W. H. Shaefer	Do.
271	Centralia	do	7	do	do	do	Centralia	Lewis A. Riley & Co	Centralia.
272	Logan	do	7	do	do	do	do	do	Do.
273	Morris Ridge	do	7	do	do	do	Mount Carmel	May, Troutman & Co	Shamokin.
268	North Ashland	do	7	do	do	P. and R. R. R	Continental	Philadelphia and Reading Coal and Iron Co.	Pottsville.
278	Potts	do	7	do	do	do	Locust Dale	do	Do.
270	Continental *a*	do	7	do	do	L. V. R. R	Centralia	Lehigh Valley Coal Co	Wilkesbarre.
	Locust Run	do	7	do	Schuylkill	P. and R. R. R	Ashland	Philadelphia and Reading Coal and Iron Co.	Pottsville.
267	Bast	do	7	Butler Twp	do	do	do	do	Do.
247	Bear Ridge	do	6	West Mahanoy Twp	do	do	Mahanoy Plane	do	Do.
238	Boston Run	do	6	Mahanoy Twp	do	do	St. Nicholas	do	Do.
237	Bear Run	do	6	do	do	do	do	do	Do.
241	Gilberton	do	6	West Mahanoy Twp	do	do	Gilberton	do	Do
	Sidney	do	6	do	do	do	Maizeville	Sidney Coal Co	Mahanoy Plane.
260	Girard Mammoth	do	6	do	do	do	Raven Run	Philadelphia and Reading Coal and Iron Co.	Pottsville.
263	Girard	do	6	Butler Twp	do	do	Girardville	do	Do.
262	Hammond	do	6	do	do	do	Conner	do	Do.
248	Indian Ridge	do	6	West Mahanoy Twp	do	do	Shenandoah	do	Do.
252	Kohinoor	do	6	do	do	do	do	do	Do.
277	Keystone	do	7	Butler Twp	do	do	Locust Dale	do	Do.
249	Shenandoah City	do	6	West Mahanoy Twp	do	do	Shenandoah	do	Do.
266	Tunnel	do	7	Butler Twp	do	do	Ashland	do	Do.
250	Turkey Run	do	6	West Mahanoy Twp	do	do	Shenandoah	do	Do.
251	West Shenandoah	do	6	do	do	do	do	do	Do.
264	Preston No. 2	do	7	Butler Twp	do	do	Girardville	do	Do.
265	Preston No. 3	do	7	do	do	do	do	do	Do.
269	Big Mine Run	do	7	do	do	do	Ashland	A. Taylor	Ashland.
253	Cambridge	do	6	West Mahanoy Twp	do	do	Shenandoah	Cambridge Coal Co	Shenandoah.
242	Draper	do	6	do	do	do	Gilberton	Philadelphia and Reading Coal and Iron Co.	Pottsville.
239	Furnace	do	6	do	do	do	do	Furnace Coal Co	Gilberton.
254	Kehley Run	do	6	do	do	do	Shenandoah	Thomas Coal Co	Philadelphia.
245	Lawrence	do	6	do	do	do	Mahanoy Plane	Gilbert Coal Co	Pottsville.
255	William Penn	do	6	do	do	P. R. R	Shaft	William Penn Coal Co	Shaft.

a The mine extends into Northumberland County.

Directory of anthracite coal mines in Pennsylvania—Continued.

WESTERN MIDDLE COAL FIELD—Continued.

Map Nos.	Names of mines.	Location.						Operators.	
		Local districts	Inspectors' districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping station.	Names.	Post-office addresses.
258	Packer No. 2	West Mahanoy	6	West Mahanoy Twp.	Schuylkill	L. V. R. R.	Lost Creek	Lehigh Valley Coal Co.	Wilkesbarre.
256	Packer No. 3	do	6	do	do	do	Shenandoah	do	Do.
257	Packer No. 4	do	6	do	do	do	Shenandoah	do	Do.
259	Packer No. 5	do	6	Butler Twp.	do	do	Girardville	do	Do.
305	Bear Valley	Shamokin	7	Coal Twp.	Northumberland.	P. and R. R. R.	Shamokin	Philadelphia and Reading Coal and Iron Co.	Pottsville.
293	Buck Ridge	do	7	do	do	do	Greenback	do	Do.
304	Burnside	do	7	do	do	do	Shamokin	do	Do.
299	Henry Clay	do	7	do	do	do	do	do	Do.
306	North Franklin	do	7	Zerbe Twp.	do	do	Treverton	do	Do.
297	Cameron	do	7	Coal Twp.	do	N. C. Rwy.	Shamokin	Mineral Railroad and Mining Co.	Wilkesbarre.
296	Luke Fidler	do	7	do	do	do	do	do	Do.
290	Hickory Ridge	do	7	do	do	do	Lancaster Switch	Union Coal Co.	Shamokin.
291	Hickory Swamp	do	7	do	do	do	do	do	Do.
286	Pennsylvania	do	7	Mount Carmel Twp.	do	do	Mount Carmel	do	Do.
	Richards	do	7	do	do	do	do	do	Do.
287	Enterprise	do	7	Coal Twp.	do	P. and R. R. R.	Excelsior	Enterprise Coal Co.	Scranton.
288	Excelsior	do	7	do	do	do	do	Excelsior Coal Co.	Excelsior.
289	Corbin	do	7	do	do	do	do	do	Do.
292	Colbert	do	7	do	do	N. C. Rwy.	Lancaster Switch	Shipman Coal Co	Shamokin.
302	Neilson	do	7	do	do	P. & R. R. R. and P. R. R.	Shamokin	J. Langdon & Co.	Elmira, N. Y.
	Natalie	do	7	do	do	do	do	Natalie Anthracite Mining Co.	Mount Carmel.
275	Midvalley	do	7	Mount Carmel Twp.	do	L. V. R. R.	Mount Carmel	Midvalley Coal Co.	Wilburton.

SOUTHERN COAL FIELD.

Map Nos.	Names of mines.	Local districts	Inspectors' districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping station.	Names.	Post-office addresses.
307	Colliery No. 1	Panther Creek	5	Packer Twp.	Carbon	C. R. R. of New Jersey.	Nesquehoning	Lehigh Coal and Navigation Co.	Lansford.
308	Colliery No. 4	do	5	do	do	do	Lansford	do	Do.
309	Colliery No. 5	do	5	do	do	do	do	do	Do.
309	Colliery No. 6	do	5	do	do	do	do	do	Do.
311	Colliery No. 8	do	8	Rahn Twp.	Schuylkill	do	Coaldale	do	Do.
310	Colliery No. 9	do	5	Packer Twp.	Carbon	do	do	do	Do.

313	Colliery No. 10	do	8	Rahn Twp	Schuylkill	do	Tamaqua	do	Do.
314	Colliery No. 11	do	8	do	do	do	do	do	Do.
312	Colliery No. 12	do	8	do	do	do	Coaldale	do	Do.
315	Colliery No. 13	do	8	do	do	do	Tamaqua	do	Do.
337	Beechwood	East Schuylkill	8	Newcastle Twp	do	P. and R. R. R	Pottsville	Philadelphia and Reading Coal and Iron Co.	Pottsville.
327	Eagle	do	8	East Norwegian Twp	do	do	St. Clair	do	Do.
324	Eagle Hill	do	8	Blythe Twp	do	do	Cumbola	do	Do.
316	East Lehigh	do	8	Tamaqua	do	do	Tamaqua	Jos. Mitchell	Tamaqua.
336	Flowery Field	do	8	Newcastle Twp	do	do	St. Clair	Geo. U. Sturdevant	St. Clair.
321	Kaska William	do	8	Blythe Twp	do	do	Middleport	Alliance Coal Mining Co	Lansford.
	Palmer Vein	do	8	do	do	do	do	do	Do.
329	Penna., Schuylkill Valley No. 1.	do	8	Newcastle Twp	do	P. R. R	Newcastle	R. White & Co	St. Clair.
335	Vulcan or Reserve	do	8	do	do	L. V. R. R	St. Clair	do	Do.
334	Wadesville	do	8	do	do	do	Pottsville	Philadelphia and Reading Coal and Iron Co.	Pottsville.
325	Pine Forest	do	8	East Norwegian Twp	do	do	Mill Creek	do	Do.
322	Silver Creek	do	8	Blythe Twp	do	do	Patterson	do	Do.
317	Tamaqua	do	8	Tamaqua	do	do	Tamaqua	Dunkelburger & Co	Tamaqua.
326	Hooker or Mount Hope.	do	8	East Norwegian Twp	do	do	St. Clair	G. B. Linderman & Co	South Bethlehem.
338	York Farm	do	8	do	do	do	do	Lehigh Valley Coal Co	Wilkesbarre.
344	Glendower	West Schuylkill	8	Foster Twp	do	P. and R. R. R	Glen Carbon	Philadelphia and Reading Coal and Iron Co.	Pottsville.
350	Otto	do	8	Reilly Twp	do	do	Branch Dale	do	Do.
342	Thomaston	do	8	Cass Twp	do	do	Heckscherville	do	Do.
349	Phœnix Park	do	8	do	do	do	Llewellyn	do	Do.
343	Richardson	do	8	Foster Twp	do	do	Glen Carbon	do	Do.
339	Ellsworth	do	8	Newcastle Twp	do	do	Broad Mountain	John H. Davis	Broad Mountain.
	Jugular	do	8	do	do	do	do	Jacob S. Hepner	Do.
	Albright	do	8	Cass Twp	do	do	Llewellyn	Albright Coal Co	Pottsville.
	Stoddart	do	8	do	do	do	Gilberton	Stoddart Coal Co	Gilberton.
345	Oak Hill	do	8	do	do	do	Minersville	Swenk & Co	Minersville.
352	Blackwood	do	8	do	do	L. V. R. R	Blackwood	Lehigh Valley Coal Co	Wilkesbarre.
351	Feger Ridge	do	8	do	do	P. and R. R. R	Newtown	do	Do.
354	East Franklin	do	8	Tremont Twp	do	do	Tremont	Philadelphia and Reading Coal and Iron Co.	Pottsville.
353	Middle Creek	Lykens Valley	8	Frailey Twp	do	do	Swatara Switch	do	Do.
359	West Brookside	do	8	Porter Twp	do	do	Brookside	do	Do.
355	Lincoln	do	8	Tremont Twp	do	do	Lorberry Junc	do	Do.
	North Brookside	do	8	Porter Twp	do	do	Good Spring	do	Do.
358	Good Spring	do	8	do	do	do	do	do	Do.
	Pine Grove	do	8	Tremont Twp	do	do	Tremont	John D. Felty	Pine Grove.
360	Williamstown	do	7	Wiconisco Twp	Dauphin	N. C. Rwy	Williamstown	Summit Branch Railroad Co	Wilkesbarre.
361	Short Mountain	do	7	do	do	do	Lykens	Lykens Valley Coal Co	Do.

GENERAL OFFICES OF CORPORATIONS NAMED IN FOREGOING DIRECTORY.

Pennsylvania Coal Company, No. 1 Broadway, New York.
Lehigh and Wilkesbarre Coal Company, No. 143 Liberty street, New York.
Delaware, Lackawanna and Western Railroad Company, No. 26 Exchange Place, New York.
Delaware and Hudson Canal Company, No. 21 Cortlandt street, New York.
Coxe Bros. & Co., 143 Liberty street, New York.
Philadelphia and Reading Coal and Iron Company, Reading Terminal, Philadelphia.
Lehigh Valley Coal Company, No. 228 South Third street, Philadelphia.
Lehigh Coal and Navigation Company, No. 226 South Third street, Philadelphia.
Hillside Coal and Iron Company, No. 21 Cortlandt street, New York.
New York, Susquehanna and Western Railroad Company, No. 15 Cortlandt street, New York.
Susquehanna Coal Company, Broad Street Station, Philadelphia.
Lykens Valley Coal Company, Broad Street Station, Philadelphia.
Mineral Railroad and Mineral Company, Broad Street Station, Philadelphia.
Summit Branch Railroad Company, Broad Street Station, Philadelphia.
Union Coal Company, Erie, Pa.
New York, Ontario and Western Railroad Company, 16 Exchange Place, New York.
Delaware, Susquehanna and Schuylkill Railroad Company, 143 Liberty street, New York.

As noted in the beginning of this article, the general depression in business conditions was severely felt by the anthracite coal trade during the year 1894, resulting in prices which have been unprofitable to the producers and very burdensome for the employees about the mines, to say nothing of the shrinkage in the revenues of the transportation companies. Efforts were inaugurated early in the year to bring about a better understanding between the several interests as to the proportion of the output each should be entitled to, as it has been fully demonstrated that the capacity to produce is far in excess of the demand. Committees comprising representatives of the corporation and individual operators, together with the railroad interests, were engaged for months during the latter half of the year in discussing the questions which naturally presented themselves in the discussion of so important a subject, but up to the close of the year nothing of a definite character had been accomplished, and the further consideration of the matter passed over into the year 1895. It is confidently expected that some satisfactory adjustment may be reached early in the year which will place the anthracite trade in better condition.

The year 1894 has not been marked with any unusual circumstances in the way of development in any of the regions. The usual amount of extensions of underground workings and repairs to breakers have been accomplished, as well as the completing of new breakers in some localities necessary to the proper development of the mines to their highest productive efficiency, but nothing has occurred to affect the general conditions of the trade other than the depression in business referred to above and the continued tendency to overproduction of coal.

During the latter part of May, 1894, a storm of unusual severity visited central Pennsylvania, the rainfall in some localities exceeding 9 inches in three days, flooding the mines and seriously interfering with mine operations for several weeks afterwards. The damage to several of the transportation lines was also very considerable.

Below is a statement showing the largest shipments of anthracite coal ever made in each month of the year during any year to December, 1894.

Largest monthly shipments of anthracite in any year to 1894.

Months and years.	Long tons.	Months and years.	Long tons.
January, 1891	3, 138, 961	August, 1888	4, 097, 563
February, 1892	3, 216, 973	September, 1888	3, 916, 326
March, 1893	3, 761, 744	October, 1893	4, 525, 663
April, 1893	3, 284, 659	November, 1894	4, 493, 281
May, 1894	3, 793, 303	December, 1892	3, 596, 082
June, 1894	5, 112, 359		
July, 1894	3, 868, 215	Total	46, 805, 129

By this table a maximum production of 46,805,129 tons a year is indicated. The actual demand for consumption will not exceed 43,000,000 tons, and it is believed, from the data accessible, that at no time has the actual consumption of anthracite coal reached 42,000,000 tons in any one year, and that the present capacity of the anthracite mines is at least 10 per cent greater than the consumption.

The shipments for the month of June, 1894, were the largest ever made in any month, being over 5,000,000 tons. This exceptional tonnage, and the unusually large shipments in May and July of the same year, were made possible on account of a formidable strike in the bituminous coal regions of Pennsylvania, Maryland, and West Virginia during the months named above, in which period much anthracite coal was used to take the place of bituminous.

It has been several years since we have been called upon to record the death of any of the more prominent persons occupying a controlling influence in the anthracite coal trade. During the year 1894 two gentlemen passed away whose long and active connection with the anthracite industries have made their names familiar to the coal trade everywhere.

Edward B. Leisenring died at Hamburg, Germany, September 18, 1894, aged 49 years. Mr. Leisenring was (as was his father, the Hon. John Leisenring of Mauch Chunk, Pa.) largely interested in the mining of coal, and was identified with numerous business enterprises in his native State and Virginia and Alabama. At the time of his death he was president of the Lehigh Coal and Navigation Company.

Ezra Brockway Ely died at his residence, Bayonne, N. J., November 23, 1894, after an illness of only one week. Mr. Ely was 56 years old at his death, and had been connected with the coal trade for about thirty-five years in various capacities. At the time of his death he was president of Coxe Bros. & Co., Incorporated, and vice-president of the Delaware, Susquehanna and Schuylkill Railroad Company. He was a member of the executive committee of the Anthracite (individual) Coal Operators' Association.

The death of Hon. Eckley B. Coxe on May 13, 1895, while this volume was in press, though after the close of the calendar year which it covers, is an event of such importance as to call for appreciative, though necessarily brief and hasty, comment. Mr. Coxe was unquestionably the most eminent, as well as the most universally beloved, of the leading representatives of anthracite mining. As a mining engineer he stood at the head of his profession; as the possessor of great wealth and the employer of thousands of workmen he was distinguished for energy, sagacity, and wise philanthropy; in political life he bore an unchallenged reputation for stainless integrity and high devotion to the public interests; for the promotion of education and scientific investigation he was not only a liberal giver, but also an intelligent and earnest laborer; and to all who knew him, his strong and winsome personality made him dear. A bare outline of his career is all that space permits in this connection.

He was born in Philadelphia June 4, 1839; graduated in 1858 from the University of Pennsylvania, and subsequently studied at the École des Mines, Paris, and the Mining Academy, Freiberg. After his return to this country he published a translation of Weisbach's Mechanics, which is a monument of patient and intelligent work. The chief labor of his life was connected with the management of the large anthracite lands and collieries of Coxe Brothers & Co., but he found time to render efficient public and private service in many other directions. He was one of the three founders, in 1871, of the American Institute of Mining Engineers, of which he served two terms as president and (at different times) ten years as vice-president, and to the Transactions of which he contributed some of its most elaborate and valuable professional papers. He was also a member of the American societies of civil and mechanical engineers, of the latter of which he was elected president in 1893. He was twice elected to the senate of Pennsylvania; was a director of the Reading Railroad Company, and a trustee of Lehigh University.

The anthracite business is peculiarly indebted to him in four particulars:

1. For his earnest support of the Pennsylvania geological survey, which has thoroughly mapped the anthracite regions, both above and below the surface.

2. For his generous and unwearied labor to promote the education not only of mining engineers but also of mining foremen and common miners.

3. For his vigorous defense of individual operators in the anthracite region against the large corporations which combined the business of transportation with that of mining.

4. For his lifelong effort to improve the methods and machinery of anthracite mining and to diminish the waste of extraction and preparation. One branch of this work was the introduction of the practice of burning the smaller sizes of anthracite, previously thrown away with the refuse from the breaker. To this problem he devoted immense labor of study and experiment, with results which are already important and are destined to become still more so.

At the close of the year 1894 indications are not wanting which mark the approach of returning confidence and the resumption of manufacturing industries in almost every department, but more especially in the iron trade, which itself involves so many auxiliary interests. It is hoped that these improved conditions will reach the anthracite trade during the coming year.

PENNSYLVANIA BITUMINOUS COAL.

Total product in 1894, 39,912,463 short tons; spot value, $29,479,820.

Pennsylvania bituminous coal fields.—The bituminous coal deposits of Pennsylvania form the northern extremity of the great Appalachian coal fields, and to a greater or less extent underlie all the territory of the State lying west of the crest of the Alleghany Mountains. The counties of Bradford, Tioga, Potter, Warren, Crawford, Venango, Forest, Elk, Cameron, Clinton, and Lycoming, in the northern portion of the State, exhibit only detached basins of the Lower Measures, which, however, are extensively mined, and the product finds ready markets for manufacturing purposes and for steam. The remaining counties, bounded by the western and southern State lines and a line drawn northward along the eastern boundaries of Fulton, Huntingdon, and Center counties, and thence westwardly along the northern boundaries of Clearfield, Jefferson, Clarion, and Mercer, embrace an almost unbroken area of one or more of the important beds belonging to the Carboniferous Measures. The counties of Allegheny, Westmoreland, Washington, Greene, and Fayette, situated in the southwestern corner of the State, contain the Upper Productive Measures, at the bottom of which lies the notable Pittsburg bed, yielding in the vicinity of Pittsburg a gas coal of the highest quality. To the eastward are the coking coals from which the celebrated Connellsville coke is made, and to the southward the Cumberland steam coals of Maryland. Small areas of this bed also occur in Indiana, Somerset, and Beaver counties. The remaining counties referred to contain only the Lower Productive Measures, ranging from the isolated areas of the Pittsburg bed to the Brookville bed, the lowest in the Lower Productive series, and the Mercer, Quakertown, and Sharon beds in the Conglomerate series. The product from this territory, as well as that from the southwestern counties, wherever the Lower Measures are being mined, is classed in the trade as semibituminous, containing, as it does, less than 18 per cent of volatile combustible matter. While an excellent quality of coke is produced from coals mined in some localities from these Lower Measures, the distinctive advantages consist in their superiority as steam and rolling-mill fuels, being much sought after for locomotive and steamship purposes. In the Freeport and Kittanning beds of the Lower Productive series cannel coal of good quality has been found to overlie the seam for considerable areas in certain localities; but on account of the veins being thin and troublesome to separate in mining it is not deemed of much commercial value.

Varieties of Pennsylvania bituminous coal.—The coal field of Pennsylvania contains almost every possible variety of bituminous coal. The greater part of the coal mined in this field is true bituminous coal, containing 20 per cent and upward of volatile combustible matter, but in the detached deposits of Tioga, Bradford, and Huntingdon counties and along the summit of the Alleghany Mountains the coal has a semibituminous character, containing only from 15 to 18 per cent of volatile matter. The bituminous coals of Pennsylvania are known the country over for their admirable qualities. Coal for domestic use, steam coal, gas coal, coking coal, blacksmithing coal, are all found in wonderful variety and profusion in the Pennsylvania Measures, and of unsurpassed quality for each purpose. To the cities of the Atlantic Coast, to those of the extreme South, and to those of the far West, Pennsylvania coal goes constantly, and is in steady demand.

Reserves.—Some twenty-one or twenty-two coal seams of commercial importance have been found and named in the bituminous field of

Pennsylvania. These have been in most cases traced with much certainty throughout the district, nearly every bituminous deposit known to exist in the State being with more or less certainty identified with some one of them. The quantity of available coal contained in these seams has been estimated by Dr. H. M. Chance, assistant geologist of the State geological survey, and a statement prepared by him is subjoined. It should be stated that no attempt is made in this table to show the total amount of bituminous coal contained in the deposits of Pennsylvania; the information it gives is of much more value, being in respect of the total amount of that coal alone which is accessible and workable, and of commercial value.

Reserves of bituminous coal in Pennsylvania.

Beds.	Long tons.	Beds.	Long tons.
Upper Barren Measures:		Lower Productive Measures:	
Washington bed, 3 to 3½ feet	787,200,000	Freeport upper bed, 3 to 5 feet	3,764,800,000
Upper Productive Measures:		Freeport lower beds, 2 to 6 feet	2,385,600,000
Waynesburg bed, 3 to 5 feet	2,126,400,000	Kittanning upper bed, 2 to 4 feet	1,596,000,000
Uniontown bed, 2 to 3 feet	312,000,000	Kittanning middle bed, 2 to 3 feet	829,800,000
Sewickley bed, 3 feet	432,000,000	Kittanning lower bed, 2 to 6 feet	4,225,200,000
Redstone bed, 2 to 3 feet	326,400,000	Clarion coals, 2 to 3 feet	696,000,000
Pittsburg bed, 6 to 12 feet	10,438,800,000	Brookville bed, 2 to 4 feet	1,627,200,000
	13,635,600,000		17,217,400,000
Lower Barren Measures:		Conglomerate series:	
Bush Creek, Colcman, etc., beds	878,400,000	Mercer coals, 2 to 3 feet	932,600,000
Lower Productive Measures:		Quakertown bed, 2 feet	57,600,000
In Westmoreland, Fayette, and Allegheny counties	2,064,000,000	Sharon coal horizon, 2 to 3 feet	38,400,000
Millerston bed, 3 feet	28,800,000		1,028,600,000
		Grand total	33,547,200,000

The total available tonnage may be divided thus:

Classification of beds.	Long tons.
Beds over 6 feet thick	10,957,200,000
Beds from 3 to 6 feet thick	19,586,800,000
Beds from 2 to 3 feet thick	3,003,200,000
Total	33,547,200,000

PRODUCTION.

The records of bituminous production in Pennsylvania for the earlier years of the industry are very incomplete. In fact, from 1840 to 1872 the only record extant is that of the shipments over some of the railroads, from a few of the districts, and these bear very little relation to the total product (see Mineral Resources, 1883–84, p. 84). For instance, this statement for 1873 showed the total shipments to have been about 4,600,000 long tons, whereas the total production for that year, the first for which any statistics were obtained, was 11,695,383 long tons. From

1873 to 1882 the product has been estimated in round numbers, the output in the latter year being about double that of 1873, approximately 22,000,000 long tons or 24,640,000 short tons. During the next decade the output increased each year, nearly doubling in 1892 the yield in 1882. In 1893 the output fell off 2,623,852 short tons, or between 5 and 6 per cent, as compared with 1892. The first half of 1893 was favorable in the bituminous regions of Pennsylvania, and operations were active; but later, when the unfavorable conditions of trade manifested themselves, production fell off and prices declined so severely that all of the benefits of the earlier months were overcome, and the average price for the year was 4 cents lower than in 1892. The unfavorable conditions were still more pronounced in 1894, and this, added to the disastrous effects of the long strike in the spring and summer of the year, caused a diminution of over 4,000,000 tons, or about 10 per cent in the tonnage, while the value declined about 16 per cent. The average price per ton fell off from 80 cents in 1893 to 74 cents in 1894. The decrease was general throughout the State, but five counties of the more important producers showing an increased output. Clearfield County suffered the heaviest loss, the product in this county being more than 2,000,000 short tons, or about 33 per cent, less than that of 1893. A decline in value is noted in nearly every county. The returns show an increase in the total number of employees, but the decrease in the average working time more than compensates for this seeming discrepancy.

The following tables exhibit the statistics of the production of bituminous coal in Pennsylvania during 1893 and 1894:

Coal product of Pennsylvania in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total production.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Allegheny	6,445,548	156,987	45,560	15,000	6,663,095	$5,481,787	$0.82	161	14,328
Armstrong	534,029	14,352	1,730	10,928	561,039	426,886	.76	214	1,080
Beaver	135,140	14,230	725	....	150,095	146,390	.98	215	318
Bedford	392,443	46,068	1,630	61,366	501,507	371,499	.74	185	896
Blair	109,272	2,585	3,794	62,251	177,902	137,310	.77	166	632
Bradford	42,158	281	300	....	42,739	55,561	1.30	167	83
Butler	153,811	965	1,240	....	156,016	125,637	.81	208	276
Cambria	2,776,201	358,900	22,799	124,567	3,282,467	2,584,416	.79	199	6,073
Center	382,052	2,316	399	73,289	458,056	344,194	.75	193	743
Clarion	533,507	15,421	2,230	....	551,158	398,384	.72	231	1,224
Clearfield	5,982,263	21,294	21,366	123,835	6,148,758	4,905,089	.80	186	10,455
Clinton	94,582	....	....	....	94,582	70,792	.76	163	175
Elk	572,647	4,349	4,849	52,320	634,165	497,975	.79	195	1,244
Fayette	1,058,492	285,835	142,693	4,774,126	6,261,146	4,563,989	.73	195	6,780
Huntingdon	288,974	9,119	5,454	....	303,547	228,432	.75	182	487
Indiana	327,762	999	285	51,620	380,666	291,488	.77	186	605
Jefferson	3,329,782	20,876	19,752	514,786	3,885,196	2,863,049	.74	210	5,537
Lawrence	162,638	33,775	323	....	196,736	201,727	1.03	218	430
Lycoming	52,261	511	420	....	53,192	64,910	1.23	279	117
McKean	19,169	....	....	....	19,169	21,086	1.10	285	19
Mercer	469,921	17,027	12,703	....	499,651	444,855	.89	187	981
Tioga	913,707	16,950	9,454	22,137	962,248	1,166,769	1.21	214	2,425
Somerset	511,816	5,387	564	14,921	532,688	335,385	.63	214	695
Westmoreland	4,760,933	91,155	100,973	2,486,699	7,439,760	6,133,014	.82	205	10,270
Washington	3,273,220	15,047	26,879	....	3,315,146	2,600,050	.78	184	6,058
Small mines	....	800,000	....	....	800,000	800,000	......	......	......
Total	33,322,328	1,934,429	426,122	8,387,845	44,070,724	35,260,674	.80	190	71,931

Bituminous coal product of Pennsylvania in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total production.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Allegheny..	88	6,039,958	230,956	40,645	43,000	6,354,559	$4,684,407	$0.74	154	14,107
Armstrong .	13	576,918	987	2,125	....	580,030	416,339	.72	168	1,153
Beaver	7	98,879	4,272	454	160	103,765	94,197	.91	146	312
Bedford	16	251,622	4,631	3,632	53,210	313,095	216,932	.69	144	855
Blair	7	238,482	3,195	5,080	9,400	256,157	191,567	.75	142	730
Butler	10	134,367	1,450	300	1,476	137,593	105,211	.76	111	497
Cambria	70	2,449,703	433,466	24,002	71,756	2,978,927	2,160,735	.73	165	6,230
Center	17	271,110	15,283	501	20,912	307,806	208,220	.68	111	855
Clarion	20	392,586	6,627	1,791	....	401,004	279,675	.70	201	926
Clearfield ...	95	4,033,749	33,347	13,154	68,214	4,148,464	2,983,214	.72	134	9,654
Elk	5	307,518	4,290	2,165	85,050	399,023	341,873	.86	147	1,107
Fayette	58	1,568,452	97,002	84,624	4,690,911	6,440,989	4,472,578	.69	198	8,847
Huntingdon	7	184,422	10,390	5,220	....	200,032	147,909	.74	133	478
Indiana	11	392,053	980	265	5,250	398,548	291,885	.70	164	724
Jefferson...	23	2,896,204	17,929	16,000	318,021	3,248,154	2,299,565	.71	164	5,184
Lawrence...	5	131,249	1,033	140	....	132,422	122,475	.92	165	490
Mercer	11	309,499	11,435	10,660	....	331,594	271,104	.82	121	1,014
Somerset ...	22	397,834	11,084	2,624	6,653	418,195	264,430	.63	150	731
Tioga	6	681,333	12,997	9,560	670	704,560	956,483	1.36	149	2,213
Washington	48	3,655,187	26,487	26,913	42,841	3,461,428	2,146,532	.62	159	6,889
Westmoreland	69	4,775,416	60,272	92,029	2,840,247	7,76 7,964	5,982,484	.77	202	11,517
Bradford, Clinton, Forest, Lycoming, and McKean ..	5	226,262	1,482	410	....	228,154	242,005	1.06	180	497
Small mines	......	....	600,000	......	....	600,000	600,000	......	....	....
Total ...	613	29,722,803	1,589,595	342,294	8,257,771	39,912,463	29,479,820	.74	165	75,010

The following table shows the total product since 1873:

Product of bituminous coal in Pennsylvania since 1873.

Years.	Short tons.	Years.	Short tons.
1873	13,098,829	1884	28,000,000
1874	12,320,000	1885	26,000,000
1875	11,760,000	1886	27,094,501
1876	12,880,000	1887	31,516,856
1877	14,000,000	1888	33,796,727
1878	15,120,000	1889	36,174,089
1879	16,240,000	1890	42,302,173
1880	21,280,000	1891	42,788,490
1881	22,400,000	1892	46,694,576
1882	24,640,000	1893	44,070,724
1883	26,880,000	1894	39,912,463

The production by counties was not reliably ascertained prior to 1886. The results obtained by the Bureau of Industrial Statistics of the State for 1882, 1884, and 1885 were published in the earlier volumes of Mineral Resources, but owing to the failure of a number of mines to report their production, the statistics were very incomplete, the total for 1885, for instance, being more than 5,000,000 tons short of the actual product. Since 1886 the product by counties has been as follows:

Bituminous coal product of Pennsylvania since 1886, by counties.

Counties.	1886.	1887.	1888.	1889.	1890.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Allegheny	4, 202, 086	4, 680, 924	5, 575, 505	4, 717, 431	4, 894, 372
Armstrong	210, 856	235, 221	226, 093	289, 218	380, 554
Beaver	208, 820	197, 863	63, 900	93, 461	139, 117
Bedford	173, 372	311, 452	248, 159	257, 455	445, 192
Blair	305, 695	287, 367	314, 013	215, 410	298. 196
Bradford	206, 998	167, 416	163, 851	129, 141	126, 687
Butler	162, 306	161, 764	194, 715	288, 591	167, 578
Cambria	1, 222, 028	1, 421, 980	1, 540, 460	1, 751, 664	2, 790, 954
Cameron	3, 200	3, 000	700	2, 300	...
Center	313, 383	508, 255	382, 770	395, 127	452, 114
Clarion	429, 544	593, 758	535, 192	596, 589	512, 387
Clearfield	3, 753, 986	5, 180, 311	5, 398, 981	5, 224, 506	6, 651, 587
Clinton	...	...	32, 000	106, 000	159, 000
Elk	526, 036	609, 757	555, 960	614, 113	1, 121, 534
Fayette	4, 494, 613	4, 540, 322	5, 208, 993	5, 897, 254	6, 413, 081
Greene	5, 600	3, 002	5, 323	53, 714	(*a*)
Huntingdon	313, 581	265, 479	281, 823	280, 133	322, 630
Indiana	103, 615	207, 597	157, 285	153, 698	357, 580
Jefferson	1, 023, 186	1, 693, 492	2, 275, 349	2, 896, 487	2, 850, 799
Lawrence	101, 154	125, 361	106, 921	143, 410	140, 528
McKean	617	9, 214	10, 443	11, 500	(*a*)
Mercer	537, 712	539, 721	487, 122	575, 751	524, 319
Somerset	349, 926	416, 240	370, 228	442, 027	522, 796
Tioga	1, 384, 800	1, 328, 963	1, 106, 146	1, 036, 175	903, 997
Venango	2, 500	2, 296	2, 000	6, 911	(*a*)
Washington	1, 612, 407	1, 751, 615	1, 793, 022	2, 364, 901	2, 836, 667
Westmoreland	5, 446, 480	6, 074, 486	6, 519, 773	7, 631, 124	8, 290, 504
Small mines	...	200, 000	240, 000	(*b*)	1, 000, 000
Total	27, 094, 501	31, 516, 856	33, 796, 727	36, 174, 089	42, 302, 173
Net increase	...	4, 422, 355	2, 279, 871	2, 377, 362	6, 128, 084

Counties.	1891.	1892.	1893.	1894.	Increase in 1894.	Decrease in 1894.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Allegheny	5, 640, 669	6, 399, 199	6, 663, 095	6, 354, 559	...	308, 536
Armstrong	484, 000	583, 519	561, 039	580, 030	18, 991	...
Beaver	129, 961	140, 835	150, 095	103, 765	...	46, 330
Bedford	389, 257	552, 461	501, 507	313, 095	...	188, 412
Blair	237, 626	259, 224	177, 902	256, 157	78, 255	...
Bradford	68, 697	57, 708	42, 739	28, 027	...	14, 712
Butler	211, 647	145, 729	156, 016	137, 593	...	18, 423
Cambria	2, 932, 973	3, 086, 554	3, 282, 467	2, 978, 927	...	303. 540
Cameron	...	...	...	...	...	...
Center	526, 753	496, 521	458, 056	307, 806	...	150, 250
Clarion	479, 887	569, 333	551, 158	401, 004	...	150, 154
Clearfield	7, 143, 382	6, 876, 785	6, 148, 758	4, 148, 464	...	2, 000, 294
Clinton	130, 802	98, 242	94, 582	100, 000	5, 418	...
Elk	973, 600	731, 575	634, 165	399, 023	...	235, 142
Fayette	5, 782, 573	7, 260, 044	6, 261, 146	6, 440, 989	179, 843	...
Forest	...	...	...	123	123	...
Greene	...	...	...	...	...	...
Huntingdon	269, 021	333, 855	303, 547	200, 032	...	103, 515
Indiana	456, 077	514, 463	380, 666	398, 548	17, 882	...
Jefferson	3, 160, 614	3, 706, 329	3, 885, 196	3, 248, 154	...	637, 042
Lawrence	164, 669	216, 561	196, 736	132, 422	...	64, 314
Lycoming	...	20, 515	53, 192	80, 160	26, 968	...
McKean	15, 345	21, 282	19, 169	19, 844	675	...
Mercer	526, 220	420, 145	499, 651	331, 594	...	168, 057
Somerset	480, 194	509, 610	532, 688	418, 195	...	114, 493
Tioga	1, 010, 872	999, 784	962, 248	704, 560	...	257, 688
Venango	...	...	...	...	...	...
Washington	2, 606, 158	2, 903, 235	3, 315, 146	3, 461, 428	146, 282	...
Westmoreland	7, 967, 493	8, 791, 068	7, 439, 760	7, 767, 964	328, 204	...
Small mines	1, 000, 000	1, 000, 000	800, 000	600, 000	...	200, 000
Total	42, 788, 490	46, 694, 576	44, 070, 724	39, 912, 463	...	*c*4, 158, 261
Net increase	486, 317	3, 906, 086	*c*2, 623, 852	...	...	...

a Included in product of small mines. *b* Included in county distribution.
c Net decrease.

In the following tables will be found a statement of the average prices which obtained in the different counties since 1889, and the statistics of labor and working time during the same period:

Average prices for Pennsylvania coal since 1889 in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Allegheny	$0.85	$0.93	$1.03	$0.91	$0.82	$0.88
Armstrong	.73	.72	.76	.76	.76	.72
Beaver	1.18	1.05	1.00	1.01	.98	.91
Bedford	.80	.80	.86	.82	.74	.69
Blair	.98	.81	.87	.85	.77	.75
Bradford	1.33	1.28	1.34	1.42	1.30	1.53
Butler	.97	.87	.89	.93	.81	.76
Cambria	.77	.83	.80	.82	.79	.73
Center	.79	.79	.75	.79	.75	.68
Clarion	.72	.75	.75	.75	.72	.70
Clearfield	.84	.85	.84	.81	.80	.72
Clinton	....	.78	1.15	1.01	.76	.81½
Elk	.81	.84	.83	.83	.79	.86
Fayette	.63	.77	.82	.77	.73	.69
Huntingdon	.75	.77	.78	.75	.75	.74
Indiana	.71	.82	.76	.77	.77	.70
Jefferson	.73	.85	.88	.81	.74	.71
Lawrence	1.05	1.02	1.02	1.02	1.03	.92
Lycoming	....	....	....	1.12	1.22	1.23
McKean	....	....	1.05	1.10	1.10	.95
Mercer	.89	.85	.90	.88	.89	.82
Somerset	.70	.65	.71	.66	.63	.63
Tioga	1.22	1.10	1.14	1.44	1.21	1.36
Washington	.66	.93	.87	.87	.78	.62
Westmoreland	.74	.80	.87	.81	.82	.77
The State	.77	.84	.87	.84	.80	.74

Statistics of labor employed and working time at Pennsylvania coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.
Allegheny	9,036	198	11,194	199	11,223	225	14,328	161	14,107	154
Armstrong	661	251	805	230	964	246	1,080	214	1,153	168
Beaver	205	251	228	201½	323	210	318	215	312	148
Bedford	662	288	605	230	975	265	806	185	855	144
Blair	595	284	503	249	848	203	632	166	730	142
Bradford	292	196	169	228	122	206	83	167	90	134
Butler	314	237	342	240	358	169	276	208	497	111
Cambria	4,140	361	4,284	258	4,913	228	6,073	199	6,230	165
Center	623	230	823	200	767	181	743	193	855	111
Clarion	938	237	895	221	985	235	1,224	231	926	201
Clearfield	9,324	336	10,067	227	10,225	212	10,455	186	9,654	134
Clinton	200	265	181	291	175	175	175	163	190	153
Elk	1,181	255	1,622	229	1,265	230	1,244	195	1,107	147
Fayette	6,503	247	7,545	216½	7,952	239	6,780	195	8,847	198
Huntingdon	611	237	595	246	560	244	487	182	478	133
Indiana	668	245	561	227	656	191	605	186	724	164
Jefferson	3,971	245	4,172	237	4,567	232	5,537	210	5,184	164
Lawrence	307	232	327	236	368	250	430	218	490	165
Lycoming					60	252	117	279	166	231
McKean	....	....	42	230	28	304	19	285	50	200
Mercer	1,023	231	972	241	876	181	981	187	1,014	121
Somerset	646	225	531	266	577	238	695	214	731	150
Tioga	2,019	192	1,980	241	2,249	223	2,425	214	2,213	149
Washington	4,644	227	4,135	222	4,895	202	6,058	184	6,889	159
Westmoreland	12,080	228	11,083	221	10,724	234	10,270	205	11,517	202
The State	61,333	232	63,661	223	66,655	223	71,931	190	75,010	165

TENNESSEE.

Total product in 1894, 2,180,879 short tons; spot value, $2,119,481.

TENNESSEE COAL FIELDS.

The great Appalachian field crosses the eastern part of Tennessee in a comparatively narrow belt, 71 miles wide at the northern boundary and narrowing to 50 miles at the southern or Alabama and Georgia State line. The general direction of the belt is northeast and southwest. The workable coal area is confined to what is known as the Cumberland table-land. About 5,100 square miles are contained in the area which is embraced in 19 counties. The coals are all bituminous in character and some are of very excellent quality. In Campbell County is a part of the famous Jellico steam coal field. The Sewanee vein is one of the most important ones in the State and is worked extensively in Grundy County. Coke of high grade is made from the coal of this seam, particularly in Grundy County. Extensive coking establishments are also found in Claiborne, Hamilton, Marion, Rhea, and Roane counties. About 500,000 tons of coal are coked in the State annually. A comprehensive paper on the Tennessee coal fields, by Prof. J. M. Safford, was published in Mineral Resources, 1892.

CONVICTS IN COAL MINES.

Mention was made in the previous report of the purchase by the State of 9,000 acres of coal land in Morgan County for the purpose of using the convicts therein, instead of leasing them to corporations. Work was begun on these mines in 1894, but up to the close of the year only 500 short tons of coal had been taken out. The idea, therefore, is still practically one of experiment only, but nevertheless the following report, by Mr. L. E. Bryant, engineer in charge, will be found interesting.[1]

Owing to troubles which had been brewing a long time between the free and convict miners, and which culminated in the Coal Creek war of two years ago, the present administration in Tennessee has sought to eliminate the primary causes of such a condition of things by employing its own convicts on its own land in the production of coal, instead of leasing them to contractors to be employed by the side of the free laborers, who have always regarded them as a menace to their best interests and organization.

The first step toward this end was accomplished by the penitentiary act of 1893, appropriating the necessary funds and appointing a committee to investigate any and all coal lands offered to the State as suitable ground on which to commence operations. After a careful inspection the committee very justly decided on 9,000 acres of land about 20 miles north of Harriman, in Morgan County, to which a railroad is building. The Coal Measures on this property reach an exaggerated development compared with the more southwestern and better known coal territory of the State, no less than nine workable seams occurring above drainage on some portions of the property, leaving fully 2,000 feet of lower measure rocks still to be explored.

Two of the veins are more favorably situated for working than the rest, and as they are of a quality to recommend them for mining, operations will first be com-

[1] Written for the Engineering and Mining Journal, September 15, 1894.

menced in them. The lower one, which ranges from 3 to 4 feet in thickness, makes an admirable coke, while the higher one is more especially suited for steam and domestic purposes. This latter vein often reaches 6 feet in thickness and mines in large, bright lumps.

The commission contemplates going into business on a large and thoroughly modern scale; the three-heading system with 40 to 45 foot rooms will probably be adopted, the conditions being favorable. The screening plant will be of the latest design for large capacity, and all coals below 2 inches will be washed and the sizes hand picked. As much of the product will be put into coke and high-class domestic coals as possible, these grades permitting farther shipment than the cheaper steam coals, and consequently command a wider market. The beehive oven will be used in the coking plant, and besides the usual furnace and foundry article, especial attention will probably be given to the production of crushed coke for base-burning anthracite stoves, as this branch of the coke industry is quite promising in the South.

In working the convicts quite a change from the ordinary method in use in this district will in all probability be introduced. It has been the custom to task the convict to a certain number of cars or tons of coal per day, relying on him to lay his track, set his props, mine, shoot, and load his coal, and deliver it on the entry. This is quite too much responsibility for the ordinary free miner, where one wants a mine kept in good condition and the mining laws are strict. The evils resulting from this are found to be badly laid track, badly set props, and, as a rule, twice as many as needed, coal not mined at all, but simply shot to pieces, and finally loaded up with all the slate, sulphur, and other refuse at hand that would help fill up the requisite number of cars for the task. The only way heretofore in use to prevent these things has been by whipping, the efficacy of which has never been proved, and its effects on the mental conditions of convicts, even if they are mostly black, can hardly be imagined by a layman.

It is now proposed to systematize the work as much as possible and relieve the convicts of all the responsibility possible and at the same time make it as nearly impossible as one can for them to do any of the things spoken of above as objectionable.

No attempt will be made to use coal-cutting machinery, but the best of the men able to handle a pick will be selected and used just as if they were machines. They will undercut coal and do nothing else, and be formed in gangs on each entry under free bosses if necessary and convict ones if found practicable. Tasks of so many feet per day will probably be introduced, but the penalty for not completing them in the eight or nine hours allowed will be overwork until it is done. After these men have cut the coal a free boss, with probably half a dozen assistants, will bore and shoot it, and an inspection of the working places will follow this, when, if everything is safe, the great mass of convicts will be turned into the rooms and the coal loaded in the presence of convict inspector bosses if possible and free if necessary, whose duty it will be to see that the men do a reasonable day's work and load the coal clean. After this crew has finished, the timbermen and track layers will follow and put the rooms in shape for the next operation.

It has been found dangerous in many camps to give powder to the convicts in the proportions of one or two shots per day, as in many cases they use only about half of it, and secrete the balance for some pyrotechnic display, which while often innocently meant, is sometimes directed toward the roof of the mine, in order to cause a cave in and give a holiday until the fall is cleaned. Anarchistic plots are not unheard of either, but the main benefit to be derived from this provision for curbing the issuance of explosives will undoubtedly be a more merchantable article of coal. Such a system as this makes it possible to establish a series of grades, as rewards of fidelity and good work, and this fact may be taken advantage of if it is found practicable. The outside laborers, inside bosses, timbermen, track layers, coal cutters and loading inspectors could be formed into a privileged class, as it were, whose rewards would be shorter hours of labor and some distinctive badge. Whether or not these incentives alone would do to keep up the requisite amount of enthusiasm is immaterial, for if the system depended on that alone a small extra monetary consideration would do the work. The trouble will come in getting rid of the coal without having clashes with local mines. The question of cost of production is the thing least to fear.

Sanitary arrangements of the latest known design will be used in the dormitories for the men, and what has heretofore been almost impossible will be attempted—that is, to keep the convicts clean. Those who have had any acquaintance with the subject will know that this will probably cause more trouble than all the other regulations together.

In the latter part of May, 1895, Mr. Bryant, in reply to an inquiry from this office, reported that, owing to legislative complications, work at the State convict mines had not been pushed as fast as at first contemplated. Shipments had begun, however, and it was expected that at the extra session of the present legislature the necessary appropriation for the construction of crushing, washing, and coking plants would be made. No material change has been made or ordered in the plans outlined in the preceding article, and Mr. Bryant expects to have the main body of the State convicts at the mines by January 1, 1896. Whether or not the experiment will prove financially remunerative to the State can only be told after that time, as the work now in progress is preliminary and consists of entry driving and room turning. Enough has been gathered from the experience so far to demonstrate that the coal is of good quality, and Mr. Bryant thinks the coke will be rather better than the average in the South. The chances of success have rather increased than decreased as the work has progressed. The mines are expected to produce from 2,000 to 4,000 tons daily. Only screened and washed coal will be shipped. The fine coal will be made into coke.

PRODUCTION.

The records of coal production in Tennessee date from 1873, but for ten years from that date the amounts reported were principally estimates, except for 1880, when the Tenth United States Census showed a total product of 641,042 short tons. The estimated output in 1873 was 350,000 short tons. From then until 1891 there was a practically steady increase in the annual production, reaching in the latter year 2,413,678 short tons, the largest output in any one year in the history of coal mining in the State. Except for the census years 1880 and 1889, the only reliable statistics of production in Tennessee have been compiled by the Geological Survey and published in Mineral Resources of the United States. The years for which they were thus obtained are from 1885 to 1894 (except the census year of 1889), and appear in a subsequent table.

In 1892 the coal-mining interests of the State suffered severely from the riots brought on by the opposition of free labor to the employment of convicts in competition with it (see Mr. Bryant's report, preceding). In that year the product was 321,614 short tons, or more than 15 per cent, less than in 1891. Owing to the action of the State authorities, these demonstrations were less marked in 1893, but the industry felt the effects of the industrial and financial depression, and a further decrease of 189,806 short tons, or nearly 10 per cent, was noted. The strike of 1894 affected some of the mines in this State, but not so generally as in others, and the product increased 278,621 tons, or about 15 per cent over that of 1893. The value increased only $71,032, about 3½ per cent, the average price in sympathy with the general decline in values falling from $1.08 per ton to 97 cents.

In the following tables the statistics of production during 1893 and 1894 are given by counties:

Coal product of Tennessee in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Anderson	306,177	1,750	3,850	....	311,777	$319,115	$1.02	247	665
Bledsoe	....	....	....	....	....	....	......	......	......
Campbell	251,796	7,231	1,476	2,000	262,503	328,897	1.25	175	936
Claiborne	154,754	500	800	25,476	181,530	163,447	.90	142	280
Franklin	600	600	....	....	1,200	2,400	2.00	100	6
Grundy	132,912	1,019	2,302	157,780	294,013	305,774	1.04	247	548
Hamilton	112,750	1,552	1,848	39,373	155,523	158,681	1.02	260	670
Marion	140,572	1,254	633	69,135	211,594	206,452	.98	262	480
Morgan	77,565	384	241	....	78,190	83,542	1.07	224	272
Rhea	1,790	9,353	1,344	84,044	96,531	86,151	.89	295	245
Roane	5,405	3,842	4,557	25,750	39,554	57,891	1.46	203	160
Scott	138,395	9,395	2,190	8,000	157,980	220,800	1.40	222	414
White	104,503	1,680	1,680	....	107,863	111,299	1.03	307	300
Small mines	....	4,000	....	....	4,000	4,000	......	......	......
Total	1,427,219	42,560	20,921	411,558	1,902,258	2,048,449	1.08	232	4,976

Coal product of Tennessee in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Anderson	7	535,108	3,014	4,600	1,500	544,222	$527,671	$0.97	256	1,217
Campbell	8	169,448	4,105	1,340	8,395	183,288	192,757	1.05	140	698
Claiborne	4	142,145	550	....	24,458	167,153	157,377	.94	169	277
Franklin, Grundy, Putnam, and White	4	327,716	2,931	8,800	144,355	483,802	415,629	.86	224	1,229
Hamilton	3	100,398	1,193	1,009	53,701	156,301	141,008	.90	218	441
Marion	3	110,945	11,143	434	62,075	184,597	209,627	1.14	183	522
Morgan	6	63,451	800	350		64,601	63,233	.98	145	373
Rhea	3	4,386	7,751	3,360	108,618	124,115	125,823	1.01	253	209
Roane	2	3,456	11,238	2,800	101,393	118,887	118,887	1.00	307	210
Scott	3	114,353	12,760	6,300	16,000	149,413	162,969	1.09	194	366
Small mines	......	....	4,500	....	....	4,500	4,500	......	......	......
Total	43	1,571,406	59,985	28,993	520,495	2,180,879	2,119,481	.97	210	5,542

The annual output of the State since 1873 has been as follows:

Coal product of Tennessee from 1873 to 1894.

Years.	Short tons.	Years.	Short tons.
1873	350,000	1884	1,200,000
1874	350,000	1885	1,440,957
1875	360,000	1886	1,714,290
1876	550,000	1887	1,900,000
1877	450,000	1888	1,967,297
1878	375,000	1889	1,925,689
1879	450,000	1890	2,169,585
1880	641,042	1891	2,413,678
1881	750,000	1892	2,092,064
1882	850,000	1893	1,902,258
1883	1,000,000	1894	2,180,879

In the following table is shown the total production, by counties, since 1889, with the increase and decrease in each county during 1894, as compared with the preceding year:

Coal product of Tennessee since 1889, by counties.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.	Increase in 1894.	Decrease in 1894.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Anderson	457,069	582,403	587,558	409,970	311,777	544,222	232,445	
Campbell	123,103	126,367	159,937	289,605	262,503	183,288		79,215
Claiborne	(*a*)	(*a*)	73,738	137,219	181,530	167,153		14,377
Franklin	(*b*)	1,500	1,400	1,400	1,200	3,000	1,800	
Grundy	400,107	349,467	398,936	358,023	294,013	365,989	71,976	
Hamilton	241,067	277,896	243,298	105,283	155,523	156,301	778	
Marion	203,923	213,202	271,809	241,974	211,594	184,597		26,997
Morgan	68,229	143,518	125,287	34,970	78,190	64,601		13,589
Putnam						659	659	
Rhea	149,194	211,465	213,649	133,424	96,531	124,115	27,584	
Roane	*c*174,551	70,452	112,308	102,588	39,554	118,887	79,333	
Scott	108,027	136,365	142,943	183,230	157,980	149,413		8,567
White	(*b*)	52,650	78,315	90,378	107,863	114,154	6,291	
Other counties and small mines	419	4,300	4,500	4,000	4,000	4,500	500	
Total	1,925,689	2,169,585	2,413,678	2,092,064	1,902,258	2,180,879	*e*278,621	
Net increase		243,896	244.093	*d*321,614	*d*189,806			

a Developing.
b Included in Roane County.
c Includes Franklin and White counties.
d Net decrease.
e Net increase.

In connection with the foregoing table the following statements of the average prices ruling in the important producing counties and the statistics of labor and working time for the same period should be considered.

Average prices for Tennessee coal since 1889 in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Anderson	$1.16	$1.17	$1.15	$1.11	$1.02	$0.97
Campbell	1.15	1.22	1.27	1.19	1.25	1.05
Claiborne			1.19	1.04	.90	.94
Grundy	.99	.94	.89	1.11	1.04	.80
Hamilton	1.30	1.15	1.12	1.11	1.02	.90
Marion	1.13	1.06	1.11	1.08	.98	1.14
Morgan	1.34	1.10	1.09	1.36	1.07	.98
Rhea	1.10	1.00	1.00	1.00	.89	1.01
Roane			1.15	1.05	1.46	1.00
Scott	1.34	1.29	1.25	1.24	1.40	1.09
White			1.31	1.25	1.03	1.03
The State	1.21	1.10	1.10½	1.13	1.08	.97

Statistics of labor employed and working time at Tennessee coal mines.

Counties.	1890. Average number employed.	1890. Average working days.	1891. Average number employed.	1891. Average working days.	1892. Average number employed.	1892. Average working days.	1893. Average number employed.	1893. Average working days.	1894. Average number employed.	1894. Average working days.
Anderson	1,325	291	1,350	242	1,072	218	665	247	1,217	256
Campbell	251	212	451	145	732	213	936	175	698	140
Claiborne	....	....	165	172	276	207	280	142	277	169
Grundy	880	310	515	311	800	309	548	247	904	238
Hamilton	500	285	475	213	365	192	670	260	441	218
Marion	523	226	615	220	375	286	480	262	522	183
Morgan	363	258	363	250	156	148	272	224	373	145
Rhea	450	200	350	250	175	307	245	295	209	253
Roane	....	....	210	277	207	282	160	203	210	307
Scott	475	241	347	182	448	243	414	222	366	194
White	....	....	246	228	300	232	300	307	300	196
The State	5,082	263	5,097	230	4,926	240	4,976	232	5,542	210

TEXAS.

Total product in 1894, 420,848 short tons; spot value, $976,458.

TEXAS COAL FIELDS.

The coal fields of Texas have been discussed in previous volumes of Mineral Resources, notably in the volumes for 1886 and 1888, in abstracts from the reports of E. T. Dumble, State geologist, and in the volumes for 1891 and 1892 by Mr. Robert T. Hill, of the United States Geological Survey, formerly professor of geology of the University of Texas. During the past two or three years active development work has been prosecuted in the San Carlos coal fields, described fully in Mineral Resources, 1893. In the volume for 1885, Mr. Charles A. Ashburner stated that discoveries of coal had been reported in El Paso and Presidio counties, but no reliable information in regard to it was obtained until 1892, when some Pittsburg (Pa.) parties investigated the rumors and found a valuable and extensive deposit. A branch railroad from Chispa Station, on the Southern Pacific Railroad, is now building, and before the close of 1895 will be completed. As soon as this means of transportation is obtained the mines will begin to ship, and as the field is in a region remote from other sources of supply a profitable enterprise is practically assured from the start.

PRODUCTION.

Reliable statistics of coal production in Texas have only been obtained since 1889, when the Eleventh United States Census, after a careful canvass of the State, reported an output of 128,216 short tons, valued at $340,620. The output from 1883 to 1888, inclusive, has been estimated at from 75,000 to 135,000 short tons annually, and while these figures were estimates merely, the fact that the product in those years was from the same mines as the output in 1889, and that the estimated product was quite close to that reported by the Census Office, indicates that the estimates were not very far from the actual output.

With the exception of a slight decrease in 1891 from the output in 1890, the product of coal in Texas has shown a steady increase since 1889. While the output in 1891 was less than that of 1890, it exceeded that of 1889 by more than 40,000 tons. The product in 1892 was 73,590 short tons, or nearly 43 per cent larger than that of 1891. In 1893 the product increased 56,516 short tons, or 23 per cent over 1892, and in 1894 the increase was 118,642 short tons, or more than 39 per cent. The product in 1894 was more than three times that of 1889, while the value was within $25,000 of reaching $1,000,000. With the bringing in of the Presidio County or San Carlos fields in 1895, and the development of industrial enterprises in the State, the production of coal is likely to continue to increase.

Owing to the fact that there is but one mine in each producing county, the production by counties can not be given in detail, without violating the confidential nature of the statistics. The following table shows the output since 1889, with the value and distribution for consumption:

Coal product of Texas since 1889.

Distribution.	1889.	1890.	1891.	1892.	1893.	1894.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Loaded at mines for shipment	120,602	180,800	169,300	241,005	300,064	417,281
Sold to local trade and used by employees	6,552	1,840	900	4,460	462	2,412
Used at mines for steam and heat	1,062	1,800	1,900	225	1,680	1,155
Total	128,216	184,440	172,100	245,690	302,206	420,848
Total value	$340,617	$465,900	$412,300	$569,333	$688,407	$976,458

UTAH.

Total product in 1894, 431,550 short tons; spot value, $603,479.

No systematic geological survey has been made of the Territory, and it is not possible to define the limits of even such coal deposits as are worked. What knowledge there is of the coal resources of the Territory is contained in a contribution by Mr. Robert Forrester to Mineral Resources for 1892. The coal mined commercially is practically all bituminous, and some in Carbon County makes an excellent coke, 48,810 tons of coal being made into coke in 1894.

The industry in the Territory is on the increase, notwithstanding the fact that the coal fields of Wyoming are about as near the principal coal markets of Utah as the coal-producing districts of the Territory itself. The product in 1894 was the largest ever obtained, though an increase over 1893 of only about 4 per cent, while the value declined slightly (a little over 1 per cent) the average price declining from $1.48 per ton to $1.40.

The following tables show the statistics of production during 1893 and 1894, by counties:

Coal product of Utah in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Carbon	304, 511	920	1, 874	50, 875	358, 180	$523, 422	$1. 46	238	416
Morgan	....	100	....	....	100	175	1. 75	50	2
Sanpete	....	2, 671	12	....	2, 683	4, 752	1. 77	220	11
Summit	45, 912	3, 958	2, 372	....	52, 242	82, 743	1. 58	194	147
Total	350, 423	7, 649	4, 258	50, 875	413, 205	611, 092	1. 48	226	576

Coal product of Utah in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Carbon	3	312, 706	1, 758	1, 900	48, 810	365, 174	$512, 389	$1. 40	222	506
Emery and Morgan	3	....	1, 364	11	....	1, 375	1, 936	1. 41	52	10
Sanpete	2	1, 800	1, 107	40	....	2, 947	6, 843	2. 32	70	30
Summit	5	50, 169	6, 944	4, 941	....	62, 054	82, 311	1. 33	147	125
Total	13	364, 675	11, 173	6, 892	48, 810	431, 550	603, 479	1. 40	199	671

There are no records of the amount of coal produced in the Territory prior to 1885. Since that time the annual output has been as follows:

Coal product of Utah since 1885.

Years.	Short tons.	Years.	Short tons.
1885	213, 120	1890	318, 159
1886	200, 000	1891	371, 045
1887	180, 021	1892	361, 013
1888	258, 961	1893	413, 205
1889	236, 651	1894	431, 550

VIRGINIA.

Total product in 1894, 1,229,083 short tons; spot value, $933,576.

VIRGINIA COAL FIELDS.

The bituminous coal fields of Virginia may be divided into two prominent areas, the Richmond basin and the Pocahontas field.

1. The Richmond basin embraces the counties of Henrico, Chesterfield, Goochland, Powhatan, and Amelia, with traces of coal in Han-

over and Dinwiddie. This coal occurs in the Triassic formation, and is of the same geologic age as the Deep River field of North Carolina. The first systematic coal mining in the United States was carried on in this field. In 1822 nearly 50,000 tons were produced here, twelve times the amount of coal shipped out of the Pennsylvania anthracite region in that year. The maximum production of the field was in 1833, when 142,587 tons of coal were shipped. At the time the earlier volumes of Mineral Resources were published, mining in this field had gradually declined and no extensive operations were being carried on. In the past two or three years, however, considerable attention has been given to these properties, and operations on quite an extensive scale are being prosecuted. Mines at Gayton, in Henrico County, and Midlothian, in Chesterfield County, are working almost continuously. The coal from the field ranges from a bright black bituminous to a semianthracite, and seems quite popular for domestic fuel in the city of Richmond, the principal market. Some experimental coke has been made, and the operators are now investigating the different makes of coke ovens with the idea of making coke on a commercial scale and saving the by-products.

2. The Pocahontas field, underlain by the lower productive Coal Measures, extends over parts of Tazewell, Russell, Buchanan, Dickinson, Wise, Scott, and Lee counties. The largest operations are in Tazewell County, and until 1892 practically all of the product was from this county. In 1892, however, the Wise County deposits were opened up by the extension through them of the Clinch River division of the Norfolk and Western Railroad. About 2,000 tons were mined there during 1892 in the progress of development. The following year (1893) Wise County produced 126,216 tons of coal, and in 1894 over 300,000 tons. The Pocahontas field reaped a rich harvest in 1894 from the strike in other regions, this one being exempted from the general order calling out the miners. As a result the output from the field increased from 779,590 short tons to 1,158,437 short tons, a gain of nearly 50 per cent.

In addition to these fields there are several outlying areas from the Appalachian system, but occurring in the lowest of the Carboniferous formations. In Rockingham and Augusta counties coal beds have been known to exist for many years. They are, however, not sufficiently persistent to be mined profitably. A triangular area running northeast and southwest occurs along the Brush and Price mountains, in Montgomery County, and some coal is taken out here for local consumption. The coal is bituminous; but on account of the pressure to which some of it has been subjected, it has in places been hardened to an appearance of anthracite, but the metamorphism has not been complete enough to authorize the use of the name of anthracite for it. In Pulaski County occurs another isolated area which is worked by the Bertha Zinc and Mineral Company for its zinc reduction works.

Another long, narrow field extends northeast and southwest along the Holston Valley, in Washington, Smyth, and Wythe counties. These are not operated at present.[1]

PRODUCTION.

As previously stated, the first coal mined systematically in the United States was from the Richmond basin, in Virginia. As early as 1822 the amount of coal mined here was 48,214 long tons. In 1833 142,587 long tons were produced. From 1833 to 1869 there is a blank in the records. In the latter year the product was 61,803 long tons, or 69,219 short tons. The Tenth United States Census reported an output of 43,079 short tons for the fiscal year ending June 30, 1880. All of the above figures represent the output of the State obtained from the Richmond basin. The output during 1880, 1881, and 1882 was estimated at 100,000 long tons, or 112,000 short tons, in each year, but this is an "estimate" merely. The development in the Pocahontas Flat Top coal field began in the fall of 1881, but owing to the wet season of 1882 and the lack of transportation facilities until the New River division of the Norfolk and Western Railroad was completed, in 1883, the first car load of coal was not shipped until the latter year. From 1883 the production of this field has grown to enormous proportions, the output in 1894 (including McDowell and Mercer counties, W. Va., and Tazewell and Wise counties, Va.) reaching 5,389,756 short tons. Four-fifths of this product, however, was from the districts north of the Bluestone River, in West Virginia, but the output of Virginia alone in this region in 1894 was 1,158,437 short tons. This was an increase of nearly 400,000 tons over 1893, and was due to this region being unaffected by the strike which paralyzed the industry in competing fields. Notwithstanding this increased activity, due to causes which should have resulted in an enhanced value, and probably did for awhile, the business for the year shows a decided falling off in the average price realized, Tazewell County's average declining from 80 cents and Wise County's from 90 cents in 1893 to 70 cents in both counties for 1894. The other counties of the State are grouped in order to maintain the confidential nature of individual returns. There was an increase here of over 100 per cent—from 33,978 short tons in 1893 to 70,646 short tons in 1894—with a proportionately greater increase in value, from $50,622 to $122,611, the average price advancing from $1.49 to $1.73. The Wise County field was opened in 1892 by the extension of the Clinch River division of the Norfolk and Western Railroad to Big Stone Gap; but, except for a small amount (about 2,000 tons) taken out in the work of development, no coal was mined in that year. The first commercial product was in

[1] For further details of the coal fields of Virginia and West Virginia, see Mineral Resources for 1883-84 and Bulletin No. 65 of the U. S. Geological Survey.

1893, when 126,216 short tons were mined. The output in 1894 was more than two and one-half times this, amounting to 330,731 short tons. The total product of the State in 1894 was 1,229,083 short tons, valued at $933,576, against 820,339 short tons, worth $692,748, in 1893, an increase in amount of 408,744 short tons and in value of $240,828. The following tables show the details of production for the two years:

Coal product of Virginia in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Tazewell	565, 245	3, 805	3, 360	80, 964	653, 374	$520, 565	$0. 80	310	600
Wise	124, 088	896	1, 232	....	126, 216	113, 436	. 90	149	260
Other counties *a*	18, 084	15, 877	17	....	33, 978	50, 622	1. 49	185	101
Total	714, 188	20, 578	4, 609	80, 964	820, 339	692, 748	. 84	253	961

a Includes Chesterfield, Henrico, Montgomery, and Pulaski counties.

Coal product of Virginia in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Tazewell	2	635, 708	1, 120	3, 360	187, 518	827, 706	$580, 328	$0. 70	302	825
Wise	13	326, 086	4, 029	616	....	330, 731	230, 637	. 70	155	514
Chesterfield, Henrico, Montgomery, and Pulaski	13	53, 919	16, 013	714	....	70, 646	122, 611	1. 73	180	296
Total	28	1, 015, 713	21, 162	4, 690	187, 518	1, 229, 083	933, 576	. 76	234	1, 635

The total production of coal in Virginia since 1880 has been as follows:

Coal product of Virginia since 1880.

Years.	Short tons.	Years.	Short tons.
1880	112, 000	1888	1, 073, 000
1881	112, 000	1889	865, 786
1882	112, 000	1890	784, 011
1883	252, 000	1891	736, 399
1884	336, 000	1892	675, 205
1885	567, 000	1893	820, 339
1886	684, 951	1894	1, 229, 083
1887	825, 263		

WASHINGTON.

Total product in 1894, 1,106,470 short tons; spot value, $2,578,441.

WASHINGTON COAL FIELDS.

The developed coal fields of Washington lie chiefly in a comparatively narrow belt, running nearly due north and south, through the western portions of Whatcom, Skagit, Snohomish, and King counties into Pierce and Thurston counties. Some distance to the east of the southern end of this belt, in Kittitas County, extensive operations have been carried on for a number of years. The main belt extends along the Cascade Range, and important mines have been opened on both the eastern and western slopes of the range. Outcroppings have been found in other localities, notably in Lincoln, Spokane, and Cascade counties, and in 1894 a small amount of coal was mined in Okanogan County. The coals of the State embrace lignite, semibituminous, and bituminous, adapted for gas and coke making and for steam and domestic purposes. Some coal resembling anthracite is reported to have been found in Yakima County. The total area of the coal deposits of Washington has not been determined, but there is no doubt that almost inexhaustible supplies are at hand, not only for the future demand of its population, but sufficient to furnish a basis for profitable traffic for transportation to the entire Pacific Coast.

PRODUCTION.

The discovery of coal in what is now the most important producing region of the Pacific States was made in 1852. The first mine was opened on Bellingham Bay in 1854. The coal from this mine was sent to San Francisco, and was the only coal shipped out of the Territory (now State) of Washington until 1870, when exportation commenced at Seattle from the Seattle, Renton, and Talbot mines in the vicinity. In 1874 the product from the Seattle mines was 50,000 tons; from July 1, 1878, to July 1, 1879, the product was 155,900 tons. In the year ended December 31, 1879, the product was 137,207 short tons. The Renton mine, opened in 1874, produced, in 1875 and 1876, 50,000 short tons. The Talbot mine, opened in 1875, produced, in 1879, 18,000 short tons of coal. Records of the operations of Washington coal mines are incomplete, and entirely wanting from 1879 to 1884. The mining during this time was confined to King and Pierce counties. During the fiscal year ended June 30, 1885, the total product of the Territory is given at 380,250 short tons, of which King County is credited with 204,480 short tons and Pierce County with 175,770 short tons.

Coal mining in Washington received a sudden impetus in 1887 and 1888, practically reaching the limit of profitable production in the latter year, for in only two years since has the product of 1888 been exceeded. The product in 1887 was more than 75 per cent larger than in 1886, and that of 1888 more than 55 per cent larger than in 1887. The product in both 1890 and 1893 exceeded that of 1888 by about 50,000 tons, but these were the only years when it did so, though in no year has the product fallen below 1,000,000 tons, since it passed that figure in 1888. In 1894 the product was 158,407 tons less than in 1893, while the value declined $342,435. There was an advance in the average price per ton from $2.31 in 1893 to $2.33 in 1894.

The following tables show the statistics of production during 1893 and 1894:

Coal product of Washington in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
King	544, 848	4, 360	28, 523	....	577, 731	$1, 284, 684	$2. 22	272	1, 256
Kittitas	239, 888	3, 048	10, 531	....	253, 467	653, 922	2. 71	162	672
Pierce	389, 196	764	7. 140	10, 974	408, 074	917, 122	2. 25	260	756
Skagit	1, 985	100	420	400	2, 905	10, 698	3. 68	94	17
Thurston	....	....	....	....	....	....	....	....	....
Whatcom	10, 192	10, 616	1, 892	....	22, 700	54, 450	2. 40	291	56
Total	1, 186, 109	18, 888	48, 506	11, 374	1, 264, 877	2, 920, 876	2. 31	241	2, 757

Coal product of Washington in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
King	7	379, 433	6, 708	36, 535	....	422, 676	$1, 107, 887	$2. 62	244	919
Kittitas	2	221, 292	2, 559	8, 729	....	232, 580	490, 860	2. 11	125	809
Okanogan, Pierce	6	389, 109	783	9, 831	7, 158	406, 881	876, 581	2. 15	235	823
Skagit, Thurston, Whatcom	4	40, 398	772	1, 758	1, 405	44, 333	103, 113	2. 33	292	111
Total	19	1, 030, 232	10, 822	56, 853	8, 563	1, 106, 470	2, 578, 441	2. 33	207	2. 662

The annual product since 1885 has been as follows:

Product of coal in Washington since 1885.

Years.	Total product.	Total value.	Average price per ton.	Total employees.	Average number of days worked.
	Short tons.				
1885	380, 250	....	....	....	....
1886	423, 525	$952, 931	$2. 25	....	....
1887	772, 601	1, 699, 746	2. 19	1, 571	....
1888	1, 215, 750	3, 647, 250	3. 00	....	....
1889	1, 030, 578	2, 393, 238	2. 32	2, 657	....
1890	1, 263, 689	3, 426, 590	2. 71	2, 206	270
1891	1, 056, 249	2, 437, 270	2. 31	2. 447	211
1892	1. 213, 427	2, 763, 547	2. 28	2, 564	247
1893	1, 264, 877	2, 920, 876	2. 31	2, 757	241
1894	1, 106, 470	2, 578, 441	2. 31	2, 662	207

The total output of the State since 1887, by counties, with the increases and decreases in 1894 as compared with 1893, is shown in the following table:

Product of coal in Washington since 1887, by counties.

[Short tons.]

Counties	1887.	1888.	1889.	1890.	1891.
King	339, 961	546, 535	415, 779	517, 492	429, 778
Kittitas	104, 782	220, 000	294, 701	445, 311	348, 018
Okanogan					
Pierce	229, 785	276, 956	273, 618	285, 886	271, 053
Skagit					1, 400
Thurston	15, 295	42, 000	46, 480	15, 000	
Whatcom					6, 000
Not specified	82, 778	130, 259			
Total	772, 601	1, 215, 750	1, 030, 578	1, 263, 689	1, 056, 249

Counties.	1892.	1893.	1894.	Increase in 1894.	Decrease in 1894.
King	508, 467	577, 731	422, 676		155, 055
Kittitas	285, 088	253, 467	232, 580		20, 887
Okanogan			50	50	
Pierce	364, 294	408, 074	406, 831		1, 243
Skagit	4, 703	2, 905	7, 537	4, 632	
Thurston	22, 119		26, 880	26, 880	
Whatcom	28, 756	22, 700	9, 916		12, 784
Not specified					
Total	1, 213, 427	1, 264, 877	1, 106, 470		*a* 158, 407

a Net decrease.

In the following tables are shown the average prices ruling in each county since 1889, and the statistics of labor employed and average working time since 1890:

Average prices for Washington coal since 1889 in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
King	$2. 55	$2. 61	$2. 35	$2. 42	$2. 22	$2. 62
Kittitas	2. 64	2. 76	2. 22	2. 11	2. 71	2. 11
Pierce	2. 11½	2. 85½	2. 33½	2. 26	2. 25	2. 15
Thurston	1. 79	2. 00		2. 01		2. 28
Whatcom			3. 00	2. 68	2. 40	2. 23
The State	2. 32	2. 71	2. 31	2. 28	2. 31	2. 33

Statistics of labor employed and working time at Washington coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.
King	1, 098	292	1, 285	226	1, 296	265	1, 256	272	919	244
Kittitas	489	259	501	148	500	178	672	162	809	125
Pierce	589	257	601	236	626	269	756	260	818	237
Thurston	30	240			42	223			38	245
Whatcom			30	150	70	305	56	291	43	328
The State	2, 206	270	2, 447	211	2, 564	247	2, 757	241	2, 662	207

WEST VIRGINIA.

Total product in 1894, 11,627,757 short tons; spot value $8,706,808.

WEST VIRGINIA COAL FIELDS.

West Virginia contains more of the great Appalachian coal field than any other State. The total area embraces about 16,000 square miles—more than 80 per cent of the total bituminous areas of Ohio and Pennsylvania combined, 60 per cent more than Pennsylvania alone, and 2,000 square miles more than Kentucky and Tennessee combined. The area underlaid by coal is about two-thirds of the total area of the State. The general boundaries of the coal fields have been briefly outlined in Mineral Resources for 1886, as follows:

The eastern boundary begins at the south, on the mountain just east of the Bluestone River, and proceeds thence to Little Sewell Mountain, on the top of which the lowest seam of the lowest coal measures may be seen; thence, but not by a very clearly defined line, with the common boundary of Nicholas and Greenbrier and Webster and Pocahontas counties to Rich Mountain, in Randolph County; following this last-named ridge to Laurel Mountain, the dividing line between Upshur County on the west and Randolph and Barbour counties on the east; and thence with the Briery Mountain into Preston County, and so on to the Pennsylvania State line. To the east of this boundary there are small outlying patches of coal, as in Greenbrier County, in Meadow Mountain, and possibly in Pocahontas County and in some of the synclinal valleys of Tucker County; but these patches are unimportant as compared to the vast area to the west, and in but few instances will they yield coal of any value except for local use. This statement will not, however, apply to the small area in Mineral and Grant counties, which is entirely separated by sub-Carboniferous outcrops from the main West Virginia coal field.

In every county west of this general eastern boundary to the Ohio River will valuable coal be found, if not outcropping in the hills, then below the surface and accessible by shafting, so that out of fifty-four counties in the State only Monroe, Pendleton, Hardy, Hampshire, Morgan, and Jefferson counties may be considered as lacking in workable coal beds.

For convenience of description the coal formation may be divided into five groups, as follows:

1. The Pottsville Conglomerate group is composed of alternating beds of conglomerate and sandstone, the former characterizing the group with beds of shale and slates, which contain in many places valuable workable coal beds. The thickness of the group varies from 100 to 1,000 feet.

2. The Lower Coal Measures, resting upon the great Millstone Grit or Pottsville Conglomerate series, containing very many important and valuable coal seams and having a thick series of sandstones, known as the Mahoning, capping the group.

3. The Lower Barren Measures, composed of reddish and blueish shales and slates, sandstones, and limestones—the latter in some parts of the State being very important—usually destitute of workable coal beds, and terminating above at the Pittsburg coal bed.

4. The Upper Coal Measures, containing several important coal seams, of which the Pittsburg or the Cumberland big seam lies at the base.

5. The Upper Barren Measures, composed of sandstones and shales.

PRODUCTION.

The development of the West Virginia coal fields has been of extraordinary growth. In 1873 the product was 672,000 short tons. In 1883 it was 2,235,833, and in 1893 it was 10,708,578 short tons, and added nearly another million tons increase in the product for 1894. In 1882, the first year covered by Mineral Resources, West Virginia ranked fifth in importance among the coal-producing States, and held that position until 1886, when she took fourth place. At this time she produced only about one-half as much as Ohio, the third in rank. The ratio of increase in the two States did not vary much until 1889, when West Virginia's product amounted to more than 60 per cent that of Ohio; in 1891 it was more than 70 per cent; in 1893 it was more than 80 per cent, and in 1894 the product of Ohio was less than 3 per cent larger than West Virginia. It must be taken into consideration, however, that in 1894 Ohio was one of the heaviest sufferers from the effects of the great strike, while West Virginia was in the main benefited. In some districts where the miners' union was strong the West Virginia operators suffered with the others, while in other districts where the union was weak the strike did good rather than damage, and in the Pocahontas field, which was exempt from the strike order, the operators and the railroad were alike unable to meet the demands upon them. Then, too, West Virginia suffered less from the effects of the industrial depression than most of the coal-producing States, for the average price declined but 2 cents per ton compared with 1893, and the decline in nearly all the other bituminous regions was considerably more than that. It is not to be supposed that the same conditions which affected the comparison of Ohio and West Virginia in 1894 will obtain in 1895 nor for some years to come, if ever, but still with the advantage possessed by the latter for extending her markets, and particularly the facilities for reaching the seaboard, the product is likely to increase in greater proportion than Ohio's, and the order of their standing will be reversed before the close of the century.

During 1894, an organization was formed by the operators along the New and Kanawha rivers in Fayette and Kanawha counties, under the name of the Kanawha and New River Coal and Coke Company, for the purpose of extending the markets for the coals of those regions, particularly in the West. The company is incorporated with a capital of $1,000,000, and the various mining companies will participate in the results on a mutual basis. Another change of importance has been made in the method of marketing West Virginia coals, and probably to this change is due in large measure the formation of the new company. Heretofore the Chesapeake and Ohio Railroad has been the purchaser of all the coal mined along its line, and has paid the operators a certain price agreed upon. The railroad company would then transport the coal to the markets and receive for freight the difference between the price at mines and delivered. At the last session of the legislature a law was passed prohibiting railroad companies from engaging in the coal business in this way, as being outside their legitimate business of common carriers, so that for the future operators will be obliged to go into the market for themselves.

In the following tables are exhibited the statistics of production in 1893 and 1894, showing the distribution of the product for consumption by counties, the value, the number of employees, and the average number of working days:

Coal product of West Virginia in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Barbour	4. 088	1, 196	....	....	5, 284	$4, 718	$0. 89	217	8
Brooke	25, 700	6, 650	550	....	32, 900	29, 015	. 88	260	79
Fayette	2, 116, 656	34, 323	12, 657	489, 224	2, 652, 860	2, 120, 758	. 80	224	4, 487
Grant	5, 600	1, 120	11	....	6, 731	5, 109	. 76	150	15
Harrison	168, 686	3, 151	228	21, 567	193, 632	128, 828	. 67	211	298
Kanawha	1, 415, 745	22, 485	5, 106	2, 916	1, 446, 252	1, 236, 861	. 86	276	2, 306
Logan	....	425	....	....	425	425	1. 00	50	4
Marion	783, 024	10, 708	13, 490	255, 112	1, 062, 334	742, 616	. 70	203	1, 536
Marshall	152, 697	5, 200	1, 100	....	158, 997	124, 407	. 78	194	245
Mason	112, 408	39, 815	1, 410	....	153, 633	143, 130	. 93	194	376
McDowell	1, 620, 409	29, 173	6, 549	510, 347	2, 166, 478	1, 526, 598	. 70	185	3, 375
Mercer	776, 217	5, 134	2, 366	211, 711	995, 428	690, 490	. 69	209	1, 281
Mineral	643, 329	9, 346	350	....	653, 025	537, 366	. 82	229	666
Monongalia	27, 500	200	350	10, 550	38, 600	27, 975	. 72	225	60
Ohio	....	80, 565	45	....	80, 610	66, 269	. 82	221	135
Preston	52, 211	1, 579	989	27, 893	82, 672	57, 131	. 69	140	200
Putnam	208, 231	1, 450	200	....	209, 881	211, 556	1. 01	204	520
Raleigh	91, 730	600	....	....	92, 330	92, 330	1. 00	165	145
Randolph	1, 494	....	....	....	1, 494	1, 494	1. 00	100	8
Taylor	63, 661	1, 820	91	13, 068	78, 640	45, 968	. 58	260	105
Tucker	322, 576	15, 749	1, 406	136, 641	476, 372	338, 126	. 71	267	675
Small mines	....	120, 000	....	....	120, 000	120, 000	......	......	......
Total	8, 591, 962	390, 689	46, 898	1, 679, 029	10, 708, 578	8, 251, 170	. 77	219	16, 524

Coal product of West Virginia in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Barbour	2	7,616	2,104	....	....	9,720	$8,679	$0.89	223	20
Brooke	4	39,623	5,222	150	....	44,995	34,461	.77	205	100
Fayette	45	2,157,737	33,726	18,522	356,627	2,566,612	1,852,472	.72	164	4,594
Grant	2	6,104	459	....	....	6,563	4,510	.69	110	23
Harrison	10	235,173	2,782	....	17,679	255,634	182,653	.71	168	519
Kanawha	23	1,059,719	17,356	5,360	1,924	1,084,359	942,782	.87	155	2,706
Marion	11	1,154,744	6,743	13,482	224,929	1,399,898	1,198,514	.86	274	1,479
Marshall	4	145,513	10,407	400	....	156,320	113,337	.72½	177	220
Mason	9	65,577	72,470	2,755	....	140,802	122,036	.86	177	391
McDowell	29	2,088,249	26,313	8,842	1,034,965	3,158,369	2,104,466	.67	207	3,891
Mercer	7	786,363	5,620	8,450	272,517	1,072,950	761,199	.71	211	1,274
Mineral	6	559,829	3,163	278	....	563,270	432,234	.77	189	564
Monongalia	3	59,883	985	645	18,045	79,558	69,039	.87	181	164
Ohio	12	18,000	84,610	300	....	102,910	86,555	.84	166	249
Preston	4	35,884	829	246	3,895	40,854	27,969	.68	152	105
Putnam	4	201,625	16,363	2,150	....	220,138	247,082	1.12	158	530
Randolph	3	15,643	560	....	....	16,203	14,602	.90	93	120
Taylor	2	84,755	9,296	108	8,523	102,682	63,498	.62	204	158
Tucker	4	277,307	4,194	2,438	80,011	363,950	225,961	.62	179	390
Logan, Raleigh, and Wayne	3	116,970	....	....	....	116,970	89,759	.77	118	327
Small mines	....	....	125,000	....	....	125,000	125,000	....	....	....
Total	187	9,116,314	428,202	64,126	2,019,115	11,627,757	8,706,808	.75	186	17,824

The annual output since 1873 has been as follows:

Coal product of West Virginia since 1873.

Years.	Short tons.	Years.	Short tons.
1873	672,000	1884	3,360,000
1874	1,120,000	1885	3,369,062
1875	1,120,000	1886	4,005,796
1876	896,000	1887	4,881,620
1877	1,120,000	1888	5,498,800
1878	1,120,000	1889	6,231,880
1879	1,400,000	1890	7,394,654
1880	1,568,000	1891	9,220,665
1881	1,680,000	1892	9,738,755
1882	2,240,000	1893	10,708,578
1883	2,335,833	1894	11,627,757

The following table will be found of interest as showing the annual increase in the coal output of West Virginia since 1880, and the average annual increase in the fourteen years:

Annual increase in the coal product of West Virginia since 1880.

Years.	Short tons.
1881 over 1880	112,000
1882 over 1881	560,000
1883 over 1882	95,833
1884 over 1883	1,024,167
1885 over 1884	9,062
1886 over 1885	636,734
1887 over 1886	875,824
1888 over 1887	617,180
1889 over 1888	733,080
1890 over 1889	1,162,774
1891 over 1890	1,826,011
1892 over 1891	518,090
1893 over 1892	969,823
1894 over 1893	919,179
Total increase in fourteen years	10,059,757
Average annual increase	718,554

In the following table will be found the total product of the State, by counties, since 1886, with the increases and decreases in 1894 as compared with 1893. The important increases were in McDowell, Marion, Mercer, and Monongalia counties, while the greater part of the decrease was borne by Kanawha County.

Coal product of West Virginia from 1886 to 1894, by counties.

[Short tons.]

Counties.	1886.	1887.	1888.	1889.	1890.
Brooke	22, 880	40, 366	11, 568	31, 119	36, 794
Fayette	1, 413, 778	1, 252, 457	1, 977, 030	1, 450, 780	1, 591, 298
Harrison	234, 597	154, 220	109, 515	174, 115	144, 403
Kanawha	876, 785	1, 126, 839	863, 600	1, 218, 236	1, 421, 116
McDowell	....	....	....	586, 529	956, 222
Marion	172, 379	365, 844	363, 974	282, 467	455, 728
Marshall	251, 333	92, 368	47, 702	47, 706	123, 669
Mason	150, 878	140, 968	72, 410	185, 030	145, 314
Mercer	328, 733	575, 885	969, 395	921, 741	1, 005, 870
Mineral	361, 312	478, 636	456, 361	493, 464	573, 684
Monongalia	....	....	....	74, 031	31, 360
Ohio	(*a*)	131, 936	140, 019	143, 170	103, 586
Preston	170, 721	276, 224	231, 540	129, 932	178, 439
Putnam	(*b*)	53, 200	145, 440	218, 752	205, 178
Raleigh	....	....	....	....	....
Taylor	(*c*)	168, 000	55, 729	83, 012	76, 618
Tucker	22, 400	24, 707	62, 517	173, 492	245, 378
Other counties and small mines	....	....	....	18, 304	100, 000
Total	4, 005, 796	4, 881, 620	5, 498, 800	6, 231, 880	7, 394, 654

Counties.	1891.	1892.	1893.	1894.	Increase in 1894.	Decrease in 1894.
Barbour	....	....	....	9, 720	9, 720	....
Brooke	33, 950	26, 521	32, 900	44, 995	12, 095	....
Fayette	2, 307, 421	2, 455, 400	2, 652, 860	2, 566, 612	....	86, 248
Grant	....	....	....	6, 563	6, 563	....
Harrison	150, 522	221, 726	193, 632	255, 634	62, 002	....
Kanawha	1, 324, 788	1, 317, 621	1, 446, 252	1, 084, 359	....	361, 893
Logan	....	....	....	11, 611	11, 611	....
McDowell	1, 267, 136	1, 696, 975	2, 166, 478	3, 158, 369	991, 891	....
Marion	1, 000, 047	919, 704	1, 062, 334	1, 399, 898	337, 564	....
Marshall	193, 703	118, 974	158, 997	156, 320	....	2, 677
Mason	159, 990	159, 644	153, 633	140, 802	....	12, 831
Mercer	1, 172, 910	1, 191, 952	995, 428	1, 072, 950	77, 522	....
Mineral	693, 574	582, 402	653, 025	563, 270	....	89, 755
Monongalia	31, 000	48, 900	38, 600	79, 558	40, 958	....
Ohio	90, 600	120, 323	80, 610	102, 910	22, 300	....
Preston	140, 399	98, 006	82, 672	40, 854	....	41, 818
Putnam	94, 230	89, 886	209, 881	220, 138	10, 257	....
Raleigh	....	95, 824	92, 330	84, 359	....	7, 971
Randolph	....	....	....	16, 203	16, 203	....
Taylor	101, 661	115, 145	78, 640	102, 682	24, 042	....
Tucker	358, 734	359, 752	476, 372	363, 950	....	112, 422
Wayne	....	....	....	21, 000	21, 000	....
Other counties and small mines	100, 000	120, 000	133, 934	125, 000	....	8, 934
Total	9, 220, 665	9, 738, 755	10, 708, 578	11, 627, 757	*d* 919, 179	....

a Included in product of Marshall County.
b Included in product of Mason County.
c Included in product of Harrison County.
d Net increase.

Uniform with the discussion of the product of other States the following tables are given, showing the average price per ton and the statistics of labor employed and working time for a series of years:

Average prices for West Virginia coal since 1889 in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Brooke	$0.73	$0.77½	$0.82½	$0.94	$0.88	$0.77
Fayette	.90	.90	.85	.84	.80	.72
Harrison	.66	.70	.72	.77	.67	.71
Kanawha	.96	.96	.97	.92	.86	.87
Logan	......	......	......	......	......	.64½
Marion	.71	.69	.70	.74	.70	.86
Marshall	.75	.81½	.80	.79	.78	.72½
Mason	.91	.93	.90	.96	.93	.86
McDowell	.67½	.71	.67½	.73	.70	.67
Mercer	.64½	.75	.74	.76	.69	.71
Mineral	.80	.87½	.84	.77	.82	.77
Monongalia	.72	.64	.65	.72	.72	.87
Ohio	.88½	.97	.78	.99	.82	.84
Preston	.66	.72	.64	.67	.69	.68
Putnam	1.12	.97	1.19	1.11	1.01	1.12
Raleigh	......	......	......	.89	1.00	.78½
Randolph	......	......	......	......	1.00	.90
Taylor	.63½	.76	.60½	.61	.58	.62
Tucker	.69½	.76	.64½	.70	.71	.62
Wayne	......	......	......	......	......	.76
The State	.82	.84	.80	.80	.77	.75

Statistics of labor employed and working time at West Virginia coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.
Brooke	50	202	59	274	51	226	79	260	100	205
Fayette	2,824	225	3,823	245	4,102	252	4,487	224	4,594	164
Harrison	305	194	285	214	473	148	298	211	439	178
Kanawha	2,756	230	2,802	217	2,677	217	2,306	276	2,706	155
Logan	......	......	......	......	......	......	......	......	150	70
Marion	865	218	1,408	279	1,114	275	1,536	203	1,479	274
Marshall	175	265	190	257	210	199	245	194	220	177
Mason	480	229	311	236	338	215	376	194	391	177
McDowell	1,315	183	1,536	227	2,061	195	3,375	185	3,891	207
Mercer	1,465	217	1,510	244	1,621	211	1,281	209	1,274	211
Mineral	620	279	624	259½	500	244	666	229	564	189
Monongalia	55	260	50	260	72	308	60	225	164	181
Ohio	153	268	131	276	222	243	135	221	249	166
Preston	337	282	304	221	170	209	200	140	105	152
Putnam	375	194	526	143	483	180	520	204	530	158
Raleigh	......	......	......	......	120	167	145	165	142	146
Randolph	......	......	......	......	......	......	8	100	120	93
Taylor	108	256	118	287	128	282	105	260	158	204
Tucker	353	309	550	306	525	306	675	267	390	179
Wayne	......	......	......	......	......	......	......	......	35	210
The State	12,236	227	14,227	237	14,867	228	16,524	219	17,824	186

WYOMING

Total product in 1894, 2,417,463 short tons; spot value, $3,170,392.

COALS AND COAL MEASURES OF WYOMING.[1]

Not less than 40 per cent of the entire area of Wyoming is underlain with Coal Measures, and over one-half of this is known to contain coal veins of commercial value. The term "Coal Measures," as used in this connection, needs to be defined, so that it will not confuse the Eastern geologists, who might consider the Measures Carboniferous, and also that it may not be synonymous with the Laramie group, which horizon has been called the Western Coal Measures. It is now defimtely known that all of the Rocky Mountain Cretaceous groups are coal bearing, and at present coal mines are being worked in the Dakota, Bear River, Montana, and Laramie groups, in Wyoming. Since all of the Cretaceous groups are coal bearing, it is only proper to refer to the Cretaceous system as the Western Coal Measures, instead of referring to a single group.

The coal fields are so numerous in the State that every county, with one exception, has coal mines opened. There are 21,464 square miles of coal lands known, which estimate will be found low when the boundaries have been defined by actual survey. The fields have numerous veins, generally ranging from six to eight workable ones, and the veins vary in thickness from 4 to 75 feet.

The following table will give the number of square miles of productive Coal Measures known in each county, together with the number of local and shipping coal mines, and the maximum and minimum thickness of the coal veins. This estimate is based upon careful field observations that have been made during the last ten years.

Square miles of productive Coal Measures in Wyoming, by counties.

Names of counties.	Areas.	Number of local mines.	Number of shipping mines.	Thickness of coal veins.
	Sq. miles.			*Feet.*
Sweetwater	3,313	....	10	4 to 12
Carbon	2,421	3	3	6 31
Crook	2,360	3	1	5 7
Fremont	2.224	3	....	4 7
Uinta	2,000	....	3	7 75
Bighorn	1,820	2	....	5 2
Converse	1,612	1	2	4 6
Sheridan	1,524	3	2	6 16
Johnson	1,320	3	....	4 7
Natrona	1,247	2	....	4 17
Weston	1,208	....	2	5 7
Albany	400	3	....	4 6
Laramie (no estimate)	....	....	....	....
Total	21,449	23	23	....

[1] By Wilbur C. Knight, University of Wyoming.

KINDS OF COAL.

There are three varieties of coal mined in Wyoming, which are as follows: Bituminous (coking and noncoking), semibituminous, and lignite. The bituminous coal is an excellent fuel for all purposes, and is sold as far east as the Missouri River and westward to the Pacific Ocean. This variety is quite hard, breaks with a bright fracture, and stands storage and long transportation with but little loss. The semibituminous coal contains a higher percentage of water and in general is utilized wherever bituminous coal can be used, except for coke making. On account of its slaking qualities it can not be successfully stored. The lignites contain a high percentage of water, often 20 per cent. They have a decided woody texture and are generally of a brown color. This fuel is largely used for steam and domestic purposes, but can not be safely burned under a locomotive boiler on account of light burning particles of coal being forced through the screens and causing great destruction by fire. This variety is chiefly mined during cold weather, when it can be transported long distances without slaking. When taken out in the heat of summer and exposed to the sun's rays it cracks and snaps and gradually falls to pieces.

THE FUEL VALUE.

Fifty-four samples of coal, representing the most noted localities in the State, have recently been analyzed and their heating power determined in the University of Wyoming. The calorimetric work was done by Professors Slosson and Colburn, and the analyses were made by the writer. The following table will give the results of these determinations:

Heating power and proximate analyses of Wyoming coals.[1]

Rank.	Owners.	Locations.	Names of mines.	Collector.	Calories per gram.	Foot-pounds per pound of coal.	Pounds of water at 212° F. evaporated by 1 pound coal.	Water.	Volatile combustible matter.	Fixed carbon.	Ash.	Sulphur.	Total fuel.
1	J. D. Curtis	Hams Fork, Uinta County	Prospect sample	O.	7, 560	10, 566, 000	14. 70	1. 50	37. 90	57. 75	2. 85	1	95. 65
2	Wm. Goodell	do	Six-foot face sample	O.	7, 467	10, 435, 000	13. 90	2. 95	38	54	4. 05	......	92
3	A. Kendall	do	Prospect sample	O.	7, 372	10, 303, 000	13. 72	3. 75	37. 25	55. 40	3. 60	. 60	92. 65
4	Sweetwater Coal Co	Hopkins, Sweetwater County	Sweetwater	K.	7, 358	10, 284, 000	13. 69	5. 55	36. 95	55. 70	1. 80	. 86	92. 65
5	F. Kindt	Rankin Carbon County	Kindt No. 1	K.	7, 140	9, 978, 000	13. 29	4. 87	35. 68	55. 15	4. 30	. 77	90. 83
6	Van Dyke Coal Co	Rock Springs, Sweetwater County	Van Dyke, lower vein, 1893.	K.	7, 132	9, 967, 000	13. 27	6. 25	34. 50	56. 50	2. 75	. 74	91
7	do	do	Van Dyke No. 1, 1894	O.	7, 110	9, 937, 000	13. 24	5. 22	38. 72	53. 96	2. 10	. 89	92. 68
8	F. Kindt	Rankin, Carbon County	Kindt No. 2	K.	7, 108	9, 934, 000	13. 23	5. 40	35. 80	55. 65	3. 15	. 70	91. 45
9	Van Dyke Coal Co	Rock Springs, Sweetwater County	Van Dyke No. 2, 1894	O.	6, 963	9, 730, 000	12. 96	4. 25	39	54. 70	2. 05	1. 04	63. 70
10	McCoid	Rankin, Carbon County	McCoid	K.	6, 952	9, 716, 000	12. 94	5. 05	34. 75	56. 15	4. 05	. 85	90. 90
11	Van Dyke Coal Co	Rock Springs, Sweetwater County	Van Dyke, upper vein, 1893.	K.	6, 922	9, 675, 000	12. 89	5. 67	35. 73	56. 85	1. 75	. 68	92. 58
12	Buffalo Fork Coal Co.	Fremont County	Surface coal	O.	6, 896	9, 638, 000	12. 84	8. 50	41. 15	46. 95	3. 40	1. 03	88. 10
13	Dillon Coal Co	Rawlins, Carbon County	New Dillon mine	O.	6, 839	9, 558, 000	12. 73	7. 25	33. 25	54. 25	4. 25	. 50	87. 50
14	Rock Springs Coal Co.	Rock Springs, Sweetwater County	No. 2	K.	6, 822	9, 534, 000	12. 70	6. 22	34. 78	55. 75	3. 25	1. 41	90. 58
15	Union Pacific Coal Co.	do	Rock Springs No. 1	K.	6, 812	9, 521, 000	12. 68	5. 38	36. 42	55. 60	2. 60	. 63	92. 02
16	do	do	Rock Springs No. 4	K.	6, 728	9, 403, 000	12. 52	5. 95	34. 55	56. 10	3. 40	1	90. 65
17	do	do	Rock Springs No. 8	K.	6, 705	9, 371, 000	12. 48	5. 95	35. 70	55. 75	2. 55	. 65	91. 45
18	do	do	Rock Springs No. 7	K.	6, 704	9, 370, 000	12. 47	6. 37	35. 18	54. 85	3. 60	. 86	90. 03
19	Dillon Coal Co	Rawlins, Carbon County	Dillon No. 2	K.	6, 616	9, 246, 000	12. 31	7. 25	33. 25	54. 25	4. 25	. 97	87. 50
20	Cambria Coal Co	Cambria, Weston County	Antelope	K.	6, 566	9, 177, 000	12. 22	6. 72	39. 38	44. 25	9. 65	3. 79	83. 63
21	do	do	Jumbo	K.	6, 557	9, 164, 000	12. 21	5. 72	40. 13	43. 65	10. 50	4. 57	83. 78
22	Rocky Mountain Coal and Iron Co.	Red Canyon, Uinta County	Red Canyon No. 6	K.	6, 553	9, 138, 000	12. 20	7. 75	35. 10	50. 60	6. 55	. 29	85. 70
23	Union Pacific Coal Co.	Carbon, Carbon County	Carbon No. 2	K.	6, 500	9, 084, 000	12. 10	7. 42	35. 43	48. 30	8. 85	......	83. 73
24	do	Rock Springs, Sweetwater County	Rock Springs No. 3, E. face.	K.	6, 436	8, 995, 000	11. 98	7. 17	33. 58	55. 60	3. 65	. 83	89. 18
25	do	Hanna, Carbon County	Hanna No. 1, market sample.		6, 427	8, 981, 000	11. 96	9. 30	44. 09	38. 56	8. 05	1. 46	82. 65
26	W. M. Carter	Casper, Natrona County	Casper No. 1	O.	6, 400	8, 945, 000	11. 91	11. 30	32. 10	53. 55	3. 20	. 40	85. 65
27	Rocky Mountain Coal and Iron Co.	Red Canyon, Uinta County	Red Canyon No. 5, lower 9 feet.	K.	6, 340	8, 861, 000	11. 80	7. 42	36. 08	48. 50	8	. 44	84. 58
28	Terry Fee	Dutton Creek, Albany County	Brown, 1893	O.	6, 164	8, 615, 000	11. 47	11. 85	34. 65	47. 30	6. 20	1. 25	81. 95
29	G. L. Young	Rock Springs, Sweetwater County	Sample No. 1	O.	6, 160	8, 609, 000	11. 46	14. 66	31. 51	50. 85	1. 98	. 56	82. 36
30	Union Pacific Coal Co.	Almy, Uinta County	Almy No. 7, Sample No. 2	K.	6, 145	8, 588, 000	11. 44	7. 37	34. 88	48. 75	9	......	83. 66
31	G. L. Young	Rock Springs, Sweetwater County	Sample No. 2	O.	6, 116	8, 547, 000	11. 38	14. 64	36. 70	46. 45	2. 21	. 48	83. 13
32	Dillon Coal Co	Rawlins, Carbon County	Dillon	K.	6, 046	8, 450, 000	11. 25	6. 55	32. 85	54. 06	6. 60	......	86. 85
33	L. R. Meyer	Carbon, Carbon County	......	O.	6, 039	8, 440, 000	11. 24	11. 15	33. 10	53	2. 75	. 65	83. 10
34	Union Pacific Coal Co.	Almy, Uinta County	Almy No. 7, lower vein	K.	6, 017	8, 410, 000	11. 20	8. 82	33. 55	51. 75	5. 90	. 65	85. 30

35	L. A. Mason	Felix, Crook County		O.	5,962	8,332,000	11.10	10.50	37.02	48.46	4.42	.35	85.48
36	G. L. Young	Rock Springs, Sweetwater County	Sample No. 3	O.	5,949	8,314,000	11.07	14.23	37.48	46.07	2.22	.44	83.55
37	Lander Fuel Co	Popo Agie River, Fremont County		K.	5,938	8,299,000	11.05	11 40	36.60	47.60	4.40	.50	84.20
38	Rocky Mountain Coal and Iron Co.	Red Canyon, Uinta County	Red Canyon No. 5, middle 2⅓ feet.	K.	5,933	8,292,000	11.04	6.81	36.49	47.45	9.25	......	83.94
39	Black Buttes Coal Co.	Black Buttes, Sweetwater County	Black Buttes No. 1	O.	5,926	8,282,000	11.03	14.45	30.07	51.98	3.50	.61	82.05
40	J. D. Woodruff	Popo Agie River, Fremont County	Gilmore	K.	5,886	8,226,000	10.96	13.12	33.13	50.40	3.35	......	83.53
41	Terry Fee	Dutton Creek, Albany County	Brown, 1894	O.	5,734	8,014,000	10.67	11.25	36.85	45	6.90	1.13	81.85
42	Sheridan Fuel Co	Sheridan, Sheridan County	Burgess	K.	5,723	7,998,000	10.65	13.05	37.55	44.70	4.70	.71	82.25
43	J. D. Harper	Sundance, Crook County	Harper	O.	5,700	7,966,000	10.61	6.25	31.50	46.40	15.85	1	77.90
44	....do	....do	....do	K.	5,680	7,938,000	10.57	7.88	33.52	43.90	14.70	1.03	77.40
45	Earl and Gillis	Popo Agie River, Fremont County	Gillis	K.	5,631	7,810,000	10.48	13.25	34.25	48	4.50	.71	82.25
46	Sheridan Fuel Co	Sheridan, Sheridan County	Grinnell	K.	5,416	7,569,000	10.08	14.42	33.18	44.75	7.65	2.87	77.93
47	Deer Creek Coal Co	Glenrock, Converse County	Deer Creek	K.	5,410	7,560,000	10 07	13.82	33.03	47.75	5.40	.61	80.78
48	Inez Coal Co	Inez, Converse County	Inez	K.	5,402	7,550,000	10.05	14.65	26.05	42.50	6.80	.66	79.15
49	Chase & Farrell	Mill Creek, Albany County	Chase	O.	5,402	7,550,000	10.05	14.50	34.50	44.75	6.25	1.03	75.25
50	Mr. Bohack	Lost Soldier, Carbon County	Bohack	O.	5,375	7,512,000	10	13.65	39.25	42.60	4.50	.80	81.85
51	J. F. Becker	Goose Creek, Sheridan County	Becker	K.	5,345	7,470,000	9.95	14.10	35.25	38.75	11.90	1.04	74
52	W. H. Holland	Buffalo, Johnson County	Holland	K.	5,293	7,397,000	9.85	13.55	35.05	45.30	6.10	......	80.35
53	Monker & Mathers	....do	Buffalo	K.	4,966	6,940,000	9.25	14.70	34.30	44.20	6.80	.34	78.50
54	Diamond Coal Co	....do	Diamond	K.	4,931	6,891,000	9.18	14.50	33.35	44.30	7.85	.42	77.65
	Average of Wyoming coals.				6,282	8,779,000	11.70						

[1] For further information regarding the fuel value of Wyoming coals, see special bulletin by Professors Slosson and Colburn, University of Wyoming, January, 1895.

THE COAL FIELDS.

Sweetwater County.—The coal field of this county is one great basin, extending from Fremont County on the north southward to the Colorado line, and from the eastern boundary westward to the Green River and probably beyond. The western portion of this basin is covered with Eocene Tertiary rocks with the exception of the Leacite Hills and the vicinity of Essex Mountain and the uplift just east of Rock Springs, which exposes Cretaceous rocks earlier than the Laramie. The coal mined in this county is found in the Laramie group and varies in quality from a high grade bituminous fuel to a lignite. There are 10 producing mines, the majority of which are located at or near Rock Springs, which is the largest coal camp in the West and produces over one-half of the coal mined in Wyoming.

Uinta County.—The Coal Measures of this county have been greatly disturbed by mountain making. Faults and folds are so numerous that it is very difficult to trace out the coal lands. In the southern part of the county coal-bearing rocks are found at Henrys Fork, Almy, Twin Creek, Hams Fork, and Coalville. The last four localities named are probably in the same coal field, which belongs to the Lower Cretaceous, and has been known as the Bear River group. The field at Henrys Fork is Laramie. In the central part of the county there are two long narrow fields of Laramie Coal Measures, of which very little is known. In the northern end of the county there is a large coal field between the Gros Ventre River and the Buffalo Fork of the Snake River, extending from Jacksons Hole eastward to the Fremont County line. This field is also Laramie, and, like the central portion of the county, has not been prospected, and but little is known of the value of the coal. Coal mines are operated at Almy, Red Canyon, and Diamondville, and have been in operation at Cokeville, Hams Fork, and Twin Creek.

Carbon County.—The Carbon coal fields are very extensive. They occupy the entire western and the greater part of the central portion of the county. Along the eastern border the coal basin extends from the Medicine Bow Mountains north and west to the Freezeout Hills, and thence west and northwest to the North Platte River. Before reaching the Platte River the field is divided, the northern arm extending north and west along the foot of the Seminole Mountains to the county line; the southern, passing westward between Rankin and the Union Pacific Railroad, emerges into the great field lying west of the Rawlins uplift, which extends from the northern to the southern boundary of the county. The country lying between these arms is mostly Cretaceous, but is not known to be coal bearing. There is also a small isolated field at the head of the Little Medicine River, the extent of which is not absolutely known. The mines of Carbon County are found in Laramie and Montana group rocks, and the coals vary in quality from an excellent bituminous to a very inferior lignite. Local coal mines are worked at Rankin and Rawlins. Shipping mines are located at Carbon, the oldest coal camp in Wyoming, and at Hanna. Some years ago mines were opened at Dana, but they were soon abandoned on account of the inferior quality of the coal.

Albany County.—There are but two small coal fields known in Albany County, which may be designated as the northern and southern, in accordance with their position. The southern field, a triangular tract, extends from the Centennial Valley north and northeast along the eastern slope of the Medicine Bow Mountains to Rock Creek on the western border and Ione Lake on the eastern. The northern field lies just north of the old 34-mile crossing of the Little Medicine River and is the eastern extension of the Little Medicine field mentioned in connection with Carbon County. Coal has also been found 3 miles north of Willcox Station, but nothing is known of its importance or extent. The coal is found in the Laramie and the Montana groups and is semibituminous and lignite. In the southern field there are three local coal mines, which until recently have partially supplied Laramie. The reduction of $2 per ton in the price of Hanna coal has greatly reduced the demand for this coal and will materially affect the production of these mines.

Sheridan County.—The Coal Measures of Sheridan County underlie all of that portion of the county lying north and east of the foothills of the Bighorn Mountains. The coal occurs in the Upper Laramie group, and although the entire series of Cretaceous rocks are found flanking the Bighorn Mountains, coal has not been found below the Laramie. There are three local and two shipping mines located near Sheridan City and numerous small banks where farmers mine coal for their own use. The coal in this section is a lignite of superior quality.

Crook County.—There are two coal fields in Crook County. The western area, which is Laramie, includes the greater portion of the county lying west and north of the Belle Fourche River, joining the coal lands of Sheridan and Johnson counties on the west and Weston County on the south. Only local banks for the supply of ranchmen are opened, and the coal is a lignite. The southeastern field extends from the southern boundary of the county as far north as Oak Creek, and from the eastern boundary as far west as Linden. Within these limits there are several isolated hills of eruptive rock, as Sundance Mountain, Inyan Kara Mountain, and Black Buttes, also the Bear Lodge Mountains, and the country for some distance east and west of Sundance, where lower rocks are exposed. Besides these two fields there is a small one in the northeast corner of the county that is probably an arm of the western area, for it resembles it in the nature of the formations and the coal. The only shipping mine in the county is located at Felix in this field. This mine was opened in 1894. The southeastern field has three local mines that produce a very good quality of bituminous coking coal.

Weston County.—Like Crook County, the upper and lower groups of the Cretaceous are coal bearing. The southeastern coal field of Crook

County extends southward into Weston County to a point some distance south of Cambria and as far west as Jerome Station. There are two shipping mines located at Cambria, where the only coke made in Wyoming is manufactured. The western field of this county is separated from the eastern by a well-developed series of Montana and Colorado group rocks. It joins Crook County on the north, Converse County on the south, and Johnson County on the west. This vast extent of coal lands is undeveloped, and but little is known concerning the value of the coal.

Johnson County.—The Johnson County coal field is the southern extension of the Sheridan and the western extensions of the Crook and Weston counties' Laramie Measures. The greater portion of Johnson County lying east of the foothills of the Bighorn Mountains is coal bearing. There are three local mines opened in the vicinity of Buffalo, which supply Buffalo, and until recently did supply Fort McKinney with fuel. The abandonment of Fort McKinney will greatly reduce the coal output of Johnson County. The coal mined is a lignite, resembling that mined in adjoining counties. The surface coal veins in Johnson County, and to a large extent in Sheridan, Crook, and Weston counties, were consumed by fire in prehistoric time. Fires are now smoldering on the Belle Fourche River that have been in constant action since 1834. Wherever the coal veins have been consumed, the country about assumes a reddish hue, the sandstones are fractured and often are a mere mass of small fragments, while in other places, where the fire has been more intense, the rocks have melted and form irregular masses that have been mistaken for eruptive débris.

Converse County.—On account of the extensive development of Tertiary rocks in the eastern part of Converse County, the exact extent of the coal lands will not be determined for years to come. The present known field has its eastern limit on the Platte River at Douglas, from which place it extends east and north in a very irregular line to Weston County, and south and west to the Laramie Mountains. From this line westward the entire country within the limits of this county is coal bearing, but is in some parts overlaid by Tertiary rocks. There is a local mine at Douglas and shipping mines at Inez and Glenrock. The coal is a lignite and found in the Laramie group.

Natrona County.—The entire eastern part of Natrona County lying north of the Laramie Mountains is coal bearing. The southern boundary extends along the Laramie Mountains until within a few miles of Casper, where it bends north and then west and northwest, following the trend of the Rattlesnake Hills westward to the Fremont County line. The northern boundary is Johnson County, in the valley country, westward of which it conforms to the southern foothills of the Bighorn Mountains, emerging into Fremont County. Tertiary rocks cover the central western portion of this field, and in some places the coal-bearing rocks have been removed by erosion. There is a second field lying between the Rattlesnake Hills and the Sweetwater Mountains, extending eastward to the Platte River and westward an unknown distance. There are two local mines in the county, one located 2 miles south of Bessemer and the other 6 or 7 miles southeast of Casper. There are numerous prospects opened along the Rattlesnake Hills and north of Casper, but none of them are productive. The coal fields are Laramie, and the coal, so far as known, is lignite.

Fremont County.—The coal lands of Fremont County are widely separated and probably belong to different horizons. The southeastern field, which is a northern branch of the great Sweetwater County coal basin, occupies a few townships south of the Green Mountains. The northeastern field occupies the most of the territory lying east of the Bighorn River and north of a line extending eastward from the junction of the Big and Little Popo Agie rivers to Natrona County. There is a third field at the head of the Big Wind River that extends from the canyon above the mouth of Warm Spring Creek, north and west toward Two-Gwo-Tee e Pass to an unknown distance. In the southeastern field the coal is lignite and belongs to the Upper Laramie group. The northeastern field is probably Lower Laramie Measures, and the coal is a semibituminous. In this field there are three local mines which supply Lander and vicinity. The northwestern field can not be assigned to any geological horizon. The identified rocks nearest to the coal veins are Carboniferous, and it is possible that the coal found is of this age, but no evidence can now be offered to substantiate this reference. The coal found in this field is bituminous and will make a light coke. In this and the southeastern field only prospect holes have been opened.

Bighorn County.—There is a large tract of coal land lying between the Bighorn River and the foothills of the Wind River Mountains, which extends from the Owl Creek Mountains north to the Stinking Water River. The eastern part of this field is overlain with Tertiary rocks, and in many localities large tracts of the coal-bearing rocks have been removed by erosion. The geological position is probably Laramie, but it is not definitely known; neither can the coals be classified. This county is extremely new and there is scarcely any demand for coal, and no mines have been opened.

Laramie County.—Coal has been discovered in Goshen Hole and a few miles southwest of Cheyenne, but the quality was so inferior that all work has been abandoned. No estimate has ever been made of the possible productive coal lands of this county.

PRODUCTION.

The records of coal production in Wyoming from the time it became an industry of commercial importance are very perfect, particularly when compared with other Rocky Mountain States and Territories. The first production of which there is any knowledge was in 1868, in which year the output was 6,925 short tons. In the following year it had increased to 49,382 short tons. At the end of ten years, in 1877, it was over 340,000 tons, and at the end of twenty years it had exceeded a million tons. In the next five years the output was more than doubled again, from 1,170,318 short tons in 1887 to 2,503,839 tons in 1892. This was the largest output ever attained in any one year, but had the effect of demoralizing prices, the average for the State falling to $1.27 per ton. Owing to a restricted product in 1893, for the purpose of maintaining prices, and also, to some extent, strikes in 1894, the product declined in the former year to 2,439,311 short tons, and in the latter to 2,417,463 short tons.

The statistics of production during the past two years are shown in the following tables:

Coal product of Wyoming in 1893, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Carbon	379,763	2,316	12,980	....	395,059	$606,325	$1.53	164	622
Converse	52,320	1,300	2,700	....	56,320	88,916	1.58	201	110
Crook	....	500	....	....	500	1,900	3.80	47	9
Fremont	....	900	....	....	900	2,250	2.50	180	2
Johnson	....	10,100	26	....	10,126	27,900	2.76	198	19
Sheridan	....	35,720	200	....	35,920	60,070	1.67	241	48
Sweetwater	1,280,675	8,391	48,140	....	1,337,206	1,528,699	1.14	179	1,729
Uinta	281,844	3,570	6,960	....	292,374	508,485	1.74	201	439
Weston	286,083	1,391	16,080	7,352	310,906	466,359	1.50	250	400
Total	2,280,685	64,188	87,086	7,352	2,439,311	3,290,904	1.35	189	3,378

Coal product of Wyoming in 1894, by counties.

Counties.	Number of mines.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employees.
		Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Carbon	6	419,896	4,554	11,900	....	436,350	$549,937	$1.26	179	539
Converse	2	69,000	1,700	3,300	....	74,000	110,500	1.50	229	140
Fremont	3	....	1,925	10	....	1,935	4,270	2.22	137	7
Johnson	3	1,500	5,180	50	....	6,730	17,047	2.53	160	12
Sheridan	6	43,995	821	....	....	44,816	68,413	1.53	269	90
Sweetwater	9	1,347,448	4,335	38,112	....	1,389,895	1,708,611	1.23	182	1,622
Uinta	2	115,083	1,432	....	....	116,515	187,781	1.61	108	245
Crook and Weston	3	313,012	1,535	18,990	13,685	347,222	523,833	1.50	261	377
Total	34	2,309,934	21,482	72,362	13,685	2,417,463	3,170,392	1.31	190	3,032

In the following table is shown the total output in the State, by counties, since 1868, and the value of the total product since 1885:

Total product of coal in Wyoming, by counties.

Years.	Carbon County.	Sweetwater County.	Uinta County.	Weston County.	Converse County.	Other counties.	Total.	Value.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	
1868	6,560	365	....	....	....	....	6,925	....
1869	30,482	16,933	1,967	....	....	....	49,382	....
1870	54,915	20,945	29,435	....	....	....	105,295	....
1871	31,748	40,566	75,014	....	....	....	147,328	....
1872	59,237	34,677	127,831	....	....	....	221,745	....
1873	61,164	44,700	153,836	....	....	....	259,700	....
1874	55,880	58,476	104,705	....	....	....	219,061	....
1875	61,750	104,664	134,394	....	....	....	300,808	....
1876	69,060	134,952	130,538	....	....	....	334,550	....
1877	74,343	146,494	122,016	....	....	....	342,853	....
1878	62,418	154,282	116,500	....	....	....	333,200	....
1879	75,424	193,252	132,315	....	....	....	400,991	....
1880	100,433	244,460	182,918	....	....	....	527,811	....
1881	156,820	270,425	200,936	....	....	....	628,181	....
1882	200,123	287,510	211,276	....	....	8,855	707,764	....
1883	248,380	304,495	190,163	....	....	36,651	779,689	....
1884	319,883	318,197	219,351	....	....	45,189	902,620	....
1885	226,863	328,601	234,657	....	....	17,207	807,328	$2,421,984
1886	214,233	359,234	255,888	....	....	....	829,355	2,488,065
1887	288,358	465,444	361,423	....	....	55,093	1,170,318	3,510,954
1888	338,947	732,327	369,333	....	29,933	11,000	1,481,540	4,444,620
1889	199,276	857,213	309,218	....	17,393	5,847	1,388,276	1,748,617
1890	305,969	978,827	350,278	200,024	25,748	9,520	1,870,366	3,183,669
1891	432,180	1,202,017	332,327	326,155	27,897	7,265	2,327,841	3,555,275
1892	499,787	1,265,441	330,104	344,300	45,907	18,300	2,503,839	3,168,776
1893	395,059	1,337,206	292,374	310,906	56,320	47,446	2,439,311	3,290,904
1894	436,350	1,389,895	116,512	341,822	74,000	58,884	2,417,463	3,170,392

The following tables show the average prices per ton which have obtained in the more important counties since 1890, and the statistics of labor engaged in the production during the same period:

Average price for Wyoming coal since 1889 in counties producing 10,000 tons or over.

Counties.	1889.	1890.	1891.	1892.	1893.	1894.
Carbon	$0.98	$1.75	$1.50	$1.11	$1.53	$1.26
Converse	1.78	1.74	1.77	1.63	1.58	1.50
Sheridan	1.50	1.50	1.00	....	1.67	1.53
Sweetwater	1.20	1.70	1.48	1.16	1.14	1.23
Uinta	1.56	1.78	1.71	1.56	1.74	1.61
Weston	....	1.45	1.50	1.50	1.50	1.50
The State	1.26	1.70	1.53	1.27	1.35	1.31

Statistics of labor employed and working time at Wyoming coal mines.

Counties.	1890.		1891.		1892.		1893.		1894.	
	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.	Average number employed.	Average working days.
Carbon	714	....	609	....	505	241	622	164	539	179
Converse	30	....	85	....	105	210	110	201	140	229
Sheridan	....	....	....	....	....	....	48	241	90	269
Sweetwater	1,672	....	1,754	....	1,643	198	1,729	179	1,622	182
Uinta	422	....	548	....	462	243	439	201	245	108
Weston	416	....	402	....	400	297	400	250	377	261
The State	3,272	....	3,411	....	3,133	225	3,378	189	3,032	190

THE MANUFACTURE OF COKE.

By Joseph D. Weeks.

[The ton used in this report is uniformly the short ton of 2,000 pounds.]

INTRODUCTION.

In this report, as in previous ones of the series, the word "coke" is used to define that coke made from bituminous coal in ovens, pits, etc., which, for convenience, may be termed "oven coke." The statistics and statements in no way refer to that other commercial coke which is a residual or by-product of the manufacture of illuminating gas, and which may be termed "gas coke." In view of the fact, however, that the processes of coke making in the so-called "by-product" ovens are analogous, and in many cases precisely the same as those employed in gas houses, and further that these by-product ovens will in the near future assume an important relation to the coke making of the United States, it is more than probable that in future reports the production of what we have heretofore termed "gas coke" may have to be included.

The coal used in coking in the United States is mined from all five of its great coal fields: (1) The Appalachian; (2) the Central; (3) the Western; (4) the Rocky Mountain, and (5) the Pacific Coast. With the exception of that made in the Appalachian field, however, the tonnage of coke produced in the United States is quite small, but 411,372 tons of the total of 9,196,244 tons produced in 1894, or about 4½ per cent, being produced outside of this field. While the production in these fields outside of the Appalachian region is quite small in percentage it is really a growing one, the proportion of coke produced in these fields in 1894 being somewhat larger than the amount produced in 1892 or 1893. These fields promise also to be of more importance in the future. This is especially true of the coke made from the Cretaceous coals of the Colorado, New Mexico, Montana, and Utah districts in the Rocky Mountain field and the cokes from the Washington district on the Pacific Coast. The cokes from the Rocky Mountain field are of great value even at the present time in smelting the ores of the far West and the Pacific Coast, and they must be of still greater importance as those sections develop more generally their mineral and manufacturing possibilities. One reason why the cokes from these fields have not already assumed greater importance is the fact of the long distances they must be carried to reach the points of consumption, and, in many cases at least, to the fact that the best methods for coking have not yet been adopted, and consequently the cokes, especially those made on the Pacific Coast, are not as well adapted to smelting as are the cokes that are brought by water at cheap rates from Europe.

A brief general description of each of these districts will be of importance, and will render clearer the conditions under which the coke is produced as well as indicate the character of the coal from which it is made.

THE APPALACHIAN FIELD.

Beginning with a few isolated patches of coal near the northern boundary of Pennsylvania, the great Appalachian coal field stretches for a distance of over 750 miles in a southwesterly direction to Tuscaloosa, Ala., where it is lost. This is at present, and promises to be in the future, the most important coal field in America. It has an average breadth of from 80 to 90 miles and an area of fully 65,000 square miles. The eastern escarpment of the Alleghany Mountains forms the eastern border of this basin, while the Cincinnati anticlinal hems it on the west and separates it from the measures of the Illinois basin. The eastern line of this field is comparatively regular, following the trend of the mountains, but the western line is very irregular, being quite broad in its northern area, contracting through Tennessee and northern Alabama, and expanding at its termination in Alabama, though it is here by no means so broad is in Pennsylvania, Ohio, and West Virginia.

Along nearly the entire length of this great coal field from Blossburg, Pa., to Birmingham, Ala., the coking industry has been established. The ovens, following the zone of best coking coal, are generally found near the eastern limits of the field, the coal in the middle or western part of the basin being, as a rule, not so well adapted to coking by methods at present used as that of the eastern. While the coal all through this basin is usually a coking coal, as pointed out by Rogers many years ago, these coals increase in bituminous matter as they go westward, so that the coal of the Pittsburg seam, which in Cumberland has only some 18 per cent volatile matter, contains 30 per cent in the Connellsville region, 32 to 33 per cent in Pittsburg, and 35 to 38 and even 40 per cent in Ohio. The veins also thin out as they go westwardly, which makes the mining more expensive. Referring to the example already given, the Pittsburg vein, which is the big vein at Cumberland, is sometimes 14 feet; in Connellsville, 9 feet; in Pittsburg, 5 to 6 feet, and in Ohio from 2½ to 4 feet. Where the veins are thin the percentage of ash, and especially the percentage of sulphur, is apt to be much higher than in the thicker vein. For all of these reasons, as stated above, the coals in the middle and western part of the Appalachian basin, as a rule, are not so good as those closer to the mountains.

The importance of the Appalachian field as a coke producer is indicated not only by the large percentage of coke produced in the United States, which comes from the Coal Measures of this field, but from the fact that in it are found the Connellsville, Pa.; the New River, Va.; the Pocahontas Flat Top, Virginia and West Virginia; the Suwanee, Tenn., and the Birmingham, Ala., coal fields, together with other important fields.

CENTRAL FIELD.

The Central field includes the coals in Indiana, Illinois, and the western part of Kentucky, the field reaching from the Cincinnati anticlinal on the east to the Mississippi River on the west. While it is estimated to cover an area of 47,250 square miles of coal fields, it is at present of but little importance as a producer of coke, the total output in 1894 being not over 38,259 tons. Most persistent efforts have been made to produce a coke from the coals of this field that would answer as a metallurgical fuel. The iron and steel works of Chicago are in this district and St. Louis is just at its western border. It is readily seen what an advantage it would be to these works could they draw their supply of coke from the coal fields which are just at their doors, instead of sending to Connellsville and the Virginias, from 500 to 650 miles distant, for their fuel. The chief reason why so little coke has been made from the Coal Measures of this district is the impurity of the coal, and in some instances its low coking power. Practically all attempts to make a metallurgical fuel from the coals of this district have been abandoned, notwithstanding repeated efforts, except in western Kentucky. At the present time, however, considerable attention is being paid to the possibility of using the by-product ovens for coking coals from this field. In the attempts to use the beehive oven in coking the coals in this district, high in ash and sulphur, it was found that washing the coal took out some of the constituents necessary to make a good coke. It is claimed by some of the advocates of the by-product oven, however, that a coal much lower in bituminous matter can be more successfully coked in the by-product oven than in the beehive oven, and it is also asserted that if the coal contains a very large percentage of water, even as high as from 15 to 20 per cent, it is rather an advantage than an injury to the coking process. If these facts are true there is no reason why the coals of this district could not be washed, even though considerable bituminous matter was washed out, and the coal thus cleaned made into a good coke in these by-product ovens.

THE WESTERN FIELD.

The Western field, which includes the States of Missouri and Kansas and Indian Territory, is of but little more importance than the Central field as a producer of coke. The coke made in this field is chiefly in the New Pittsburg district of Kansas and in the lead district of Missouri for use by the lead and zinc smelters in the neighborhood. A small amount is also made at McAlester, Ind. T.

ROCKY MOUNTAIN FIELD.

Located, as the Rocky Mountain field is, in close proximity to the mines of the precious metals, as well as near good iron ore, it is the most important coking field in the United States next to the Appalachian and has more promise than any of the others. It includes the coal fields of Dakota, Montana, Idaho, Wyoming, Utah, Colorado, and New Mexico.

PACIFIC COAST FIELD.

So far the only coals coked on the Pacific Coast are those of Washington, chiefly those in the neighborhood of Wilkeson, in Pierce County, and at Cokedale, in Skagit County. The coals of Washington are Cretaceous, and still preserve at many places the lignite characteristics. In some parts they have been altered locally in character and are true coking coals.

GEOLOGICAL HORIZON OF COALS COKED.

By far the largest part of the coal used for coking in the United States comes from three seams, the Pittsburg seam of the Upper Coal Measures (No. XV of Rogers), the great Conglomerate (the lower formation of the Carboniferous), and the Pratt seam of Alabama. The coal used in Connellsville is from the Pittsburg seam, known locally as the Connellsville seam; that used in the New River and Flat Top districts of Virginia and West Virginia is from the Conglomerate, known as the Pottsville Conglomerate in Pennsylvania and as No. XII of the Rogers Virginia survey. The identification of the Pratt seam with the northern coals is not definite. It is from this seam that most of the coke produced in Alabama is made.

In addition to the above-named coal seams, coke is also made to a considerable extent in the Appalachian field from the lower measures, especially from the upper Freeport and the lower Kittanning. The Blossburg and Clearfield, the 6-foot and 11-foot veins of the Cumberland and Potomac coal fields, and the Kanawha splint and gas coals are from the lower measures. In Colorado, as elsewhere in the Rocky Mountains, the Carboniferous strata are not, in an economic sense, coal-bearing; the productive measures being, without a single important exception, of the Upper Cretaceous age. Indeed, of the 18,100 square miles of coal fields credited to Colorado, all but 150 square miles, which is believed belong to the Dakota, may be assigned to the Laramie group, or uppermost of the Cretaceous terranes of North America. What the Carboniferous is to the Appalachian system and to Europe, the Laramie is to the Rocky Mountain region, it being preeminently the coal-bearing formation throughout the country west of the one hundred and fifth meridian.

CONDITIONS IN WHICH COAL IS USED.

As a rule, good coking coals are exceedingly friable, but a small proportion of lumps is produced in mining, though even the lumps rapidly crumble on exposure to the air. Notable examples of these are the Connellsville and Flat Top coals. The Connellsville coal is so valuable for coke, and there is so much other coal in its immediate vicinity that will stand transportation, that it is hardly mined at all for any purpose than coke making. A few thousand tons a year, outside of that used locally at the mines and in the houses of the operators, will cover the total production of the Connellsville region for domestic and steam or heating purposes. The result is that all of the coal as it comes from the mine, or "run of mine," as it is termed, is coked in the Connellsville region. On the other hand, there is a very good demand for Pocahontas, or Flat Top, coal for steam or heating purposes, it being one of the best steam coals in the world. As consumers prefer this coal in lumps, a great deal of the coal mined in the Pocahontas Flat Top region is screened, and the slack from these screenings, mixed to a greater or less extent with run of mine, is coked.

In many parts of the United States in which coking is carried on, and especially in those districts in which coking is not an extensive industry, coke is made chiefly for the purpose of utilizing this slack or fine coal which results from the mining and preparation of coal for steam, household, and other purposes of the general market. Practically all of the coal used in coking in Georgia, Illinois, Indiana, Indian Territory, Kansas, Missouri, and Washington is of this character, while a large proportion of that from Colorado, Kentucky, Montana, Ohio, Tennessee, Virginia, and West Virginia is also slack coal. Even in Pennsylvania a considerable portion of the coal used is screenings or slack produced in mining. Of the 14,337,937 tons of coal used in coking in the United States in 1894, 4,294,734 tons, or about 30 per cent, were slack or screenings. It is this use of slack which makes it so difficult at times to ascertain just how much coal has been used to produce a given quantity of coke. The coal is regarded as having no value; it is not weighed when it is charged into the oven, and there is no way to ascertain the actual amount of coal charged; it can only be estimated.

It is also true that coke makers using coal somewhat high in ash, and even pure coals low in volatile matter, are gradually learning of the great importance of thoroughly comminuting the coal before using. Quite a number of machines, mostly on the principle of the old Carr disintegrator, are erected for the purpose of disintegrating or finely dividing the coal and making it somewhat homogeneous, both in size of pieces and distribution of ash, before putting it into the ovens. The effect of this disintegration is chiefly to disseminate the ash (which exists in the coal largely as slate) thoroughly through the coal mass, instead of permitting it to go into the oven in the form of slate, in which condition it not only interferes with the coking process, especially the rising of the gas through the mass of the coal, but it remains in the resultant coke in such a condition as to require a much larger amount of heat and lime to flux it out if the coke is to be used as a blast-furnace fuel.

OVENS USED IN THE UNITED STATES.

It still holds true that the solid wall oven, or, as it may be termed, the "open retort," usually of the beehive form, is practically the only one yet used in this country. Some closed retort ovens of the Belgian type exist in Pennsylvania, and a few retorts, which may be regarded as by-product coke ovens, were used in Colorado and West Virginia. There is also a block of by-product retort ovens on the Semet-Solvay principle in operation at Syracuse, N. Y., near the Solvay Soda Ash Works, the design of these ovens being chiefly to collect ammonia from the gases that pass off for use in the Solvay or ammonia process of soda making. Somewhat similar ovens or retorts on the Huessener principle have been erected at Winifrede, W. Va. These ovens have been erected chiefly for the recovery of the by-products from the slack coal, which is produced in large quantities, the coke being used for domestic purposes. Accompanying these ovens, in addition to the ordinary tar and ammonia plants, is a Slocum benzole plant. There is also a bench of retorts, built on the Huessener coke-oven principle, in operation in Colorado.

Considerable attention has been given during 1894 to the erection in the United States of coke ovens for the saving of by-products. The author of this report has made a special examination into the forms chiefly in use in Europe, and will publish in the near future a complete statement regarding the principle on which these ovens are constructed, their method of operation, and the results obtained both technically and commercially. Here it need only be said that these ovens are closed retorts into the coking chamber of which no air is admitted, the gases being removed through hydraulic mains, and after being deprived of their tar, ammonia, and in some cases benzole, are returned to the ovens and burned in the flues under the bottom and in the side walls of the ovens in connection with air. The usual dimensions of these ovens vary somewhat with the style, being from 25 to 33 feet long, 14 to 26 inches wide, and 6 to 7 feet high, taking a charge of from 4 to 8 short tons of coal, and coking the coal in from eighteen to forty-eight hours. The length of the coking time depends somewhat on the character of the coal, but more especially on the width of the oven and the thickness or thinness of the wall between the flues and coking chamber. The yield of by-products depends chiefly upon the coal, the tightness of the oven, the heat at which the oven is operated, and the character of the by-product plant. It can be said in a general way, however, that from Connellsville coal, for example, from 1 to 1.2 per cent of sulphate of ammonia can be procured per ton of coal, from 3 to 3½ per cent of tar, and from three-fourths of 1 per cent to 1¾ per cent of benzole. There is also a portion, varying somewhat with the coal, of excess gas—the gas more than is needed for the coking of the coal. This will vary from 25 to 50 per cent, say, with Connellsville coal, 4,000 to 5,000 cubic feet excess gas. At most of the coke works in Europe the waste heat, or heat as it comes from the flues after having done its work, is passed under boilers for raising steam. The amount of water evaporated by this waste heat per ton of coal charged will vary from one-half ton to 1 ton.

These by-product ovens can be broadly divided into two classes:

1. Those in which the flues in the side walls are horizontal. There are usually three flues in the side walls of these ovens; the gas passes first into the upper flue, passes along the entire length, passes down into the middle flue, passes its entire length and into the third or bottom flue, and then passes out of the flue. These flues are usually the same length as the coking chamber. The ovens of this type are known as Carves, Huessener, or Huessener-Carves, and the Semet-Solvay. In some of these horizontal-flue ovens the air is heated by recuperators before mixing with the gas and burning; in others, not.

2. The vertical-flue oven, in which the flues in the side walls are divided into two pairs, consisting of 16 vertical flues each, or 32 flues to a side. The burning gases passing into the coking chamber underneath the first pair of 16 flues distribute themselves through the 16 flues, pass up the side of the oven, meeting in the top, and pass over and down through the second pair of 16 flues and out of the oven. There is but one type of vertical flue oven in use, which is known as the Otto-Hoffmann, but should be more properly styled the Otto-Hoffmann-Coppee, the vertical-flue being a characteristic of the retort oven, on which some improvements were made by Dr. C. Otto and to which Mr. Hoffmann added a Siemens regenerator for preheating the air. The essential feature of the Otto-Hoffmann oven is that it as a vertical-flue oven with preheating of the air by a Siemens regenerator.

A complete report on the various forms of the by-product ovens, as stated above, will be given in the supplementary report. There are some 3,000 of these ovens in operation in Europe, especially in Westphalia, Germany; Mons district, Belgium, and Durham district, England. They are making a coke that is a perfectly satisfactory metallurgical fuel either for blast furnaces or foundries; indeed, the foundry coke made in these by-product ovens commands a higher price than the coke made from the same coal in beehive ovens. A bank of 60 Otto-Hoffmann ovens is being erected in this country at Johnstown by the Cambria Iron Company; a set of 50 Semet-Solvay ovens is being built at Dunbar to use Connellsville coal, and as this report is being written plans are being considered for 3 sets of by-product ovens near Pittsburg, two of which will probably be Slocum "full-depth" ovens, which are modified Carves-Huessener ovens with thin walls and narrow coking chamber, and the third probably on the Huessener principle, the chief feature of which, in contradistinction from the others, is auxiliary firing or the introduction into the flues at given points of additional gas to maintain the heat of the flues and the use of the air without preliminary heating.

PRODUCTION OF COKE IN THE UNITED STATES.

In the following table will be found a statement of the production of coke in the United States, by States, followed, for purposes of comparison, by similar tables for 1892 and 1893:

Manufacture of coke in the United States, by States and Territories, in 1894.

States and Territories.	Establishments.	Ovens.		Coal used.	Yield of coal in coke.	Coke produced.	Total value of coke.	Value of coke per ton.
		Built.	Building.					
				Short tons.	*Per ct.*	*Short tons.*		
Alabama	22	5,551	50	1,574,245	58.7	923,817	$1,871,348	$2.025
Colorado (*a*)	8	*b* 1,154	250	542,429	58.5	317,196	903,970	2.85
Georgia	1	338	0	166,523	55.9	93,029	116,286	1.25
Illinois	1	24	0	3,800	57.9	2,200	4,400	2.00
Indiana	2	94	0	13,489	48.6	6,551	13,102	2.00
Indian Territory	1	80	0	7,274	42	3,051	10,693	3.50
Kansas	6	61	0	13,288	63.5	8,439	15,660	1.855
Kentucky	6	293	0	66,418	44.8	29,748	51,566	1.73
Missouri	3	10	0	3,442	65.4	2,250	3,563	1.58
Montana	2	153	0	22,500	44.4	10,000	110,000	11.00
New Mexico	1	50	0	13,042	50	6,529	28,213	4.32
Ohio	8	363	0	55,324	59	32,640	90,875	2.78
Pennsylvania	101	25,824	118	9,059,118	66.9	6,063,777	6,585,489	1.086
Tennessee	11	1,860	0	516,802	56.6	292,646	480,124	1.64
Utah	1	83	0			*c* 16,056		
Virginia	2	736	100	280,524	64.2	180,091	295,747	1.64
Washington	3	84	0	8,563	61.2	5,245	18,249	3.48
West Virginia	78	7,858	60	1,976,128	60.4	1,193,933	1,639,687	1.373
Wisconsin	1	120	0	6,343	67	4,250	19,465	4.58
Wyoming	1	24	0	8,685	50	4,352	15,232	3.50
Total	259	44,760	578	14,337,937	64	9,179,744	12,273,669	1.337
New York	1	12	13			16,500		
	260	44,772	591			9,196,244		

a Includes Utah's production of coal and coke and value of same.
b Includes 36 gas retorts.
c Included with Colorado's coke production.

From this table it appears that the total production of coke in the United States in 1894 was 9,196,244 tons, as compared with 9,477,580 tons in 1893 and 12,010,829 tons in 1892. The production of 1894 is the smallest in the history of coking in the United States since 1888. This great falling off is due to the depression in the iron business and chiefly to the falling off in the production of pig iron, in the manufacture of which is consumed by far the largest proportion of the coke made in the United States. In 1894 the total production of pig iron smelted with coke exclusively, or with a mixture of coke and anthracite, was 6,314,891 tons, as compared with 6,687,830 tons in 1893 and 8,390,359 tons in 1892. This is a reduction in round numbers of 363,000 tons as compared with 1893, and 2,000,000 tons as compared with 1892. The falling off in coke production was 281,336 tons in 1893 as compared with 1894, and 2,814,585 tons as compared with 1892. It will be seen from this, therefore, that the falling off in production of coke is very nearly accounted for in the falling off in the production of pig iron:

Manufacture of coke in the United States, by States and Territories, in 1893.

States and Territories.	Establishments.	Ovens. Built.	Ovens. Building.	Coal used.	Yield of coal in coke.	Coke produced.	Total value of coke.	Value of coke per ton.
				Short tons.	*Per ct.*	*Short tons.*		
Alabama	23	5, 548	60	2, 015, 398	58	1, 168, 085	$2, 648, 632	$2. 27
Colorado (*a*)	8	*b* 1, 154	200	628, 935	57. 7	362, 986	1, 137, 488	3. 13
Georgia	1	338	0	171, 645	52. 8	90, 726	136, 089	1. 50
Illinois	1	24	0	3, 300	66. 7	2, 200	4, 400	2. 00
Indiana	2	94	0	11, 549	49. 6	5, 724	9, 048	1. 58
Indian Territory	1	80	0	15, 118	47	7, 135	25, 072	3. 51
Kansas	6	75	0	13, 645	62. 8	8, 565	18, 640	2. 18
Kentucky	4	283	100	97, 212	50	48, 619	97, 350	2. 00
Missouri	3	10	0	8, 875	66. 5	5, 905	9, 735	1. 65
Montana	2	153	0	61, 770	48. 5	29, 945	239, 560	8. 00
New Mexico	1	50	0	14, 698	39. 5	5, 803	18, 476	3. 18
New York	1	12	0	15, 150	84. 8	12, 850	35, 925	2. 80
Ohio	9	435	0	42, 963	52	22, 436	43, 671	1. 95
Pennsylvania	102	25, 744	19	9, 386, 702	66	6, 229, 051	9, 468, 036	1. 52
Tennessee	11	1, 942	0	449, 511	59	265, 777	491, 523	1. 85
Utah	1	83	0	....	....	*c* 16, 605	....	....
Virginia	2	594	206	194, 059	64. 5	125, 092	282, 898	2. 26
Washington	3	84	0	11, 374	59	6, 731	34, 207	5. 08
West Virginia	75	7, 354	132	1, 745, 757	60. 8	1, 062, 076	1, 716, 907	1. 62
Wisconsin	1	120	0	24, 085	62	14, 958	95, 851	6. 41
Wyoming	1	24	0	5, 400	54	2, 916	10, 206	3. 50
Total	258	44, 201	717	14, 917, 146	63. 5	9, 477, 580	16, 523, 714	1. 74

a Includes Utah's production of coal and coke and value of same.
b Includes 36 gas retorts.
c Included with Colorado's coke production.

Manufacture of coke in the United States, by States and Territories, in 1892.

States and Territories.	Establishments.	Ovens. Built.	Ovens. Building.	Coal used.	Yield of coal in coke.	Coke produced.	Total value of coke.	Value of coke per ton.
				Short tons.	*Per ct.*	*Short tons.*		
Alabama	20	5, 320	90	2, 585, 966	58	1, 501, 571	$3, 464, 623	$2. 31
Colorado (*a*)	9	*b* 1, 128	220	599, 200	62. 3	373, 229	1, 234, 320	3. 31
Georgia	1	300	0	158, 978	51. 5	81, 807	163, 614	2. 00
Illinois	1	24	0	4, 800	66	3, 170	7, 133	2. 25
Indiana	2	84	0	6, 456	49. 7	3, 207	6, 472	2. 02
Indian Territory	1	80	0	7, 138	50	3, 569	12, 402	3. 47
Kansas	6	75	0	15, 437	59. 2	9, 132	19, 906	2. 18
Kentucky	5	287	100	70, 783	51	36, 123	72, 563	2. 01
Missouri	3	10	0	11, 088	65. 8	7, 299	10, 949	1. 50
Montana	2	153	0	64, 412	53. 6	34, 557	311, 013	9. 00
New Mexico	1	50	0	0	0	0	0	0
Ohio	10	436	0	95, 236	54. 4	51, 818	112, 907	2. 18
Pennsylvania	109	25, 366	269	12, 591, 345	66. 1	8, 327, 612	15, 015, 336	1. 80
Tennessee	11	1, 941	0	600, 126	59	354, 096	724, 106	2. 05
Utah	1	83	0	....	....	*c* 7, 309	....	....
Virginia	2	594	206	226, 517	65. 3	147, 912	322, 486	2. 18
Washington	3	84	30	12, 372	58	7, 177	50, 446	7. 03
West Virginia	72	5, 843	978	1, 709, 183	60. 5	1, 034, 750	1, 821, 965	1. 76
Wisconsin	1	120	0	54, 300	62. 2	33, 800	185, 900	5. 50
Wyoming	1	24	0	0	0	0	0	0
Total	261	42, 002	1, 893	18, 813, 337	64	12, 010, 829	23, 536, 141	1. 96

a Includes Utah's production of coal and coke and value of same.
b Includes 36 gas retorts.
c Included with Colorado's coke production.

It will be noted that Pennsylvania still maintains its supremacy as the chief coke-producing State, its production in 1894 being 6,063,777 tons out of a total of 9,196,244 tons, or 65.9 per cent. In 1893 its production was 65.7 per cent and in 1892 69 per cent. It will be seen, therefore, that notwithstanding its falling off in production, chiefly in the Connellsville region, as a result of the great strike of some weeks' duration in that district in the early summer of 1894, Pennsylvania maintained its relative position as a coke-producing State. West Virginia, which in 1893 stood third as a coke-producing State, in 1894, became the second, producing 1,193,933 tons, or about 13 per cent, while Alabama, which was the second State in 1893, became third in 1894, producing but 923,817 tons, or 10.4 per cent. No other State produced as much as 500,000 tons. Colorado still maintains its position as the fourth State, producing 301,140 tons in 1894, or 3.3 per cent. Tennessee still follows Colorado closely, producing 292,646 tons in 1894, or 3.2 per cent. Virginia produced 180,091 tons, or nearly 2 per cent. These six are the only States that produced over 100,000 tons of coke in 1894.

Comparing the tonnage of the States in 1893 and 1894, it will be seen that of the six chief coke-producing States the production declined in Alabama, Colorado, and Pennsylvania, but increased slightly in Tennessee, Virginia, and West Virginia. The reduction in production in Alabama in 1894 as compared with 1893 was 244,268 tons, or about 21 per cent; in Colorado 45,841 tons, or 13 per cent, and in Pennsylvania 165,274 tons, or nearly 3 per cent; while the increased production in Tennessee was 26,869 tons, or 10 per cent; in West Virginia 131,857 tons, or 12.4 per cent, and in Virginia 54,999 tons, or 44 per cent. There was also a slight increase in the production of Georgia and Ohio. The production of the other States is so small that no comparison need be made with previous years.

In the following table are consolidated the statistics of the manufacture of coke in the United States from 1880 to 1894, inclusive. In the column of "coke produced" in 1894 is included the coke produced in New York, but as there is but one works in New York we have not included the amount of coal used, the total value of the coal, nor the value of the coke. The exclusion of New York, however, will not greatly alter either the average value of coke at ovens, the yield of coal in coke, or the average value per ton of coal.

In the following table are shown the statistics of the manufacture of coke in the United States from 1880 to 1894, inclusive:

Statistics of the manufacture of coke in the United States, 1880 to 1894, inclusive.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	186	12, 372	1, 159	5, 237, 741	3, 338, 300	$6, 631, 267	$1. 99	63
1881	197	14, 119	1, 005	6, 546, 662	4, 113, 760	7, 725, 175	1. 88	63
1882	215	16, 356	712	7, 577, 648	4, 793, 321	8, 462, 167	1. 77	63
1883	231	18, 304	407	8, 516, 670	5, 464, 721	8, 121, 607	1. 49	64
1884	250	19, 557	812	7, 951, 974	4, 873, 805	7, 242, 878	1. 49	61
1885	233	20, 116	432	8, 071, 126	5, 106, 696	7, 629, 118	1. 49	63
1886	222	22, 597	4, 154	10, 688, 972	6, 845, 369	11, 153, 366	1. 63	64
1887	270	26, 001	3, 584	11, 859, 752	7, 611, 705	15, 321, 116	2. 01	64
1888	261	30, 059	2, 587	12, 945, 350	8, 540, 030	12, 445, 963	1. 46	66
1889	252	34, 165	2, 115	15, 960, 973	10, 258, 022	16, 630, 301	1. 62	64
1890	253	37, 158	1, 547	18, 005, 209	11, 508, 021	23, 215, 302	2. 02	64
1891	243	40, 245	911	16, 344, 540	10, 352, 688	20, 393, 216	1. 97	63
1892	261	42, 002	1, 893	18, 813, 337	12, 010, 829	23, 536, 141	1. 96	64
1893	258	44, 201	717	14, 917, 146	9, 477, 580	16, 523, 714	1. 74	63. 5
1894	260	44, 772	591	*a*14,337, 937	9, 196, 244	*a*12,273, 669	1. 337	64

a Excluding New York.

TOTAL NUMBER OF COKE WORKS IN THE UNITED STATES.

The following table gives the number of establishments manufacturing coke in the United States at the close of each year from 1880 to 1894, by States:

Number of establishments in the United States manufacturing coke on December 31 of each year from 1880 to 1894.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama	4	4	5	6	8	11	14	15	18	19	20	21	20	23	22
Colorado	1	2	5	7	8	7	7	7	7	9	8	7	9	8	8
Georgia	1	1	1	1	1	2	2	2	1	1	1	1	1	1	1
Illinois	6	6	7	7	9	9	9	8	8	4	4	1	1	1	1
Indiana	2	2	2	2	2	2	4	4	3	4	4	2	2	2	2
Indian Territory	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Kansas	2	3	3	4	4	4	4	4	6	6	7	6	6	6	6
Kentucky	5	5	5	5	5	5	6	6	10	9	9	7	5	4	6
Missouri	0	0	0	0	0	0	0	1	1	3	3	3	3	3	3
Montana	0	0	0	1	3	2	4	2	1	2	2	2	2	2	2
New Mexico	0	0	2	2	2	2	2	1	1	2	2	1	1	1	1
New York	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1
Ohio	15	15	16	18	19	13	15	15	15	13	13	9	10	9	8
Pennsylvania	124	132	137	140	145	133	108	151	120	109	106	109	109	102	101
Tennessee	6	6	8	11	13	12	12	11	11	12	11	11	11	11	11
Texas	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Utah	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1
Virginia	0	0	0	1	1	1	2	2	2	2	2	2	2	2	2
Washington	0	0	0	0	1	1	1	1	3	1	2	2	3	3	3
West Virginia	18	19	22	24	27	27	29	39	52	53	55	55	72	75	78
Wisconsin	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
Wyoming	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
Total	186	197	215	231	250	233	222	270	261	253	253	243	261	258	260

The word "establishment" is rather an indefinite one. In some cases proprietors of coke works owning several different banks or blocks of ovens will report them all as one establishment, they being under one general management. In other cases they will be reported separately. The number differs so much from year to year as to make this table of but little value for comparison.

The number of establishments in the country for each year since 1850 for which there are any returns is as follows:

Number of coke establishments in the United States since 1850.

Years.	Number.	Years.	Number.
1850 (census year)	4	1886, December 31	222
1860 (census year)	21	1887, December 31	270
1870 (census year)	25	1888, December 31	261
1880 (census year)	149	1889, December 31	253
1880, December 31	186	1890, December 31	253
1881, December 31	197	1891, December 31	243
1882, December 31	215	1892, December 31	261
1883, December 31	231	1893, December 31	258
1884, December 31	250	1894, December 31	260
1885, December 31	233		

NUMBER OF COKE OVENS IN THE UNITED STATES.

The following table shows the number of coke ovens in each State and Territory on December 31 of each year from 1880 to 1894, together with the total number of ovens in the United States at the close of each of these years. In the earlier years covered by this table some coke was made in pits and on the ground, and in testing the adaptability of certain coals to the manufacture of coke this is still customary, though in the latter years but little of the coke reported as produced in the United States was made in anything but ovens.

Number of coke ovens in the United States on December 31 of each of the years from 1880 to 1894.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama	316	416	536	767	976	1,075	1,301	1,555	2,475	3,944	4,805	5,068	5,320	5,548	5,551
Colorado	200	267	344	352	409	434	483	532	602	834	916	948	*a* 1,128	*a* 1,154	*a* 1,154
Georgia	140	180	220	264	300	300	300	300	290	300	300	300	300	338	338
Illinois	176	176	304	316	325	320	335	278	221	149	148	25	24	24	24
Indiana	45	45	37	37	37	37	100	119	103	111	101	84	84	94	94
Indian Territory	20	20	20	20	20	40	40	80	80	78	78	80	80	80	80
Kansas	6	15	20	23	23	23	36	39	58	68	68	72	75	75	61
Kentucky	45	45	45	45	45	33	76	98	132	166	175	115	287	283	293
Missouri	0	0	0	0	0	0	0	4	4	9	10	10	10	10	10
Montana	0	0	0	2	5	2	16	27	40	90	140	140	153	153	153
New Mexico	0	0	0	12	70	70	70	70	70	70	70	*b* 0	50	50	50
New York	......	......	......	......	......	......	......	......	......	......	......	......	......	*c* 12	*c* 12
Ohio	616	641	647	682	732	642	560	585	547	462	443	421	436	435	363
Pennsylvania	9,501	10,881	12,424	13,610	14,285	14,553	16,314	18,294	20,381	22,143	23,430	25,324	25,366	25,744	25,824
Tennessee	656	724	861	992	1,105	1,387	1,485	1,560	1,634	1,639	1,664	1,995	1,941	1,942	1,860
Utah	20	20	20	20	20	20	20	0	0	34	80	80	83	83	83
Virginia	0	0	0	200	200	200	350	350	550	550	550	550	594	594	736
Washington	0	0	0	0	0	2	11	30	30	30	30	80	84	84	84
West Virginia	631	689	878	962	1,005	978	1,100	2,080	2,792	3,438	4,060	4,621	5,843	7,354	7,858
Wisconsin	0	0	0	0	0	0	0	0	50	50	70	120	120	120	120
Wyoming	0	0	0	0	0	0	0	0	0	0	20	24	24	24	24
Total	12,372	14,119	16,356	18,304	19,557	20,116	22,597	26,001	30,059	34,165	37,158	40,057	42,002	44,201	44,772

a Includes 36 gas retorts.

b Coke was made in pits.

c Semet-Solvay ovens.

We have in the introduction to this report commented on the kinds of coke ovens in use in the United States. As compared with 1893 the above table shows an increase of but 571 ovens in the United States in 1894. In Alabama there was an increase of 3 ovens; in Kentucky, 10; in Pennsylvania, 80; in Virginia, 142; in West Virginia, 504; while there was a decrease in Kansas of 14; in Ohio, 72, and in Tennessee, 82.

As we have noted in previous volumes of this series, a calculation based upon this table and the one showing production indicates that the ovens in certain States were in much more active operation during the year than those in other States. For instance, Alabama had 5,551 ovens at the close of 1894, as compared with 7,858 ovens in West Virginia, and made only some 270,000 tons less than were made in West Virginia. The product per oven in West Virginia in 1894 was 152 tons; in Alabama, 166 tons; and in Pennsylvania, 235 tons. The product per oven in 1893 in these States was, in West Virginia, 144 tons; in Alabama, 211 tons; and in Pennsylvania, 242 tons.

As is elsewhere stated, most of the ovens in operation in the United States are of the solid-wall type, in which the coal is coked by heat generated in the oven itself, a certain amount of the heat generated at a burning being stored in the walls of the oven. Most of the ovens are of the regular beehive shape; a few are somewhat modified in form, the oven being long and shaped like a muffle. The principle of coking, however, is the same in these long ovens (which are sometimes called Welsh ovens or drag ovens, certain shapes used in this country being also known as the Thomas oven, from its inventor) as in the beehive; that is, the coking of the coal is by the heat generated by the combustion of the coal in the oven itself with such slight heat as may be stored in the walls of the oven from a previous burning.

We have also stated elsewhere that a bank of 12 by-product ovens on the Semet-Solvay principle has been in operation at Syracuse, N. Y., for the last two years, and a bank of retorts on the principle of the Huessener by-product coke oven is in operation in West Virginia, and a somewhat similar bank in operation in Colorado, and that the construction of a bank of Otto-Hoffmann ovens was begun in 1895 at Johnstown, Pa., and a bank of Semet-Solvay ovens at Dunbar, Pa., while other sets of ovens on the Carves-Huessener and Slocum principles will probably be built in 1895 near Pittsburg. In addition to these flue ovens for the saving of by-products, there are some flue or retort ovens without the saving of by-products in operation in Pennsylvania, but they are of little account.

NUMBER OF OVENS BUILDING IN THE UNITED STATES.

The following table gives the number of ovens actually in course of construction at the close of each year from 1880 to 1894. It should be understood that this table does not include the increase in the number of ovens during the year. It only gives the number of ovens actually in course of construction at the close of each year. It will be noted that the number in course of erection at the close of 1894 was 591, which is the smallest of any year since 1885:

Number of coke ovens building in the United States at the close of each of the years from 1880 to 1894.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama	100	120	0	122	242	16	1,012	1,362	406	427	371	50	90	60	50
Colorado	50	0	0	0	24	0	0	0	100	50	30	21	220	200	250
Georgia	40	40	44	36	0	0	0	0	0	0	0	0	0	0	0
Illinois	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indiana	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0
Indian Terr'y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kansas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kentucky	0	0	0	0	0	0	2	0	2	100	303	24	100	100	0
Missouri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Montana	0	0	0	0	12	0	0	0	0	50	0	0	0	0	0
New Mexico	0	0	12	28	0	0	0	0	0	0	0	0	0	0	0
New York	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*a* 13
Ohio	25	0	0	0	0	0	0	223	12	0	1	0	0	0	0
Pennsylvania	836	761	642	211	232	317	2,558	802	1,565	567	74	11	269	19	118
Tennessee	68	84	14	10	175	36	126	165	84	40	292	0	0	0	0
Virginia	0	0	0	0	0	0	100	300	0	250	250	250	206	206	100
Washington	0	0	0	0	0	0	21	0	100	0	80	0	30	0	0
West Virginia	40	0	0	0	127	63	317	742	318	631	334	555	978	132	60
Wisconsin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wyoming	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1,159	1,095	712	407	812	432	4,154	3,594	2,587	2,115	1,735	911	1,893	717	591

a Semet-Solvay.

PRODUCTION OF COKE FROM 1880 TO 1894.

The production of coke in the several States and Territories from 1880 to 1894 is shown in the following table:

Amount of coke produced, in short tons, in the United States, 1880 to 1894, inclusive, by States and Territories.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
Alabama	60,781	109,033	152,940	217,531	244,009	301,180	375,054	325,020
Colorado	25,568	48.587	102,105	133,997	115,719	131,960	142,797	170,698
Georgia	38,041	41,376	46,602	67,012	79,268	70,669	82,680	79,241
Illinois	12,700	14,800	11,400	13,400	13,095	10,350	8,103	9,198
Indiana	0	0	0	0	0	0	6,124	17,658
Indian Territory	1,546	1,768	2,025	2,573	1,912	3,584	6,351	10,060
Kansas	3,070	5,670	6,080	8,430	7,190	8,050	12,493	14,950
Kentucky	4,250	4,370	4,070	5,025	2,223	2,704	4,528	14,565
Missouri	0	0	0	0	0	0	0	2,970
Montana	0	0	0	0	75	175	0	7,200
New Mexico	0	0	1,000	3,905	18,282	17,940	10,236	13,710
New York	....	....	....	....	....	....	....	0
Ohio	100,596	119,469	103,722	87,834	62,709	39,416	34,932	93,004
Pennsylvania	2,821,384	3,437,708	3,945,034	4,438,464	3,822,128	3,991,805	5,406,597	5,832,849
Tennessee	130,609	143,853	187,695	203,691	219,723	218,842	368,139	396,979
Utah	1,000	0	250	0	0	0	0	0
Virginia	0	0	0	25,340	63,600	49,139	122,352	166,947
Washington	0	0	0	....	400	311	825	14,625
West Virginia	138,755	187,126	230,398	257.519	223,472	260,571	264,158	442,031
Wisconsin	0	0	0	0	0	0	0	0
Wyoming	0	0	0	0	0	0	0	0
Total	3,338,300	4,113,760	4,793,321	5,464,721	4,873,805	5,106,696	6,845,369	7,611,705

Amount of coke produced, in short tons, in the United States, 1880 to 1894, etc.—Cont'd.

States and Territories.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama	508, 511	1, 030, 510	1, 072, 942	1, 282, 496	1, 501, 571	1, 168, 085	923, 817
Colorado	179, 682	187, 638	245, 756	277, 074	365, 920	346, 981	301, 140
Georgia	83, 721	94, 727	102, 233	103, 057	81, 807	90, 726	93, 029
Illinois	7, 410	11, 583	5, 000	5, 200	3, 170	2, 200	2, 200
Indiana	11, 956	8, 301	6, 013	3, 798	3, 207	5, 724	6, 551
Indian Territory	7, 502	6, 639	6, 639	9, 464	3, 569	7, 135	3, 051
Kansas	14, 831	13, 910	12, 311	14, 174	9, 132	8, 565	8, 439
Kentucky	23, 150	13, 021	12, 343	33, 777	36, 123	48, 619	29, 748
Missouri	2, 600	5, 275	6, 136	6, 872	7, 299	5, 905	2, 250
Montana	12, 000	14, 043	14, 427	29, 009	34, 557	29, 945	10, 000
New Mexico	8, 540	3, 460	2, 050	2, 300	0	5, 803	6, 529
New York	0	0	0	0	0	12, 850	16, 500
Ohio	67, 194	75, 124	74, 633	38, 718	51, 818	22, 436	32, 640
Pennsylvania	6, 545, 779	7, 659, 055	8, 560, 245	6, 954, 846	8, 327, 612	6, 229, 051	6, 063, 777
Tennessee	385, 693	359, 710	348, 728	364, 318	354, 096	265, 777	292, 646
Utah	0	761	8, 528	7, 949	7, 309	16, 005	16, 056
Virginia	149, 199	146, 528	165, 847	167, 516	147, 912	125, 092	180, 091
Washington	0	3, 841	5, 837	6, 000	7, 177	6, 731	5, 245
West Virginia	531, 762	607, 880	833, 377	1, 009, 051	1, 034, 750	1, 062, 076	1, 193, 933
Wisconsin	500	16, 016	24, 976	34, 387	33, 800	14, 958	4, 250
Wyoming	0	0	0	2, 682	0	2, 916	4, 352
Total	8, 540, 030	10, 258, 022	11, 508, 021	10, 352, 688	12, 010, 829	9, 477, 580	9, 196, 244

The following table gives the relative rank of the States and Territories in the production of coke in the years 1880 to 1894, both inclusive:

Rank of the States and Territories in production of coke from 1880 to 1894.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Pennsylvania	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Alabama	5	5	4	3	2	2	2	4	3	2	2	2	2	2	3
West Virginia	2	2	2	2	3	3	4	2	2	3	3	3	3	3	2
Colorado	7	6	6	5	5	5	5	5	5	5	5	5	4	4	4
Tennessee	3	3	3	4	4	4	3	3	4	4	4	4	5	5	5
Virginia				8	7	7	6	6	6	6	6	6	6	6	6
Georgia	6	7	7	7	6	6	7	8	7	7	7	7	7	7	7
Kentucky	9	10	10	11	12	13	14	12	9	12	11	10	9	8	9
Montana					15	15		16	12	10	10	11	10	9	12
Ohio	4	4	5	6	8	8	8	7	8	8	8	8	8	10	8
Utah	12		13							19	13	14	13	11	11
Wisconsin									18	9	9	9	11	12	18
New York														13	10
Kansas	10	9	9	10	11	11	9	10	11	11	12	12	12	14	13
Indian Territory	11	11	11	13	13	12	12	14	15	15	14	13	16	15	19
Washington					14	14	15	11	10	17	17	16	15	16	16
Missouri								17	17	16	15	15	14	17	20
New Mexico			12	12	9	9	10	13	14	18	19	20		18	15
Indiana							13	9	13	14	16	18	17	19	14
Wyoming												19		20	17
Illinois	8	8	8	9	10	10	11	15	16	13	18	17	18	21	21

An inspection of the above table indicates that the relative rank of quite a number of the States as coke producers changed in 1894. Pennsylvania still holds the rank which it has occupied in the fifteen years covered by the table. Alabama, which, in the different years covered by the table, has changed its position several times, being as low as fifth, and as high as second in 1893, became third in 1894. West Virginia, which, through most of the recent years, has been third, became second. Colorado maintains the position it had in 1893 as fourth; Tennessee, its position as fifth; Virginia as sixth, and Georgia as seventh, while Kentucky drops from eighth to ninth, and Montana from ninth to twelfth. Ohio has risen from the tenth to the eighth, while Utah maintains its old position as eleventh, and Wisconsin drops from the twelfth to the eighteenth.

VALUE AND AVERAGE SELLING PRICE OF COKE.

In the following table is given the total value of coke produced in the United States in each year from 1880 to 1894, inclusive:

Total value at the ovens of the coke made in the United States in the years from 1880 to 1894, inclusive, by States and Territories.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
Alabama	$183, 063	$326, 819	$425, 940	$598, 473	$609, 185	$755, 645	$993, 302	$775, 090
Colorado	145, 226	267, 156	476, 665	584, 578	409, 930	512, 162	569, 120	682, 778
Georgia	81, 789	88, 753	100, 194	147, 166	169, 192	144, 198	179, 031	174, 410
Illinois	41, 950	45, 850	29, 050	28, 200	25, 639	27, 798	21, 487	19, 594
Indiana	0	0	0	0	0	0	17, 953	51, 141
Indian Territory	4, 638	5, 304	6, 075	7, 719	5, 736	12, 902	22, 229	33, 435
Kansas	6, 000	10, 200	11, 460	16, 560	14, 580	13, 255	19, 204	28, 575
Kentucky	12, 250	12, 630	11, 530	14, 425	8, 760	8, 499	10, 082	31, 730
Missouri	0	0	0	0	0	0	0	10, 395
Montana	0	0	0	0	900	2, 063	0	72, 000
New Mexico	0	0	6, 000	21, 478	91, 410	89, 700	51, 180	82, 260
New York	....	....	....	....	....	....	....	....
Ohio	255, 905	297, 728	266, 113	225, 660	156, 294	109, 723	94, 042	245, 981
Pennsylvania	5, 255, 040	5, 898, 579	6, 133, 698	5, 410, 387	4, 783, 230	4, 981, 656	7, 664, 023	10, 746, 352
Tennessee	316, 607	342, 585	472, 505	459, 126	428, 870	398, 459	687, 865	870, 900
Utah	10, 000	0	2, 500	0	0	0	0	0
Virginia	0	0	0	44, 345	111, 300	85, 993	305, 880	417, 368
Washington	0	0	0	0	1, 900	1, 477	4, 125	102, 375
West Virginia	318, 797	429, 571	520, 437	563, 490	425, 952	485, 588	513, 843	976, 732
Wisconsin	0	0	0	0	0	0	0	0
Wyoming	0	0	0	0	0	0	0	0
Total	6, 631, 265	7, 725, 175	8, 462, 167	8, 121, 607	7, 242, 878	7, 629, 118	11, 153, 366	15, 321, 116

States and Territories.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama	$1, 189, 679	$2, 372, 417	$2, 589, 447	$2, 986, 242	$3, 464, 623	$2, 648, 632	$1, 871, 348
Colorado	716, 305	643, 479	959, 246	896, 984	*a* 1, 234, 320	*a* 1, 137, 488	*a* 903, 970
Georgia	177, 907	149, 059	150, 995	231, 878	163, 614	136, 089	116, 286
Illinois	21, 038	29, 764	11, 250	11, 700	7, 133	4, 400	4, 400
Indiana	31, 993	25, 922	19, 706	7, 596	6, 472	9, 048	13, 102
Indian Territory	21, 755	17, 957	21, 577	30, 483	12, 402	25, 072	10, 693
Kansas	29, 073	26, 593	29, 116	33, 296	19, 906	18, 640	15, 660
Kentucky	47, 244	29, 769	22, 191	68, 281	72, 563	97, 350	51, 566
Missouri	9, 100	5, 800	9, 240	10, 000	10, 949	9, 735	3, 563
Montana	96, 000	122, 023	125, 655	258, 523	311, 013	239, 560	110, 000
New Mexico	51, 240	18, 408	10, 025	10, 925	0	18, 476	28, 213
New York	....	....	....	....	....	35, 925	....
Ohio	166, 330	188, 222	218, 090	76, 901	112, 907	43, 671	90, 875
Pennsylvania	8, 230, 759	10, 743, 492	16, 333, 674	12, 679, 826	15, 015, 336	9, 468, 036	6, 585, 489
Tennessee	490, 491	731, 496	684, 116	701, 803	724, 106	491, 523	480, 124
Utah	0	3, 042	37, 196	35, 778	....	....	....
Virginia	260, 000	325, 861	278, 724	265, 107	322, 486	282, 898	295, 747
Washington	0	30, 728	46, 696	42, 000	50, 446	34, 207	18, 249
West Virginia	905, 549	1, 074, 177	1, 524, 746	1, 845, 043	1, 821, 965	1, 716, 907	1, 639, 687
Wisconsin	1, 500	92, 092	143, 612	192, 804	185, 900	95, 851	19, 465
Wyoming	0	0	0	8, 046	0	10, 206	*b* 15, 232
Total	12, 445, 963	16, 630, 301	23, 215, 302	20, 393, 216	23, 536, 141	16, 523, 714	12, 273, 669

a Includes Utah's value. *b* Value estimated.

While this table gives the totals of the values as returned in the schedules, the figures do not always represent the same thing. A statement as to the actual selling price of the coke was asked for, and in most cases, including possibly 80 per cent of all the coke produced, the figures are the actual selling price. In some cases, however, the value is an estimate. Considerable of the coke made in the United States is produced by proprietors of blast furnaces for consumption in their own furnaces, none being sold. The value, therefore, given for this coke would be an estimate based, in some instances where there are coke works in the neighborhood selling coke for the general market, upon the price obtained for this coke; in other cases the cost is estimated at the cost of the coke at the furnace, plus a small percentage for profit on the coking operation, while in still other cases the value given is only the actual cost of the coke at the ovens.

In the following table is given the average value per short ton of the coke made in the United States for each year from 1880 to 1894, inclusive, by States and Territories:

Average value per short ton at the ovens of the coke made in the United States in the years from 1880 to 1894, inclusive, by States and Territories.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama	$3.01	$3.00	$2.79	$2.75	$2.50	$2.50	$2.65	$2.39	$2.34	$2.30	$2.41	$2.33	$2.31	$2.27	$2.025
Colorado	5.68	5.29	4.67	4.36	3.45	3.88	3.99	4.00	4.00	3.43	3.90	3.24	3.31	*a*3.13	*a*2.85
Georgia	2.15	2.15	2.15	2.20	2.13	2.04	2.17	2.20	2.12	1.57	1.48	2.25	2.00	1.50	1.25
Illinois	3.30	3.10	2.55	2.10	1.96	2.68	2.65	2.13	2.84	2.57	2.25	2.25	2.25	2.00	2.00
Indiana	.....	.....	.....	.....	.....	.....	2.93	2.81	2.68	3.12	3.28	2.00	2.02	1.58	2.00
Indian Territ'y	3.00	3.00	3.00	3.00	3.00	3.60	3.50	3.33	2.90	2.70	3.25	3.22	3.47	3.51	3.50
Kansas	1.95	1.80	1.70	1.96	2.02	1.65	1.54	1.91	1.96	1.91	2.37	2.35	2.18	2.18	1.855
Kentucky	2.88	2.89	2.83	2.87	3.94	3.14	2.23	2.18	2.04	2.28	1.80	2.02	2.01	2.00	1.73
Missouri	.....	.....	.....	.....	.....	.....	.....	3.50	3.50	1.10	1.51	1.46	1.50	1.65	1.58
Montana	.....	.....	.....	.....	12.00	11.72	.....	10.00	8.00	8.69	8.71	8.91	9.00	8.00	11.00
New Mexico	.....	.....	6.00	5.50	5.00	5.00	5.00	6.00	6.00	5.32	4.89	4.75	0	3.18	4.32
New York	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.80	.....
Ohio	2.54	2.49	2.57	2.57	2.49	2.78	2.69	2.65	2.48	2.50	2.92	1.99	2.18	1.95	2.78
Pennsylvania	1.86	1.70	1.55	1.22	1.25	1.25	1.42	1.84	1.26	1.40	1.91	1.82	1.80	1.52	1.086
Tennessee	2.42	2.33	2.52	2.25	1.95	1.31	1.87	2.19	1.27	2.03	1.96	1.93	2.05	1.85	1.64
Utah	10.00	.....	10.00	.....	.....	.....	.....	.....	.....	4.00	4.36	4.50	0	.....	.....
Virginia	.....	.....	.....	1.75	1.75	1.75	2.50	2.50	1.74	2.22	1.68	1.58	2.18	2.26	1.64
Washington	.....	.....	.....	.....	4.75	4.75	5.00	7.00	0	8.00	8.00	7.00	7.03	5.08	3.48
West Virginia	2.30	2.30	2.26	2.19	1.19	1.86	1.94	2.22	1.70	1.76	1.83	1.83	1.76	1.62	1.373
Wisconsin	.....	.....	.....	.....	.....	.....	.....	.....	3.00	5.75	5.75	5.61	5.50	6.41	4.58
Wyoming	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.00	0	3.50	*b*3.50
Average	1.99	1.88	1.77	1.49	1.49	1.49	1.63	2.01	1.46	1.62	2.02	1.97	1.96	1.74	1.337

a Utah included. *b* Value estimated.

From this table it appears that the average value per ton of coke made in the United States in 1894 was the lowest since the beginning of the publication of this report in 1880, it being $1.337, the nearest approach to this being in 1888, when the average price was $1.46. The price varied from $1.086 in Pennsylvania to $11 in Montana, the average price at ovens in West Virginia being $1.373; in Alabama, $2.025, and in Tennessee, $1.64. In comparing and considering prices the statement previously made as to the value of these values must always be borne in mind.

COAL CONSUMED IN THE MANUFACTURE OF COKE.

In the following table is given the total number of tons of coal used in the manufacture of coke in the United States for the years 1880 to 1894:

Amount of coal used in the manufacture of coke in the United States from 1880 to 1894, inclusive, by States and Territories.

[Short tons.]

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
Alabama	106,283	184,881	261,839	359,699	413,184	507,934	635,120	550,047
Colorado	51,891	97,508	180,549	224,089	181,968	208,069	228,060	267,487
Georgia	63,402	68,960	77,670	111,687	132,113	117,781	136,133	158,482
Illinois	31,240	35,240	25,270	31,370	30,168	21,487	17,806	16,596
Indiana	...	...	...	...	...	...	13,030	35,600
Indian Territory	2,494	2,852	3,266	4,150	3,084	5,781	10,242	20,121
Kansas	4,800	8,800	9,200	13,400	11,500	15,000	23,062	27,604
Kentucky	7,206	7,406	6,006	8,437	3,451	5,075	9,055	29,129
Missouri	...	...	...	...	...	...	...	5,400
Montana	...	...	...	...	165	300	...	10,800
New Mexico	...	...	1,500	6,941	29,990	31,889	18,194	22,549
New York	...	...	...	...	...	...	...	...
Ohio	172,453	201,145	181,577	152,502	108,164	68,796	59,332	164,974
Pennsylvania	4,347,558	5,393,503	6,149,179	6,823,275	6,204,604	6,178,500	8,290,849	8,938,438
Tennessee	217,656	241,644	313,537	330,961	348,295	412,538	621,669	655,857
Utah	2,000	...	500	...	...	...	...	...
Virginia	...	...	...	39,000	99,000	81,899	200,018	235,841
Washington	...	...	...	...	700	544	1,400	22,500
West Virginia	230,758	304,823	366,653	411,159	385,588	415,533	425,002	698,327
Wisconsin	...	...	...	...	...	...	...	...
Wyoming	...	...	...	...	...	...	...	...
Total	5,237,741	6,546,762	7,577,646	8,516,670	7,951,974	8,071,126	10,688,972	11,859,752

States and Territories.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama	848,608	1,746,277	1,809,964	2,144,277	2,585,966	2,015,398	1,574,245
Colorado	274,212	299,731	407,023	452,749	*a* 599,200	*a* 628,935	*a* 542,429
Georgia	140,000	157,878	170,388	164,875	158,978	171,645	166,523
Illinois	13,020	19,250	9,000	10,000	4,800	3,300	3,800
Indiana	26,547	16,428	11,753	8,688	6,456	11,549	13,489
Indian Territory	13,126	13,277	13,278	20,551	7,138	15,118	7,274
Kansas	24,934	21,600	21,809	27,181	15,437	13,645	13,288
Kentucky	42,642	25,192	24,372	64,390	70,783	97,212	66,418
Missouri	5,000	8,485	9,491	10,377	11,088	8,875	3,442
Montana	20,000	30,576	32,148	61,667	64,412	61,770	22,500
New Mexico	14,628	7,162	3,980	4,000	0	14,698	13,042
New York	...	...	...	...	...	15,150	...
Ohio	124,201	132,828	126,921	69,320	95,236	42,963	55,324
Pennsylvania	9,673,097	11,581,292	13,046,143	10,588,544	12,591,345	9,386,702	9,059,118
Tennessee	630,099	626,016	600,387	623,177	600,126	449,511	516,802
Utah	...	2,217	24,058	25,281	...	...	...
Virginia	230,529	238,793	251,683	285,113	226,517	194,059	280,524
Washington	...	6,983	9,120	10,000	12,372	11,374	8,563
West Virginia	863,707	1,001,372	1,395,266	1,716,976	1,709,183	1,745,757	1,976,128
Wisconsin	1,000	25,616	38,425	52,904	54,300	24,085	6,343
Wyoming	...	...	...	4,470	0	5,400	8,685
Total	12,945,350	15,960,973	18,005,209	16,344,540	18,813,337	14,917,146	14,337,937

a Includes Utah's consumption.

In regard to this table, it is to be noted that in many cases the statement as to the amount of coal used in the production of coke is an estimate. At but few works is the coal weighed before being charged into the ovens. A great deal of the coke made in the United States is from run of mine; that is, all of the product of mining, lump, nut, and slack, as it comes to the mouth of the pit in the mine car is charged into the ovens, and if no coal is sold as coal it is comparatively easy to ascertain from the amounts paid for mining what is the amount of coal charged into the ovens. But even in such cases considerable difficulty arises from the fact that mining is paid for by the measured bushel or ton of so many cubic feet, while our statistics are by weight, and the measured bushel or ton is often not the equivalent of the weighed bushel or ton. It is also true that in certain districts where the men are paid by the car the car contains even of measured tons more than the men are paid for. Under such circumstances it is not to the interest of the operator to weigh the coal as it is charged into the oven.

Further, in many districts coke making is simply for the purpose of utilizing the slack coal produced in mining or that which falls through the screen at the tipple when lump coal is sold. In such cases the slack is rarely, if ever, weighed as it is charged into the ovens, so that any statement as to the amount of coal used at such works will be an estimate. At some works the coal is often weighed for a brief period, and the coke being weighed as it is sold a percentage of yield is ascertained which is used in statements as to the amount of coal used and the yield of this coal in coke.

Great care has been exercised, in view of these facts, to reach a satisfactory estimate as to the amount of coal used in the production of coke, as given in the table immediately preceding, and the percentage yield of coal in coke as shown in the table next subsequent. Analyses of coals from most of the districts in the United States have been secured. These analyses, checked by personal knowledge as to the wastefulness of the methods of coking in each district, have enabled the writer to reach a conclusion as to whether the returns made were approximately correct or not. Where it has been judged that they were incorrect, correspondence has usually led to a revision of the same. It is sometimes the custom of coke manufacturers who do not weigh the coal charged into the ovens to estimate that the yield of coke is equal to the percentage of the fixed carbon and ash in the coal. A report from a certain coke works showed a yield of 77 per cent. This was equal to the average amount of fixed carbon and ash in the coal. Further inquiry developed the fact that at other mines in this district, using the same character of coal, the yield as reported varied from 50 to 66 per cent. Upon the attention of the party making the return showing 77 per cent being called to these facts, the yield was reduced to 63 per cent. As coke is sold by weight, it has always been assumed that the production of coke was accurate, and where the coal was not weighed, yield of coal in coke being ascertained, a calculation could be made which would show approximately the amount of coal used.

But even under these conditions it is believed that more coal was actually used in the production of coke in each of the years covered by the above table than is shown.

The amount of coal necessary to produce a ton of coke, assuming that the above tables are approximately correct, was as follows:

Coal required to produce a ton of coke in tons or pounds.

Years.	Tons.	Pounds.	Years.	Tons.	Pounds.
1880	1.57	3,140	1888	1.51	3,020
1881	1.59	3,180	1889	1.55	3,100
1882	1.58	3,160	1890	1.56	3,120
1883	1.56	3,120	1891	1.58	3,160
1884	1.63	3,260	1892	1.57	3,140
1885	1.58	3,160	1893	1.57	3,140
1886	1.56	3,120	1894	1.56	3,120
1887	1.56	3,120			

It is believed that the amount of coal used is greater than that reported. This would increase the amount of coal given above as necessary to produce a ton of coke.

In the following table is shown the percentage of yield of coal in the manufacture of coke for the years 1880 to 1894. The statements made above must be kept in mind in examining this table. By the "yield" is of course meant the percentage of the constituents of the coal that remain as coke, and in the coke after the process of coking.

While these tables show an average of something like 64 per cent for most of the years, it is believed that even this is a little too high. Probably the actual yield of coal in coke throughout the United States, if the actual weight of coal charged into the ovens and the actual weight of the coke drawn had been taken, would not have exceeded 60 or 61 per cent.

Percentage yield of coal in the manufacture of coke in the United States in the years 1880 to 1894, inclusive, by States and Territories.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama	57	59	58	60	60	59	59	59	60	59	59	60	58	58	58.7
Colorado	49	50	57	60	64	63	62.6	64	65.6	63	60	61	63.9	*a*57.7	58.5
Georgia	60	60	60	60	60	60	60	50	60	60	60	62.5	51.5	52.8	55.9
Illinois	41	42	45	43	43	48	46	55½	56.9	60	55	52	66	66.7	57.9
Indiana	0	0	0	0	0	0	47	50	45	51	51	44	49.7	49.6	48.6
Indian Territ'y	62	62	62	62	62	62	62	50	57	50	50	46	50	47	42
Kansas	64	64.4	65	62.9	62¼	53⅔	54.2	54	59	64	56	52	59.2	62.8	63.5
Kentucky	60	60	59	60	64	53	50	50	54	52	51	52	51	50	44.8
Missouri	0	0	0	0	0	0	0	55	52	62	65	66	65.8	66.5	65.4
Montana	0	0	0	0	46	58½	0	66⅔	60	46	45	47	53.6	48.5	44.4
New Mexico	0	0	66⅔	57¼	57½	56¼	56	61	58	48	51.5	57.5	0	39.5	50
New York	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	84.8	.....
Ohio	58	59	57	58	58	57	59	56	54	56	59	56	54.4	52	59
Pennsylvania	65	64	64	65	62	64.6	65.2	65¼	68	66	65	66	66.1	66	66.9
Tennessee	60	60	60	62	63	53	59	61	61	57	58	58	59	59	56.6
Texas	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0
Utah	50	0	50	0	0	0	0	0	0	34	35	31	.....	.....	.....
Virginia	0	0	0	64½	64¼	60	61.1	70.8	64.7	61	66	58.8	65.3	64.5	64.2
Washington	0	0	0	0	57.5	57	58.9	65	0	55	64	60	58	59	61.2
West Virgina	60	61	63	63	62	63	62	63.3	61.6	61	59	58.8	60.5	60.8	60.4
Wisconsin	0	0	0	0	0	0	0	0	50	62.5	65	65	62.2	62	67
Wyoming	0	0	0	0	0	0	0	0	0	0	0	60	0	54	50
Total average	63	63	63	64	61	63	64	64.2	66	64	64	63	64	63.5	64

a Average, including Utah.

In connection with these tables of yields it should be said that there is no doubt that the yield of coal in coke is increasing throughout the United States. Better forms of oven are being used; slight modifications in construction are being made, which increases the yield; the coal is being crushed and disintegrated, which not only improves the quality but increases the yield as well, and better methods of burning are being employed, all of which tend not only to make a better coke but to get more coke out of a given weight of coal.

In the following table will be found a statement of the amount and value of coal used in the manufacture of coke in the United States in the years 1894, 1893, and 1892. The chief point in these tables is to show the average value of coal used per ton and the amount and value of coal necessary to make a ton of coke. The average value of coal per ton in 1892 was 75 cents; in 1893, 70 cents, and in 1894, 65.8 cents. The amount of coal necessary to make a ton of coke in 1892 was 1.57 tons; in 1893, the same, and in 1894, 1.56 tons. The value of the coal necessary to make a ton of coke in 1892 was $1.18; in 1893, $1.10, and in 1894, $1.03.

Some interesting comparisons can be deduced from this table and the one published elsewhere as to the average value at the ovens of the coke made in the United States. For example: The average price per ton for all coke produced in the United States in 1894 was $1.337; it will be noted, therefore, that the amount received for the coke per ton above the value of the coal was $0.307. Making a comparison by States it will be seen that the average price received for a ton of coke in Pennsylvania in 1894 was $1.086, while the average value of the coal was $0.88 a ton, leaving only 20 cents as the price received for the coke in excess of the value of the coal that went into a ton. In Alabama the selling price of coke was $2.025, while the value of the coal was $1.56. In Colorado the relative figures were $2.85 per ton for coke and value of coal $1.70; in Tennessee, $1.64 for coke and $1.29 for coal; in Virginia, $1.64 for coke and $1.72 for coal; in West Virginia, $1.373 for coke and $0.93 for coal. From the above it is evident that there must be either an error in the amount of coal that entered into a ton of coke in Virginia or in the value of the coke produced. The probability is that the error is in the value of the coal, and probably consists in charging the coke oven with the coal at the market price received for lump coal sold as coal instead of charging it at what the corresponding price for slack should be:

Amount and value of coal used in the manufacture of coke in the United States in 1894, and amount and value of same per ton of coke.

States and Territories.	Coal used.	Total value of coal.	Value of coal per ton.	Amount of coal per ton of coke.	Value of coal to a ton of coke.
	Short tons.			*Short tons.*	
Alabama	1, 574, 245	$1, 443, 043	$0. 917	1. 70	$1. 56
Colorado (*a*)	542, 429	539, 065	. 994	1. 71	1. 70
Georgia	166, 523	121, 882	. 73	1. 79	1. 31
Illinois	3, 800	950	. 25	1. 73	. 43
Indiana	13, 489	6, 265	. 465	2. 06	. 96
Indian Territory	7, 274	1, 819	. 25	2. 38	. 60
Kansas	13, 288	6, 275	. 47	1. 57	. 74
Kentucky	66, 418	14, 304	. 215	2. 23	. 48
Missouri	3, 442	1, 556	. 45	1. 53	. 69
Montana	22, 500	78, 750	3. 50	2. 25	7. 88
New Mexico	13, 042	18, 259	1. 40	2. 00	2. 80
New York	....	....	....	....	....
Ohio	55, 324	52, 689	. 95	1. 70	1. 62
Pennsylvania	9, 059, 118	5, 317, 695	. 589	1. 49	. 88
Tennessee	516, 802	377, 229	. 73	1. 77	1. 29
Utah (*b*)	....	....	....	....	....
Virginia	280, 524	309, 730	1. 10	1. 56	1. 72
Washington	8, 563	16, 391	1. 914	1. 63	3. 12
West Virginia	1, 976, 128	1, 102, 105	. 558	1. 66	. 93
Wisconsin	6, 343	17, 443	2. 75	1. 50	4. 13
Wyoming	8, 685	5, 211	*c* . 60	2. 00	1. 20
Total and averages.	14, 337, 937	9, 430, 661	. 658	1. 56	1. 03

a Figures given for Colorado include the statistics of Utah.
b Included with Colorado figures.
c Value estimated.

Amount and value of coal used in the manufacture of coke in the United States in 1893, and amount and value of same per ton of coke.

States and Territories.	Coal used.	Total value of coal.	Value of coal per ton.	Amount of coal per ton of coke.	Value of coal to a ton of coke.
	Short tons.			*Short tons.*	
Alabama	2, 015, 398	$1, 894, 666	$0. 94	1. 725	$1. 62
Colorado (*a*)	628, 935	599, 773	. 95	1. 73	1. 65
Georgia	171, 645	171, 645	1. 00	1. 89	1. 89
Illinois	3, 300	660	. 20	1. 50	. 30
Indiana	11, 549	4, 043	. 35	2. 02	. 71
Indian Territory	15, 118	3, 779	. 25	2. 12	. 53
Kansas	13, 645	7, 117	. 52	1. 59	. 82
Kentucky	97, 212	34, 804	. 36	2. 00	. 72
Missouri	8, 875	3, 168	. 36	1. 50	. 54
Montana	61, 770	185, 310	3. 00	2. 06	6. 18
New Mexico	14, 698	21, 069	1. 43	2. 53	3. 63
New York	15, 150	39, 550	2. 61	1. 18	3. 08
Ohio	42, 963	24, 700	. 58	1. 91	1. 10
Pennsylvania	9, 386, 702	5, 738, 798	. 61	1. 51	. 92
Tennessee	449, 511	363, 260	. 808	1. 69	1. 37
Utah (*b*)	....	....	....	....	....
Virginia	194, 059	212, 467	1. 09	1. 55	1. 70
Washington	11, 374	25, 163	2. 21	1. 69	3. 74
West Virginia	1, 745, 757	1, 044, 219	. 60	1. 64	. 98
Wisconsin	24, 085	*c* 72, 255	3. 00	1. 61	4. 83
Wyoming	5, 400	3, 240	. 60	1. 85	1. 11
Total and averages.	14, 917, 146	10, 449, 686	. 70	1. 57	1. 10

a Figures given for Colorado include the statistics of Utah.
b Included with Colorado figures.
c Value estimated.

Amount and value of coal used in the manufacture of coke in the United States in 1892, and amount and value of same per ton of coke.

States and Territories.	Coal used.	Total value of coal.	Value of coal per ton.	Amount of coal per ton of coke.	Value of coal to a ton of coke.
	Short tons.			*Short tons.*	
Alabama	2,585,966	$2,551,946	$0.99	1.72	$1.70
Colorado (*a*)	599,200	617,744	1.03	1.605	1.65
Georgia	158,978	*b* 143,080	.90	1.943	1.75
Illinois	4,800	1,200	.25	1.514	.38
Indiana	6,456	2,333	.36	2.013	.72
Indian Territory	7,138	1,785	.25	2.00	.50
Kansas	15,437	8,297	.54	1.69	.91
Kentucky	70,783	19,681	.28	1.96	.55
Missouri	11,088	4,165	.38	1.51	.57
Montana	64,412	193,236	3.00	1.864	5.59
New Mexico	0	0	0	0	0
Ohio	95,236	82,890	.87	1.84	1.60
Pennsylvania	12,591,345	8,372,171	.67	1.512	1.01
Tennessee	600,126	624,275	1.04	1.70	1.77
Utah (*c*)					
Virginia	226,517	243,112	1.07	1.53	1.64
Washington	12,372	29,344	2.37	1.724	4.09
West Virginia	1,709,183	1,106,806	.65	1.65	1.07
Wisconsin	54,300	149,325	2.75	1.606	4.42
Wyoming	0	0	0	0	0
Total and averages	18,813,337	14,151,390	.75	1.57	1.18

a Figures given for Colorado include the statistics of Utah.
b Value estimated.
c Included with Colorado figures.

CONDITION IN WHICH COAL IS CHARGED INTO OVENS.

In the following table will be found a statement of the condition of coal when charged into ovens; that is, whether it is run of mine, slack, washed or unwashed. The tables for 1894, 1893, and 1892 are given. The headings explain themselves. It is only necessary to state that run of mine, washed, includes that run-of-mine coal which is crushed before being washed:

Character of coal used in the manufacture of coke in 1894.

States and Territories.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Alabama	411,097	7,429	477,820	677,899	1,574,245
Colorado (*a*)	126,642	0	415,787	0	542,429
Georgia	0	166,523	0	0	166,523
Illinois	0	0	0	3,800	3,800
Indiana	0	0	8,689	4,800	13,489
Indian Territory	0	0	0	7,274	7,274
Kansas	0	0	13,288	0	13,288
Kentucky	0	2,980	7,900	55,538	66,418
Missouri	0	0	3,442	0	3,442
Montana	0	22,500	0	0	22,500
New Mexico	0	0	13,042	0	13,042
New York					
Ohio	0	0	14,845	40,479	55,324
Pennsylvania	8,671,534	118,279	204,811	64,494	9,059,118
Tennessee	166,990	61,841	149,958	138,013	516,802
Virginia	103,874	0	176,650	0	280,524
Washington	0	0	0	8,563	8,563
West Virginia	162,270	14,901	1,607,735	191,222	1,976,128
Wisconsin	6,343	0	0	0	6,343
Wyoming	0	0	8,685	0	8,685
Total	9,648,750	394,453	3,102,652	1,192,082	14,337,937

a Including Utah's consumption.

From the above table it appears that of the 14,337,937 tons of coal coked in the United States 10,043,203 tons were run of mine and 4,294,734 tons slack. Of the 10,043,203 tons run of mine only 9,648,750 tons were used unwashed, and of the 4,294,734 tons of slack 3,102,652 were used unwashed; so that of the total of 14,337,937 tons of coal made into coke in the United States in 1894 but 1,586,535 tons, or 11 per cent, was washed.

For comparison the following tables are inserted, showing the character of coal used in the manufacture of coke in the United States in 1892 and 1893:

Character of coal used in the manufacture of coke in 1893.

States and Territories.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Alabama	1, 246, 307	51, 163	292, 198	425, 730	2, 015, 398
Colorado (*a*)	109, 915	0	519, 020	0	628, 935
Georgia	0	0	0	171, 645	171, 645
Illinois	0	0	0	3, 300	3, 300
Indiana	0	0	930	10, 619	11, 549
Indian Territory	0	0	0	15, 118	15, 118
Kansas	0	0	12, 445	1, 200	13, 645
Kentucky	825	11, 973	26, 759	57, 655	97, 212
Missouri	0	0	8, 875	0	8, 875
Montana	0	44, 000	0	17, 770	61, 770
New Mexico	14, 698	0	0	0	14, 698
New York	....	....	15, 150	....	15, 150
Ohio	0	0	24, 859	18, 104	42, 963
Pennsylvania	8, 302, 307	216, 762	739, 128	128, 505	9, 386, 702
Tennessee	179, 126	0	137, 483	132, 902	449, 511
Virginia	107, 498	0	86, 561	0	194, 059
Washington	0	10, 974	0	405	11, 374
West Virginia	324, 932	15, 240	1, 176, 656	228, 929	1, 745, 757
Wisconsin	20, 474	0	3, 611	0	24, 085
Wyoming	0	0	5, 400	0	5, 400
Total	10, 306, 082	350, 112	3, 049, 075	1, 211, 877	14, 917, 146

a Utah included.

Character of coal used in the manufacture of coke in 1892.

States and Territories.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Alabama	2, 463, 366	0	11, 100	111, 500	2, 585, 966
Colorado (*a*)	82, 098	0	517, 102	0	599, 200
Georgia	0	0	0	158, 978	158, 978
Illinois	0	0	4, 800	0	4, 800
Indiana	0	0	0	6, 456	6, 456
Indian Territory	0	0	0	7, 138	7, 138
Kansas	0	0	15, 437	0	15, 437
Kentucky	0	5, 955	7, 883	56, 945	70, 783
Missouri	0	0	11, 088	0	11, 088
Montana	0	28, 000	0	36, 412	64, 412
New Mexico	0	0	0	0	0
Ohio	35, 334	0	32, 402	27, 500	95, 236
Pennsylvania	11, 237, 253	159, 698	1, 059, 994	134, 400	12, 591, 345
Tennessee	176, 453	15, 000	367, 827	40, 846	600, 126
Virginia	106, 010	0	120, 507	0	226, 515
Washington	0	0	0	12, 372	12, 372
West Virginia	298, 824	115, 397	1, 108, 353	186, 609	1, 709, 183
Wisconsin	54, 300	0	0	0	54, 300
Wyoming	0	0	0	0	0
Total	14, 453, 638	324, 050	3, 256, 493	779, 156	18, 813, 337

a Including Utah's production.

From a comparison of the three tables given above it appears that in 1892, 78.5 per cent of the coal used was run of mine; in 1893, 71.4 per cent, and in 1894, 70 per cent. In 1892, 21.5 per cent of the coal used was slack; in 1893, 28.6 per cent, and in 1894, 30 per cent. In 1892, 6 per cent of the total was washed; in 1893, 10.5 per cent, and in 1894, 11 per cent.

In the following table the statistics regarding the character of the coal for the years 1890 to 1894, inclusive, are consolidated:

Character of coal used in the manufacture of coke in the United States since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	14,060,907	338,563	2,674,492	931,247	18,005,209
1891	12,255,415	290,807	2,945,359	852,959	16,344,540
1892	14,453,638	324,050	3,256,493	779,156	18,813,337
1893	10,306,082	350,112	3,049,075	1,211,877	14,917,146
1894	9,648,750	394,453	3,102,652	1,192,082	14,337,937

IMPORTS.

The following table gives the quantities and value of coke imported and entered for consumption into the United States from 1869 to 1894, inclusive. In the reports of the Treasury Department the quantities given are long tons. These have been reduced to short tons to make the table consistent with the other tables in this report:

Coke imported and entered for consumption in the United States, 1869 to 1894, inclusive.

Years ending—	Quantity.	Value.	Years ending—	Quantity.	Value.
	Short tons.			*Short tons.*	
June 30, 1869	....	$2,053	June 30, 1882	14,924	$53,244
1870	....	6,388	1883	20,634	113,114
1871	....	19,528	1884	14,483	36,278
1872	9,575	9,217	1885	20,876	64,814
1873	1,091	1,366	Dec. 31, 1886	28,124	84,801
1874	634	4,588	1887	35,320	100,312
1875	1,046	9,648	1888	35,201	107,914
1876	2,065	8,657	1889	28,608	88,008
1877	4,068	16,686	1890	20,808	101,767
1878	6,616	24,186	1891	50,753	223,184
1879	6,035	24,748	1892	27,420	86,350
1880	5,047	18,406	1893	37,183	99,683
1881	15,210	64,987	1894	32,566	70,359

THE COKING INDUSTRY, BY STATES.

ALABAMA.

The coal fields of Alabama form the southern extremity of the great Appalachian coal basin. The State geological survey estimates that the coal deposits embrace an area of some 8,660 square miles, though the actual mining operations are confined to ten counties. These coal fields, and consequently the coking districts, are divided into three distinct districts, which take their names from the chief rivers draining them; that portion of the coal field drained by the Warrior River and its tributaries and the Tennessee River and its tributaries in Alabama constitutes the Warrior coal field. This is the most important of the three districts, and includes the coking operations in the neighborhood of Birmingham. The Coosa field is drained by the Coosa River. The coal mines in this field are in St. Clair and Shelby counties. The Cahaba field lies along the Cahaba River, and the coal in this field is mined in the counties of Shelby, Jefferson, and Tuscaloosa.

The chief coking operations in Alabama are carried on in the Warrior field, and chiefly in the neighborhood of Birmingham, where an extensive blast-furnace industry is located. In this district the well-known Pratt coal seam is mined. From the coal of this seam is produced one of the best metallurgical cokes made in the South and the fuel upon which has been founded the notable blast-furnace industry of Alabama.

Of the 5,551 coke ovens in Alabama at the close of 1894, 4,914 are in the Warrior field, 567 in the Cahaba field, and 70 in the Coosa field. Of the 923,817 tons of coke produced in the State in 1894, 920,097 tons, or 99½ per cent, were from the Warrior field; 1,185 tons, less than one-fourth of 1 per cent, from the Cahaba field; and 2,535 tons, less than one-half of 1 per cent, from the Coosa field.

Regarding the character of the coke made in Alabama it may be said that it is on the whole an excellent fuel, though not equal either in purity, calorific power, or as a metallurgical fuel to that made from the coal seams of the northern portion of the Appalachian region.

Analyses of the coal and coke of the Pratt seam are as follows:

Analyses of coals and cokes from the Pratt seam, Alabama.

	Coal.		Coke.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Fixed carbon	61.600	64.300	93.01	83.27
Volatile matter	31.480	32.080	.16	.93
Ash	5.416	2.080	6.83	15.06
Sulphur	.918	.470	....	.74
Moisture	1.508	1.070	....	....
Total	100.922	100.000	100.00	100.00

Two recent analyses of the coke produced at the ovens of the Mary Lee Coal and Railway Company, of Jefferson, Ala., are as follows:

Analyses of coke produced by the Mary Lee Coal and Railway Company, Jefferson, Ala.

	Per cent.	Per cent.
Volatile matter	0.120	....
Fixed carbon	91.702	90.15
Sulphur	.878	.73
Ash	9.300	9.20
Phosphorus	....	.217

The above analyses certainly indicate a good fuel, especially the coke from the Pratt seam, though varying greatly in the percentage of ash. This is no doubt due to the fact that a great deal of coke is made from the slack coal and screenings, and the lot of coal from which the coke containing the highest percentage of ash was made contained an unusually large amount of slate.

Considerable attention has been given in Alabama to coal washing or coal separation, as well as to the preparation of the coal before coking. The result has been a very marked improvement in the character of the coke produced. The Standard Coal Company, of Brookwood, in Tuscaloosa County, washed all of the coal used in 1893 and 1894. One hundred and sixty analyses were made of the coke, which showed but 8.51 per cent of ash and 5.83 per cent of sulphur. A complete analysis of what is regarded as an average sample of the coke from this company is as follows:

Analysis of Standard Coal Company's coke, Alabama.

Constituents.	Per cent.
Moisture	0.85
Volatile matter	1.05
Sulphur	.56
Ash	8.50
Fixed carbon	89.04
Total	100.00

The results at the above works in 1894 showed the average ash in the coke after washing to be 8.50 to 9, and the sulphur three-fourths of 1 per cent. This coke had a large demand in Mexico.

As a rule the coke produced in the Coosa field is not as good as that produced in the other districts, though even here the coke is not a bad fuel, as will be seen from the following analysis of coke produced in the ovens of the Coal City Mining Company, in St. Clair County:

Analysis of Coal City coke, Alabama.

	Per cent.
Fixed carbon	90.224
Sulphur	.816
Ash	7.040
Volatile matter	1.920
Total	100.000

The following are the statistics of the manufacture of coke in Alabama from 1880 to 1894, inclusive.

Statistics of the manufacture of coke in Alabama, 1880 to 1894, inclusive.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*		*Per ton.*	*Per cent.*
1880	4	316	100	106, 283	60, 781	$183, 063	$3. 01	57
1881	4	416	120	184, 881	109, 033	326, 819	3. 00	59
1882	5	536	....	261, 839	152, 940	425, 940	2. 79	58
1883	6	767	122	359, 699	217, 531	598, 473	2. 75	60
1884	8	*a* 976	242	413, 184	244, 009	609, 185	2. 50	60
1885	11	1, 075	16	507, 934	301, 180	755, 645	2. 50	59
1886	14	*a* 1, 301	1, 012	635, 120	375, 054	993, 302	2. 65	59
1887	15	1, 555	1, 362	550, 047	325, 020	775, 090	2. 39	59
1888	18	2, 475	406	848, 608	508, 511	1, 189, 579	2. 34	60
1889	19	3, 944	427	1, 746, 277	1, 030, 510	2, 372, 417	2. 30	59
1890	20	4, 805	371	1, 809, 964	1, 072, 942	2, 589, 447	2. 41	59
1891	21	5, 068	50	2, 144, 277	1, 282, 496	2, 986, 242	2. 33	60
1892	20	5, 320	90	2, 585, 966	1, 501, 571	3, 464, 623	2. 31	58
1893	23	5, 548	60	2, 015, 398	1, 168, 085	2, 648, 632	2. 27	58
1894	22	5, 551	50	1, 574, 245	923, 817	1, 871, 348	2. 025	58. 7

a One establishment made coke on the ground.

From the above table it will be noticed that the production of coke in Alabama in 1894 was the lowest since 1888, and 38½ per cent less than in 1892. This falling off is of course due to the depression in the pig-iron industry and does not indicate any permanent decline in production.

In the production of these 923,817 tons of coke, 1,574,245 tons of coal were used, the yield of coal in coke being 58.7 per cent, a slight increase over the yield of the previous year. Of this total amount of coal 418,526 tons, or 26.6 per cent, was run of mine; 1,155,719 tons, or 73.4 per cent, was slack, showing that very much the larger proportion of coal made into coke in Alabama is slack. Of the run of mine only a very small amount was washed, but of the slack 677,899 tons, or 58.6 per cent of the total amount of slack used, was washed before being coked. To make a ton of coke it required 1.70 tons of coal. The value of this coal is reported at 91.7 cents, making the value of coal necessary to make a ton of coke $1.56.

As is stated elsewhere, it must be noted that this value per ton is the value reported by the different works on the blanks returned, some estimating its value at cost, others at what the coal would sell for as coal in the market. A similar statement can be made regarding the value of the coke, this value in some cases being the selling price, and in others, where coke was made by the furnace owners, an assumed value, usually what coke would have cost the furnace had it purchased it in the general market.

The character of the coal used in the manufacture of coke in Alabama since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Alabama since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	1,480,669	0	206,106	123,189	1,809,964
1891	1,943,469	0	192,238	8,570	2,144,277
1892	2,463,366	0	11,100	111,500	2,585,966
1893	1,246,307	51,163	292,198	425,730	2,015,398
1894	411,097	7,429	477,820	677,899	1,574,245

From the first table given it will be noted that the number of coke ovens in Alabama at the close of 1894 was 5,551, as compared with 5,548 in 1893, only a slight increase. The number of establishments has been reduced from 23 to 22. It should be noted that in this connection is meant the number of firms producing coke and not the total number of banks of ovens in the State. The Tennessee Coal, Iron and Railway Company have ovens in several different places, and the same is true of the Sloss Iron and Steel Company. The total number of blocks or banks of ovens in Alabama is considerably in excess of 22.

COLORADO.

The most important coke-producing districts, outside of those which draw their supplies from the coal beds of the Appalachian field, are those of Colorado. It is the only one of the States of the far West that is a large producer of coke, and its coke production is especially important in view not only of its value in the smelting of the precious metals, but of iron as well, the only blast furnaces of any importance west of the Mississippi River being those of Colorado.[1]

While the coal of the Huerfano County districts in the Raton field is altogether of the semicoking kind known as "domestic," and though the same product is much used as a steam fuel, the Coal Measures in Las Animas County contain chiefly true coking coal. The transition from the so-called "domestic" to the coking coal is very gradual, and there is a considerable extent of measures along the eastern border in the northern part of Las Animas County which affords a variety of coal that cokes too strongly for domestic purposes, and yet not enough to produce a desirable metallurgical coke in the ordinary beehive oven. The coals of the Upper Measures are, if anything, more superior for coke making than those of the Lower.

The Trinidad district of the Raton coal field is situated near the southern extremity of the eastern border of the field, and embraces the region immediately tributary to Trinidad. This district includes the mines of Sopris, Engleville, Starkville, and Gray Creek. The producing mines have from 4 to 8 feet of coal in the seams worked, though so

[1] The coal fields, and consequently the coking districts, of this State, as well as the geological horizons from which the coal is produced, were thoroughly described by Mr. R. C. Hills in Mineral Resources of the United States, 1892.

far as is known no two of them are located on the same seam. The inclination of the beds is very slight, and most of the coal is mined above water level. The measures are traversed by dikes, and for several miles along the outcrop the workable coal is transformed into a worthless natural coke by intrusions of doleritic material. All the producing mines are located along the outcrop of the Lower Measures, and it is only along the southern boundary that the Upper Measures appear.

The Raton Canyon district of the Raton coal field lies immediately north of the Trinidad district, and in this are the Victor and Berwind seams, the slack from the Berwind mine being coked at El Moro and from the Victor near the mine. The measures of the southern portion of this district are but slightly inclined; in the northern portion the inclination is as high as 15 degrees. Coke is not produced from the coal of any of the other subdistricts in this field, and consequently they are not described. In this report we shall include the coke made in the two districts described, viz, the Trinidad and the Raton Canyon, under the title Trinidad or El Moro. The coal of the South Platte field, the second named by Mr. Hills, is a lignite and does not coke. The only important mines of the South Park district, those near Como, are operated in the interest of the Union Pacific railroad. The coal cokes strongly. The North Park coal is decidedly lignitic and therefore not a coking coal.

Coming to the fields of the western group, the first division named by Mr. Hills is the La Plata field, in which is included what in the coke reports of Mineral Resources we have termed the "Durango district." In the La Plata field in Colorado there are approximately 1,250 square miles in which the coal-bearing formation is either exposed and accessible or is more or less deeply buried beneath later accumulations. There are two coal-bearing horizons in this field; an upper, which contains large seams of coal and is undoubtedly Laramie, and a lower, containing a few smaller seams, concerning the age of which some uncertainty exists. The inclination of the beds varies considerably. The Upper Measures everywhere contain a large thickness of workable coal, which varies greatly not only in the thickness and purity of the individual seams, but in the thickness and character of the material separating them. The coal of the Lower Measures is not as good. The coal at the two extremities of the field is of the semicoking or domestic kind, while that of the central part, near the northern border, possesses pronounced coking properties.

The Durango district is the most important in La Plata County; indeed, the most important in this field. The coal from the Porter seam belongs to the Lower Measures and is usually 3 feet 6 inches thick. Slack from this mine is made into coke at Durango. The slack from this mine is low in ash, but the structure is said by Mr. Hills to be "reedy."

In the Grand River field is included the Crested Butte district, in which as good a coke is made as is produced outside of the Appalachian field, and in some cases the coke equals any produced in the United States. The character of the coal in this district invariably depends on the presence or absence of intrusive eruptive rocks in the neighborhood and their relation to the measures. Thus, on the northeastern border, from Jerome Park to the State line, and from the same line to the north fork of the Gunnison, the coal is of the semicoking kind; whereas in the West Elk Mountains the bulk of the coal is coking.

The workings of the Crested Butte mine are on the lower of two seams, each from 4 to 7 feet thick and separated from one another about 75 feet. The mine workings are confined to a zone of coking coal less than one mile wide, which graduates into semicoking coal on one side and into anthracite on the other. The coke produced is low in ash and of somewhat "reedy" structure when coarse slack is used. Nevertheless it commands a high price in the Denver market.

The Coal Basin district of the Grand River field includes the most important area of coking coal in this field, and what is prospectively the most valuable in the State. It is situated mainly on the drainage of Coal Creek, a tributary of Crystal River, in Pitkin County. The workable beds are five in number, aggregating over 30 feet in thickness of workable coal. The coal of this district is rather low in ash and volatile matter and high in coke residue, more especially in the vicinity of the eruptive body. The coke as made in beehive ovens is of a coarse nonreedy structure, has an easy cross fracture, and, while fine grained, is found to contain 53 per cent of cell space. Such coke is better adapted for the use of lead smelters than any other produced in the State, though it is probably not as well glazed as an iron smelter would desire. He also states that should it be required for iron smelting, coals very rich in volatile matter, but which produce reedy coke, are available for a mixture that would furnish a highly-glazed, porous, nonreedy product of requisite purity.

The coal used for coking at Cardiff is from Spring Gulch, where the workings are on the three lower seams, though the lower one is generally too bony to be mined. The coke is low in ash, but of "reedy" structure; nevertheless it is preferred by lead smelters to the coke from the Raton field.

As the coal from the other districts in this field are of little importance at present as producers of coke—indeed, most of them give a noncoking coal—it is not necessary to describe them. A similar remark may be made regarding the Yampa field.

The coal coked on the Dolores, above Rico, where a 20-inch seam was mined, and the product made into coke for the smelting works at that place, is in southwestern Colorado, the coal seam being in the Dakota Cretaceous. This coal has also been mined in a small way near Grand Junction.

As will be gathered from the above, the chief coke-producing districts in Colorado are, naming them in the order of coke production, the Trinidad or El Moro, the Crested Butte, and the Durango. Some coal is coked in Denver in retorts, but this coal is brought from the other coal fields.

The cokes of Colorado differ greatly in value. The coke is chiefly made from unwashed slack, 415,787 tons of the 542,429 tons used in coke making in this State in 1894 being of this character. In the earlier years of the production of coke in this State attempts were made to reduce the ash and increase the value of the coke made in the El Moro district by washing, but it was found that this process removed a large quantity of the bituminous matter which gave the coke its good structure when unwashed, and it was found to be more economical to allow the ash to remain in the coke and flux it out by the expenditure of the carbon of the coke rather than to wash the coal before coking.

Analyses of coke from the El Moro and Crested Butte fields are as follows:

Analyses of El Moro and Crested Butte, Colorado, cokes.

	El Moro.		Crested Butte.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Fixed carbon	87.47	75.30	92.44	87.11
Volatile matter		5.20	0.41	0.56
Ash	10.68	19.50	7.15	12.30
Sulphur			0.37	0.42
Water	*a* 1.85			
Total	100.00	100.00	100.37	100.39

a Including volatile matter.

A great deal of attention has been paid recently in this State to improvements in the processes of manufacture, which were referred to in the last report.

In addition to these ovens some coke is made in Denver for domestic use only. The gas produced from the coal is used for its carbonization, the tar, ammonia, and other by-products being sold. This concern has 36 gas retorts.

The following are the statistics of the manufacture of coke in Colorado for the years 1880 to 1894, inclusive:

Statistics of the manufacture of coke in Colorado, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*		*Per ton.*	*Per cent.*
1880	1	200	50	51,891	25,568	$145,226	$5.68	49
1881	2	267	0	97,508	48,587	267,156	5.29	50
1882	5	344	0	180,549	102,105	476,665	4.67	57
1883	7	352	0	224,089	133,997	584,578	4.36	60
1884	8	409	24	181,968	115,719	409,930	3.45	64
1885	7	434	0	208,069	131,960	512,162	3.88	63
1886	7	483	0	228,060	142,797	569,120	3.99	62.6
1887	7	532	0	267,487	170,698	682,778	4.00	64
1888	7	602	100	274,212	179,682	716,305	4.00	65.6
1889	9	834	50	299,731	187,638	643,479	3.43	63
1890	8	916	30	407,023	245,756	959,246	3.90	60
1891	7	948	21	452,749	277,074	896,984	3.24	61
1892 (*a*)	9	*b* 1,128	220	599,200	*c* 373,229	1,234,320	3.31	62.3
1893 (*a*)	8	*b* 1,154	200	628,935	*d* 362,986	1,137,488	3.13	57.7
1894 (*a*)	8	*b* 1,154	250	542,429	*e* 317,196	903,970	2.85	58.5

a Includes Utah's production and value of coal and coke.
b Includes 36 gas retorts.
c Colorado's coke production, 365,920 tons.
d Colorado's coke production, 346,981 tons.
e Colorado's coke production, 301,140 tons.

The character of the coal used in the manufacture of coke in Colorado and Utah since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Colorado and Utah since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	36,058	0	395,023	0	431,081
1891	93,752	0	384,278	0	478,030
1892	82,098	0	517,102	0	599,200
1893	109,915	0	519,020	0	628,935
1894	126,642	0	415,787	0	542,429

GEORGIA.

Coking in Georgia is an industry of comparatively little importance. The only coal produced in the State is from the extreme northwestern portion, which is cut by the eastern border of the Appalachian coal field. In this small field coke has been produced for many years, the production in 1894 amounting to 93,029 tons, an increase of about 2,300 tons over that of 1893. All of the coal used was run of mine washed. Nearly all the coal mined at this works was made into coke, and all the coal run through the washer has been considered as charged into the ovens, without any reference to the loss of coal in washing.

The statistics of the production of coke in Georgia, 1880 to 1894, are as follows:

Statistics of the manufacture of coke in Georgia, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	1	140	40	63,402	38,041	$81,789	$2.15	60
1881	1	180	40	68,960	41,376	88,753	2.15	60
1882	1	220	44	77,670	46,602	100,194	2.15	60
1883	1	264	36	111,687	67,012	147,166	2.20	60
1884	1	300	0	132,113	79,268	169,192	2.13	60
1885	2	300	0	117,781	70,669	144,198	2.04	60
1886	2	300	0	136,133	82,680	179,031	2.17	60
1887	2	300	0	158,482	79,241	174,410	2.20	50
1888	1	290	0	140,000	83,721	177,907	2.12	60
1889	1	300	0	157,878	94,727	149,059	1.57	60
1890	1	300	0	170,388	102,233	150,995	1.48	60
1891	1	300	0	164,875	103,057	231,878	2.25	62.5
1892	1	300	0	158,978	81,807	163,614	2.00	51.5
1893	1	338	0	171,645	90,726	136,089	1.50	52.8
1894	1	338	0	166,523	93,029	116,286	1.25	55.9

The character of the coal used in the manufacture of coke in Georgia since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Georgia since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	0	0	0	170,388	170,388
1891	106,131	0	0	58,744	164,875
1892	0	0	0	158,978	158,978
1893	0	0	0	171,645	171,645
1894	0	166,523	0	0	166,523

ILLINOIS.

Though Illinois possesses large bodies of coking coal, all attempts to make coke on a large scale in this State have been practically abandoned, at least for the present, and until a more satisfactory way of dealing with coals like those in this State has been developed. Extraordinary efforts have been made to establish a coke industry in Illinois, chiefly with a view to utilizing the large amount of slack coal, that not only goes to waste, but which is expensive to dispose of. The chief difficulty in the way of making a satisfactory coke from this coal is that the coking qualities of much of it are inferior, though it has been found in some cases that by wetting the coal it cokes readily. A further difficulty is offered by the impurities in the coal, chiefly sulphur. No methods have yet been employed on a large scale for producing a coke free enough from these impurities and good enough in other respects to make it a blast-furnace fuel. Very carefully engineered and constructed washing plants have been erected for the purpose of treating the slack coal of this State on an extensive scale, but these plants have not been successful in removing the sulphur, which, as stated above, is the chief impurity that reduced the value of the coke made from the coals of this State.

In view of the character of the coal, therefore, all the coke produced in Illinois, which in 1894 was only 2,200 tons, is for domestic purposes and to be used in the manufacture of water gas.

The following are the statistics of the manufacture of coke in Illinois for the years from 1880 to 1894:

Statistics of the manufacture of coke in Illinois, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	6	176	0	31,240	12,700	$41,950	$3.30	41
1881	6	176	0	35,240	14,800	45,850	3.10	42
1882	7	304	0	25,270	11,400	29,050	2.55	45
1883	7	316	0	31,170	13,400	28,200	2.10	43
1884	9	325	0	30,168	13,095	25,639	1.96	43
1885	9	320	0	21,487	10,350	27,798	2.68	48
1886	9	335	0	17,806	8,103	21,487	2.65	46
1887	8	278	0	16,596	9,108	19,594	2.13	55.5
1888	8	221	0	13,020	7,410	21,038	2.84	56.9
1889	4	149	0	19,250	11,583	29,764	2.57	60
1890	4	148	0	9,000	5,000	11,250	2.25	55
1891	1	25	0	10,000	5,200	11,700	2.25	52
1892	1	24	0	4,800	3,170	7,133	2.25	66
1893	1	24	0	3,300	2,200	4,400	2.00	66.7
1894	1	24	0	3,800	2,200	4,400	2.00	57.9

The character of the coal used in the manufacture of coke in Illinois since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Illinois since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	0	0	0	9,000	9,000
1891	0	0	10,000	0	10,000
1892	0	0	4,800	0	4,800
1893	0	0	0	3,300	3,300
1894	0	0	0	3,800	3,800

INDIANA.

Indiana is another State, like Illinois, in which persistent attempts to produce coke on a large scale have been practically failures. There is an abundance of coal in Indiana that is good coking coal. This, mixed with the noncoking block coals, ought to produce, in some one of the many flue ovens that are used in Europe, coke that would be valuable for many purposes if not for blast-furnace use, while the by-products would make the manufacture of coke a financial success.

Experiments looking to such a use of the coals of this State have been in progress during the year 1894 with some very satisfactory results, excellent cokes having been made from a mixture of high and low volatile coals of Indiana in by-product ovens. It is probable that these experiments may lead to the use of Indiana coal for the manufacture of coke for metallurgical use.

The statistics of the manufacture of coke in Indiana from 1886 to 1894, both inclusive, are given in the following table:

Statistics of the manufacture of coke in Indiana, 1886 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1886	4	100	18	13,030	6,124	$17,953	$2.93	47
1887	4	119	0	35,600	17,658	51,141	2.81	50
1888	3	103	0	26,547	11,956	31,993	2.68	45
1889	4	111	0	16,428	8,301	25,922	3.12	51
1890	4	101	0	11,753	6,013	19,706	3.28	51
1891	2	84	0	8,688	3,798	7,596	2.00	44
1892	2	84	0	6,456	3,207	6,472	2.02	49.7
1893	2	94	0	11,549	5,724	9,048	1.58	49.6
1894	2	94	0	13,489	6,551	13,102	2.00	48.6

The character of the coal used in the manufacture of coke in Indiana since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Indiana since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	0	0	0	11,753	11,753
1891	0	0	0	8,688	8,688
1892	0	0	0	6,456	6,456
1893	0	0	930	10,619	11,549
1894	0	0	8,689	4,800	13,489

INDIAN TERRITORY.

The coking ovens of the Osage Coal and Mining Company, located at McAlester, still continue the only ones in the Indian Territory. These works are for the utilization of the slack coal produced in mining. The coke finds its chief market in Kansas and Missouri. The following analysis of the McAlester coke was furnished by the Osage Coal and Mining Company:

Analysis of coke produced at McAlester, Ind. T.

	Per cent.
Water	0.21
Volatile matter	2.45
Fixed carbon	87.02
Ash	10.32
Total	100.00
Sulphur	1.22

The statistics of the manufacture of coke in the Indian Territory from 1880 to 1894 are as follows:

Statistics of the manufacture of coke in the Indian Territory, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	1	20	0	2,494	1,546	$4,638	$3.00	62
1881	1	20	0	2,852	1,768	5,304	3.00	62
1882	1	20	0	3,266	2,025	6,075	3.00	62
1883	1	20	0	4,150	2,573	7,719	3.00	62
1884	1	20	0	3,084	1,912	5,736	3.00	62
1885	1	40	0	5,781	3,584	12,902	3.60	62
1886	1	40	0	10,242	6,351	22,229	3.30	62
1887	1	80	0	20,121	10,060	33,435	3.33	50
1888	1	80	0	13,126	7,502	21,755	2.90	57
1889	1	78	0	13,277	6,639	17,957	2.70	50
1890	1	78	0	13,278	6,639	21,577	3.25	50
1891	1	80	0	20,551	9,464	30,483	3.22	46
1892	1	80	0	7,138	3,569	12,402	3.47	50
1893	1	80	0	15,118	7,135	25,072	3.51	47
1894	1	80	0	7,274	3,051	10,693	3.50	42

The character of the coal used in the manufacture of coke in Indian Territory since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Indian Territory since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	0	0	0	13,278	13,278
1891	0	0	9,500	11,051	20,551
1892	0	0	0	7,138	7,138
1893	0	0	0	15,118	15,118
1894	0	0	0	7,274	7,274

KANSAS.

The coke industry of Kansas is only of local importance, the production of coke in this State being chiefly for domestic purposes and the smelting of lead, most of the coke produced in the State being made by the lead and zinc smelters for their own use.

The statistics of the manufacture of coke in Kansas from 1880 to 1894 are as follows:

Statistics of the manufacture of coke in Kansas, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	2	6	....	4, 800	3, 070	$6, 000	$1. 95	64
1881	3	15	....	8, 800	5, 670	10, 200	1. 80	64. 4
1882	3	20	....	9, 200	6, 080	11, 460	1. 70	65
1883	4	23	....	13, 400	8, 430	16, 560	1. 96	62. 9
1884	4	23	....	11, 500	7, 190	14, 580	2. 02	62. 5
1885	4	23	....	15, 000	8, 050	13, 255	1. 65	53⅔
1886	4	36	....	23, 062	12, 493	19, 204	1. 54	54. 2
1887	4	39	....	27, 604	14, 950	28, 575	1. 91	54
1888	6	58	....	24, 934	14, 831	29, 073	1. 96	59
1889	6	68	....	21, 600	13, 910	26, 593	1. 91	64
1890	7	68	....	21, 809	12, 311	29, 116	2. 37	56
1891	6	72	....	27, 181	14, 174	33, 296	2. 35	52
1892	6	75	....	15, 437	9, 132	19, 906	2. 18	59. 2
1893	6	75	0	13, 645	8, 565	18, 640	2. 18	62. 8
1894	6	61	0	13, 288	8, 439	15, 660	1. 855	63. 5

The character of the coal used in the manufacture of coke in Kansas since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Kansas since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	0	0	19, 619	2, 190	21, 809
1891	0	0	27, 181	0	27, 181
1892	0	0	15, 437	0	15, 437
1893	0	0	12, 445	1, 200	13, 645
1894	0	0	13, 288	0	13, 288

KENTUCKY.

While the cokes made in Kentucky are excellent fuels, the depression in the iron business of the last few years has interfered with the development of coke making. Had the blast furnaces and steel works at Middlesboro, in the southeastern portion of the State, been in operation there would have been a large development of the coke industry in the eastern field; and it might also be said that had it not been for the same depression the cokes of the western coal fields would have found a much larger market at St. Louis and possibly at Chicago.

As a coke-producing field the earlier of these two districts was the western field. More than twenty-five years ago coke was made from these coals for use in the old Airdrie furnace, near Paradise, in Muhlenberg County, which adjoins Christian, and two small works, one with 7 and the other with 3 ovens, the former at Mercer Station, in Muhlenberg County, and the other at Earlington, in Hopkins County, have been reported as in existence, but no coke has been made in either for a number of years. The vein from which the coke is made is supposed to be No. 7 of the western coal field. It is from 4 to 6 feet 2 inches thick, with slate partings. Where the coal has much cover it is quite pure. It is fairly bituminous and "goes off" readily when charged into the ovens.

This western coal field has an area of 4,500 square miles, is a broad synclinal, having its center axis nearly parallel with the Green River. The coals of the Lower Measures are brought to the surface around the eastern, southern, and western parts of the field. There are twelve workable coals in this field, but all are not present in any one vertical section. The Green River cuts entirely through the center of this field, exposing in its course outcrops of all of the coals of the field. The coke produced, according to a statement made by Prof. John R. Procter, formerly State geologist, to whom we are indebted for many of the facts contained in this description of the coal field, is of excellent physical structure, but high in sulphur. The coals used in coking in this district are the coals of the Upper Measures.

Two coke works were in operation in this district in 1894; one, the St. Bernard Coal Company, at Earlington, in Hopkins County; the other, the Ohio Valley Coal and Mining Company, at De Koven, in Union County, one of the Ohio River counties.

Analyses of the St. Bernard coke are given, as follows:

Analyses of St. Bernard, Kentucky, coke.

	Per cent.	Per cent.
Volatile matter	0.615	0.34
Fixed carbon	87.275	90.69
Sulphur	2.21	2.37
Ash	12.110	8.96

Exhaustive experiments with the coals of this district have been made at the instance of the St. Bernard Coal Company, of Earlington, Hopkins County, the most extensive miner of coal in the State. The tests and analyses were made at the Cambria Iron Works, Johnstown, Pa., by Mr. John Fulton and Mr. T. T. Morrell.

The following table exhibits the physical and chemical properties of the St. Bernard coke as compared with Connellsville:

Comparison of Connellsville and St. Bernard cokes.

	Locality.	
	Standard coke, Connellsville. (a)	St. Bernard, Kentucky. (b)
Grams in 1 cubic inch:		
Dry	12.46	12.87
Wet	20.25	20.92
Pounds in 1 cubic foot:		
Dry	47.47	49.03
Wet	77.15	79.70
Percentage:		
Dry	61.53	63.59
Wet	38.47	36.41
Compressing strength per cubic inch, one-fourth ultimate strength	284	328
Height of furnace charge supported without crushing	114	131
Order in cellular space	1	1
Hardness	3.5	3.2
Specific gravity	1.500	1.400
Chemical analysis:		
Fixed carbon	87.46	86.94
Moisture	0.49	....
Ash	11.32	12.10
Sulphur	.69	1.96
Phosphorus	.029	.012
Volatile matter	.011	....

a Authority, Prof. A. S. McCreath. *b* Authority, T. T. Morrell.

Regarding these tests, Mr. Fulton writes:

From this table the very close resemblance of the physical structure of the St. Bernard coke to that of Connellsville will be observed. It is so nearly equal to it in cellular space and hardness that no distinction should be drawn. Its burden-bearing property slightly exceeds the Connellsville.

This coke was made from washed slack. The sulphur is undoubtedly lower than would be found in ordinary practice. It is doubtful if coke can be made regularly from these coals with less than 2 to 2.5 per cent of sulphur.

A letter from the manager of the St. Bernard works states that the ash ranged in 1894 from 12 to 13 per cent and the sulphur 2½ per cent.

There is also a small bank of ovens built in this district at De Koven. Only a small amount of coke was made here from washed slack, the coke having the following analysis:

Analysis of coke from De Koven, Ky.

	Per cent.
Moisture	0.50
Volatile matter	.85
Fixed carbon	85.85
Ash	12.80
Total	100.00
Sulphur	2.14

The eastern and southern district, which may be termed the Pineville or Mingo Mountain district, overlaps into Tennessee, a considerable portion of the production of this district being credited to Tennessee rather than to Kentucky.

The eastern coal field has an area of 11,180 square miles, and is remarkable for the purity of some of its coals and the superior quality of the coke produced from it. It has been admitted that excellent coke can be made from at least three of the coals of eastern Kentucky. The main coking coal of this region has been named by the Geological Survey the "Elkhorn" seam, from the stream in Pike County, where it was first discovered and proven to be a coking coal of great excellence. Since its discovery it has been traced as a thick bed above drainage through several counties in southeastern Kentucky, and has been identified as a workable coal in several additional counties. The coal attains its greatest thickness in Pike, Letcher, and Harlan counties, Ky., and Wise County, Va. It produces a coke of from 92 to 94 per cent of fixed carbon and low in sulphur and ash. This coal field extends into Tennessee, where the coal is largely used for the production of coke. Analyses of the coal from this bed in Bell County, in which is situated the Pineville region, are as follows:

Analyses of coals from Bell County, Kentucky.

	Per cent.	Per cent.
Volatile combustible matter	37.90	38.60
Fixed carbon	57.78	57.30
Ash	3.12	2.70
Sulphur	1.030	.629

The coke produced from Bell County coal in the neighborhood of Middlesboro and Pineville is among the best cokes of the South and gives most excellent results in the blast furnace. The mines are well located and will permit of an almost indefinite expansion in the future. Analyses of cokes made from these coals in Bell County, taken from Professor Procter's report, as are the analyses of the coals above, are as follows:

Analyses of coke from Bell County, Kentucky.

	Per cent.	Per cent.
Fixed carbon	95.80	94
Ash	4	5.60
Sulphur	1.710	.629

These cokes were made from the same coals of which the analyses are given above. Recently disintegrators for preparing the coal before coking have been introduced at the Middlesboro ovens with the most gratifying result, the value of the coke as a blast-furnace fuel being improved.

The statistics of the manufacture of coke in Kentucky from 1880 to 1894 are as follows:

Statistics of the manufacture of coke in Kentucky, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Value of coke at ovens, per ton.	Total value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	5	45	....	7,206	4,250	$2.88	$12,250	60
1881	5	45	....	7,406	4,370	2.89	12,630	60
1882	5	45	....	6,906	4,070	2.83	11,530	59
1883	5	45	....	8,437	5,025	2.87	14,425	60
1884	5	45	....	3,451	2,223	3.94	8,760	64
1885	5	33	....	5,075	2,704	3.14	8,489	53
1886	6	76	2	9,055	4,528	2.23	10,082	50
1887	6	98	....	29,129	14,565	2.18	31,730	50
1888	10	132	2	42,642	23,150	2.04	47,244	54
1889	9	166	100	25,192	13,021	2.28	29,769	52
1890	9	175	303	24,372	12,343	1.80	22,191	51
1891	7	115	24	64,390	33,777	2.02	68,281	52
1892	5	287	100	70,783	36,123	2.01	72,563	51
1893	4	283	100	97,212	48,619	2.00	97,350	50
1894	6	293	0	66,418	29,748	1.73	51,566	44.8

The character of the coal used in the manufacture of coke in Kentucky since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Kentucky since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	0	3,000	2,100	19,272	24,372
1891	11,000	0	3,500	49,890	64,390
1892	0	5,955	7,883	56,945	70,783
1893	825	11,973	26,759	57,655	97,212
1894	0	2,980	7,900	55,538	66,418

MISSOURI.

The same statement can be made regarding the production of coke in Missouri as is made regarding the Kansas coke industry. The three works in this State at which coke is made are all run in connection with the smelting of zinc, the coke being made especially for this purpose. At some, if not all, of the works the coke is 24-hour coke. The value given for the coke must be regarded simply as an estimate representing about the cost of manufacturing it. The probability is that the yield of coal in coke is too high. However, as the coke is burned for twenty-four hours, it may be that the yield is greater than would be the result of longer burning.

The statistics of the production of coke in Missouri from 1887, when coking began in this State, to 1894 are as follows:

Statistics of the manufacture of coke in Missouri, 1887 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Value of coke at ovens, per ton.	Total value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1887	1	4	....	5,400	2,970	$3.50	$10,395	55
1888	1	4	....	5,000	2,600	3.50	9,100	52
1889	3	9	....	8,485	5,275	1.10	5,800	62
1890	3	10	....	9,491	6,136	1.51	9,240	65
1891	3	10	....	10,377	6,872	1.45	10,000	66
1892	3	10	....	11,088	7,299	1.50	10,949	65.8
1893	3	10	0	8,875	5,905	1.65	9,735	66.5
1894	3	10	0	3,442	2,250	1.58	3,563	65.4

The character of the coal used for coke in Missouri since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Missouri since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	0	0	9,491	0	9,491
1891	0	0	10,377	0	10,377
1892	0	0	11,088	0	11,088
1893	0	0	8,875	0	8,875
1894	0	0	3,442	0	3,442

MONTANA.

The production of coke in Montana in 1894 shows a decided falling off as compared with previous years, being only some 10,000 tons, as compared with 29,945 tons in 1893 and 34,557 tons in 1892. The production of 1894 was the smallest of any year since 1887. This great decline in production is the result of the depression in silver, the silver smelters in Montana, who are the chief customers for the coke, requiring a very much less amount of coke than in previous years.

Coke has been made from two of the coal fields of Montana, viz, the Bozeman and the Gardner.

The Bozeman field lies in the midst of the Belt range, 12 miles east of Bozeman. There are two varieties of coal in this field: A solid block or dicey coal, which can be mined in pieces as large as the width of the seam, and which withstands weather and transportation excellently; and a friable, chippy variety, coming out in lenticular masses, which crumble, upon exposure to the weather or upon being transported, into minute fragments about an inch long by half an inch wide and of about one-eighth of an inch thick. Both are varieties of bituminous coal, and make a fair coke, though, as is usually the case, the friable coal makes the better.

The Gardner field lies on the Upper Yellowstone, near the entrance to Yellowstone National Park. The only valuable portions of this field, as far as present developments show, are from 2 to 2½ miles long.

It can be said of the coke produced in this field, in a general way, that it averages from 9 to 17 per cent in ash, with a slight trace of sulphur. The coke finds a ready market at Butte, Anaconda, Helena, and other places in the immediate neighborhood of the ovens.

The statistics of the manufacture of coke in Montana from 1883, when ovens were first reported, to 1894, are as follows:

Statistics of the manufacture of coke in Montana, 1883 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Value of coke at ovens, per ton.	Total value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1883	1	2	0	0	0	0	0	0
1884	3	5	12	165	75	$12.00	$900	46
1885	2	2	0	300	175	11.72	2,063	58.5
1886	4	16	0	0	0	0	0	0
1887	2	27	0	10,800	7,200	10.00	72,000	66⅔
1888	1	40	0	20,000	12,000	8.00	96,000	60
1889	2	90	50	30,576	14,043	8.69	122,023	46
1890	2	140	0	32,148	14,427	8.71	125,655	45
1891	2	140	0	61,667	29,009	8.91	258,523	47
1892	2	153	0	64,412	34,557	9.00	311,013	53.6
1893	2	153	0	61,770	29,945	8.00	239,560	48.5
1894	2	153	0	22,500	10,000	11.00	110,000	44.4

The character of the coal used in the manufacture of coke in Montana since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Montana since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	0	22,852	0	9,296	32,148
1891	0	34,000	0	27,667	61,667
1892	0	28,000	0	36,412	64,412
1893	0	44,000	0	17,770	61,770
1894	0	22,500	0	0	22,500

NEW MEXICO.

A small amount of coke is made in New Mexico for the use of the silver smelters of the Territory. The industry is of but little importance, but 6,529 tons being produced in 1894.

The statistics of the production of coke in New Mexico from 1882, when coke ovens were first reported, until 1894, were as follows:

Statistics of the manufacture of coke in New Mexico, 1882 to 1894.

Years.	Establishments.	Ovens built. (*a*)	Ovens building.	Coal used.	Coke produced.	Value of coke at ovens, per ton.	Total value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1882	2	0	12	1,500	1,000	$6.00	$6,000	$66\frac{2}{3}$
1883	2	12	28	6,941	3,905	5.50	21,478	$57\frac{1}{4}$
1884	2	70	0	29,990	18,282	5.00	91,410	$57\frac{1}{4}$
1885	2	70	0	31,889	17,940	5.00	89,700	$56\frac{1}{4}$
1886	2	70	0	18,194	10,236	5.00	51,180	56
1887	1	70	0	22,549	13,710	6.00	82,260	61
1888	1	70	0	14,628	8,540	6.00	51,240	58
1889	2	70	0	7,162	3,460	5.32	18,408	48
1890	2	70	0	3,980	2,050	4.89	10,025	51.5
1891	1	70	0	4,000	2,300	4.75	10,925	57.5
1892	1	50	0	0	0	0	0	0
1893	1	50	0	14,698	5,803	3.18	18,476	39.5
1894	1	50	0	13,042	6,529	4.32	28,213	50

a At one works there are ten stone pits, with an average capacity of 10 tons each.

The character of the coal used in the manufacture of coke in New Mexico since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in New Mexico since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	3,980	0	0	0	3,980
1891	4,000	0	0	0	4,000
1892	0	0	0	0	0
1893	14,698	0	0	0	14,698
1894	0	0	13,042	0	13,042

NEW YORK.

In 1892 12 by-product ovens on the Semet-Solvay principle were built at Syracuse, N. Y., and while they have been operated chiefly on Pennsylvania coal they have been frequently used for testing coals from other districts. These ovens are horizontal-flue ovens, having movable flues, and are adapted for the saving of by-products. The operation of these ovens has been very successful. Coals that have not been regarded as very high-grade coking coals have been used with the most gratifying results. The yield of coal in coke is as high as 85 per cent. This includes not only what might be termed "commercial" coke, that is, large coke, but the "breeze" as well. In the supplementary report on by-product coke ovens, which will be presented in the near future, we shall treat comprehensively of these ovens.

Owing to the fact that there is but one bank of ovens in this State, the proprietors decline to permit the publication of detailed statistics regarding the same. All that can be said is that there is one establishment in the State, 12 ovens built and 13 building, and the production of coke in 1894 was 16,500 tons.

OHIO.

Though Ohio was among the first States to manufacture coke, this industry has never been an important one in the State, either with reference to the actual amount of coke produced or as to its character. In 1894 but 32,640 tons of coke were made in this State, of which but 6,223 tons were made from coal produced in the State, the rest being made at Cincinnati and its neighborhood from coal brought down the Ohio River. And yet it would seem that under proper conditions a fairly good quality of coke could be produced in Ohio, at least for some purposes, though possibly not the best coke for blast-furnace use. It is evident, however, that little or no coke produced from Ohio coal can compete with Connellsville coke when the latter sells at the mines at 90 cents and $1 a ton.

According to Professor Orton, the seams of coal that have been coked with any success in this State are No. 4, corresponding to the Lower Kittanning of Pennsylvania; No. 6, corresponding to the Middle Kittanning, and No. 7, the equivalent of the Upper Freeport. The coal coked at Leetonia, at which point the best coke made in the State is produced, is from No. 4, the Lower Kittanning. This coal is used to but a small extent in Pennsylvania for coking, and the same is true of the Middle Kittanning, used at Hammondsville and at Zanesville, while the Upper Freeport, the Hocking Valley coal at Happy Hollow, is the bed used largely in the Alleghany Mountain, Snow Shoe, and Broad Top districts. The Steubenville coke is made from the Lower Freeport, the same vein that is used at the important Walston mines of the Rochester and Pittsburg Coal and Iron Company, near Punxsutawney, Pa.

It should be said, however, that Ohio coke, as a rule, is soft and brittle, high in sulphur, and in some cases in ash also, though this is not always true, some of the Ohio cokes, that from Leetonia, being among the commercial cokes lowest in ash and sulphur found in the country. These weak, soft cokes do not stand transportation, nor do they carry the furnace burden as well as harder cokes and those that carry more ash.

When the inferiority of the coke is due to excess of sulphur or ash, either the coal itself or careless mining is responsible. When the cause is the coal, the impurities may be removed by washing, unless the specific gravity of the coal and the impurities are nearly equal, and even then, with the proper washing apparatus, the coal can be cleaned to a large extent. When the cause of the impurities is careless mining, greater care may give a purer coke. When the coke is reasonably pure, but soft and brittle, the inferiority of the coke may possibly be due to the lack of that constituent in the coke which gives strength and hardness, or it may be due to imperfect methods of coking. There is no doubt that too little study has been given to adapting the oven and method of coking to Ohio coals. The ovens most commonly used have been the beehive, though some very thorough trials have been made with the Belgian or retort ovens, but without the saving of by-products. In the use of the beehive ovens there seems to have been but little attempt to study adaptability of form or methods of burning to the coal used. The beaten track that has been successful in other localities, where the coal charged into the ovens has been in many cases an essentially different fuel, has been followed, and the result has been that not even that success has been attained which might have been secured had there been a more careful study of the coal and a more earnest effort to discover that form of oven and the details of burning best adapted to the materials used.

In this report we have divided the coke production of Ohio into two districts: The Cincinnati district, which includes the ovens in the neighborhood of Cincinnati, and all of which made coke from coa- brought down the Ohio River from points usually outside of the State, and, second, the Ohio district, which includes the ovens at Leetonia, those in the Hocking Valley, and those near Steubenville and Bridgeport, making coal from entirely different seams.

As the coking industry of this State is of so slight importance at the present time, and does not promise to be of any importance in the near future, we shall omit any detailed description of the various coal fields in which coke has been and can be produced. These are described in previous volumes of the Mineral Resources, to which reference can be had. We simply include statistics.

The statistics of the manufacture of coke in the Cincinnati district from 1880 to 1894 are as follows:

Statistics of the manufacture of coke in the Cincinnati district, Ohio, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Value of coke at ovens, per ton.	Total value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	4	32	0	16,141	10,326	$4.09	$42,255	64
1881	4	32	0	20,607	13,237	4.11	54,439	64
1882	4	32	0	19,687	12,045	3.78	47,437	64
1883	5	57	0	33,978	20,106	3.28	65,990	59
1884	5	57	0	32,134	18,840	3.24	61,072	59
1885	5	82	0	17,480	10,962	3.27	35,873	63
1886	5	82	0	17,015	10,566	2.99	31,633	62.1
1887	5	150	20	56,723	32,894	2.91	95,754	56
1888	6	156	12	63,217	35,868	2.67	95,618	57
1889	5	146	0	75,892	45,108	2.68	120.899	59
1890	5	150	0	68,266	43,278	3.97	171,848	63
1891	3	130	0	13,403	9,080	3.47	31,529	67.6
1892	4	146	0	31,330	19,320	3.33	64,319	61.6
1893	3	142	0	13,700	9,000	3.00	27,000	65.7
1894	3	92	0	42,995	26,417	3.09	81,751	61

CINCINNATI DISTRICT.

All the coke made in this district is from the dust and screenings of the coal yards at Cincinnati and from the coal boats and barges that bring coal from the Upper Ohio, chiefly from the Pittsburg and the

Kanawha regions of West Virginia. Some run-of-mine coal is also coked at North Bend. The North Bend block of ovens, the largest in the Cincinnati district, is on the Ohio River, a short distance below Cincinnati, and generally uses when in operation slack from Pittsburg mines. The proprietors of this works have in contemplation the erection of some form of oven other than the beehive, possibly a modified beehive with the saving of by-products, possibly some one of the well-known flue by-product ovens.

OHIO DISTRICT.

This district, as noted above, includes all of the ovens coking Ohio coal, and the ovens at Leetonia, in the Hocking Valley, and in the vicinity of Steubenville and Bridgeport, which is opposite Wheeling.

The following table gives the statistics of the production of coke in the Ohio district for the years 1880 to 1894:

Statistics of the manufacture of coke in the Ohio district, Ohio, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	11	584	25	156, 312	90, 270	$213, 650	$2. 37	57
1881	11	609	0	180, 438	106, 232	243, 289	2. 39	59
1882	12	615	0	161, 890	91, 677	218, 676	2. 39	57
1883	13	625	0	118, 524	67, 728	159, 670	2. 36	57
1884	14	675	0	76, 030	43, 869	95, 222	2. 17	58
1885	8	560	0	51, 316	28, 454	73, 850	2. 60	55
1886	10	478	0	42, 317	24, 366	62, 409	2. 56	57¾
1887	10	435	203	108, 251	60, 110	150, 227	2. 50	55½
1888	9	391	0	60, 984	1, 326	70, 712	2. 25	51
1889	8	316	0	56, 936	30, 016	67, 323	2. 24	52. 7
1890	8	293	1	58, 655	31, 335	46, 242	1. 47	53. 4
1891	6	291	0	55, 917	39, 638	45, 372	1. 53	53
1892	6	290	0	63, 905	22, 498	48, 588	1. 50	50. 9
1893	6	293	0	29, 263	33, 436	16, 671	1. 24	46
1894	5	271	0	12, 329	16, 223	9, 124	1. 466	50. 5

TOTAL PRODUCTION OF COKE IN OHIO.

In the following table the statistics of the production of coke in the several districts of Ohio for the years 1880 to 1894 are consolidated:

Statistics of the manufacture of coke in Ohio, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	15	616	25	172, 453	100, 596	$255, 905	$2. 54	58
1881	15	641	0	201, 045	119, 469	297, 728	2. 49	59
1882	16	647	0	181, 577	103, 722	266, 113	2. 57	57
1883	18	682	0	152, 502	87, 834	225, 660	2. 57	58
1884	19	732	0	108, 164	62, 709	156, 294	2. 49	58
1885	13	642	0	68, 796	39, 416	109, 723	2. 78	57
1886	15	560	0	59, 332	34, 932	94. 042	2. 69	59
1887	15	585	223	164, 974	93, 004	245. 981	2. 65	56
1888	15	547	12	124, 201	67. 194	166, 330	2. 48	54
1889	13	462	0	132, 828	75, 124	188, 222	2. 50	56
1890	13	443	1	126, 921	74, 633	218, 090	2. 92	59
1891	9	421	0	69, 320	38, 718	76, 901	1. 99	56
1892	10	436	0	95, 236	51, 818	112, 907	2. 18	54. 4
1893	9	435	0	42, 963	22, 436	43, 671	1. 95	52
1894	8	363	0	55, 324	32, 640	90, 875	2. 78	59

The character of the coal used in the manufacture of coke in Ohio since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Ohio since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	34,729	0	54,473	37,719	126,921
1891	5,200	0	64,120	0	69,320
1892	35,334	0	32,402	27,500	95,236
1893	0	0	24,859	18,104	42,963
1894	0	0	14,845	40,479	55,324

PENNSYLVANIA.

The coking districts of Pennsylvania are divided in this and previous volumes of Mineral Resources into the twelve districts named in the table given below. The division of these districts is chiefly geographical, and for the most part explains itself.

The Alleghany Mountain district includes the ovens along the line of the Pennsylvania Railroad from Gallitzin eastward over the crest of the Alleghanies to beyond Altoona. The Alleghany Valley district includes 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. The Beaver district includes the ovens in Beaver County; the Blossburg and Broad Top those in the Blossburg and Broad Top coal fields. The ovens of the Clearfield-Center district are chiefly in the two counties from which it derives its name. The Connellsville district is the well-known region in western Pennsylvania, in Westmoreland and Fayette counties, extending from just south of Latrobe to Fairchance. 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, sometimes called the Latrobe, district is near the town of this name.

The coals coked in Pennsylvania are chiefly the Pittsburg seam of the Upper Monongahela River series of Rogers's Geological Survey of Pennsylvania and the Upper Freeport and Lower Kittanning of the Lower Measures of the Alleghany River series of Rogers. Practically all the coal coked in Pennsylvania along the line of the Pennsylvania Railroad and south of the same until the Alleghany Mountains are reached is mined from the Upper Coal Measures, while that coked north of this district is from the Lower Measures. No general description of these well-known coal beds need be given here. It may be said, however, in a general way that the Pittsburg bed is one of the most important coal seams in the world. It extends as a bituminous coal bed from the extreme eastern portion of the Appalachian coal field at Cumberland, where it is the Big Vein, to far out into Ohio.

Within the Coal Measures proper there are probably one hundred different individual coal beds which in special localities have a thickness of over 1 foot. Not more than one-fifth of these beds, however, can be considered workable in a commercial sense; that is, have a thickness of over 2 feet, which is a minimum thickness under the most favorable circumstances at which any of the Pennsylvania beds may be worked. At the present time under ordinary circumstances a bed of 3 feet in thickness is about as thin a bed as can be profitably worked.

Dr. H. M. Chance estimates that the bituminous coal areas of Pennsylvania cover about 9,000 square miles. Practically this entire amount of coal is coking coal. Some of it produces better coke than others, but practically the entire bed in Pennsylvania produces coking coal. In the eastern part it is low in volatile matter and in the western part high, the typical coking coal being that at Connellsville, which contains some 29 or 30 per cent volatile matter and cokes readily in the beehive oven, making a typical furnace fuel.

Regarding the Upper Freeport and Middle Kittanning seams it may be said that these cover a much larger territory and will give a much larger amount of coal than even the Pittsburg seam. As will be seen by reference to the detailed description of the several coking districts, the coal from these Lower Measures are coking, not only in Alleghany River Valley of Pennsylvania, but in the Upper Potomac regions of Maryland and West Virginia and in the Kanawha district of the latter State. It is probable also that some of the beds of coal in the States to the south of West Virginia will be identified with the Lower Productive Measures, or Alleghany River series of Pennsylvania.

The statistics of the production of coke in Pennsylvania by districts in 1892, 1893, and 1894 are given in the following tables:

Coke production in Pennsylvania in 1894, by districts.

Districts.	Establishments.	Number of ovens.	Number of ovens building.	Coal used.	Coke produced.	Value of coke at ovens.	Average price per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per ct.*
Alleghany Mountain	15	1,253	0	92,965	58,823	$71,161	$1.21	63.3
Alleghany Valley	2	116	0	0	0	0	0	0
Beaver	2	8	0	2,968	1,624	4,251	2.62	54.7
Blossburg	1	250	0	670	332	896	2.70	49.6
Broad Top	5	454	14	53,216	34,089	51,815	1.52	64.1
Clearfield-Center	8	694	0	61,428	38,825	51,482	1.33	63.2
Connellsville	29	17,829	0	7,656,169	5,192,080	5,405,691	1.04	67.8
Greensburg	3	118	0	27,290	15,872	18,413	1.16	58.2
Irwin	5	725	0	176,318	110,995	119,764	1.08	63
Pittsburg	9	779	104	371,569	227,100	351,825	1.55	61.1
Reynoldsville-Walston	8	1,755	0	336,554	207,238	297,596	1.44	61.6
Upper Connellsville	14	1,843	0	279,971	176,799	212,595	1.20	63.1
Total	101	25,824	118	9,059,118	6,063,777	6,585,489	1.086	66.9

Coke production in Pennsylvania in 1893, by districts.

Districts.	Establishments.	Number of ovens.	Number of ovens building.	Coal used.	Coke produced.	Value of coke at ovens.	Average price per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per ct.*
Alleghany Mountain ..	15	1,260	0	275,865	173,131	$264,292	$1.53	62.8
Alleghany Valley	2	116	0	10,927	6,557	11,147	1.70	60
Beaver	2	10	0	2,998	1,644	4,446	2.70	54.8
Blossburg	2	407	0	22,176	11,463	31,427	2.74	51.7
Broad Top	5	456	14	136,069	86,752	150,196	1.73	63.8
Clearfield-Center	8	695	0	155,119	98,650	171,482	1.74	63.6
Connellsville	28	17,504	5	7,095,491	4,805,623	7,141,031	1.49	67.7
Greensburg	3	88	0	29,983	18,393	26,303	1.43	61
Irwin	5	725	0	238,832	150,463	195,609	1.30	63
Pittsburg	10	885	0	357,400	216,268	438,801	2.03	60.5
Reynoldsville-Walston	8	1,755	0	562,033	339,314	586,212	1.73	60.4
Upper Connellsville...	14	1,843	0	499,809	320,793	447,090	1.39	64
Total	102	25,744	19	9,386,702	6,229,051	9,468,036	1.52	66

Coke production in Pennsylvania in 1892, by districts.

Districts.	Establishments.	Number of ovens.	Number of ovens. building.	Coal used.	Coke produced.	Value of coke at ovens.	Average price per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per ct.*
Alleghany Mountain ..	16	1,260	0	724,903	448,522	$775,927	$1.73	61.9
Alleghany Valley	3	148	0	0	0	0	0	0
Beaver	2	10	0	3,925	2,154	6,270	2.91	54.9
Blossburg	2	404	0	30,746	16,675	45,855	2.75	54.2
Broad Top	5	488	8	185,600	117,554	216,090	1.84	63.3
Clearfield-Center	7	731	0	231,357	147,819	264,422	1.79	63.9
Connellsville	31	17,309	0	9,389,549	6,329,452	11,598,467	1.83	67.4
Greensburg	2	58	0	15,005	9,037	13,173	1.46	60.2
Irwin	4	696	0	328,193	202,809	284,029	1.40	61.8
Pittsburg	15	725	261	292,357	176,365	376,613	2.14	60.3
Reynoldsville-Walston.	8	1,734	0	683,539	425,250	743,227	1.75	62.2
Upper Connellsville....	14	1,843	0	706,171	451,975	691,323	1.53	64
Total	109	25,366	269	12,591,345	8,327,612	15,015,336	1.80	66.1

From the above table it will be seen that of the 9,196,244 tons of coke produced in the United States in 1894, 6,063,777 tons, or 65.9 per cent, were produced in Pennsylvania. In 1893 Pennsylvania produced 6,229,051 tons, or 65.7 per cent of the total of 9,477,580 tons produced in the United States. The Connellsville, Pittsburg, and Reynoldsville-Walston districts each produced more coke than any State in the Union, except Pennsylvania, West Virginia, Alabama, Colorado, and Tennessee. Virginia and the Upper Connellsville region produced about equal amounts of coke. In the production of these 6,063,777 tons of coke, 9,059,118 tons of coal, valued at $5,317,695, or 58.9 cents a ton, was used. The yield of the coal and coke was given at 66.9 per cent, but this is evidently an error, growing out of the fact, as we have already explained, that much of the coal is not weighed before charging and much of that charged is paid for by the measured bushel, while coke is sold by the weighed ton.

Of the 9,059,118 tons of coal used, 8,789,813 tons, or 97 per cent, was run of mine; 269,305 tons, or 3 per cent, slack. Of the total amount of run of mine but 118,279 tons was washed, and of the slack but 64,494 tons was washed. In other words, but 182,773 tons, or 2 per cent, of the total of 9,059,118 tons of coal coked in Pennsylvania in 1894 was washed.

The average value of the coke produced in Pennsylvania in 1894 was $1.086, as compared with $1.52 in 1893 and $1.80 in 1892.

The great falling off in coke production in Pennsylvania in the last two years, as well as the great reduction in price, is due to the condition of the iron industry, already referred to in this report.

In the following table the statistics are given of the production of coke in Pennsylvania for the years 1880 to 1894:

Statistics of the manufacture of coke in Pennsylvania, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	124	9, 501	836	4, 347, 558	2, 821, 384	$5, 255, 040	$1. 86	65
1881	132	10, 881	761	5, 393, 503	3, 437, 708	5, 898, 579	1. 70	64
1882	137	12, 424	642	6, 149, 179	3, 945, 034	6, 133, 698	1. 55	64
1883	140	13, 610	211	6, 823, 275	4, 438, 464	5, 410, 387	1. 22	65
1884	145	14, 285	232	6, 204, 604	3, 822, 128	4, 783, 230	1. 25	62
1885	133	14, 553	317	6, 178, 500	3, 991, 805	4, 981, 656	1. 25	64. 6
1886	108	16, 314	2, 558	8, 290, 849	5, 406, 597	7, 664, 023	1. 42	65. 2
1887	151	18, 294	802	8, 938, 438	5, 832, 849	10, 746, 352	1. 84	65. 3
1888	120	20, 381	1, 565	9, 673, 097	6, 545, 779	8, 230, 759	1. 26	68
1889	109	22, 143	567	11, 581, 292	7, 659, 055	10, 743, 492	1. 40	66
1890	106	23, 430	74	13, 046, 143	8, 560, 245	16, 333, 674	1. 91	65. 6
1891	109	25, 324	11	10, 588, 544	6, 954, 846	12, 679, 826	1. 82	66
1892	109	25, 366	269	12, 591, 345	8, 327, 612	15, 015, 336	1. 80	66. 1
1893	102	25, 744	19	9, 386, 702	6, 229, 051	9, 468, 036	1. 52	66
1894	101	25, 824	118	9, 059, 118	6, 063, 777	6, 585, 489	1. 086	66. 9

The character of the coal used in the manufacture of coke in Pennsylvania since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Pennsylvania since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	11, 788, 625	303, 591	630, 195	323, 732	13, 046, 143
1891	9, 470, 646	256, 807	558, 106	302, 985	10, 588, 544
1892	11, 237, 253	159, 698	1, 059, 994	134, 400	12, 591, 345
1893	8, 302, 307	216, 762	739, 128	128, 505	9, 386, 702
1894	8, 671, 534	118, 279	204, 811	64, 494	9, 059, 118

CONNELLSVILLE DISTRICT.

The Connellsville district still remains the most important coke-producing center in the United States, and one of the most important in the world. The Connellsville coal basin is in the southwestern part of Pennsylvania, some 50 or 60 miles from Pittsburg. According to a recent topographic survey, made by Mr. Kenneth Allen, civil engineer, for the H. C. Frick Coke Company, the basin has a length of 43.6 miles, and an average width of 3.1 miles, or an area of 137 square miles. This entire territory is supposed to be underlaid with the Connellsville seam of coal, which is without a fault, the beds yielding from 8 to 10 feet of workable coal. On the basis of 137 square miles there would be 87,680 acres of coal. There is not this amount now, however, as considerable of it has been worked out. It is estimated that the amount of coal land still remaining is somewhere about 60,000 acres, which at the usual average of this coal per acre would leave about 450,000,000 tons of coal still available in the Connellsville vein. There are in this district several other veins of coal lying under the Connellsville seam that will be available to make a coke much above the average of cokes when the Connellsville vein is exhausted, and the trough in which the Connellsville region is found extends both to the north and south in which the same coal bed occurs, though the coal is not of the same high grade.

This Connellsville seam of coal yields from 8 to 10 feet of workable coal. The coal is clean, almost entirely free from slate and sulphur, remarkably soft, easily mined, uniform in quality and thickness. purity of this coal and its chemical and physical characteristics make it peculiarly adapted for coking, and is what gives it such great value. It is cheaply mined, and cokes easily with but little care. It is this cheapness of mining and of coking that makes it possible to put coke from this district in competition with cokes and fuels in the most distant parts of the United States. The following may be regarded as a typical analysis of the Connellsville coal:

Analysis of Connellsville coal.

	Per cent.
Water	1.130
Volatile matter	29.812
Fixed carbon	60.420
Sulphur	.689
Ash	7.949

There are in this region 17,829 coke ovens, the smallest plant having 16, the largest 905. At a recent date these plants were supplied with coal from 89 mines, divided as follows: Thirty-six drifts, 32 slopes, and 21 shafts. The shafts vary in depth from 50 to 542 feet; slopes vary from 180 to 6,000 feet horizontal depth, while some of the drifts extend over 2 miles under ground. The coal is carried from the mine in wagons, ranging in size from 1½ tons to 2½ tons capacity. Iron lorries are used for conveying the coal from the bins at the pit mouth to the ovens, and have a capacity of from 6 to 8 tons. Both the wagons and lorries are generally drawn by horses or mules; but at large plants wire-rope haulages have been introduced for transporting coal under ground, and small locomotives are used on the ovens for hauling the lorries. The prevailing system of mining is what is known in this country as the "double-heading-pillar-and-room" system, and it is estimated that 90 per cent of the coal is recovered. The roof over the coal is fair; the bottom generally good, but in many cases a soft fire clay bottom is found. "Rooms" are driven 4 yards wide, leaving pillars 9 yards. The drift mines are all opened from the outcrop, and are self-draining. The shaft and slope mines are pumped by compressed air or steam. The fan is the favorite means of ventilating. The average miner mines and loads 8 tons of this coal in nine hours.

In this district beehive ovens are used exclusively, and are built in single rows, or what are called "bank ovens," and in double rows, called "block ovens." The ovens vary in size from 10 feet 6 inches to 12 feet in diameter and from 5 to 7 feet high in the clear. The fire brick used in the construction of ovens is made in the district. It requires 3,000 crown brick, 1,200 lining brick, 120 bottom tile, and 20 cubic yards of stone to build a standard beehive oven.

The process of coking is very simple. The coal is dumped from the lorry into the oven through an opening in the crown, which is called the "trunnel head," probably a corruption of "tunnel head." These lorries are made to carry one charge at a time, and as the quantity of coal charged or put into the ovens varies according to the size of the ovens the size or capacity of the lorries also varies. In the larger ovens 4½ tons of coal is the usual charge for 48-hour coke and 6 tons for 72-hour coke.

The following statement of the method of operating the ovens in this district is taken, as is also some of the other information contained in this report, from a monograph on Connellsville coal published by the H. C. Frick Coke Company:

Now that the oven is charged, the next step is to level its contents. The coal was dropped from the lorry through the trunnel head and it naturally fell into the oven in a pyramidal shape, and must be leveled. This is done through the door by means of a long iron rod with a scraper welded onto the end of it. The oven door is now walled up with fire brick and plastered over with a luting made of very fine sharp sand or good loam. In about thirty minutes a pale blue smoke slowly arises out of the trunnel head, from which the damper has in the meantime been removed. At first the smoke is very pale and weak; but it gradually grows darker and stronger, and in about thirty minutes more it goes off with a puff similar to an explosion of powder, which signifies the coal has ignited. The coal burns from the top down, and the process of burning, or, as the workmen call it, "airing" of the ovens is regulated through the door by means of little holes made around the arch in the form of a semicircle. Through these openings the air is admitted, and the smoke and impurities are expelled through the trunnel head. In seventy-two hours after the coal has been charged, if properly handled, the oven will be "around," or coked, and we have good "foundry" coke. When the oven is "around" it looks like a mass of red-hot coals. The coke "drawers" now take charge of the ovens, and, after knocking the doors down, cool the coke by introducing water into the ovens by means of a hose with a long piece of ¾-inch gas pipe attached to the end. When the coke is thoroughly cooled it is drawn out of the oven and loaded direct into railroad cars. The implement used for drawing the coke out is the same as that used for leveling the coal.

When the ovens are first started the coal is ignited by means of wood, red-hot coals, etc., just the same as a coal fire has to be started in a stove. After repeated charging and drawing, however, the ovens become hot, and the coal is ignited by the heat retained in the oven walls from the last charge.

For cooling the coke pure water is absolutely necessary to insure the purest coke. If the water contains sulphur and other impurities the coke absorbs them, and it becomes injurious to metals manufactured with it.

The following is an analysis of what is probably the best coke in the region, at least so far as ash is concerned:

Analysis of Connellsville coke.

	Per cent.
Water	0.070
Volatile matter	.880
Fixed carbon	89.509
Sulphur	.711
Ash	8.830

The following is another analysis of Connellsville coke, as determined by Prof. A. S. McCreath:

Analysis of Connellsville coke.

	Per cent.
Water	0.030
Volatile matter	.460
Fixed carbon	89.576
Sulphur	.821
Ash	9.113

The following are the analyses of the Connellsville bed at the different mines of the H. C. Frick Coke Company:

Analyses of Connellsville coal from the H. C. Frick Coke Company's mines in Fayette County, Pennsylvania.

Names of mines.	Locations.	Fixed carbon.	Volatile matter.	Ash.	Sulphur.	Total.
		Per cent.	*Per cent.*	*Per ct.*	*Per ct.*	*Per ct.*
Henry Clay	Broad Ford	61.49	32.40	5.10	1.01	100
Frick	do	60.92	32.60	5.40	1.08	100
Valley	Valley Works	63.78	30.60	4.50	1.12	100
Trotter	Trotter Station	63.34	30.20	5.40	1.06	100
Eagle	Sherrick	62.68	27.90	7.50	1.92	100
Summit	Summit	59.80	33.80	5.40	1.00	100
Tip Top	Tinshnan	60.90	32.10	5.60	1.40	100
Morgan	Morgan	58.10	33.60	7.10	1.20	100
Foundry	Sherrick	65,36	28.40	4.90	1.34	100
White	do	63.30	28.80	6.80	1.10	100

Probably the most exhaustive analyses of the coke from this region have been made by Mr. J. Blodgett Britton. The following is the average of a large number of analyses of all sorts of Connellsville coke, and can, therefore, be regarded as a fair analysis of good coke:

Average composition of Connellsville coke.

	Per cent.
Moisture	0.490
Ash	11.332
Sulphur	.693
Phosphoric acid	.029
Carbon, by difference	87.456

Mr. E. C. Pechin gives a typical verified analysis of this coke, as follows:

Typical analysis of Connellsville coke according to Mr. E. C. Pechin.

	Per cent.
Volatile matter	1.296
Carbon, hydrogen, and nitrogen	89.147
Ash	9.523
Water	.032
Sulphur	.084
Ash ignited:	
Silica	5.413
Alumina	3.262
Sesquioxide	.479
Lime	.243
Magnesia	.007
Phosphoric acid	.912
Potash and soda	Traces.

In commenting on this analysis, Mr. Pechin, who has had considerable experience with Connellsville coke, says: "A large number of analyses of Connellsville coke have been made, showing less carbon and more sulphur. As regards carbon, I have had a number of analyses made at different times out of different lots, showing somewhat more carbon than the above."

At the Edgar Thomson Steel Works, near Pittsburg, a large amount of coke is used from the works of the H. C. Frick Coke Company, and frequent analyses for ash are made. The average of a large number of these analyses, covering the deliveries of 150,000 tons, gives 9.75 per cent of ash, the range being from 9.11 to 10.91 per cent; 9.75 may, therefore, be regarded as the average ash in good Connellsville coke.

It is nothing unusual in a furnace using Connellsville coke and Lake Superior ores to make a ton of 2,240 pounds of pig iron with less than 1,800 pounds of coke.

The following are the statistics of the manufacture of coke in the Connellsville region from 1880 to 1894:

Statistics of the manufacture of coke in the Connellsville region, Pennsylvania, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	Short tons.			Per cent.
1880	67	7,211	731	3,367,856	2,205,946	$3,948,643	$1.79	66.5
1881	70	8,208	654	4,018,782	2,639,002	4,301,573	1.63	65.7
1882	72	9,283	592	4,628,736	3,043,394	4,473,789	1.47	65.8
1883	74	10,176	101	5,355,380	3,552,402	4,049,738	1.14	66.3
1884	76	10,543	200	4,829,054	3,192,105	3,607,078	1.13	66.1
1885	68	10,471	48	4,683,831	3,096,012	3,776,388	1.22	66.1
1886	36	11,324	1,895	6,305,460	4,180,521	5,701,086	1.36	66.3
1887	73	11,923	98	6,182,846	4,146,989	7,437,669	1.79	67
1888	38	12,818	1,320	7,191,708	4,955,553	5,884,081	1.19	69
1889	29	14,458	430	8,832,371	5,930,428	7,974,633	1.34	67
1890	28	15,865	30	9,748,449	6,464,156	12,537,370	1.94	66
1891	33	17,551	0	7,083,705	4,760,665	8,903,454	1.87	67
1892	31	17,309	0	9,389,549	6,329,452	11,598,407	1.83	67.4
1893	28	17,504	5	7,095,491	4,805,623	7,141,031	1.49	67.7
1894	29	17,829	0	7,656,169	5,192,080	5,405,691	1.04	67.8

The record of coke production in the Connellsville region during 1894 shows the effect of labor troubles. The opening months of the year gave a fair output of coke, but with the beginning of the strike in May the output declined greatly, as will be seen from the monthly shipments of coke from the Connellsville region in 1894. It was really not until August, with the closing of the strike, that production began to increase and ran up rapidly until September, when 35,841 cars of coke were shipped. The following table shows the shipments for each month:

Monthly shipments of coke from the Connellsville region during 1894.

	Cars.		Cars.
January	17,558	August	23,476
February	20,560	September	35,841
March	23,216	October	30,294
April	20,678	November	30,714
May	3,328	December	31,774
June	11,518		
July	11,518	Total	260,475

The price of coke during the year was also considerably affected by the labor troubles, and for a time it was difficult to state just what the ruling prices were.

At the opening of the year furnace coke was quoted at $1, formerly $1.15, and crushed coke at $1.45. Within a very few weeks prices began to sag, and soon furnace coke was quoted at 90 cents per ton, with other grades in proportion. The strike, which began in the early part of May, soon decreased the supply, and gave prices a shove upward. For weeks prices of coke advanced and various figures were paid, although the highest recognized by circular were $1.70 for furnace coke. When the strike became general throughout the region, and production was practically stopped, prices were at almost any figure.

The little coke in the market was eagerly sought. In some cases sales of foundry coke at $5 per ton were reported, but this figure, of course, was exceptional, and could not be considered the market. Furnaces in some instances paid unheard-of rates for sufficient coke to bank down with. With the close of the strike came a better supply of coke, and circular prices again ruled. Later, the general weakness in the iron and steel trade affected the coke market, and prices became weaker. The closing prices of the year for furnace and foundry coke were exactly those quoted during the first week in January.

In the following table is given the average monthly prices of Connellsville coke for each month of the year:

Average monthly prices of coke during 1894.

	Furnace.	Foundry.	Crushed.
January	$0.95 to $1.00	$1.10	$1.38
February	.95	1.15	1.41
March	1.00	1.15	1.40
April	.92	1.04	1.32
May	.92	1.07	1.32
June	1.00	1.15	1.40
July	1.00	1.15	1.40
August	$1.15 to 2.00	$1.81 to 3.00	$2.06 to 3.25
September	1.30 to 1.40	1.85 to 2.67	2.13 to 3.25
October	1.00	1.12	1.40
November	1.01	1.15	1.40
December	1.00	1.15	1.40

Some coke was sold in 1894 for less than 92 cents; indeed, it is asserted that some was sold early in the year as low as 85 cents.

The following table gives the ruling prices of blast-furnace coke free on board at the ovens for the past fourteen years:

Monthly prices of Connellsville blast-furnace coke free on board at ovens.

Months.	1881.		1882.		1883.		1884.	1885.	1886.
January	$1.50 to	$1.75	$1.70 to	$1.80	$1.15 to	$1.20	$1.00	$1.10	$1.20
February	1.50	1.75	1.70	1.80	1.10	1.20	1.00	1.10	1.20
March	1.50	1.75	1.70	1.75		1.05	1.00	1.10	1.35
April	1.60	1.75	1.70	1.75		1.05	1.10	1.20	1.35
May	1.60	1.65	1.65	1.70	.95	1.05	1.10	1.20	1.50
June	1.60	1.65	1.50	1.65		.90	1.10	1.20	1.50
July	1.50	1.60	1.35	1.50		.90	1.10	1.20	1.50
August		1.60		1.35		.90	1.10	1.20	1.50
September		1.60	1.25	1.35		1.00	1.10	1.20	1.50
October	1.60	1.65		1.25		1.00	1.10	1.20	1.50
November	1.60	1.65	1.25	1.35		1.00	1.10	1.20	1.50
December	1.60	1.70	1.15	1.35		1.00	1.10	1.20	1.50

Months.	1887.	1888.	1889.		1890.	1891.	1892.	1893.	1894.	
January	$1.50	$1.75		$1.25	$1.75	$1.90	$1.90	$1.90	$0.95 to	$1.00
February	2.00	1.75		1.25	1.75	1.90	1.90	1.90		.95
March	2.00	$1.25 to 1.50		1.25	2.15	1.90	1.90	1.90		1.00
April	2.00	1.00		1.15	2.15	1.90	1.90	1.70		.92
May	2.00	1.00		1.10	2.15	1.90	1.80	1.60		.92
June	2.00	1.00		1.10	2.15	1.90	1.80	1.50		1.00
July	2.00	1.00	$1.00 to	1.10	2.15	1.90	1.75	1.45		1.00
August	2.00	1.00		1.10	2.15	1.90	1.75	1.25	1.15	2.00
September	2.00	1.00	1.25	1.50	2.15	1.85	1.75	1.20	1.30	1.40
October	2.00	1.00		1.50	2.15	1.85	1.75	1.20		1.00
November	2.00	1.25		1.75	2.15	1.80	1.75	1.10		1.01
December	2.00	1.25		1.75	2.15	1.80	1.75	1.05		1.00

THE UPPER CONNELLSVILLE DISTRICT.

This district includes that portion of the trough or basin in which the Connellsville coke is found that is located northward from a point just below Latrobe. The coal differs somewhat from that found in the lower part of the basin. It has to be washed in order to get the best results in coking, and for this reason the district is known as the "washed-coal district." As showing the character of the coal in this district and the coke made from it, the following analyses are given, furnished by the Isabella Furnace Company:

Analyses of coal from Coketon, Pa.

	Top of vein.	Bottom of vein.
	Per cent.	*Per cent.*
Bituminous matter	25.52	18.18
Fixed carbon	70.91	60.57
Ash	3.34	20.08
Sulphur	.23	1.17

Analyses of coke from Coketon, Pa.

	Un-washed.	Washed.	
		No. 1.	No. 2.
	Per cent.	*Per cent.*	*Per cent.*
Moisture and volatile matter	1.26	....	....
Fixed carbon	86.58	89.15	83.93
Ash	10.67	9.65	14.80
Sulphur	1.49	1.20	1.27
Silica in ash	....	4.67	6.12

The following analysis was made by Prof. A. S. McCreath of coke produced by the Alexandria Coal Company, of Unity Township, Westmoreland County, Pa., in this district:

Analysis of coke from the Upper Connellsville district, Pennsylvania.

	Per cent.
Water	0.033
Volatile matter	.713
Fixed carbon	88.274
Sulphur	.880
Ash	10.100
Total	100.000

An analysis of coke made by the Latrobe Coal Company, in Unity Township, near Latrobe, in this district, is as follows:

Analysis of Latrobe Coal Company's coke.

	Per cent.
Fixed carbon	89.119
Ash	9.392
Sulphur	1.183
Volatile matter	.202
Water	.104
Total	100.000

The following analysis was furnished recently by the Alexandria Coal Company of this district:

Analysis of coke made at the Alexandria Coal Company's works.

	Per cent.
Water	0.033
Volatile matter	.713
Fixed carbon	88.274
Sulphur	.880
Ash	10.100
Total	100.000

The following are the statistics of the manufacture of coke in the Upper Connellsville region for the years 1880 to 1894:

Statistics of the manufacture of coke in the Upper Connellsville district, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Value of coke at ovens, per ton.	Total value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	8	757	0	319,927	229,433	$1.73	$397,945	59
1881	10	986	0	588,924	343,728	1.60	548,362	58
1882	11	1,118	0	650,174	375,918	1.43	536,503	58
1883	11	1,118	0	668,882	389,053	1.08	422,174	58
1884	11	1,118	0	496,894	294,477	1.06	311,665	59
1885	11	1,168	40	555,735	319,297	1.08	346,168	57
1886	12	1,337	29	691,331	442,968	1.29	572,073	64.1
1887	16	1,442	87	717,274	470,233	1.79	840,144	65.6
1888	16	1,977	0	657,966	441,966	1.40	617,189	68
1889	13	1,568	80	635,220	417,263	1.46	609,828	65.6
1890	14	1,569	28	889,277	577,246	1.75	1,008,102	64.9
1891	14	1,724	0	1,000,184	649,316	1.71	1,111,056	65
1892	14	1,843	0	706,171	451,975	1,53	691,323	64
1893	14	1,843	0	499,809	320,793	1.39	447,090	64
1894	14	1,843	0	279,971	176,799	1.20	212,595	63

From the above table it will be seen that the production of coke in 1894 in the Upper Connellsville district was only 176,799 tons, the smallest production for any of the years covered by the table, the nearest approach to it being in 1880, when but 229,433 tons were produced.

THE ALLEGHANY MOUNTAIN DISTRICT.

In this district are included not only the ovens along the line of the Pennsylvania Railroad east of Blairsville, including not only those on both sides of the Alleghany Mountains in Cambria and Blair counties, but the ovens in Somerset County as well, these latter being included, as there is but one establishment in Somerset County, to prevent disclosing the business of this single company.

In what would be regarded as a normal year the Alleghany Mountain district would be one of the most important in the United States. As will be seen from the statistics given below, in 1891 and 1892 over 448,000 tons of coke were made in this district each year, and from 1880 up to 1893 the production constantly increased. The depression in the iron trade, however, and the low price at which other cokes coming in competition with these were sold, has decreased the production, so that in 1894 but 58,823 tons were made, as compared with 173,131 tons in 1893, and, as stated above, 448,522 tons in 1892.

The coal seams of Blair and Cambria counties are all from the Lower Productive Measures, and are, naming them in their descending order, the Upper and Lower Freeport, the Lower Kittanning, and the Brook ville. The Brookville seam is what is known as "Bed A," and the Lower Kittanning as "Bed B." The workable beds vary from 2½ to 5 feet in thickness. The average composition of the coal mined is from 17 to 27 per cent volatile matter, 1 per cent water, from 4 to 6 per cent ash, the remainder being fixed carbon, with a very small amount of sulphur.

It is probable that with the possible exception of the Pittsburg district, more thorough and careful experiments have been made in the Alleghany Mountain district in the adaptation of ovens to coal than in any other district in Pennsylvania. At one time there were 100 Belgian ovens in operation at Johnstown, but these have been torn down. Recently, however, the Cambria Iron Company has become interested in the by-product oven, and with others have interested themselves in the formation of a company known as the Otto Coke and Chemical Company, to control the Otto-Hoffmann by-product oven for this country. They are now (1895) erecting a bank of 60 by-product ovens on the Otto-Hoffmann principle, and contemplate the erection of additional ovens in the near future.

The following are some analyses of cokes produced in the Alleghany Mountain district:

An analysis of coke made at the Gallitzin works is as follows:

Analysis of Gallitzin, Alleghany Mountain, Pennsylvania, coke.

	Per cent.
Fixed carbon	90.687
Ash	7.488
Sulphur	.927
Volatile matter	.790
Moisture	.108
Total	100.000

The following is an analysis of the coke made at the Altoona Coal and Coke Company's works. Other analyses of cokes from this district will be found in former reports:

Analysis of coke from the Alleghany Mountain district, Pennsylvania.

	Per cent.
Fixed carbon	89.275
Ash	9.030
Sulphur	.783
Volatile matter	.748
Moisture	.164
Total	100.000

The following analysis is of coke produced by the Cresson and Clearfield Coal and Coke Company of Frugality, Cambria County:

Analysis of coke from the Alleghany Mountain district, Pennsylvania.

	Per cent.
Volatile matter	3.65
Fixed carbon	85.80
Ash	10.55
Total	100.00
Sulphur	.70
Phosphorus	.01

The statistics of the manufacture of coke in the Alleghany Mountain district from 1880 to 1894 are as follows:

Statistics of the manufacture of coke in the Alleghany Mountain district of Pennsylvania, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Value of coke at ovens, per ton.	Total value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	8	291	0	201,345	127,525	$2.27	$289,929	63
1881	9	371	0	225,563	144,430	2.28	329,198	64
1882	10	481	0	284,544	179,580	2.10	377,286	63
1883	10	532	0	200,343	135,342	1.78	240,641	68
1884	12	614	0	241,459	156,290	1.30	203,213	65
1885	11	523	82	327,666	212,242	1.30	286,539	65
1886	10	579	14	351,070	227,369	1.64	374,013	64.8
1887	10	694	150	461,922	297,724	2.25	671,437	64.4
1888	12	950	145	521,047	335,689	1.43	479,845	64.4
1889	16	1,069	20	564,112	354,288	1.69	601,964	63.5
1890	16	1,171	0	633,974	402,514	1.81	730,048	63.5
1891	16	1,201	0	708,523	448,067	1.75	782,175	63
1892	16	1,260	0	724,903	448,522	1.73	775,927	61.9
1893	15	1,260	0	275,865	173,131	1.53	264,292	62.8
1894	15	1,253	0	92,965	58,823	1.21	71,161	63.3

CLEARFIELD-CENTER DISTRICT.

This district includes the ovens in Clearfield and Center counties, including Snow Shoe, Moshannon, and other well-known coal districts. While considerable of the coke produced in this district is from run of mine, a large amount is also from slack. The same conditions that have prevailed in other Pennsylvania districts to reduce the production of coke are also manifest in this, and the production of 1894, which was but 38,825 tons, is the smallest since 1884, when the production was 23,431 tons.

As stated above, in this district are situated the Snow Shoe and Moshannon beds. The Snow Shoe basin is in Center County, the Upper Kittanning coal bed of the Lower Productive Measures, being the most important in the region, varying in thickness from 5 to 7 feet. The Upper Freeport, which has a thickness of from 3 to 4 feet, caps the highest knobs in the coal area, while the Lower Freeport coal bed, which is so important in the Karthaus district, is very much thinner. The average analysis of the coal shows about 68 or 70 per cent of fixed carbon, 23 to 24 per cent of volatile matter, one-half to 1 per cent of sulphur, 6 to 7 per cent ash, and less than 1 per cent water. The coal is admirably adapted for coking. It produces such an excellent fuel that, though many of the ovens in this county were originally built to use slack coal only, considerable run of mine is now used.

In Clearfield County the Moshannon or Lower Freeport bed is most extensively mined. It varies in thickness from 3 to 5 feet. The Lower Kittanning is also of importance as a coal producer in this district. The bulk of the coal production is used for steam purposes, although the coal makes a most excellent coke.

Analyses of coal and coke, by Booth, Garrett & Blair, chemists, are as follows:

Analysis of Irvona coal (Big Moshannon vein).

	Per cent.
Fixed carbon	71.752
Volatile matter	21.600
Ash	5.615
Water at 212° F.	1.033
Total	100.000

Analysis of Irvona coke.

	Per cent.
Fixed carbon	88.994
Volatile matter	.670
Ash	10.173
Water at 212° F.	.163
Total	100.000
Sulphur	.775

The statistics of the manufacture of coke in the Clearfield-Center district for the years 1880 to 1894 are as follows:

Statistics of the manufacture of coke in the Clearfield-Center district, Pennsylvania, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Value of coke at ovens, per ton.	Total value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	1	0	0	200	100	$2.00	$200	50
1881	2	50	0	20,025	13,350	1.70	22,695	67
1882	1	50	0	25,000	17,160	1.60	27,406	69
1883	1	60	0	26,500	18,696	1.50	28,844	71
1884	1	60	0	33,000	23,431	1.40	32,849	71
1885	2	245	0	69,720	48,103	1.46	70,331	69
1886	3	299	20	84,870	55,810	1.70	94,877	66
1887	6	523	10	154,566	97,852	2.02	198,095	63.3
1888	6	601	0	172,999	115,338	1.51	174,220	66.6
1889	6	671	0	195,473	120,734	1.78	215,112	61.7
1890	7	701	0	331,104	212,286	1.85	391,957	64
1891	7	666	0	293,542	183,911	1.84	339,082	63
1892	7	731	0	231,357	147,819	1.79	264,422	63.9
1893	8	695	0	155,119	98,650	1.74	171,482	63.6
1894	8	694	0	61,428	38,825	1.33	51,482	63

THE BROAD TOP DISTRICT.

In this district are included all of the ovens in what is known as the Broad Top coal field, the ovens being situated in Bedford and Huntingdon counties. Here also the same statement can be made as in connection with the other districts of Pennsylvania regarding the falling off in production, the production of 1894 being but 34,089 tons, the smallest production since these statistics began to be published.

The Broad Top semibituminous coal field is one of the outlying patches of coal cut off from the main border of the Alleghany Mountains. The Kelly bed, the chief bed mined in Bedford County, shows 74 per cent of carbon, 19 per cent of volatile matter, 5½ per cent of ash, 1 per cent of sulphur, and little or no water. It makes an admirable coke, and is used in the iron furnaces of this county. In Huntingdon County the Lower Productive Coal Measures are also worked. The coals coke easily and with good results. The coal beds average from 3 to 7 feet in thickness and the coke is used in the iron furnaces of the country.

The following is an analysis of coke made from coal of the Broad Top district:

Analysis of Broad Top, Pennsylvania, cokes.

	Powelton oven coke.
	Per cent.
Fixed carbon	89.43
Volatile matter	2.13
Moisture	.43
Ash	7.20
Sulphur	.69
Total	99.88

The statistics of the manufacture of coke in the Broad Top region, Pennsylvania, for the years of 1880 to 1894, are as follows:

Statistics of the manufacture of coke in the Broad Top region, Pennsylvania, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Value of coke at ovens, per ton.	Total value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	5	188	105	92,894	51,130	$2.40	$123,748	55
1881	5	188	105	111,593	66,560	2.51	167,074	59
1882	5	293	50	170,637	105,111	2.05	215,079	62
1883	5	343	110	220,932	147,154	1.84	271,692	66
1884	5	453	0	227,954	151,959	1.74	264,569	66
1885	5	537	0	190,836	112,073	1.65	185,656	58
1886	5	562	100	171,137	108,294	1.73	187,321	63.3
1887	5	581	0	262,730	164,535	2.11	347,061	62.6
1888	5	591	0	196,015	119,469	2.40	286,655	61
1889	5	589	0	152,090	91,256	2.05	186,718	60
1890	5	482	16	247,823	157,208	2.00	314,416	63
1891	5	448	0	146,008	90,728	2.17	197,048	62
1892	5	448	8	185,600	117,554	1.84	216,090	63.3
1893	5	456	14	136,069	86,752	1.73	150,196	63.8
1894	5	454	14	53,216	34,089	1.52	51,815	64

THE PITTSBURG DISTRICT.

Practically all the coal made into coke in the Pittsburg district is slack, usually obtained from the mines along the several pools of the Monongahela River and brought to Pittsburg by barges. The Pittsburg seam of coal at Pittsburg does not make as good a coke in the beehive ovens as coals from the mines farther east. It contains too much volatile matter and makes a spongy coke. This, however, can be avoided, it is believed, by some form of the by-product oven.

This district includes the ovens at and near Pittsburg, as well as the ovens in Washington County that use slack from the mines of that county. This and the Greensburg district are the only two districts in Pennsylvania that show an increase in production in 1894 over 1893, the production of this district in 1894 being 227,100 tons, as compared with 216,268 tons in 1893. This increase is probably due to the fact that the coke ovens in Pittsburg were kept more actively employed during the strike in the Connellsville region.

The statistics of the manufacture of coke in the Pittsburg district, Pennsylvania, for the years 1880 to 1894 are as follows:

Statistics of the manufacture of coke in the Pittsburg district, Pennsylvania, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Value of coke at ovens, per ton.	Total value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	21	534	0	194, 393	105, 974	$2.40	$254, 500	55
1881	21	538	0	178, 509	96, 310	2.15	206, 965	54
1882	21	557	0	114, 956	64, 779	2.07	134, 378	61
1883	20	542	0	119, 310	66, 820	1.89	126, 020	56
1884	20	535	0	97, 367	53, 857	1.87	99, 911	55
1885	17	416	4	91, 101	46, 930	1.55	72, 509	51.5
1886	18	730	0	228, 874	138, 646	1.88	221, 617	60.6
1887	20	880	235	366, 184	177, 097	1.78	315, 546	48.4
1888	22	980	0	428, 899	264, 156	1.33	350, 818	62
1889	17	600	21	233, 571	141, 324	2.00	283, 402	60.5
1890	14	541	0	149, 230	93, 984	1.82	171, 465	63
1891	13	590	11	154, 054	94, 160	2.14	201, 458	61
1892	15	725	261	292, 357	176, 365	2.14	376, 613	60.3
1893	10	885	0	357, 400	216, 268	2.03	438, 801	60.5
1894	9	779	104	371, 569	227, 100	1.55	351, 825	61

THE BEAVER DISTRICT.

About the same amount of coke is made in this district each year for use at local manufactories. The industry, however, is of so little importance it requires no description.

The following are the statistics of the manufacture of coke in the Beaver district, Pennsylvania, for the years 1880 to 1894:

Statistics of the manufacture of coke in the Beaver district, Pennsylvania, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	5	106	....	8,013	4,880	$10,150	$2.08	61
1881	5	106	....	6,887	4,333	9,013	2.08	63
1882	5	106	....	11,699	7,960	15,124	1.90	68
1883	5	107	....	19,510	12,395	21,062	1.70	64
1884	4	89	....	2,250	1,390	2,168	1.56	62
1885	4	89	....	686	438	696	1.59	63
1886	3	87	....	698	411	646	1.57	59
1887	3	65	....	25,207	13,818	24,137	1.75	55
1888	4	145	....	262	175	260	1.48	66.6
1889	3	90	....	3,100	1,853	3,848	2.07	60
1890	3	90	....	4,010	2,148	4,564	2.12	53.5
1891	3	88	....	4,224	2,332	6,663	2.86	55
1892	2	10	0	3,925	2,154	6,270	2.91	54.9
1893	2	10	0	2,998	1,644	4,446	2.70	54.8
1894	2	8	0	2,968	1,624	4,251	2.62	54.7

ALLEGHANY VALLEY DISTRICT.

This district includes the coke works of Armstrong and Butler counties, situated in the valley of the Alleghany River. The coal used is from the Freeport and Kittanning veins, and the industry is of little importance unless coke from other districts sells at a high price. No coke was produced in this district in 1894.

The statistics of the manufacture of coke in the Alleghany Valley district for the years 1890 to 1894 are as follows:

Statistics of the manufacture of coke in the Alleghany Valley district, Pennsylvania, 1880 to 1894, inclusive.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	5	97	0	45,355	23,470	$49,068	$2.10	52
1881	5	109	0	55,676	29,650	64,664	2.18	53
1882	6	159	0	76,000	41,897	80,294	1.92	55
1883	6	159	0	64,810	34,868	62,982	1.81	54
1884	7	209	0	55,110	31,430	54,859	1.75	57
1885	5	208	0	28,630	15,326	30,151	1.97	53.5
1886	5	208	0	51,580	28,948	44,422	1.54	56
1887	5	288	88	77,666	44,621	84,913	1.90	57.1
1888	5	376	0	37,792	21,719	36,008	1.66	57.5
1889	4	198	0	13,105	6,569	10,538	1.62	50
1890	3	148	0	33,049	18,733	40,204	2.15	56.7
1891	3	148	0	21,833	11,314	25,909	2.29	52
1892	3	148	0	0	0	0	0	0
1893	2	116	0	10,927	6,557	11,147	1.70	60
1894	2	116	0	0	0	0	0	0

REYNOLDSVILLE-WALSTON DISTRICT.

This district includes all the ovens on the Rochester and Pittsburg Railroad, as well as those on the low-grade division of the Alleghany Valley road and the mines of the New York, Lake Erie, and Western

Railroad. It is one of the most important coking districts of Pennsylvania, its production in 1894 being 207,238 tons, making it the third in point of production in the State, and the second in point of production in those districts that coke coal in the immediate vicinity of the ovens. The latter relation brings it second in the State to the Connellsville district.

The most important producer in Jefferson County, in this district, is the Rochester and Pittsburg Coal and Iron Company. The coal used is from the Lower Freeport bed, which in the mines of this company is 6 feet thick, and is an excellent coking coal. The coal is used as it comes from the mine without washing. The coke possesses the characteristics of a good coke in an eminent degree, having a bright, silvery luster, a resonant metallic ring when struck, a good structure, with hardness and tenacity. Some physical and chemical tests are given below:

Tests of 72-hour Walston foundry coke.

[Physical analyses.]

Locality.	Grams in one cubic inch.		Pounds in one cubic foot.		Percentage.		Compressive strength per cubic inch (¼) ultimate strength.	Height of furnace charge, supported without crushing.	Order in cellular space.	Hardness.	Specific gravity.
	Dry.	Wet.	Dry.	Wet.	Coke.	Cells.					
Standard coke, Connellsville	12.46	20.25	47.47	77.15	61.53	38.47	284	114	I	3.5	1.500
Walston coke	16.63	23.4	63.36	89.15	71.07	28.93	270	109	I	3.7	1.900

[Chemical analyses.]

Locality.	Fixed carbon.	Moisture.	Ash.	Sulphur.	Phosphorus.	Volatile matter.
Standard coke, Connellsville	87.46	0.49	11.32	0.69	0.029	0.011
Walston coke (A. S. McCreath, 72-hour coke)	88.476	.148	9.731	.951	.008	.692

[Coke analyses.]

	No. 1.	No. 2.	No. 3.
	Per cent.	*Per cent.*	*Per cent.*
Water	0.064	0.234	0.145
Volatile matter	.794	.552	.731
Fixed carbon	88.293	88.869	88.266
Sulphur	1.017	1.012	.826
Ash	9.832	9.333	10.032
Total	100.000	100.000	100.000
Phosphorus	....	.0085	.0080

Walston coal.

	Per cent
Water	0.983
Volatile matter	30.933
Fixed carbon	60.916
Sulphur	1.063
Ash	6.105
Total	100.000
Phosphorus	0.0065

Regarding this coke, Mr. Fulton states: These tests show a compact, hard-bodied coke, harder than the average Connellsville standard. This coke has been carefully prepared and can not be distinguished from Connellsville coke. The cells are a little less than the Connellsville, but the difference is not large enough to induce any marked change in blast furnaces. This coke is capable of sustaining fast driving in the largest blast furnaces. It will prove an excellent fuel for this and kindred uses.

The coals coked in Clearfield County in this district are of a character similar to those in the Clearfield-Center district, and need not be described here.

At the Bell, Lewis & Yates mines, also in Jefferson County, a large amount of coke is made, the coal produced being from the beds of the Lower Productive Measures, having the characteristics elsewhere described.

The following is an analysis of coke made at the ovens of the Bell, Lewis & Yates Coal Mining Company:

Analysis of coke made at Bell, Lewis & Yates Coal Mining Company's works.

	Per cent.
Water	0.05
Volatile matter	1.61
Fixed carbon	85.76
Sulphur	.68
Phosphorus	.024
Ash	11.876

The following are the statistics of the manufacture of coke in the Reynoldsville-Walston district for the years 1880 to 1894:

Statistics of the manufacture of coke in the Reynoldsville-Walston district, Pennsylvania, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	3	117	0	45, 055	28, 090	$46, 359	$1. 65	62
1881	4	125	2	99, 489	44, 260	80, 785	1. 85	44
1882	5	177	0	87, 314	44, 709	80, 339	1. 80	51
1883	6	229	0	76, 580	37, 044	65, 584	1. 77	48
1884	7	321	0	159, 151	78, 646	113, 155	1. 44	49
1885	8	600	143	183, 806	114, 409	153, 795	1. 35	62
1886	9	783	500	271, 037	161, 828	217, 834	1. 35	59. 7
1887	11	1, 492	134	507, 320	316, 107	592, 728	1. 88	62. 3
1888	9	1, 636	100	404, 346	253, 662	320, 203	1. 26	62. 7
1889	8	1, 747	0	514, 461	313, 011	436, 857	1. 40	60. 8
1890	8	1, 737	0	652, 966	406, 184	771, 996	1. 90	62
1891	7	1, 747	0	769, 100	470, 479	744, 098	1. 58	61
1892	8	1, 734	0	683, 539	425, 250	743, 227	1. 75	62. 2
1893	8	1, 755	0	562, 033	339, 314	586, 212	1. 73	60. 4
1894	8	1, 755	0	336, 554	207, 238	297, 596	1. 44	61. 6

THE BLOSSBURG DISTRICT.

In this district are included establishments making coke from the coal of the Blossburg coal field, which is the most northern point in the great Appalachian field, and is an isolated patch cut off from the main body of coal. All of the coal used in coking in this district is washed slack, the ovens being erected simply for the purpose of utilizing this slack. The coal, as a rule, is rather dry, but makes an excellent coke. The Blossburg seam, which is the one usually used, is composed of several distinct coal benches, and varies in thickness from 2½ to 4 feet. Considerable coal produced in this county is shipped to Syracuse and coked in the Semet-Solvay by-product coke ovens at that point. This coke production, however, is credited to New York.

The following are the statistics of the manufacture of coke in the Blossburg, Pennsylvania, district from 1880 to 1894:

Statistics of the manufacture of coke in the Blossburg district, Pennsylvania, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	1	200	0	72, 520	44, 836	$134, 500	$3. 00	62
1881	1	200	0	88, 055	56, 085	168, 250	3. 00	64
1882	1	200	0	100, 119	64, 526	193, 500	3. 00	64
1883	2	344	0	71, 028	44, 690	122, 450	2. 74	63
1884	2	344	32	62, 365	39, 043	93, 763	2. 40	63
1885	2	296	0	46, 489	26, 975	59, 423	2. 17	58
1886	2	405	0	136, 136	81, 801	174, 532	2. 13	60
1887	2	406	0	182, 623	103, 873	234, 622	2. 26	56. 9
1888	2	407	0	32, 063	38, 052	81, 400	2. 14	61
1889	2	407	0	31, 806	18, 422	47, 765	2. 59	58
1890	2	407	0	41, 785	23, 196	62, 804	2. 71	55. 5
1891	2	407	0	46, 084	24, 351	66, 195	2. 72	53
1892	2	404	0	30, 746	16, 675	45, 855	2. 75	54. 2
1893	2	407	0	22, 176	11, 463	31, 427	2. 74	50. 7
1894	1	250	0	670	332	896	2. 70	50

THE GREENSBURG DISTRICT.

The Greensburg district includes a small number of ovens situated in the Greensburg coal basin, erected chiefly for the utilization of the slack coal. The coal is all from the Pittsburg vein.

The following are the statistics of the manufacture of coke in the Greensburg district from 1889 to 1894:

Statistics of the manufacture of coke in the Greensburg district, Pennsylvania, 1889 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1889	2	50	16	32,070	20,459	$21,523	$1.05	63.8
1890	2	58	0	44,000	30,261	44,290	1.46	68.7
1891	2	58	0	38,188	22,441	36,627	1.63	59
1892	2	58	0	15,005	9,037	13,173	1.46	60.2
1893	3	88	0	29,983	18,393	26,303	1.43	61
1894	3	118	0	27,290	15,872	18,413	1.16	58.2

THE IRWIN DISTRICT.

The Irwin district comprises the ovens situated near the town of that name; also those located in what may be termed the Irwin basin, on the Youghiogheny River. This district is of some importance as a coke producer, its production in 1894 being 110,995 tons, which made it the fifth in point of production in the State. The chief producer, however, in this district is the Carnegie Steel Company, Limited, which has a large number of ovens at Larimer, on the Pennsylvania Railroad, using the slack from the gas coal mined in the immediate vicinity.

The following are the statistics of the manufacture of coke in the Irwin district for the years 1889 to 1894:

Statistics of the manufacture of coke in the Irwin district, Pennsylvania, 1889 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Value of coke at ovens, per ton.	Total value of coke at ovens.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1889	4	696	0	373,913	243,448	$1.44	$351,304	65
1890	4	661	0	270,476	172,329	1.49	256,458	63.7
1891	4	696	0	323,099	197,082	1.35	266,061	61
1892	4	696	0	328,193	202,802	1.40	284,029	61.8
1893	5	725	0	238,832	150,463	1.30	195,609	63
1894	5	725	0	176,318	110,995	1.08	119,764	63

TENNESSEE.

The coal fields of Tennessee are a continuation directly of the southern end of the eastern Kentucky coal fields and generally of the great coal deposits of western Pennsylvania and West Virginia.

The Tennessee Coal, Iron and Railroad Company, the largest producer of coke in Tennessee, mines most of the coal used in its ovens from the Sewanee seam; the Roane Iron Company from a seam which seems quite identical with the Sewanee. The Dayton Coal and Iron Company makes a large amount of coke from coal beds in the immediate vicinity of its blast furnaces. Whether these are equivalent to the Sewanee has not been determined; indeed, it may be said in a general way, although considerable geological survey work has been done in the Tennessee coal field, much more systematic geological explorations and mining developments are needed before our knowledge of this coal field can in any sense be considered complete.

In Tennessee is also included the larger part of the production of coke in what is known as the Mingo Mountain or Middlesboro district, this district overlapping from Kentucky into the northeastern part of the State.

The following are some analyses of Tennessee coals, and cokes made from the same:

Analyses of two samples of coal from mines of Roane Iron Company, Tennessee.

	Per cent.	Per cent.
Fixed carbon	60.110	60.750
Ash	11.520	5.270
Sulphur	1.049	....
Volatile matter	26.62	32.59
Water	1.750	1.390

Analyses of two samples of coal from the Sewanee seam, Tracy mines, Tennessee.

	Per cent.	Per cent.
Fixed carbon	62.000	63.500
Volatile matter	25.41	29.90
Ash	10.820	6.600
Sulphur	....	Trace.
Water	1.770	....

Analysis of coke produced from coal from Sewanee seam, Tracy mines.

	Per cent.
Fixed carbon	83.364
Ash	15.440
Sulphur	.142

Analyses of coal and coke from the Etna mines.

	Coal.	Coke.
	Per cent.	*Per cent.*
Fixed carbon	74.200	94.560
Volatile matter	21.39	4.650
Ash	2.700	.790
Sulphur	.700	.008
Water	1.300	....
Phosphorus	.005	....

Analysis of coal from Soddy mines, Sewanee seam.

	Per cent.
Fixed carbon	64.390
Volatile matter	27.82
Ash	6.640
Water	1.150

Analyses of coke.

	Rockwood coal.	Dayton coal.	Buckeye Coal Co.	Glen Mary Coal and Coke Co.	Unwashed slack Glen Mary Coal and Coke Co.		Mingo Mountain Coal and Coke Co.
Fixed carbon	84.187	84.150	88.30	61.63	91.00	89.70	89.96
Ash	14.141	14.880	9.85	1.64	9.00	10.30	8.92
Sulphur	.182		.37	.29	.60		.89
Volatile matter and moisture			1.48				.76
Gas				36.73			
Phosphorus							.008
Total	98.510	99.030	100.00	100.29	100.60	100.00	100.538

The analysis of coke from the Buckeye Coal Company, Pioneer, Tenn., which is exceedingly low in sulphur, was made from washed slack and nut, and, as we have been informed, is the average of at least a dozen analyses, in none of which the sulphur exceeded four-tenths of 1 per cent.

The following are the statistics of the manufacture of coke in Tennessee for the years 1880 to 1894:

Statistics of manufacture of coke in Tennessee, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	6	656	68	217,656	130,609	$316,607	$2.42	60
1881	6	724	84	241,644	143,853	342,585	2.38	60
1882	8	861	14	313,537	187,695	472,505	2.52	60
1883	11	992	10	330,961	203,691	459,126	2.25	62
1884	*a* 13	1,105	175	348,295	219,723	428,870	1.95	63
1885	12	1,387	36	412,538	218,842	398,459	1.82	53
1886	12	1,485	126	621,669	368,139	687,865	1.87	59
1887	11	1,560	165	655,857	396,979	870,900	2.19	61
1888	11	1,634	84	630,099	385,693	490,491	1.27	61
1889	12	1,639	40	626,016	359,710	731,496	2.03	57
1890	11	1,664	292	600,387	348,728	684,116	1.96	58
1891	11	1,995	0	623,177	364,318	701,803	1.93	58
1892	11	1,941	0	600,126	354,096	724,106	2.05	59
1893	11	1,942	0	449,511	265,777	491,523	1.85	59
1894	11	1,860	0	516,802	292,646	480,124	1.64	56.6

a One establishment made coke in pits.

It will be seen from the above statement that the production of coke in Tennessee increased in 1894 over 1893, this State and the two Virginias being the only coke-producing States that showed any increase in production.

The character of the coal used in the manufacture of coke in Tennessee since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Tennessee since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	255,359	0	273,028	72,000	600,387
1891	184,556	0	377,914	60,707	623,177
1892	176,453	15,000	367,827	40,846	600,126
1893	179,126	0	137,483	132,902	449,511
1894	166,990	61,841	149,958	138,013	516,802

It will be seen from the above statement that most of the coke made in Tennessee is made from slack, 287,971 tons of the total of 516,802 tons of coal coked being slack, about one-half being used washed and the other half unwashed.

UTAH.

As there is but one works in Utah Territory we have included the statistics of the production of coke with that of Colorado, as the coals in this Territory are practically of the same character as those in the westerly district of Colorado.

VIRGINIA.

But one of the two coke works in Virginia draws any portion of its supplies of coal from Virginia coal mines. The coke works at Pocahontas, in the Flat Top region, gets most of its coal from Virginia; the mines, however, are on the line between Virginia and West Virginia, and some of the coal used is mined in the latter State. The ovens at Lowmoor, in Alleghany County, which are on the Chesapeake and Ohio Railroad, just east of the West Virginia line, draw their entire coal supplies from the New River coal fields of West Virginia. As the coke is made in Virginia, its production is credited to this State; but the several coal fields from which the coal is drawn will be described in connection with the report on West Virginia.

The following are the statistics of the manufacture of coke in Virginia from 1883 to 1894:

Statistics of the manufacture of coke in Virginia, 1883 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1883	1	200	0	39,000	25,340	$44,345	$1.75	65
1884	1	200	0	99,000	63,600	111,300	1.75	64.25
1885	1	200	0	81,899	40,139	85,993	1.75	60
1886	2	350	100	200,018	122,352	305,880	2.50	61.2
1887	2	350	300	235,841	166,947	417,368	2.50	70.8
1888	2	550	0	230,529	140,199	260,000	1.74	64.7
1889	2	550	250	238,793	146,528	325,861	2.22	61
1890	2	550	250	251,683	165,847	278,724	1.68	66
1891	2	550	250	285,113	167,516	265,107	1.58	58.8
1892	2	594	206	226,517	147,912	322,483	2.18	65.3
1893	2	594	206	194,059	125,092	282,898	2.26	64.5
1894	2	736	100	280,524	180,091	295,747	1.64	64.2

The character of the coal used in the manufacture of coke in Virginia since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Virginia since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	98, 215	0	153, 468	0	251, 683
1891	107, 498	0	177, 615	0	285, 113
1892	106, 010	0	120, 507	0	226, 517
1893	107, 498	0	86, 561	0	194, 059
1894	103, 874	0	176, 650	0	280, 524

WASHINGTON.

In Washington there are three coke works, two of which were in operation in 1894, one making coke from the coal of the Wilkeson coal field near Tacoma, the other, at Cokedale, near Fairhaven, in Skagit County. These coals, like those of Colorado and Montana, are Cretaceous, and still preserve at many places their lignite characteristics. As is described in connection with the report on Colorado coals, at some places these lignitic coals have been altered locally in character and are true coking coals. The coke is a fair fuel, but does not equal that brought from Europe at a high cost. It is all made from washed slack and commands a good price for local uses. Analyses of the coke made from both the Wilkeson and Cokedale coals are as follows:

Analysis of Wilkeson coke, Tacoma, Wash.

	Per cent.
Water and volatile matter	2
Carbon	84
Ash	14
Total	100

Analysis of ash from above coke.

	Per cent.
Silicon	35. 00
Aluminum	18. 03
Lime	4. 02
Oxide of iron	37. 08
Magnesia	None.
Total	94. 13

Analysis of coke from Cokedale, Skagit County, Wash.

	Per cent.
Moisture	0.30
Volatile matter	3.80
Fixed carbon	86.38
Sulphur	.62
Phosphorus	.30
Ash	8.60
Total	100.00

The following are the statistics of the manufacture of coke in Washington for the years 1884 to 1894, the only years in which coke has been made:

Statistics of the production of coke in Washington, 1884 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1884	1	0	0	700	400	$1,900	$4.75	57.5
1885	1	2	0	544	311	1,477	4.75	57
1886	1	11	21	1,400	825	4,125	5.00	58.9
1887	1	30	0	22,500	14,625	102,375	7.00	65
1888	3	30	100	0	0	0	0	0
1889	1	30	0	6,983	3,841	30,728	8.00	55
1890	2	30	80	9,120	5,837	46,696	8.00	64
1891	2	80	0	10,000	6,000	42,000	7.00	60
1892	3	84	30	12,372	7,177	50,446	7.03	58
1893	3	84	0	11,374	6,731	34,207	5.08	59
1894	3	84	0	8,563	5,245	18,249	3.48	61.2

The character of the coal used in the manufacture of coke in Washington since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Washington since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	0	9,120	0	0	9,120
1891	0	0	10,000	0	10,000
1892	0	0	0	12,372	12,372
1893	0	10,974	0	405	11,374
1894	0	0	0	8,563	8,563

WEST VIRGINIA.

Five coking districts are recognized in West Virginia, viz, the Kanawha, the New River, the Flat Top, the Upper Monongahela, and the Upper Potomac. The first two are compact and continuous. They include the ovens along the line of the Chesapeake and Ohio Railroad from west of Low Moor, in Virginia, to the Kanawha Valley. The Flat Top region includes the ovens in what is sometimes called the Pocahontas district. The fourth district, the Upper Monongahela or

Northern, is a scattered one, including the ovens in Preston, Taylor, Harrison, and Marion counties, on the upper waters of the Monongahela. The district we have termed the Upper Potomac includes the coke ovens in the Elk Garden and Upper Potomac fields. A description of the coals used in coking in each district will be given under their several heads.

POCAHONTAS-FLAT TOP DISTRICT.

This district, known in its early history as the Pocahontas and later as the Flat Top, from the mountain, which is the most important and conspicuous feature of this region, is located in the counties of Tazewell, in southwestern Virginia, and Mercer and McDowell, in southeastern West Virginia. This field can be divided roughly into (1) the Pocahontas district, including the workings at and near the town of Pocahontas, Va.; (2) the Bluestone district, including the workings on the Bluestone, near Bramwell, in Mercer County, W. Va., on the southeast slope of Flat Top Mountain; (3) the Elkhorn district, including the workings in McDowell County, W. Va., on the northeast slope of the Flat Top Mountain, on the head waters of the Elkhorn.

This coal is semibituminous, somewhat dull in luster, rather hard in the veins, requiring powder to mine it, but, as will be seen from the following analysis, is low in volatile matter and ash and high in fixed carbon. It is a superior grade of steam coal, giving an exceedingly bright, hot, clear fire. It makes an excellent coke. The following is an average of fifteen analyses of coal from the Pocahontas and Bluestone subdistricts:

Analysis of Pocahontas-Flat Top coal.

	Per cent.
Water	1.011
Volatile matter	18.812
Fixed carbon	72.708
Sulphur	.787
Ash	5.191

Recent analyses of the coke made in the ovens of the Southwest Virginia Improvement Company at Pocahontas are given in the following table:

Analyses of coke from the Flat Top region, West Virginia.

	No. 1.	No. 2.
	Per cent.	*Per cent.*
Moisture	0.570	0.347
Volatile matter	1.028	.757
Fixed carbon	92.266	92.550
Ash	5.584	5.749
Sulphur	.552	.597
Total	100.00	100.00

The Flat Top coke is an excellent fuel. It is low in ash, as will be seen from the above analyses, high in carbon, somewhat cellular, and, as compared with most cokes of the country, bright, hard, strong, and dense. It is, however, somewhat fragile and dull in luster. The wastage in drawing and transporting is large, but in the furnace it bears a heavy burden, and gives a large output with a small consumption per ton of pig.

The statistics of the manufacture of coke in the Flat Top district for the years 1886 to 1894 are as follows:

Statistics of the manufacture of coke in the Flat Top district of West Virginia from 1886 to 1894, inclusive.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1886	2	10	38	1,075	658	$1,316	$2.00	61.2
1887	5	348	642	76,274	51,071	100,738	1.97	67
1888	13	882	200	164,818	103,947	183,938	1.77	63
1889	16	1,433	431	387,533	240,386	405,635	1.69	64
1890	17	1,584	252	566,118	325,576	571,239	1.75	57.5
1891	19	1,889	358	537,847	312,421	545,367	1.70	58
1892	30	2,848	933	595,734	353,696	596,911	1.69	59.3
1893	34	4,349	80	746,051	451,503	713,261	1.58	60.5
1894	36	4,648	18	1,229,136	746,762	989,876	1.325	60.7

From the above statement it will be seen that the production of coke in 1894 increased 65.4 per cent over the production of 1893. The number of establishments has increased two and the number of coke ovens some three hundred. This indicates that as relates to production the year 1894 was the best in the Pocahontas Flat Top district. The price received for the coke was less than ever before. It is probable that the strike in the Connellsville district early in the year had considerable influence toward increasing the production of coke in the Flat Top district in 1894.

NEW RIVER DISTRICT.

The New River district includes the ovens along the Chesapeake and Ohio Railroad from Quinnimont to Nuttallburg. The coal of this region is very much of the same character as that of the Flat Top region, these coking coals being spoken of as "New River" or "Flat Top," though they are mined from the same beds in the same formation, the former from the northern and the latter from the southern part of the same coal-bearing area. The length of this New River or Flat Top field, from northeast to southwest, is about 60 miles; its average breadth, from southeast to northwest, is not far from 16 miles. It is the largest field of distinctively-coking coals in the United States. These coal beds find their greatest development in the vicinity of Pocahontas, where the lower one, the Quinnimont, of New River, the No. 3, or Pocahontas, of the Flat Top region, attains a thickness of 12 feet of practically solid coal. The beds become thinner when passing to the northward.

The following analyses were made of coal and coke produced in the New River district of West Virginia by the Quinnimont Coal and Coke Company:

Analyses of coal and coke from the New River district, West Virginia.

	Coal.	Coke.
	Per cent.	*Per cent.*
Water	0.760	0.520
Volatile matter	18.650	.480
Fixed carbon	79.260	93.850
Sulphur	.230	.300
Ash	1.100	4.850
Total	100.000	100.000

The statistics of the manufacture of coke in the New River district from 1880 to 1894 are as follows:

Statistics of the manufacture of coke in the New River district, West Virginia, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	6	468	40	159,032	98,427	$239,977	$2.44	62
1881	6	499	0	219,446	136,423	334,652	2.45	62
1882	6	518	0	233,361	148,373	352,415	2.38	64
1883	6	546	0	264,171	167,795	384,552	2.29	64
1884	8	547	12	219,839	135,335	274,988	2.03	62
1885	8	519	0	244,769	156,007	325,001	2.08	63¾
1886	8	513	5	203,621	127,006	281,778	2.22	62
1887	11	518	50	253,373	159,836	401,164	2.51	63
1888	12	743	0	334,695	199,831	390,182	1.95	60
1889	12	773	0	268,185	157,186	351,132	2.23	58.6
1890	12	773	4	275,458	174,295	377,847	2.17	63
1891	13	787	102	309,073	193,711	426,630	2.20	63
1892	14	965	0	315,511	196,359	429,376	2.19	62
1893	13	947	10	281,600	178,049	355,965	2.00	63
1894	14	1,089	0	222,900	140,842	245,154	1.74	63.2

KANAWHA DISTRICT.

While the Kanawha district is a very important coking district, producing 104,160 tons of coke in 1894, its importance has been overshadowed by the Flat Top and New River coals already mentioned. The Kanawha Coal Measures are not the same as those furnishing coal for the New River and Flap Top regions. The beds of the Kanawha district correspond to the Lower Coal Measures of Pennsylvania, and need not be described in detail here.

The statistics of the manufacture of coke in the Kanawha district from 1880 to 1894 are as follows:

Statistics of the manufacture of coke in the Kanawha district, West Virginia, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	4	18	0	6,789	4,300	$9,890	$2.30	63.3
1881	4	18	0	11,516	6,900	16,905	2.45	60
1882	5	(*a*) 138	0	40,782	26,170	62,808	2.40	64
1883	5	(*a*) 147	0	58,735	37,970	88,090	2.32	64.6
1884	6	(*a*) 177	15	60,281	39,000	76,070	1.95	64.6
1885	7	(*b*) 181	63	65,348	37,551	63,082	1.68	57
1886	7	302	170	89,410	54,329	117,649	2.17	60.7
1887	7	548	0	153,784	96,721	201,418	2.08	63
1888	9	572	8	141,641	84,052	146,837	1.75	59
1889	6	474	0	109,466	63,678	117,340	1.84	58
1890	6	474	0	182,340	104,076	196,583	1.89	57
1891	6	474	0	241,427	134,715	276,420	2.05	56
1892	6	506	0	242,627	140,641	284,174	2.02	58
1893	6	506	0	215,108	122,241	237,308	1.94	56.8
1894	6	506	0	176,746	104,160	181,586	1.74	58.9

a Eighty of these ovens are Coppée, the balance beehive.
b Sixty of these ovens are Coppée, the balance beehive.

UPPER MONONGAHELA DISTRICT.

The Upper Monongahela district includes the ovens in the group of counties lying along the line of the Baltimore and Ohio Railroad, near the head waters of the Monongahela River—Preston, Taylor, Harrison, and Marion. The coal used in the district is chiefly from the Pittsburg bed. As mined, the seam is from 7 feet 6 inches to 10 feet thick. The coke produced in this district is a good fuel, and though made largely from washed slack it is finding a place in the markets of the country.

The following is an analysis of the foundry coke produced by the Monongah Coal and Coke Company, of Monongah, W. Va., one of the largest coke producers in the region:

Analysis of foundry coke produced by the Monongah Coal and Coke Company, of Monongah, W. Va.

	Per cent.
Moisture	0.35
Volatile matter	.70
Ash	8.54
Fixed carbon	90.41
Total	100.00
Sulphur	.872

At Austen, Preston County, the Upper Freeport seam, which is here from 5 to 5½ feet thick, is coked, making a clear, even, silvery coke of a fairly good quality. The following are analyses of the coal ana coke as mined at Austen:

Analyses of Austen, W. Va., coal and coke.

	Coal.	Coke.	
		48 hours.	72 hours.
	Per cent.	*Per cent.*	*Per cent.*
Fixed carbon	66.28	90.56	87.98
Volatile matter	31.12	....	....
Ash	2.48	9.19	11.57
Water	.12	.25	.45
Total	100.00	100.00	100.00
Sulphur	.64	.19	.21

The statistics of the production of coke in the Upper Monongahela district of West Virginia from 1880 to 1894 are as follows:

Statistics of the manufacture of coke in the Upper Monongahela district, West Virginia, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	8	145	0	64,937	36,028	$68,930	$1.91	55
1881	9	172	0	73,863	43,803	78,014	1.78	59
1882	11	222	0	92,510	55,855	105,214	1.88	60
1883	13	269	0	88,253	51,754	90,848	1.76	59
1884	13	281	100	78,468	49,139	74,894	1.52	63
1885	12	278	0	105,416	67,013	97,505	1.45	63.5
1886	12	275	104	131,896	82,165	113,100	1.38	62.3
1887	15	646	0	211,330	132,192	268,999	2.03	62.5
1888	17	567	110	213,377	138,097	175,840	1.27	64.7
1889	17	674	200	210,083	128,685	171,511	1.33	62.5
1890	18	1,051	50	276,367	167,459	260,574	1.56	60
1891	15	1,081	56	517,615	291,605	462,677	1.58	56
1892	19	1,129	45	441,266	265,363	390,296	1.47	60.1
1893	19	1,158	42	379,506	225,676	295,123	1.31	59
1894	20	1,221	42	280,748	158,623	179,525	1.13	56.5

The above table tells the usual story regarding the production of coke in 1894. It has fallen off 67,053 tons as compared with 1893, and for the same reasons that reduced production in other districts.

UPPER POTOMAC DISTRICT.

What we have termed the Upper Potomac district includes the ovens along the line of the West Virginia Central and Pittsburg Railway, running south from near Cumberland, Md. This region is an extension southwardly of the well-known Cumberland region, though in the Upper Potomac portion of the extension the Cumberland or Big Vein coal is not found, the coal mined being regarded until recently as the Upper Freeport and Lower Kittanning, the former known locally as the Thomas and the latter as the Davis vein. Mr. John Fulton has recently stated he believes that the two benches of the Davis vein instead of being one seam of coal are two of the Pennsylvania seams with the slate parting very thin. Speaking of them, however, under the names by which they have been usually known, the Upper Freeport (Thomas) vein measures nearly 8 feet, with from 4 to 6 feet of merchantable coal, while the Lower Kittanning (Davis) vein measures 11 feet, and works 6½ feet, and is remarkably low in sulphur. Describing the two coals as they occur in this field, Prof. I. C. White, in a report made to Hon. H. G. Davis, president of the West Virginia Central and Pittsburg Railway Company, says:

The Upper Freeport coal is one of the regular, persistent, and valuable beds of the Coal Measures, and it nearly always furnishes a quality of fuel that makes excellent coke. It has long been coked successfully in the Broad Top, Clearfield, and other regions of Pennsylvania. It has a thickness of nearly 8 feet from roof to floor in the Upper Potomac field, but a bony coal and slate just above the center of the bed render a portion of this thickness unavailable, so that seldom more than 6 feet of merchantable coal can be obtained from this seam. The upper portion of this bed comes out in good sized lumps, and will make a good shipping coal, while the lower bench is softer and will make good coke. This bed goes under the Potomac near Bayard, and underlies the entire basin from that point to Thomas, a distance of 15 miles, while the width across, from one outcrop to the other varies from 3 to 4 miles.

At a vertical distance of 170 feet below the floor of the Upper Freeport coal we come to the roof of the most valuable coal in the basin, the one which has been referred to under the name of Lower Kittanning, or "Davis seam." The entire thickness of this bed is about 11 feet, but as the bottom bench is separated from the middle or main one by a slate of considerable thickness, the lowest ply of coal, which is nearly 3 feet thick, is not usually mined, since there is 6 feet of clean coal above this after it has been freed from all slates, of which there are two streaks in the upper portion of the bed, but they both come out without trouble, taking with them of coal, slate, and all only 8 inches from the thickness of the bed, leaving, as just stated, exactly 6 feet of coal free from impurities.

The Lower Kittanning coal in the Upper Potomac region is one of the purest beds with which the writer is acquainted anywhere in the country, being singularly free from sulphur, so much so in fact that it already has a great reputation as a smithing coal, being as highly prized for this purpose as the celebrated Blossburg coal of Pennsylvania, with which bed, strange to say, it seems to be exactly identical.

The following are analyses of these coals made by the United States Geological Survey from full sections:

Analyses of Thomas and Davis coals, Upper Potomac field, West Virginia.

	Thomas (Upper Freeport).			Davis (Lower Kittanning).	
	Upper.	Middle.	Bottom.	No. 1.	No. 2.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	0.64	0.68	0.96	0.80	0.70
Volatile matter	22.87	23.88	22.90	26.84	22.03
Fixed carbon	65.60	65.99	72.76	67.18	70.53
Ash	10.89	9.45	3.38	5.18	6.74
Total	100.00	100.00	100.00	100.00	100.00
Sulphur	.64	1.39	.59	1.68	.924
Phosphorus	.06	1.02	.01	....	....

An analysis of the Davis coal from the mines of the Cumberland Coal Company's Douglas mine, made by the chemist of the Tremont Nail Company at Wareham, Mass., is as follows:

Analysis of Davis coal at Douglas, W. Va.

	Per cent.
Moisture	1.10
Volatile matter	22.65
Fixed carbon	69.68
Ash	6.57
Total	100.00

Though all three seams of coal mined in the Elk Garden and Upper Potomac regions are coking coals, only two are coked, the Thomas (Upper Freeport) and Davis (Lower Kittanning), and chiefly the latter. In addition to its being more valuable as a steam than as a coking coal, the Big Vein is lower in volatile matter than either the Thomas or Davis veins, and does not coke as readily.

Slack or fine coal only is used, experience having shown that the run of mine or lump does not yield as good a coke. The charge is 5½ tons for 48-hour coke and 6½ tons for 72-hour. The actual yield of coke by weight at the Coketon plant, using the Davis seam, is over 67 per cent.

The coke is a bright, silvery, porous, hard fuel, and has a most excellent reputation for foundry uses because of its physical characteristics and low sulphur. It is shipped largely for this purpose to South America. It is also an excellent blast-furnace fuel, and, when selected and crushed, has a large sale for domestic purposes.

Analyses of coke made from the Davis seam at Coketon, W. Va., are as follows:

Analyses of coke made from the Davis seam at Coketon, W. Va.

[Per cent.]

	48-hour.	72-hour.	48-hour.	72-hour.	48-hour.	72-hour.	48-hour.	72-hour.	48-hour.	72-hour.
Water	0.25	0.16	Trace	Trace	Trace	Trace	Trace	Trace	0.84	1.20
Volatile matter	.86	1.17	1.48	1.36	0.310	0.320	1.81	2.51	2.02	1.38
Fixed carbon	89.08	92.30	90.19	92.31	90.765	90.835	88.72	90.11	89	90.90
Ash	9.81	6.37	8.33	6.33	8.925	8.845	9.47	6.80	9.14	6.52
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	.60	.54	.90	.84	.752	.725	.53	.58	.191	.147
Phosphorus	.05	.04	.031	.021	.034	.037	.038	.013	.030	.009
Chemist	U. S. Geological Survey.		Hunt & Clapp.		Booth & Garrett.		Riverside Iron Co.		Hugo Blanck.	

The average of above analyses is as follows:

Average of ten samples of Coketon coke.

	48-hour.	72-hour.
	Per cent.	*Per cent.*
Water	0.218	0.39
Volatile matter	1.296	1.348
Fixed carbon	89.352	91.291
Ash	9.134	6.971
Total	100.00	100.00
Sulphur	.5946	.566
Phosphorus	.0366	.024

The analyses by Dr. Hugo Blanck, of Pittsburg, are quoted from a report of Prof. I. C. White. The sulphur is questionably low in these analyses.

Statistics of the production of coke in the Upper Potomac district of West Virginia are as follows:

Statistics of the manufacture of coke in the Upper Potomac district of West Virginia, 1887 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1887	1	20	50	3,565	2,211	$4,422	$2.00	62
1888	1	28	0	9,176	5,835	8,752	1.50	64
1889	2	84	0	26,105	17,945	28,559	1.58	69
1890	2	178	28	94,983	61,971	118,503	1.91	65
1891	2	390	39	111,014	76,599	133,549	1.75	69
1892	3	395	0	114,045	78,691	121,208	1.54	69
1893	3	394	0	123,492	84,607	115,250	1.36	68.5
1894	2	394	0	66,598	43,546	43,546	1.00	65.4

PRODUCTION OF COKE IN WEST VIRGINIA, BY DISTRICTS.

In the following table will be found consolidated the statistics of the production of coke in West Virginia in the three years especially covered by this report, viz, 1892, 1893, and 1894, by districts:

Production of coke in West Virginia in 1894, by districts.

Districts.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke produced.	Average price of coke, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
Kanawha	6	506	0	176,746	104,160	$181,586	$1.74	58.9
New River	14	1,089	0	222,900	140,842	245,154	1.74	63.2
Flat Top	36	4,648	18	1,229,136	746,762	989,876	1.33	60.7
Northern	20	1,221	42	280,748	158,623	179,525	1.13	56.5
Upper Potomac	2	394	0	66,598	43,546	43,546	1.00	65.4
Total	78	7,858	60	1,976,128	1,193,933	1,639,687	1.373	60.4

Production of coke in West Virginia in 1893, by districts.

Districts.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke produced.	Average price of coke, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
Kanawha	6	506	0	215,108	122,241	$237,308	$1.94	56.8
New River	13	947	10	281,600	178,049	355,965	2.00	63
Flat Top	34	4,349	80	746,051	451,503	713,261	1.58	60.5
Northern	19	1,158	42	379,506	225,676	295,123	1.31	59
Upper Potomac	3	394	0	123,492	84,607	115,250	1.36	68.5
Total	75	7,354	132	1,745,757	1,062,076	1,716,907	1.62	60.8

Production of coke in West Virginia in 1892, by districts.

Districts.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke produced.	Average price of coke, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
Kanawha	6	506	0	242,627	140,641	$284,174	$2.02	58
New River	14	965	0	315,511	196,359	429,376	2.19	62
Flat Top	30	2,848	933	595,734	353,696	596,911	1.69	59.3
Northern	19	1,129	45	441,266	265,363	390,296	1.47	60.1
Upper Potomac	3	395	0	114,045	78,691	121,208	1.54	69
Total	72	5,843	978	1,709,183	1,034,750	1,821,965	1.76	60.5

Statistics of the manufacture of coke in West Virginia, 1880 to 1894.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880	18	631	40	230,758	138,755	$318,797	$2.30	60
1881	19	689	0	304,823	187,126	429,571	2.30	61
1882	22	878	0	366,653	230,398	520,437	2.26	63
1883	24	962	9	411,159	257,519	563,490	2.19	63
1884	27	1,005	127	385,588	223,472	425,952	1.91	62
1885	27	978	63	415,533	260,571	485,588	1.86	63
1886	29	1,100	317	425,002	264,158	513,843	1.94	62
1887	39	2,080	742	698,327	442,031	976,732	2.21	63.3
1888	51	2,764	318	854,531	525,927	896,797	1.71	61.5
1889	53	3,438	631	1,001,372	607,880	1,074,177	1.76	60
1890	55	4,060	334	1,395,266	833,377	1,524,746	1.83	60
1891	55	4,621	555	1,716,976	1,009,051	1,845,043	1.83	58.8
1892	72	5,843	978	1,709,183	1,034,750	1,821,965	1.76	60.5
1893	75	7,354	132	1,745,757	1,062,076	1,716,907	1.62	60.8
1894	78	7,858	60	1,976,128	1,193,933	1,639,687	1.373	60.4

It will be noted from the above statement that the production of coke in West Virginia increased 131,857 tons, or 12.4 per cent, in 1894 over that of 1893, though, owing to the reduced value per ton, the value of the coke at the ovens was somewhat less.

The character of the coal used in the manufacture of coke in West Virginia since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in West Virginia since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	324, 847	0	930, 989	139, 430	1, 395, 266
1891	276, 259	0	1, 116, 060	324, 657	1, 716, 976
1892	298, 824	115, 397	1, 108, 353	186, 609	1, 709, 183
1893	324, 932	15, 240	1, 176, 656	228, 929	1, 745, 757
1894	162, 270	14, 901	1, 607, 735	191, 222	1, 976, 128

WISCONSIN.

All the coke made in Wisconsin is from Connellsville, Pa., coal, and the coke is standard Connellsville. Its production, therefore, is not of so much interest as the production of coke for developing certain regions. It is an interesting product, however, as showing that coal can be carried to a distance and successfully made into coke:

Statistics of the manufacture of coke in Wisconsin.

Years.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1888	1	50	....	1, 000	500	$1, 500	$3. 00	50
1889	1	50	....	25, 616	16, 016	92, 092	5. 75	62. 5
1890	1	70	....	38, 425	24, 976	143, 612	5. 75	65
1891	1	120	0	52, 904	34, 387	192, 804	5. 61	65
1892	1	120	0	54, 300	33, 800	185, 900	5. 50	62. 2
1893	1	120	0	24, 085	14, 958	95, 851	6. 41	62
1894	1	120	0	6, 343	4, 250	19, 465	4. 58	67

The character of the coal used in the manufacture of coke in Wisconsin since 1890 is shown in the following table:

Character of coal used in the manufacture of coke in Wisconsin since 1890.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1890	38, 425	0	0	0	38, 425
1891	52, 904	0	0	0	52, 904
1892	54, 300	0	0	0	54, 300
1893	20, 474	0	3, 611	0	24, 085
1894	6, 343	0	0	0	6, 343

WYOMING.

There is but one coke-making establishment in Wyoming—that of the Cambria Iron Company, located at Cambria, Weston County. This establishment made coke in 1891 and 1893, but none in 1892. The coal occurs probably in the lowest portion of the Dakota measures of the

Colorado Cretaceous and almost upon the topmost rocks of the Jurassic. The vein is 6½ to 7½ feet in thickness, with good roof and floor. Regarding the character of the coal, it has been classed all the way from lignite to a high grade coking bituminous coal. This difference in classification may be due to the fact that the samples upon which judgment was based were taken from different parts of the vein in which there may have been actual variations caused by partial metamorphism by heat.

All of the coal used in coking was unwashed slack, which does not give as good a result as washed slack. When the latter is used the coke is of fine texture and very strong. It is dense and capable of sustaining any weight ordinarily required of coke used as this is in silver smelting. As at present produced, however, the coke is very high in ash.

The statistics of the production of coke in Wyoming for the years 1891, 1892, 1893, and 1894 are as follows:

Statistics of the production of coke in Wyoming from 1891 to 1894, inclusive.

	1891.	1892.	1893.	1894.
Number of establishments	1	1	1	1
Number of ovens built	24	24	24	24
Number of ovens building	0	0	0	0
Amount of coal used ....short tons..	4,470	0	5,400	8,685
Coke produced ....short tons..	2,682	0	2,916	4,352
Total value of coke at ovens	$8,046	0	$10,206	$15,232
Value of coke per ton	$3.00	0	$3.50	*a*$3.50
Yield of coal in coke ....per cent..	60	0	54	50

a Value estimated.

The character of the coal used in the manufacture of coke in Wyoming is shown in the following table:

Character of coal used in the manufacture of coke in Wyoming since 1891.

Years.	Run of mine.		Slack.		Total.
	Unwashed.	Washed.	Unwashed.	Washed.	
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1891	0	0	4,470	0	4,470
1892	0	0	0	0	0
1893	0	0	5,400	0	5,400
1894	0	0	8,685	0	8,685

ORIGIN, DISTRIBUTION, AND COMMERCIAL VALUE OF PEAT DEPOSITS.

By N. S. Shaler.

DESCRIPTION.

The term "peat" is properly applied to those deposits of vegetable matter which have been accumulated below the surface of permanent water areas. In some cases, as will be seen from the account of bogs given below, the water may be held, not as in a lake, but in the interstices of living and dead vegetation lying on slopes of considerable declivity. The most characteristic form of peat is that in which material when first removed from the bog appears as a tolerably compact, black, vegetable mud, the particles of which are so soft as to resemble half-melted wax. This is ordinarily the condition of lake-bog peat at the depth of a foot or more below the growing surface. Near the top of the deposit, however, where a portion of the roots of the plants which afford the materials of which it is made are still living, or are in an undecayed state, the mass often has a somewhat fibrous character.

COMMERCIAL HISTORY.

The commercial importance of peat deposits was developed in countries where and in times when the original forests were insufficient for the needed fuel supply, or where the progress of agriculture had made the amount of wood insufficient for domestic use. In all such regions, where peat bogs were accessible, it became the custom to cut this imperfectly decayed vegetable matter into slabs or blocks, which, when dried in the sun, were stored under roofs in order to protect them from subsequent wetting. The greatest consumption of peat seems to have been during the eighteenth century, when the forests of northern Europe had been to a great extent cleared away, while the use of coal had not as yet become general through the extension of the modern means of transportation. In this century the rural population of northern Germany, Scandinavia, Russia, France, and the British Isles, except in the case of the wealthier classes, to a gréat extent depended on this material for household uses. Owing to the fact that, in favorable situations, the accumulations of peat would be renewed to a depth of 2 to 3 feet in the course of thirty or forty years, the supply from European bogs, though drawn upon for many centuries, seems never to have approached exhaustion.

The first settlers of this country, coming as they did from portions of the Old World where peat was in common use, naturally brought with them the habit of making use of this material as a fuel. At many places in New England where wood could be had for the cost of cutting and drawing it to the house the people were by custom led to betake themselves to peat. The material, however, was not much availed of except in the southeastern portion of Massachusetts, on Cape Cod, and the islands of Nantucket and Marthas Vineyard, where the forests were never very well developed and where firewood in time became rather scarce. Here the use of peat became somewhat general and continued until the progressive cheapness of anthracite coal led to the general abandonment of the local fuel. Until within thirty years, however, the larger part of the agricultural population on the island of Marthas Vineyard adhered to the use of the material. At present it is made to serve in but few households in this district. Still, in the town of Gay Head, in the western extremity of the islands, the people, mostly the descendants of the Indian tribe which originally occupied the district, still supply their fires from the numerous bogs which there occur. The persistence of the habit of peat-using in this town is due to the fact that there are no considerable woods within its bounds. More than a quarter of a century ago peat was considerably used, owing to the high price of coal, in Chatham Township, and to a small extent in other portions of New Jersey, but the cheapening of the fuel from the mines of Pennsylvania has ever since made the use of peat commercially unsuccessful.

The modern decline in the use of peat for fuel having taken place in all countries where it has been in former times extensive is clearly to be accounted for on economic grounds. In any state to which peat can be conveniently brought, peat ranks as an inferior fuel; although it can be produced at small cost in the way of labor, it does not give an enduring heat; a large mass has to be handled to obtain a given effect, and in wet weather the porous nature of the substance causes it to absorb much water. By the use of various devices it has been found possible to produce from this vegetable mud a compact material fairly comparable in quality with lignite or the poorer bituminous coals. Some studies made by the present writer appear, however, to indicate that it is difficult by any manufacturing process to make from peat a fuel which will compete with anthracite coal at a less price than about $10 a ton. Therefore, while the bog fuel may be profitably used in its natural or manufactured state in certain parts of the world which are distant from coal beds, there is little reason to believe that an extended industry will ever again be founded on it.

Within the limits of the United States there is probably no district where the manufacture of peat into a compact fuel can profitably be essayed. It may be that in case electricity should come into general use as the motive power of railways it will be found profitable to convert the heat-giving value existing in certain peat bogs near such lines into that form of energy. In this case, the energy could be conveyed by wire and would thus be independent of those considerations which rest upon the bulky nature of peat fuel. It should be noted, however, that the limitations as to the distance to which electromotive force can be profitably conveyed would set rather narrow bounds to any such use of bog fuel.

Many instances could be cited in various arts where the abandonment of a substance for a particular use has been followed by its being made of service in some other economic field. It seems that another case of the same nature will be found with peat. During this century this substance has been much used for manurial purposes; it seems likely, indeed, that in time it may have a value in this economic field fit to compare with that which it had in former times as a domestic fuel. Experience has shown that peat may be of service to the agriculturist in either of several ways. Where the mass has been made up by the decay of leaves and twigs such as are often borne in large quantities into a lake basin by a swift flowing stream, the substance has a distinct value on account of the fertilizing materials which it contains. In general, however, peat, especially that formed by the water-loving mosses, will not from the chemical nature of its components repay even a short transportation. On dry soils, however, this half-decayed vegetable matter may be found of distinct value for the reason that the sands of which they are composed are unable to retain moisture in sufficient quantity for the effective service of till crops, and this water-retaining capacity is very much increased by the admixture of peaty matter. For such use the varieties of peat formed in bogs fed by streams which are muddy in times of rain are the most valuable. The fine sediment serves to fill in the interstices between the grains of sand and the soil.

A third use of peat in the agricultural arts is as an absorbent material when commingled with other substances; thus, in utilizing waste fish or the offal from slaughterhouses or manure from barns it may be made to serve a valuable purpose. It is indeed extensively used in this way in many parts of the United States; and, as our agriculture becomes more intensive, the service which it can render will be better appreciated. It seems very likely that in the development of our tillage arts it will be more and more the custom for farmers to procure the raw materials and to compound fertilizers according to their needs. Where this is done peat will be found a valuable substance in forming the compost bed, its great absorbent power giving it a peculiar value in such work.

The secondary uses of peat above noted, even more than its original value as a fuel, make it desirable to set forth in a brief way the conditions of its formation and the distribution of the deposits in the United States.

PROCESS OF FORMATION.

The formation of peat deposits depends upon a certain arrest in the process of decay which normally occurs in dead organic matter where it lies in the open air, an arrest which is accomplished where the materials are kept permanently wet. In any ordinarily dry forest we observe that the fallen leaves and branches are, by the process of decay, at first converted into a blackened and softened mass, which rapidly passes through the further processes of decay by which the carbon of the woody matter is returned to the air whence it came and the ash or mineral substance to the soil whence it was extracted by the roots. If we can trace such a forest bed toward the margin of a swamp we may note that as the earth becomes more and more humid the process of decomposition takes place more slowly and the dark mold becomes thicker. A little observation will show that beneath the water plane of the swamp the decay stops with those changes which blacken and soften the dead vegetable matter. The arrest of the disintegration arising from the action of the water is due, in part at least, to the fact that the oxygen of the air does not have free contact with the carbon, and thus can not convert it into the gaseous substance known as "carbon dioxide," nor can various other combinations which take place in the air be effected. Moreover, when buried beneath the water, various microscopic organisms effective in producing decay are shut out from the mass, which, in its submerged state, never undergoes changes which deprive it of its fixed carbon, though for a long time it may yield considerable amounts of a light, burnable gas. In this unchanged condition it may remain for an indefinitely long time, perhaps, indeed, until by changes of the height of the land it is lowered beneath the ocean level to be buried in strata and in course of ages to become a coal bed.

Although bogs are ordinarily formed beneath lake basins by the gradual growth of water-loving vegetation from their sides and bottoms, a process which goes on until the lake may be converted into a normal peat swamp, there is another way in which peat may be accumulated and which in certain regions gives rise to very extensive bogs which were not formed in a water basin; these are commonly known as climbing bogs, and in one or another of their several forms they are widely disseminated. In high latitudes peat deposits are due to the growth in a luxuriant form of the common sphagnum. Starting on the borders of a lake basin, the dense mass of branches of this plant will, if the air be very moist, grow not only over the surface of the water but upward from its level upon slopes which may have an inclination of 5 or 10 degrees. As the lower part of the vegetable mat decays it forms a peat of ordinary quality, which may gradually attain a thickness of many feet. In the process of growth these highland morasses often extend into forests, where they gradually kill the trees, so that the region once wooded may become an open moorland.

In southern regions other species of plants, particularly and in the main the ordinary species of cane, affect, though in another way, the establishment and extension of climbing bogs; it is the habit of these reeds to grow in close-set order, it not infrequently happening that more than 100 stalks are found on the area of a square foot. The small interspaces between the separate shoots become, for some distance above the surface of the earth, densely filled with fallen leaves and other waste from the plants. This interstitial matter serves to hold the water and to maintain a wet surface, which serves to prevent the complete decay of the vegetable matter. By the accumulation of this material peaty layers, sometimes having a thickness of 2 or 3 feet, may be accumulated on surfaces having a slope of as much as 5 degrees; but the deposits thus formed never have the considerable thickness common in the moss-formed peat. They are, moreover, much less pure, for the reason that the cane contains a relatively large amount of siliceous ash. It should be also noted that the cane-made peats abound in materials suited to the growth of ordinary crops. They afford, indeed, very fertile soils, while the moss peats are not fitted to nurture any of our important crop plants.

It should be noted that the quality of peat as regards its fuel value, either for immediate use in its natural state or after artificial treatment, varies greatly, according to its previous history. It may be said in general, at least as far as the deposits of this country are concerned, that none of the climbing bogs, either those formed by mosses or by cane, have any noteworthy value. The last-named group may indeed be entirely excluded from the consideration. Furthermore, that the lake bogs afford the best peat for fuel purposes at some distance from the neighboring highland and at a considerable depth, generally at least 4 or 5 feet below the surface. In such positions the deposit is formed where it is not affected by wash from the shores and where the material, having been long exposed to the agents of change, has lost, through the expelled gases, its more volatile material, and at the same time has become more compact.

There is another feature connected with the growth of lake bogs which should be noted, as it may be of importance to those who are led to examine them from an economic point of view. The greater part of the peat-filled lakes were formed at the close of the Glacial period. When abandoned by the ice, these basins became filled with water and around their margins the growth of mosses began, these delicate plants forming a lodgment wherever the blows of the waves were not sufficient to break them up. Gradually the mantle of vegetation spread out from the shores, floating upon the surface of the lake. In time the moss raft thickened, and from its lower decaying surface quantities of peaty matter dropped through the intervening water to the bottom. If the basin was not very large, and if the circumstances, such as climate, favored the growth of the plants, the whole of the basin may have become filled with the accumulation, the lake water, except so far as held in the interstices of the swamp, having been expelled. It is, however, a common case, especially in the larger basins, that the central portion of the area, though covered by a mantle of vegetation sufficiently firm to uphold the feet of a man, is underlaid by a considerable depth of water, which, in turn, rests upon a more or less considerable layer of peat which has dropped down from the superficial covering. In most cases, such a deposit is recognized as a "quaking bog," but in some instances it may be impossible, even by jumping on the surface, to induce motion, and yet the layer of unexpelled water may exist at the depth of three or four feet below the surface. Such bogs can only be explored by the use of boring tools or of pricking rods. It not infrequently happens, especially in a large bog through which a stream finds its way, that the barrier which retains the lake has been somewhat cut down, so that the surface becomes partly dried. In this case the area of peat may become covered by a forest composed of those species, such as the white cedar and the water maple, which tolerate a considerable amount of moisture about their roots, the nature of the underlying material being indicated only by the level character of the area.

DISTRIBUTION OF PEAT BOGS.

The considerations already presented above make it plain that the formation of peat deposits depends upon the existence of sufficient rainfall and the occurrence in any region of basins suited for the accumulation of such deposits. In a word, the formation of the accumulations depends upon climate and topography.

Excessively hot summers appear so to promote the decomposition of vegetable matter, even where it is accumulated below water level, that peat accumulates very slowly or not at all. A very short summer season, such as occurs in high latitudes, is also unfavorable to the formation of such deposits, for the reason that the amount of growth of the vegetation in any one year is relatively very small. Within the arctic circle such fossil woody matter is only found in notable quantities within those districts which are warmed by the ocean streams; where metamorphosed peats in the form of coal are formed they indicate other conditions of climate than those which exist at the present day.

Within the limits of North America, it seems likely that peat deposits of considerable depth exist nearly as far north as the arctic circle. Their considerable development, however, is limited to the region occupied by the eastern glacial fields of the last ice epoch. They do not, indeed, occur in all portions of this area. A line drawn from the Atlantic coast in southern New Jersey westward through northern Pennsylvania, Ohio, northern Indiana, northern Illinois, central Wisconsin, and eastern Minnesota will, in a rough way, describe that northeastern portion of the United States where peat deposits may be regarded as common and of sufficient importance to deserve mention in the general resources of the country. As it will hereafter be noted, there are many local deposits formed under peculiar circumstances in other parts of the country which deserve notice.

In the peat district of the northeastern United States and the adjacent portions of Canada the accumulations are generally of the lake-bog type. In eastern Canada, Newfoundland, and the maritime provinces climbing bogs of the type so common in Ireland and other portions of northwestern Europe occur, but they lack the extent and depth of those in the Old World. Within the United States the only climbing bogs of a conspicuous character occur in eastern Maine, but even there they are relatively unimportant except from a scientific point of view. Similar accumulations of a smaller sort formed on declivities may be noted in the more western parts of New England and in northeastern New York. Nowhere within the limits of the United States, so far as is known to the writer, are these high-lying bogs of other than scientific interest.

The practical limitation of the eastern peat bogs of the United States to the glaciated district is due in part to the relatively moist climate of that area, but in larger measure to the very numerous lakes of small size which were developed in this region by the last ice sheet which was imposed upon it. While the glacier lay upon the surface, it wore it in an irregular manner, forming numerous basin-shaped hollows in the bed rock. When the ice melted away the detritus which it had taken into its mass and that which had been accumulated in the form of eskers, in channels or ice arches of the old subglacial streams, was distributed over the surface without relation to the natural water-courses, so that when the earth was bared it became covered with innumerable lakelets or larger bodies of water. Immediately after the Glacial period these basins, in New England alone, were probably to be numbered by the tens of thousands. It seems likely, indeed, that somewhere near one-fourth of the area was wet enough to favor the more or less complete preservation of peaty matter. A large number of these basins were drained by the cutting down of their drift barriers through the action of the effluent stream; the greater part of the others, especially those, by far the most numerous, which were less than a quarter of a mile in diameter, have been converted into peat bogs. Where the basins were more than a quarter of a mile in diameter, unless they were so shallow as to permit the plentiful growth of pond lilies in front of the advancing margin of the bog, thereby protecting the growing mosses from the stroke of the waves, we rarely find peat accumulations. It should be noted, however, that in certain cases where the basins are retained and walled by sands, the varying height of the water level in different seasons has hindered the growth of the bog-making plants. In general, it may be said that the water basins which owe their origin to glacial action have been reduced to peat bogs, only the larger and rarer lakes having been preserved by the action of the waves from the process of occlusion.

After the close of the glacial period another action set in which led to the formation of a peculiar class of basins. During the ice epoch the land beneath the glacial covering was tilted down to the northward with a variable slope, which in the region from Lake Michigan eastward appears to have been at a rate which varied, but which amounted in general to a foot or two in a mile of northing. Some time after the ice went away a reversed movement set in, the land in the north being elevated to its present position. This movement in certain parts of New England, particularly in eastern Massachusetts, greatly diminished the flow of some of the rivers and so permitted them, as in the case of the Sudbury and the Neponset, to become to a considerable extent occupied by bogs. It seems likely that certain of the peat accumulations in New York may have been formed under similar conditions.

Although peat swamps occur in a considerable variety of conditions, the following general statements and classification may prove serviceable to those who are seeking these deposits. In general it may be said that bogs are rare in regions which may be termed mountainous, where the streams have the character of torrents; in such regions of steep slopes even the irregularities of surface due to glacial action are not likely to produce water basins. Where the surface approaches a level and has little drift upon it, basins which have been converted into peat bogs are apt to be not uncommon; but for the reason that excavations which would contain water are relatively rare on the surface of glaciated bed rock, peat bogs do not usually abound in such fields. It is where the drift is thick and irregularly disposed that such deposits are most likely to be found.

The bogs found in drift basins differ somewhat in their number and their character, according to the nature of the Glacial waste. Where the loose material has the nature known as till or bowlder clay, the basins now occupied by the bogs are likely to be entered by considerable streams bearing muddy waters. In such positions the peat is apt to be relatively impure. On the other hand, where the basins are situated in fields occupied by stratified sands and gravel, from which the clay has been washed, inflowing streams are rare, and where they exist they are seldom muddy, even in times of flood, so that the peat accumulations are tolerably well preserved from admixture with earthy matter. In general it may be noted that the washed drift, where it lies in the shape of pitted plains or undulating kame deposits, affords fields which most abound in peat, though the areas are generally small.

In some parts of the country, particularly in Michigan, morainal deposits lying on approximately level surfaces often constitute dams which serve to retain shallow lakes that have been converted into swamps. Some of the most extensive bogs in southern Michigan owe their origin to this cause.

Along the coast of New Jersey the process of down sinking of the land, which apparently has gone on for some thousands of years, probably at an average rate of from 1 to 3 feet in a century, has produced a flooding of ancient valleys, which are now partly occupied by the sea and partly by fresh water. Extensive deposits of peat, as well as of marine marsh accumulations, appear to have been formed in this manner.

Southward along the Atlantic Coast to the central parts of Florida a depression of the shore lands essentially similar to that which has taken place in New Jersey has occurred. Owing to the warmer climate the peaty accumulations do not develop as well as they would in similar positions in a higher latitude; the deposits appear in general to contain much more ash, and in most cases are unfit for use as fuel; they have, however, more value for use in the preparation of fertilizers than those which are formed farther to the north.

Along the Mississippi and other rivers which have a well-developed fluviatile or inundation plain these fields formed by the deposits laid down during flood times normally slope from the banks toward the sides of the valley in which the stream lies. There is thus, at the foot of the territory which is above the level of inundation, a belt of morasses commonly known as "back swamps." It often happens that these lowlands are the seat of a considerable peaty accumulation composed mainly of leaves and stems of trees and of the silt of the finer sort which is precipitated from the river, which occupies the area for a considerable part of the year. This bog earth is entirely unfit for use as fuel, but is of great value for use as a fertilizer, either in its native state or as admixed with other manurial substances.

West of the Mississippi the swamps continue with gradually diminishing value until they come near to the margin of the district which may be termed arid. From western Texas northward traces of peat may be found at various points as far north in the United States as the Canadian border and western Minnesota, and scantily yet farther to the west. It may be said in general, however, that even in the glaciated district deposits of much economic value even to the agriculturist are not common in the country west of the Mississippi.

As regards the number and area of bogs, that portion of New England which lies to the east of the Berkshire hills and the Green Mountains is by far the richest part of this country, the reason for this being that the rocks in that section are locally very much diversified, so that they have induced a very irregular surface when affected by glacial action. The contrast between this section and the portions of New York which have a similar climate will show the importance of these conditions. In New England there are probably per unit of area at least five times as many morasses as there are on those portions of New York which are underlaid by horizontally stratified rock.

Another general fact is that along the eastern face of North America the thickness of the peat deposits, and the proportion of the lakes which have been closed by such accumulations, steadily decreases as we go away from the shore. This indicates the importance of a moist climate in favoring the development of peat deposits. It may also be said that the average fuel value of peat decreases as we pass from the seashore toward the inland district, while the value of the material for fertilizing purposes increases. The reason for this is that as the peat grows more slowly the admixture of animal organic matter derived from the bones of fishes and the shells of crustaceans and mollusks constitutes a relatively larger portion of the mass, while at the same time the fine silt, borne in by the streams, which generally has some fertilizing value, is also relatively greater.

PETROLEUM.[1]

By Joseph D. Weeks.

[The barrel used in this report, unless otherwise specified, is of 42 Winchester gallons.]

IMPORTANT FEATURES OF THE YEAR.

The most notable features in connection with the production of petroleum in 1894 are: (1) The continued decline in production in the older fields and the increase in the newer fields, especially in the Lima-Indiana field and in California, the total production for the United States showing an increase; (2) the increase of consumption over production, resulting in a heavy decline in stocks held at the wells, and (3) the increase in price as compared with 1893.

Briefly summarized, the facts regarding these three features of 1894 are as follows:

DECREASE IN OLD FIELDS AND INCREASE IN NEW.

The production of New York declined from 1,031,391 barrels in 1893 to 942,431 in 1894; of Pennsylvania from 19,283,122 barrels in 1893 to 18,077,559 barrels in 1894; West Virginia about held its own, the production increasing from 8,445,412 barrels in 1893 to 8,577,624 barrels in 1894; Ohio increased from 16,249,769 barrels in 1893 to 16,792,154 barrels in 1894. The chief increase was in what is known as the Macksburg or Eastern Ohio district, in which the oil is of the same character as that of the Pennsylvania and New York field, the increase being from 2,601,394 barrels in 1893 to 3,183,370 barrels in 1894. The Lima district about held its own. The production of Indiana increased from 2,335,293 barrels in 1893 to 3,688,666 barrels in 1894; Colorado decreased from 594,390 barrels in 1893 to 515,746 barrels in 1894; California increased from 466,179 barrels in 1893 to 705,969 barrels in 1894, while Kansas, which did not appear as a producer in 1893, produced 40,000 barrels in 1894. The total increase in production in the United States was from 48,412,666 barrels in 1893 to 49,344,516 barrels in 1894, an increase in the production of the United States of 931,850 barrels.

[1] For much of the statistical information used in this report the writer is indebted to the previous publications of Mineral Resources and to the reports of the Eleventh Census, the Oil City Derrick, the American Manufacturer and Iron World, and Stowell's Petroleum Reporter of Pittsburg. Other special acknowledgments will be given in the body of the report.

DECREASE IN STOCKS.

The stocks of crude petroleum in the Appalachian oil field at the close of 1894 was 6,499,880 barrels, as compared with 12,316,611 barrels at the close of 1893, a reduction of nearly 6,000,000 barrels, though the production of the Appalachian field had declined only some 600,000 barrels.

INCREASE IN PRICE.

The average value of certificate oil in the Appalachian field in 1894 was $83\frac{7}{8}$ cents a barrel, as compared with 64 cents a barrel in 1893 and $55\frac{5}{8}$ cents in 1892. In the Lima field the average price advanced from $36\frac{5}{8}$ in 1892 to $47\frac{1}{4}$ cents in 1893 and 48 cents a barrel in 1894. The total value of the 48,412,666 barrels produced in 1893 was $28,932,326, or $59\frac{3}{4}$ cents a barrel, while the total value of the 49,344,516 barrels produced in 1894 was $35,522,095, or nearly 72 cents a barrel.

PRODUCTION AND VALUE.

LOCALITIES.

The petroleum-producing localities in the United States remain about as they were in 1893, though Wyoming and Kansas are added to their number. While petroleum has been found in nearly every State and Territory, the localities in which it has been produced in paying quantities are few. These are the well-known oil regions of New York and western Pennsylvania and the various districts of West Virginia and eastern Ohio, which are designated in this report as the Appalachian oil field. This is the most important of the oil-producing territories, its total production in 1894 being some 30,781,924 barrels of the total production of 49,344,516 barrels, or 62.4 per cent. Outside of this Appalachian field the most important oil-producing districts are the limestone fields of Lima, Ohio, and of Indiana, continuations of the Lima district. The different sections in this field, however, produce oils varying greatly in quality. In what we have called this Lima-Indiana field there were produced in 1894, 17,296,510 barrels. In addition to these two oil fields the Florence oil district of Colorado and the oil fields of southern California have heretofore been the only other important producing districts. In 1894 there were produced in the Colorado oil field 515,746 barrels and in the California oil field 705,969 barrels. The only other important oil district, so far as concerns production in 1894, was Kansas, in which 40,000 barrels were produced. The Wyoming field also begins to assume some importance, 2,369 barrels having been produced in this field in 1894. Outside of these six fields the total production of the United States in 1894 was but 1,998 barrels. It would be useless to give space to these minor fields were it not for their promise of the future. For example, Indiana was insignificant in petroleum production until 1889, Kansas had no production in 1892 or 1893, and Wyoming has been carried heretofore as the name of a district in which there were great possibilities of oil production.

TOTAL PRODUCTION AND VALUE.

In the following table is given a statement of the total amount and the total value of all crude petroleum produced in the United States in 1893 and 1894 by States and important districts:

Total amount and value of crude petroleum produced in the United States in 1893 and 1894.

States and districts.	1893.		1894.	
	Barrels.	Value.	Barrels.	Value.
New York	1,031,391	$660,090	942,431	$790,464
Pennsylvania:				
Pennsylvania	19.196,051	12,285,473	18,017,869	15,112,488
Franklin	66,278	265,112	57,070	228,280
Smiths Ferry	20,793	13,308	2,620	2,198
	19,283,122	12,563,893	18,077,559	15,342,966
West Virginia:				
West Virginia	8,427,448	5,393,567	8,553,046 (West Virginia and Burning Springs)	7,173,867
Burning Springs	5,964	4,955		
Volcano	12,000	27,000	14,560	38,176
Petroleum	....	....	10,018	9,674
	8,445,412	5,425,522	8,577,624	7,221,717
Ohio:				
Macksburg	2,601,394 (Macksburg and Eastern and Southern)	1,664,892	3,183,370	2,670,052
Eastern and Southern				
Lima	13,646,804	6,448,115	13,607,844	6,531,765
Mecca-Belden	1,571	11,335	940	4,476
	16,249,769	8,124,342	16,792,154	9,206,293
Indiana	2,335,293	1,050,882	3,688,666	1,774,260
Kentucky	3,000	1,500	1,500	450
Missouri	50	154	8	40
Colorado	594,390	497,581	515,746	303,652
California	470,179	608,092	705,969	823,423
Texas	50	210	60	300
Indian Territory	10	60	130	810
Illinois	....	....	300	1,800
Wyoming	....	....	2,369	15,920
Kansas	....	....	40,000	40,000
Total	48,412,666	28,932,326	49,344,516	35,522,095

From the above table it will be seen that the total production of petroleum in the United States in 1894 was 49,344,516 barrels, as compared with 48,412,666 barrels in 1893 and 50,509,136 barrels in 1892. The increased production in 1894 over 1893 is chiefly in the new fields. There is a decline of production in New York, Pennsylvania, and Colorado, a slight increase in West Virginia and eastern Ohio; a slight decline in the Lima field, while there is a marked advance in production in Indiana and California.

CHARACTER OF THE OILS PRODUCED.

The oils produced in the Franklin, some of the Burning Springs, and the Volcano, West Virginia, and the Mecca-Belden, Ohio, districts, and in Missouri, Texas, and Indian Territory are chiefly lubricating oils, being used either as lubricators in their natural state or for the production of high-grade lubricating oil. All of the other oils are what are known as illuminating or fuel oils. The Indiana and Lima oils were for a while after their first production regarded chiefly as fuel oils, and while they are still used to a large extent for fuel purposes the illuminating oil produced from them, especially the oil from the most eastward pool in Ohio, is of a very high character, the recent methods adopted for refining being such as thoroughly to remove from it its offensive odor and to make from it an illuminating oil better than that produced from the Appalachian crude.

PRODUCTION BY FIELDS.

The production of petroleum in the chief producing fields of the United States in 1893 and 1894 was as follows:

Production of petroleum in the United States in 1893 and 1894, by fields.

[Barrels of 42 gallons.]

Fields.	Production.	
	1893.	1894.
Appalachian	31,362,890	30,781,924
Lima-Indiana	15,982,097	17,296,510
Florence, Colorado	594,390	515,746
Southern California	466,179	705,969
Kansas	....	40,000
Wyoming	....	2,369
Other	7,110	1,998
Total	48,412,666	49,344,516

VALUE OF PETROLEUM PRODUCED IN 1894.

The total value of the petroleum produced in the United States in 1894 was $35,522,095, or 71.988 or 72 cents a barrel. The value in 1893 was 59¾ cents a barrel. The total value of the oil produced in 1894 was nearly $7,000,000 greater than that of the product of 1893, though the increase in production was a little less than 1,000,000 barrels. The average value of certificate oil, which includes most of that produced in the Appalachian field, in 1894 was 83⅞ cents a barrel. The average value of the Lima oil was 48 cents a barrel. The average value of the Franklin oil was $4 a barrel; of the Colorado, 58⅞ cents a barrel; of the California, $1.17 a barrel; of the Wyoming, $6.72 a barrel, and of the Kansas, $1 a barrel.

PRODUCTION OF CRUDE PETROLEUM IN THE UNITED STATES, 1859 TO 1894.

In the following table will be found a statement of the production of crude petroleum in the United States from the beginning of production marked by the drilling of the Drake well in 1859 up to and including the production of 1894, the table being by years and States:

Product of crude petroleum in the United States from 1859 to 1894.

[Barrels.]

Years.	Pennsylvania and New York.	Ohio.	West Virginia.	Colorado.	California.	Indiana.	Kentucky and Tennessee.	Illinois.	Kansas.	Texas.	Missouri.	Indian Territory.	Wyoming.	United States.
1859	2,000													2,000
1860	500,000													500,000
1861	2,113,609													2,113,609
1862	3,056,690													*a* 3,056,690
1863	2,611,309													2,611,309
1864	2,116,109													2,116,109
1865	2,497,700													2,497,700
1866	3,597,700													3,597,700
1867	3,347,300													3,347,300
1868	3,646,117													3,646,117
1869	4,215,000													4,215,000
1870	5,260,745													5,260,745
1871	5,205,234													5,205,234
1872	6,293,194													6,293,194
1873	9,893,786													9,893,786
1874	10,926,945													10,926,945
1875	8,787,514	*b* 200,000	*b* 3,000,000		*b* 175,000									*b* 12,162,514
1876	8,968,906	31,763	120,000		12,000									9,132,669
1877	13,135,475	29,888	172,000		13,000									13,350,363
1878	15,163,462	38,179	180,000		15,227									15,396,868
1879	19,685,176	29,112	180,000		19,858									19,914,146
1880	26,027.631	38,940	179,000		40,552									26,286,123
1881	27,376,509	33,867	151,000		99,862									27,661,238
1882	30,053,500	39,761	128,000		128,636		*c* 160,933							30,510,830
1883	23,128,389	47,632	126,000		142,857		4,755							23,449,633
1884	23,772,209	90,081	90,000		262,000		4,148							24,218,438
1885	20,776,041	650,000	91,000		325,000		5,164							21,847,205
1886	25,798,000	1,782,970	102,000		377,145		4,726							28,064,841
1887	22,356,193	5,018,015	145,000	76,295	678,572		4,791							28,278,866
1888	16,488,668	10,010,868	119,448	297,612	690,333		5,096							27,612,025
1889	21,487,435	12,471,466	544,113	316,476	303,220	33,375	5,460	1,460	500	48	20			35,163,513
1890	28,458,208	16,124,656	492,578	368,842	307,360	63,496	6,000		1,200	54	278			45.822,672
1891	33,009,236	17,740,301	2,406,218	665,482	323.600	136,634	9,000		1,400	54	25	30		54.291,980
1892	28,422,377	16,362,921	3,810,086	824,000	385,049	698,068	6,500			45	10	80		50,509,136
1893	20,314,513	16,249,769	8,445,412	594,390	470,179	2,335,293	3,000			50	50	10		48,412,666
1894	19,019,990	16,792,154	8,577,624	515,746	705,969	3,688,666	1,500	300	40,000	60	8	130	2,369	49,344,516
Total	497,512,870	113,782,343	29,059,479	3,658,843	5,475,419	6,955,532	221,013	1,760	43,100	311	391	250	2,369	656,713,680

a In addition to this amount, it is estimated that for want of a market some 10,000,000 barrels ran to waste in and prior to 1862 from the Pennsylvania fields; also a large amount from West Virginia and Tennessee. *b* Including all production prior to 1876 in Ohio, West Virginia, and California. *c* This includes all the petroleum produced in Kentucky and Tennessee prior to 1883.

From the above table it appears that the enormous total of 656,713,680 barrels of crude petroleum, more than 100,000,000 tons, have been produced in the United States since the beginning of operations at Titusville, Pa., in 1859. By far the largest portion of this has been produced in what is known as the "Pennsylvania and New York oil fields," these fields producing alone 497,512,870 barrels of the total of 656,713,680 barrels, or nearly 76 per cent. Ohio has produced 113,782,343 barrels and West Virginia 29,059,479 barrels, and Colorado and California have produced respectively 3,658,843 and 5,475,419 barrels, while Indiana, which does not figure as a producer of petroleum until 1889, has produced 6,955,532 barrels, over 6,000,000 barrels of which has been produced in the last two years.

For convenience of reference a statement is given below of the production of petroleum in the United States from 1890 to 1894, by States:

Production of petroleum in the United States from 1890 to 1894.

[Barrels of 42 gallons.]

States.	1890.	1891.	1892.	1893.	1894.
Pennsylvania and New York	28, 458, 208	33, 009, 236	28, 422, 377	20, 314, 513	19, 019, 990
Ohio	16, 124, 656	17, 740, 301	16, 362, 921	16, 249, 769	16, 792, 154
West Virginia	492, 578	2, 406, 218	3, 810, 086	8, 445, 412	8, 577, 624
Colorado	368, 842	665, 482	824, 000	594, 390	515, 746
California	307, 360	323, 600	385, 049	470, 179	705, 969
Indiana	63, 496	136, 634	698, 068	2, 335, 293	3, 688, 666
Kentucky	6, 000	9, 000	6, 500	3, 000	1, 500
Illinois	....	....	....	....	300
Kansas	1, 200	1, 400	....	....	40, 000
Texas	64	54	45	50	60
Missouri	278	25	10	50	8
Indian Territory	....	30	80	10	130
Wyoming	....	....	....	....	2, 369
Total	45, 822, 672	54, 291, 980	50, 509, 136	48, 412, 666	49, 344, 516

EXPORTS.

In the following table are given the exports of crude petroleum and its products from the United States from 1871 to 1894, together with a statement of the production of the United States in the years named. The figures of exports are from the Statistical Abstract of the United States, published by the Bureau of Statistics, Treasury Department The figures of production were collected by the writer:

Quantity of crude petroleum produced in, and the quantities and values of petroleum products exported from, the United States during each of the calendar years from 1871 to 1894, inclusive.

Years ending Dec. 31—	Production.		Exports.											
			Mineral, crude (including all natural oils without regard to gravity).		Mineral, refined or manufactured.						Residuum (tar, pitch, and all other from which the light bodies have been distilled).		Total.	
	Barrels (of 42 gallons).	Gallons.			Naphthas, benzine, gasoline, etc.		Illuminating.		Lubricating (heavy paraffin, etc.).					
			Gallons.	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*
1871...	5, 205, 234	218, 619, 828	11, 278, 589	2, 171, 706	8, 396, 905	895, 910	132, 178, 843	33, 493, 351	240, 228	92, 408	101, 052	10, 450	152, 195, 617	36, 663, 825
1872...	6, 293, 194	264, 314, 148	16, 363, 975	2, 761, 094	8, 688, 257	1, 307, 058	118, 259, 832	29, 456, 453	438, 425	180, 462	568, 218	56, 618	144, 318, 707	33, 761, 685
1873...	9, 893, 786	415, 539, 012	19, 643, 740	2, 665, 171	10, 250, 497	1, 266, 962	207, 595, 988	41, 357, 686	1, 502, 503	517, 466	1, 377, 180	117, 595	240, 369, 908	45, 924, 880
1874...	10, 926, 945	458, 931, 690	14, 430, 851	1, 428, 494	10, 616, 644	997, 355	206, 562, 977	30, 168, 747	993, 068	269, 886	2, 504 628	177, 794	235, 108, 168	33, 042, 276
1875...	12, 162, 514	510, 825, 588	16, 536, 800	1, 738, 589	14, 048, 726	1, 392, 192	203, 678, 748	28, 168, 572	938, 052	265, 837	2, 323, 986	169, 671	237, 526, 312	31, 734, 861
1876...	9, 132, 669	383, 572, 098	25, 343, 271	3, 343, 763	13, 252, 751	1, 502, 498	220, 831, 608	44, 089, 066	1, 157, 929	370, 431	2, 863, 896	239, 461	263, 449, 455	49, 545, 219
1877...	13, 350, 363	560, 715, 246	28, 773, 233	3, 267, 309	19, 565, 909	1, 938, 672	307, 373, 842	51, 366, 205	1, 914, 129	577, 610	4. 256, 112	390, 077	361, 883, 225	57, 539, 873
1878...	15, 396, 868	646, 668, 456	24, 049, 604	2, 169, 790	13, 431, 782	1, 077, 402	306, 212, 506	36, 855, 798	2, 525, 545	698, 182	3, 126, 816	220, 835	349, 346, 253	41, 022, 007
1879...	19, 914, 146	836, 394, 132	28, 601, 650	2, 069, 458	19, 524, 582	1, 367, 996	365, 597, 467	32, 811, 755	3, 168, 561	713, 208	4, 827, 522	273, 050	421, 719, 782	37, 235, 467
1880...	26, 286, 123	1, 104, 017, 166	36, 748, 116	2, 772, 400	15, 115, 131	1, 344, 529	286, 131, 557	29, 047, 908	5, 607, 009	1, 141, 825	3. 177, 630	198, 983	346, 779, 443	34, 505, 645
1881...	27, 661, 238	1, 161, 771, 996	40, 430, 108	3, 089, 297	20, 655, 116	1, 981, 197	444, 666, 615	42, 122, 683	5, 053, 862	1, 165, 605	3. 756, 018	197, 321	514, 561, 719	48, 556, 103
1882...	30, 510, 830	1, 281, 454, 860	45, 011, 154	3, 373, 302	16, 969, 839	1, 304, 041	428, 424, 581	37, 635, 981	8, 821, 536	2, 034, 487	4, 265. 352	275, 263	503, 492, 462	44, 623, 074
1883...	23, 449, 633	984, 884, 586	59, 018, 537	4, 439, 097	17, 365, 314	1, 195, 035	440, 150, 660	39, 470, 352	10, 108, 394	2, 193, 245	6, 502, 524	465, 350	533, 145, 429	47, 763, 079
1884...	24, 218, 438	1, 017, 174, 396	79, 679, 395	6, 102, 810	13, 676, 421	1, 132, 528	433, 851, 275	39, 450, 794	11, 985, 219	2, 443, 385	5, 303, 298	327, 599	544, 495, 608	49, 457, 116
1885...	21, 847, 205	917, 582, 610	81, 435, 609	6, 040, 685	14, 739, 469	1, 160, 999	445, 880, 518	39, 476, 082	12, 978, 955	2, 659, 210	5, 713, 908	334, 767	560, 784, 459	49, 671, 743
1886...	28, 064, 841	1, 178, 723, 322	76, 346, 480	5, 068, 409	14, 474, 951	1, 264, 736	485, 120, 680	39, 012, 922	13, 948, 367	2, 689, 464	1, 993, 824	109, 673	591, 884, 302	48, 145, 204
1887...	28, 278, 866	1, 187, 712, 372	80, 650, 286	5, 141, 833	12, 382, 213	1, 049, 043	485, 242, 107	37, 007, 336	20, 582, 613	3, 559, 280	2, 989, 098	141, 350	601, 846, 317	46, 898, 842
1888...	27, 612, 025	1, 159, 705, 050	77, 549, 452	5, 454, 705	13, 481, 706	1, 083, 429	455, 045, 784	37, 236, 111	24, 510, 437	4, 215, 449	1, 870, 596	116, 009	572, 457, 975	48, 105, 703
1889...	35, 163, 513	1, 476, 867, 546	85, 189, 658	6, 134, 002	13, 984, 407	1, 208, 116	551, 769, 666	41, 215, 192	27, 903, 267	4, 638, 724	1, 858, 458	97, 265	680, 705, 456	53, 293, 299
1890...	45, 822, 672	1, 924, 552, 224	96, 572, 625	6, 535, 499	12, 462, 636	1, 050, 613	550, 873, 438	39, 826, 086	32, 090, 537	4, 766, 850	1, 830, 612	91, 905	693, 829, 848	52, 270, 953
1891...	54, 291, 980	2, 280, 263, 160	96, 722, 807	5, 365, 579	11, 424, 993	868, 137	531, 445, 099	34, 879, 759	33, 310, 264	4, 999, 978	1, 002, 414	61, 382	673, 905, 577	46, 174, 835
1892...	50, 509, 136	2, 121, 383, 712	104, 397, 107	4, 696, 191	16, 393, 284	1, 037, 558	589, 418, 185	31, 826, 545	34, 026, 855	5, 130, 643	403, 032	38, 220	744, 638, 463	42, 729, 157
1893...	48, 412, 666	2, 033, 331, 972	111, 703, 508	4, 567, 391	17, 304, 605	1, 074, 710	642, 239, 816	31, 719, 404	32, 432, 857	4, 738, 892	541, 044	41, 661	804, 221, 230	42, 142, 058
1894...	49, 344, 516	2, 072, 469, 672	121, 926, 349	4, 415, 915	15, 555, 754	943, 970	730, 368, 626	30, 676, 217	40, 190, 577	5, 449, 000	211, 008	14, 704	908, 252, 314	41, 499, 806

FOREIGN MARKETS.

A great many statements have recently appeared to the effect that the United States is being crowded out of certain of the world's markets for petroleum by Russian oil. In view of these statements, the following table of exports of petroleum from the United States for the fiscal years ending June 30, 1890, to 1894 is of great value. In discussing this table little need be said about the exports of crude petroleum. We do not care to send petroleum abroad as crude, and as a rule it is not sent in this condition except to countries that encourage refining by levying a heavy duty on refined products. France is a notable example of the adoption of this policy, and yet an inspection of the table shows that the attempt to supply France with illuminating oils refined at home has not been a success. The exports of crude hardly increased in the years 1890 to 1893, but did advance materially in 1894, being 68,947,436 gallons in 1890 and 84,434,953 gallons in 1894. On the other hand, the exports of refined oil as illuminating oil increased from 2,088,291 gallons in 1890 to 11,812,001 gallons in 1894. The total exports of crude increased from 95,450,653 gallons in 1890 to 121,926,349 gallons in 1894. Nor are the exports of naphthas much of a factor in estimating what has been the effect of the Russian product on our trade. The Russian oil does not yield a high percentage of the light oils. It is in illuminating and lubricating oils and residuum that the competition of Russian oil will be more seriously felt.

Examining the table it will be seen that our total exports of illuminating oils have increased in the five years covered by the table from 523,295,090 gallons in 1890 to 730,368,626 gallons in 1894, an increase of 207,073,536 gallons, or nearly 40 per cent. Each year of the five shows an increase over the preceding year. In these five years the exports to Europe have increased from 343,583,460 gallons to 490,252,345, and this though the Belgian, German, Dutch, and Swedish and Norwegian have fallen off. The notable changes in Europe are the decrease in exports to Germany from 140,264,089 gallons in 1890 and 162,187,071 gallons in 1891 to 86,388,785 gallons in 1894, and the increase in the exports to the United Kingdom from 66,393,246 gallons in 1890 to 274,555,010 in 1894. But it has been in exports to Asia that the reported falling off has occurred. The table will show that we have more than held our own. The exports of illuminating to Asia and Oceanica have increased from 137,530,258 gallons in 1890 to 195,212,962 gallons in 1894. The exports to most of the chief countries of these great divisions of the world, to China, East Indies, and Australasia, have increased, Japan about holding its own, though exports to Japan in 1894 show a marked increase as compared with 1893. Indeed, one of the marked features of the table is the notable changes from 1893 to 1894. The exports of lubricating show an increase of 33⅓ per cent in the five years, though residuum shows a decided reduction. Residuum, however, is an item of but little importance so far as concerns United States petroleum.

The statistics given above do not justify the assertion that the Russian oil is crowding us out of our markets. Where we are to get the oil to supply our trade is a more vital question; with production and stocks declining so rapidly, while consumption is increasing, it will not be a matter of surprise if we do lose these markets to some extent, but if so, it will be from lack of oil to sell.

Exports of petroleum in its various forms from the United States, 1890 to 1894, by countries.

[Gallons.]

Countries.	1890.	1891.	1892.	1893.	1894.
CRUDE.					
Europe:					
France	68, 947, 436	61, 663, 973	69, 100, 657	69, 424, 609	84, 434, 953
Germany	1, 188, 266	3, 107, 137	5, 247, 209	4, 182, 963	4, 877, 593
Spain	13, 934, 088	17, 103, 416	17, 064, 929	21, 112, 042	15, 176, 034
Other Europe	3, 680, 631	2, 380, 600	1, 935, 014	3, 948, 842	2, 009, 727
Total	87, 750, 421	84, 255, 126	93, 347, 809	98, 668, 456	106, 498, 307
North America:					
Mexico	2, 217, 846	3, 854, 176	3, 499, 514	5, 508, 769	8, 026, 189
Cuba	4, 913, 330	3, 300, 455	6, 316, 406	6, 955, 315	6, 865, 549
Other North America	36, 806	4, 338	425, 348	548, 068	534, 304
Total	7, 167, 982	7, 158, 969	10, 241, 268	13, 012, 152	15, 426, 042
All other countries	532, 250	1, 000	3, 690	22, 900	2, 000
Total crude	95, 450, 653	91, 415, 095	103, 592, 767	111, 703, 508	121, 926, 349
REFINED.					
Naphthas.					
Europe:					
France	4, 195, 704	2, 831, 929	1, 561, 284	4, 080, 839	3, 764, 569
Germany	2, 015, 298	3, 227, 106	3, 471, 652	4, 127, 354	4, 278, 757
United Kingdom	5, 603, 994	5, 058, 325	6, 813, 416	8, 209, 526	6, 834, 760
Other Europe	928, 616	824, 537	686, 398	658, 270	364, 135
Total	12, 743, 612	11, 941, 897	12, 532, 750	17, 076, 989	15, 242, 221
North America	59, 563	86, 910	35, 762	122, 237	173, 649
South America	78, 180	71, 192	89, 609	55, 940	79, 777
Asia and Oceanica	45, 214	55, 005	57, 787	39, 625	57, 057
Africa	10, 864	16, 143	12, 070	9, 214	3, 050
Total	193, 821	229, 250	195, 228	227, 016	313, 533
Total naphthas	12, 937, 433	12, 171, 147	12, 727, 978	17, 304, 005	15, 555, 754
Illuminating.					
Europe:					
Belgium	41, 391, 323	32, 397, 015	31, 471, 121	33, 541, 439	36, 312, 974
Denmark	7, 147, 115	9, 135, 043	7, 019, 575	12, 262, 308	9, 290, 251
France	2, 088, 291	3, 764, 974	3, 005, 535	8, 161, 023	11, 812. 001
Germany	140, 264, 082	162, 187, 071	133, 417, 314	119, 277, 484	86, 388, 785
Italy	19, 747, 758	20, 955, 728	22, 324, 113	22, 815, 279	22, 945, 037
Netherlands	47, 315, 526	54, 879, 032	76, 607, 780	51, 298, 480	31, 868, 189
Sweden and Norway	11, 772, 106	8, 957, 350	11, 159, 824	16, 312, 922	9, 848, 074
United Kingdom	66, 393, 246	81, 028, 529	94, 901, 777	180, 996, 321	274, 555, 010
Other Europe	7, 464, 013	8, 759, 531	6, 450, 040	8, 654, 660	7, 232, 024
Total	343, 583, 460	382, 064, 273	386, 357, 079	453, 319, 916	490, 252, 345
North America:					
British North America	5, 104, 864	5, 230, 259	5, 735, 411	6, 311, 042	8, 218, 417
West Indies	4, 404, 548	3, 303, 506	4, 262, 935	4, 439, 118	4, 174, 856
Other North America	2, 520, 131	3, 303, 608	2, 250, 162	2, 204, 602	1, 759, 565
Total	12, 029, 543	11, 837, 373	12, 248, 508	12, 984, 762	14, 182, 838

Exports of petroleum in its various forms from the United States, etc.—Continued.

Countries.	1890.	1891.	1892.	1893.	1894.
REFINED—continued.					
Illuminating—Continued.					
South America:					
Argentine Republic	3,113,750	3,476,192	4,825,196	4,070,719	3,162,846
Brazil	8,695,291	10,470,656	14,028,476	15,556,685	12,154,709
Uruguay	3,492,158	3,165,880	4,293,400	2,882,105	2,520,571
Other South America	6,236,596	4,792,161	6,827,814	6,041,571	5,503,680
Total	21,537,795	21,904,889	29,974,886	28,551,080	23,341,806
Asia and Oceanica:					
China	13,072,000	27,160,660	17,370,600	27,874,230	40,377,296
Hongkong	11,150,220	10,814,630	16,529,790	12,758,820	16,888,820
East Indies	63,456,071	63,285,770	55,907,410	57,404,175	85,907,557
Japan	37,892,930	31,000,629	23,761,930	26,869,510	37,272,450
British Australasia	7,976,572	10,276,095	10,376,260	11,053,991	11,821,881
Other Asia and Oceanica	3,982,465	4,630,690	3,095,516	2,637,250	2,944,958
Total	137,530,258	147,168,474	127,041,536	138,597,976	195,212,962
Africa	8,426,714	8,058,806	8,865,999	8,206,932	7,049,455
All other countries	187,320	85,990	408,650	579,150	329,220
Total illuminating	523,295,090	571,119,805	564,896,658	642,239,816	730,368,626
Lubricating.					
Europe:					
Belgium	1,955,145	2,337,030	2,632,954	2,426,926	2,931,204
France	3,088,183	3,948,257	2,461,722	2,426,659	3,050,547
Germany	3,670,937	4,186,225	4,512,639	3,798,953	5,637,471
Italy	510,622	591,996	404,971	788,805	1,356,340
Netherlands	2,037,437	1,504,623	2,229,116	1,842,608	2,346,896
United Kingdom	17,055,447	18,767,573	18,779,806	17,683,132	19,668,767
Other Europe	146,557	111,165	209,713	249,474	415,385
Total	28,444,328	31,446,869	31,240,921	29,216,557	35,406,610
North America	524,898	570,380	656,991	1,043,770	1,725,709
South America	721,669	889,610	798,194	1,207,232	1,509,708
Asia and Oceanica	457,363	582,392	813,618	888,032	1,433,191
Africa	14,264	25,479	81,352	77,266	115,359
Total	1,718,194	2,067,861	2,350,155	3,216,300	4,783,967
Total lubricating	30,162,522	33,514,730	33,591,076	32,432,857	40,190,577
Residuum (barrels).					
Europe	10,017	9,058	6,361	10,404	2,056
North America	42,141	28,833	6,622	2,202	2,973
All other countries	758	175	287	276	....
Total residuum	52,916	38,066	13,270	12,882	5,029

PRODUCTION BY STATES AND FOREIGN COUNTRIES.

APPALACHIAN OIL FIELD.

The Appalachian oil field should include, strictly speaking, all of the oil-producing territory within the limits of the well-known and well-defined Appalachian region of the eastern part of the United States. In the production of this field, therefore, should be included all the petroleum output of New York, Pennsylvania, West Virginia, the eastern part of Ohio, eastern Kentucky, eastern Tennessee, Alabama, and Georgia. The production of oil in this region at the present time, however, is confined chiefly to the first four localities named; that is, New York, Pennsylvania, West Virginia, and eastern Ohio, though very promising indications have been met with in the other localities named, and oil is produced in small quantities. In view of the fact that the center of production of this Appalachian oil field, as well as the southern limit of the field, has been gradually extended in the last three years southward, it is not at all improbable that the production of some of the other States named may be very much larger in the future than at the present time. Some of the territory in these States has been tested by drilling without satisfactory results, but this is no evidence that other tests may not show deposits of oil of considerable extent. It is not at all uncommon in the history of petroleum production that extensive pools have been struck in sections that had once been tested by drilling and in which work was abandoned in the belief that the supply of oil in these districts would not justify extensive operations.

In the present report, however, in view of the small production of the localities in the Appalachian field outside of the first four named above, New York, Pennsylvania, West Virginia, and eastern Ohio, the Appalachian field will be regarded as including only these four districts. In subsequent parts of the report, however, under their appropriate title, the production will be given and the oil-producing localities described, not only for the States that have been omitted from the report of production in the Appalachian field, but also for the four States whose production is included in this field.

For many years the oil districts in these four States, with the exception of those in New York and Pennsylvania, were distinctly marked and widely separated, and it was possible to make reports that would show clearly all of the important facts regarding the petroleum production in each of these States. Within the last few years, however, the discovery of new oil pools has made the field in these four States practically one continuous oil belt composed of productive pools distinctly marked and stretching from Cattaraugus County, N. Y., to south of Macksburg, Ohio. These oil pools pay no attention to State lines. The Bradford, one of the northernmost, is partly in New York and partly in Pennsylvania. The Sistersville and Eureka fields are in both West Virginia and Ohio, while there are pools which are partly in Pennsylvania and partly in West Virginia. The pipe lines in receiving oil do not discriminate between the products of the States as such, providing the oil is of the usual quality received as merchantable petroleum. Notwithstanding this little consideration that oil pools give to State lines, the accounts kept by the pipe-line producers make it possible, in most cases, to ascertain very nearly the production of each State, though it is almost impossible to give accurately by States statistics other than the production. This is particularly true of well records and the statements of shipments, deliveries, and stocks. Stocks and shipments for the entire Appalachian field can be given accurately, but when once the oil is in the pipe line it is impossible to say whether the deliveries in the Bradford region are New York or Pennsylvania oil, and in the Southwestern region whether they are

Pennsylvania, West Virginia, or Ohio oil; a similar statement can be made regarding the stocks. Well records might so be kept as to give the data for each State accurately, but the importance of a report of this character would not justify the labor involved. Under the head, therefore, of the Appalachian Oil Field we shall treat the field as a whole, giving the well records, production, shipments, stocks, etc., for the entire field, while in connection with the report on each State we shall, as far as possible, give the statistics of production as well as a description of the field in detail.

Elsewhere in this report, as well as in the volume Mineral Resources of the United States, 1892, and in the report on the Mineral Industries at the Eleventh Census, will be found quite complete statements regarding the geological occurrence of petroleum in New York and Pennsylvania, and statements regarding the character and composition of the oils from these States. The statements regarding the oil horizons of Pennsylvania will apply generally to the entire oil-producing territory of the western slopes of the Appalachian system. The great deposits are in the Devonian, though considerable oil is produced from the Carboniferous. The amount of oil found in the latter is, however, small compared with that found in the former. The petroleums from the Appalachian field, which are chiefly used in the production of illuminating oil (though some very high-grade natural lubricants are found, as are also some very inferior oils low in illuminating hydrocarbons), are, as they come from the ground, clear, semitransparent, generally of an amber color, but varying somewhat in this regard with their density. These oils, as a rule, produce from 10 to 11 per cent of naphtha, from 75 to 78 per cent of illuminating oils, from 2 to 6 per cent of heavy oils, from 2¾ to 4 per cent of residuum, and show from 5 to 8 per cent of water and loss. It is hardly necessary to state, however, that the percentages of naphtha, illuminating and heavy oils can be varied somewhat, the percentage of either of these produced from a given oil being varied by changes in the temperature and other conditions of distillation in the refining process.

As has been stated, the oil found in the Appalachian region, as well as in other sections, is usually found in pools, and in the Appalachian oil field these pools are usually in the same rock. The oil-bearing sand rock, though, is by no means in the same geological horizon throughout the field. Indeed, it frequently happens that in the same well, piercing several sand rocks, oil will be found at different depths and in different horizons. This gives rise to the expressions "First," "Second," "Third sand rock," the "Hundred Foot" sand or the "Big Injun" sand. In many cases the new developments in old fields come from drilling deeper the wells that have been exhausted at the higher level.

The oil pools in the Appalachian field follow the general trend of the Alleghany Mountains; that is, they lie in a southwest and northeast direction. The entire length of the oil field from the northernmost development in New York to the extreme southwestern development in Ohio is, roughly speaking, 700 miles. The width of the field varies greatly, but its extreme width may be stated to be about 75 miles. Throughout this distance these pools are found. Sometimes three or four pools of irregular size will be superimposed, one above the other, in the different geological horizons. In other cases in the same horizons pools will overlap each other, while in other cases a sand rock which at one place will be productive will at another be barren of oil, though underneath this barren soot oools may be found in other horizons.

While these pools are not continuous through the entire region, it is customary to include contiguous pools in a given section in what is known as a field, these fields being composed of a greater or less number of contiguous pools. The pools, as well as the fields, differ greatly in the amount of oil produced, some yielding but a few thousand barrels and then being completely exhausted, while others, like the McDonald field, yield millions of barrels.

The most notable fields in the Appalachian region, beginning at the north, are the Allegany, of New York; the Bradford, of New York and Pennsylvania; the Middle, Venango and Clarion, Butler and Armstrong, the McDonald, Washington, Wildwood, and Alleghany, in Pennsylvania; the Mannington, in West Virginia; the Eureka and Sistersville, in West Virginia and Ohio, and the Steubenville, Marietta, Macksburg, and Corning, in southeastern Ohio.

PRODUCTION OF THE APPALACHIAN OIL FIELD FROM 1889 TO 1894.

While petroleum has been produced for many years in the four States constituting the Appalachian field, it was not until 1890 that the production of eastern Ohio (and not until 1891 that the production of eastern Ohio outside of the Macksburg district) and not until 1891 that the production of West Virginia showed the notable increase which marked these localities as important petroleum producers.

In the following table is given the production since 1889 of what may be regarded as the three chief divisions of the Appalachian oil field, namely, (1) Pennsylvania and New York; (2) West Virginia; (3) eastern Ohio. In examining this table what is said above regarding the difficulty of making an exact division between the oil produced in the several States should be borne in mind.

Production of petroleum in the Appalachian oil field from 1889 to 1894.

[Barrels of 42 gallons.]

Years.	Pennsylvania and New York.	West Virginia.	Eastern Ohio.	Total.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
1889	21,487,435	544,113	318,277	32,349,825
1890	28,458,208	492,578	1,116,521	30,067,307
1891	33,009,236	2,406,218	424,323	35,839,777
1892	28,422,377	3,810,086	1,193,414	33,425,877
1893	20,314,513	8,445,412	2,602,965	31,362,890
1894	19,019,990	8,577,624	3,184,310	30,781,924

From the above it appears that during the last four years there has been a gradual decline in the production of petroleum in the Appalachian oil field. The production in 1891, the year of the largest production in this field, was 35,839,777 barrels. This fell off about 2,400,000 barrels in 1892, about 2,100,000 barrels in 1893, but only some 600,000 barrels in 1894. It will be noted that the falling off has been entirely in the Pennsylvania and New York field, the production having dropped from 33,009,236 barrels in 1891 to 19,019,990 barrels in 1894. On the other hand, the production of West Virginia increased from 2,406,218 barrels in 1891 to 8,577,624 barrels in 1894, while the production of eastern Ohio increased from 424,323 barrels in 1891 to 3,184,310 barrels in 1894. The production in 1894 of these last two districts, West Virginia and eastern Ohio, was the largest in the history of oil production in these States.

PRODUCTION IN THE APPALACHIAN OIL FIELD, BY MONTHS.

In the following table is given the production of crude petroleum in the Appalachian oil field from 1890 to 1894, by months:

Production of crude petroleum in the Appalachian field from 1890 to 1894, by months.

[Barrels.]

Years.	January.	February.	March.	April.	May.	June.
1890	2,170,937	2,102,264	2,384,864	2,381,786	2,451,461	2,450,622
1891	2,968,164	2,451.901	2,618,394	2,592,998	2,549,787	2,565,856
1892	3,016,062	2,923,272	2,885,531	2,802.221	2,741,848	2,757,436
1893	2,491,853	2,350,490	2,769,501	2,493,590	2,673,648	2,669,110
1894	2,627,123	2,330,582	2,671,051	2,494,772	2,654,299	2,637,416

Years.	July.	August.	September.	October.	November.	December.	Total.
1890	2,603,281	2,598,332	2,666,877	2,858,500	2,676,825	2,721,558	30,067,307
1891	2,540,907	2,740,797	3,088,801	3,823,643	4,070,287	3,828,242	35,839,777
1892	2,759,309	2,851,348	2,698,196	2,729,444	2,606,646	2,654,564	33,425,877
1893	2,658,141	2,757,351	2,682,296	2,651,591	2,513,281	2,652,038	31,362.890
1894	2,659,718	2,605,494	2,465,689	2,638,689	2,460,880	2,536,211	30,781,924

From the above table it appears that the fluctuation in the monthly production of petroleum in the Appalachian oil field in 1894 was not very marked, the differences, as a rule, being chiefly those growing out of the number of days in the month. There was no such notable fluctuation in production as that shown in 1891, when in the month of November the total production was 4,070,287 barrels, as compared with 2,540,907 barrels in the July previous. The months of October and November, 1891, were those of the great development in the McDonald field. This production by months indicates that there were no notable discoveries of petroleum in the Appalachian field in 1894. Indeed, it may be said that the increased activity in this oil field in 1894 only resulted in maintaining the production of 1893, every attempt to discover either an important new field or important extensions of old ones being practical failures. The year 1894, however, showed a marked tendency on the part of operators to return to the old fields, as will be more plainly shown by the well records given elsewhere. As will be seen from these records, Butler and Armstrong counties have proved more attractive to the oil operators during the close of 1894 than either of the great southwestern fields, Sistersville, Mannington, or McDonald. Indeed, it may be said in a general way that no new fields have been found, and none seem to be in sight, while the old fields are attracting more attention than heretofore. Undoubtedly, with the rise in the price of oil, many localities in the old fields that were abandoned because of the small production of the wells or the cost of producing oil, can again be operated with profit.

AVERAGE DAILY PRODUCTION OF THE APPALACHIAN FIELD FROM 1890 TO 1894.

The figures that are usually in the mind of the oil operator, either producer, refiner, or dealer, when production is spoken of is the average daily production. This is given in the following table for the years from 1890 to 1894. These averages are ascertained by dividing the production of each month by the number of days in the month, and the average for the year is obtained by dividing the total production of the year by 365 or 366, as the case may be:

Average daily product of crude petroleum in the Appalachian field each month for the years 1890 to 1894, by months and years.

[Barrels.]

Years.	January.	February.	March.	April.	May.	June.
1890	70,030	75,081	76,931	79,393	79,079	81,687
1891	95,747	87,568	84,464	86,433	82,251	85,529
1892	97,292	100,802	93,082	93,407	88,447	91,915
1893	80,382	83,946	89,339	83,120	86,247	88,970
1894	84,746	83,235	86,163	83,159	85,622	87,914

Years.	July.	August.	September.	October.	November.	December.	Average.
1890	83,977	83,817	88,896	92,210	89,228	87,792	82,376
1891	81,965	88,412	102,960	123,343	135,676	123,492	98,191
1892	89,010	91,979	89,940	88,047	86.888	85,631	91,328
1893	85,746	88,947	89,410	85,535	83,776	85,550	85,926
1894	85,797	84,048	82,190	85,119	82,030	81,813	84,334

As usually given, the tables of average daily production include only the average daily receipts from wells as published by the pipe lines; that is, the average of the runs from the wells, as they are usually termed. In the above table, however, by average daily production is meant the average total production, including some oil that is not reported in the daily returns of pipe-line runs. This table needs but little comment, the conditions having been discussed in the statement under production. The fluctuations in the average daily production in 1894 are quite slight, the range being from 81,813 barrels in December to 87,914 barrels in June. The fluctuations in 1891 have already been commented upon.

PIPE-LINE RUNS IN THE APPALACHIAN OIL FIELD IN 1894.

Usually the terms "production" and "pipe-line" runs are regarded as synonymous, but production is somewhat in excess of runs. By "pipe-line runs" are meant the amounts of oil which the several pipe lines receive from the wells. If all oil were sent from the wells by pipe lines these runs would indicate the total production of petroleum in a given year less the oil remaining in tanks at the wells. In other words, on the basis that all oil was shipped from the wells by pipe lines, the total production of a year would be the total runs plus the stocks of oil on hand at the wells at the close of the year minus the well stocks at the beginning of the year. However, as some oil is not sent to the pipe lines, the table of production of the Appalachian oil field, as given elsewhere, will be greater than the pipe-line runs. The production of the Appalachian field in 1894 is given as 30,781,924 barrels. The pipe-line runs are 30,117,096 barrels, making a difference between the pipe-line runs and the production of 664,828 barrels.

In the following table will be found the pipe-line runs in the Appalachian oil field in 1894, by lines and by months:

Pipe-line runs in the Appalachian oil field in 1894, by lines and months.

[Barrels.]

Months.	National Transit.	Tide water.	Octave.	South-west.	Franklin.	Western and Atlantic.	Producers and Refiners' Pipe Line Company, Limited.
January	646, 383	125, 106	1, 690	436, 190	4, 985	33, 158	91, 153
February	572, 010	113, 847	1, 852	422, 193	4, 161	23, 524	96, 935
March	694, 124	134, 784	1, 688	488, 980	5, 642	8, 349	97, 719
April	639, 307	144, 975	1, 810	478, 787	5, 550	1, 543	87, 414
May	673, 198	160, 856	1, 903	505, 681	4, 663	1, 543	103, 716
June	698, 288	160, 856	1, 756	514, 685	4, 894	....	112, 997
July	697, 432	162, 630	....	482, 181	5, 628	....	107, 661
August	725, 035	161, 848	....	463, 787	4, 062	....	92, 827
September	683, 003	143, 725	....	439, 147	3, 967	....	92, 037
October	759, 017	155, 208	....	464, 323	5, 603	....	89, 243
November	715, 989	142, 364	....	416, 091	4, 127	....	95, 376
December	744, 230	145, 698	....	428, 300	3, 788	....	129, 771
Total	8, 248, 016	1, 751, 897	10, 699	5, 540, 345	57, 070	68, 117	1, 196, 849

Months.	Elk.	Emery.	Mellon.	Eureka.	Buckeye-Macksburg.	Total.
January	18, 584	30, 774	279, 109	746, 311	138, 172	2, 551, 615
February	17, 602	28, 585	255, 225	629, 180	121, 627	2, 286, 741
March	18, 351	32, 098	297, 778	678, 666	150, 095	2, 608, 274
April	17, 131	38, 081	242, 845	598, 685	190, 677	2, 446, 805
May	17, 283	30, 098	199, 727	667, 391	239, 912	2, 605, 971
June	16, 553	31, 823	185, 277	623, 623	228, 267	2, 579, 019
July	18, 317	28, 889	167, 015	692, 245	221, 999	2, 583, 997
August	18, 865	29, 740	153, 454	659, 621	249, 472	2, 558, 711
September	18, 000	26, 600	192, 195	615, 882	202, 364	2, 416, 920
October	19, 014	28, 696	202, 094	637, 495	220, 557	2, 581, 250
November	18, 614	26, 983	183, 276	611, 187	199, 787	2, 413, 794
December	20, 560	27, 092	170, 857	613, 929	199, 774	2, 483, 999
Total	218, 874	359, 459	2, 528, 852	7, 774, 215	2, 362, 703	30, 117, 096

The Charles Miller and the Producers' pipe lines, which appeared as receivers of oil in 1893, received no oil in 1894, and hence are dropped. The Western and Atlantic has been absorbed by the National Transit. The pipe line runs, or receipts from wells, given in the above table, are of New York and Pennsylvania oil, with the exception of the Mellon, Eureka, and Buckeye-Macksburg. In the figures of total production are included that portion of the production of Smiths Ferry, Pa., and Volcano and Burning Springs, W. Va., which are not delivered to the pipe lines. The remainder of the deliveries, 664,828 barrels, should be charged to dump oil and other production which is not included in pipe-line runs.

SHIPMENTS OF OIL FROM THE APPALACHIAN FIELD.

In the following table are given the total deliveries of petroleum by the pipe lines of the Appalachian oil field from 1889 to 1894, by years and months. These figures must not be regarded as showing the actual consumption of the petroleum produced in this field. To them must be added, in order to ascertain what becomes of the oil produced in this region, all of the sediment, dump oil or oil that does not pass through the pipe lines, as well as the oil that is destroyed by fire or accident or disposed of in other ways than by refining and direct consumption. There is also a certain amount of loss by evaporation and otherwise. This is provided for by the pipe lines in receiving oil from the producers, a certain number of gallons per barrel being allowed for such loss. Forty-four gallons are usually delivered to the pipe line as a barrel, but certificates are issued for 42 gallons only.

The table given below only shows the deliveries of oil to customers in the regular way of business. The total consumption of oil during the year can only be ascertained by adding to the production of a year the stocks at the beginning of the year and subtracting from this total the stocks at the close of the year. This will in no case be the same as deliveries. For example, at the close of 1893 the total stocks of petroleum in the Appalachian Field reported in tanks was 12,316,611 barrels. The total production of this field in 1894 was 30,781,924 barrels, making a total of stocks at the beginning of the year and production during the year of 43,098,535 barrels. The total stocks at the close of the year were 6,499,880 barrels, which, subtracted from the above total of available petroleum for 1893, namely, 43,098,535 barrels, leaves a remainder of 36,598,655 barrels, which may be regarded as the total consumption of the oil produced in the Appalachian field. Pipe-line deliveries were, however, but 36,207,275 barrels, which shows a consumption during 1894 of 391,380 barrels more than the pipe-line deliveries. This excess is made up of dump oil, direct deliveries, waste, and the amounts which were from time to time credited by the pipe-line companies for increase in "B. S.":

Total deliveries of petroleum in the Appalachian oil field, 1889 to 1894, by months.

[Barrels.]

Months.	1889.	1890.	1891.	1892.	1893.	1894.
January	2, 400, 456	2, 681, 646	2, 475, 783	2, 420, 825	2, 957, 358	3, 141, 722
February	2, 288, 229	2, 185, 007	2, 170, 172	2, 443, 546	2, 584, 742	2, 656, 026
March	2, 286, 948	2, 184, 018	2, 430, 705	2, 586, 075	2, 843, 938	2, 912, 594
April	2, 244, 615	2, 348, 385	2, 157, 605	2, 338, 421	2, 666, 199	2, 846, 805
May	2, 265, 150	2, 488, 036	2, 073, 199	2, 278, 027	3, 033, 700	2, 819, 413
June	2, 277, 214	2, 509, 056	2, 163, 811	2, 108, 386	3, 074, 443	2, 914, 400
July	2, 964, 866	2, 687, 061	2, 260, 996	2, 314, 405	3, 319, 658	2, 927, 036
August	2, 640, 433	2, 645, 399	2, 498, 573	2, 626, 043	3, 248, 873	3, 256, 397
September	2, 590, 127	2, 711, 887	2, 704, 645	2, 770, 472	3, 000, 740	2, 966, 864
October	2, 797, 732	2, 783, 121	2, 802, 254	2, 824, 508	3, 316, 914	3, 271, 371
November	2, 441, 055	2, 717, 439	2, 604, 135	2, 916, 265	3, 096, 578	3, 208, 560
December	2, 718, 608	2, 743, 225	2, 783, 766	2, 978, 921	3, 152, 238	3, 286, 087
Average.	2, 492, 953	2, 557, 023	2, 427, 137	2, 550, 491	3, 024, 615	3, 017, 273
Totals	29, 915, 433	30, 684, 280	29, 125, 644	30, 605, 894	36, 295, 381	36, 207, 275

From the above table it will be seen that the total deliveries in 1894 of petroleum produced in the Appalachian oil field were only some 90,000 barrels less than the deliveries in 1893. This shows that the consumption of petroleum from this field in 1894 was some 3,000,000 barrels a month, while the production was only about 2,500,000 barrels a month, the deliveries of the pipe lines, and practically the consumption, being 500,000 barrels a month, or, to be exact, 5,425,551 barrels for the entire year, in excess of the production. This remarkable consumption of petroleum, so much in excess of the production, coupled as it is with the reduction in stocks to less than 6,500,000 barrels—making the consumption in the last two years 11,146,125 barrels in excess of production—can not but have a marked effect in the near future upon the price of petroleum.

STOCKS OF PETROLEUM IN THE APPALACHIAN FIELD.

In the following table will be found a statement of the stocks of petroleum in the tanks of the pipe-line companies in the Appalachian oil field at the close of each month from 1889 to 1894:

Total stocks of petroleum in the Appalachian oil field at the close of each month, 1889 to 1894.

[Barrels of 42 gallons.]

	1889.	1890.	1891.	1892.	1893.	1894.
January	18, 529, 228	11, 356, 634	11, 068, 179	16, 973, 225	17, 305, 206	11, 755, 219
February	17, 597, 956	11, 282, 453	11, 340, 147	17, 416, 399	17, 042, 245	11, 384, 776
March	16, 994, 558	11, 472, 854	11, 419, 782	17, 587, 512	16, 834, 533	11, 295, 959
April	16, 441, 298	11, 503, 776	11, 793, 604	18, 028, 753	16, 641, 773	10, 751, 983
May	16, 044, 384	11, 445, 975	12, 138, 347	18, 464, 378	16, 285, 855	10, 639, 454
June	15, 656, 582	11, 318, 438	12, 455, 630	19, 056, 902	15, 845, 548	10, 381, 209
July	14, 928, 784	11, 170, 539	12, 640, 790	19, 446, 441	15, 182, 551	9, 869, 915
August	14, 248, 456	11, 057, 828	12, 791, 156	19, 563, 635	14, 730, 600	9, 210, 959
September	13, 581, 845	10, 942, 934	13, 039, 230	19, 394, 242	14, 261, 432	8, 730, 456
October	12, 823, 467	10, 923, 831	13, 936, 108	19, 039, 149	13, 559, 543	8, 038, 376
November	12, 353, 863	10, 783, 567	15, 413, 864	18, 529, 914	12, 904, 344	7, 283, 988
December	11, 873, 442	10, 691, 729	16, 457, 089	18, 037, 385	12, 316, 611	6, 499, 880
Average	15, 089, 489	11, 162, 547	12, 874, 494	18, 461, 495	15, 242, 520	9, 653, 515

This table needs but little comment. The stocks do not represent the total stocks in the region, but only those held by the pipe lines. As a rule, stocks at the wells are not included unless the tanks at the wells are in the custody of the pipe-line companies and the oil has been measured as it runs into them. A notable feature in this table is the great decrease of stocks in 1894, the stocks at the close of this year being but 6,499,880 barrels, as compared with 12,316,611 barrels at the close of 1893 and 18,037,385 barrels at the close of 1892. The largest stock reported at the close of any one month was in August, 1892, when 19,563,635 barrels were reported in stock. In the two years and a half since that date the stocks have been reduced over 13,000,000 barrels, or, in other words, the stocks at the close of 1894 are only about one-third of what they were at the close of August, 1892. The stock at the close of December, 1894, is the smallest in this region since March, 1879, the stock on hand at the close of that month being 6,318,099 barrels.

PRICES OF CRUDE PETROLEUM IN THE APPALACHIAN OIL FIELD.

The prices of crude petroleum in the Appalachian oil field given in the following table, which is taken from Stowell's Petroleum Reporter, shows the monthly and yearly average prices either of pipe-line certificate or of crude petroleum at the primary markets from 1860 to 1894. In the earlier years covered by the table there were no pipe lines, and the price given for oil is the price per barrel either at the wells or at some delivery point in the oil region, usually the price at the wells. In the later years the price given is that of pipe-line certificates, which until recently have been issued by the pipe-line companies, usually for 1,000 barrels each, to the owners of the oil in their tanks, these certificates being to bearer and transferable. The price quoted for these certificates is the price at the wells or at the tanks of the pipe lines near the wells into which the oil is received from the wells. As a rule the holder of the certificate desiring to receive the oil represented by the certificate could secure it from any of the tanks of the company wherever situated—that is, on a certificate, except in unusual cases calling for a given amount of oil of a certain grade, there was no reference as to where the oil covered by the certificate was to be delivered. In such cases, however, the pipe-line company is entitled to make a charge for storage and pipage, the storage charged per month, as well as the pipage, being regulated somewhat by the selling price of the oil. In the selling price of the oil, therefore, no charges for storage in tanks nor for transportation are included. Practically, therefore, the prices given are the prices for the oil at or near the wells.

The average prices cover only the ordinary grades of oil. They do not include the prices of special oils, such as that from the Franklin district in Pennsylvania or the lubricating oils from Burning Springs or Volcano in West Virginia, nor the oil from the Mecca-Belden district in Ohio, but only that grade of oil which is known as Pennsylvania oil and is used chiefly for the production of illuminants. It is also true that at certain times oils from different districts in the Appalachian field have been worth an advance on certificate oil, and frequently old oil or tank oil—that is, oil that has stood for some time in tanks—is worth less than fresh oil, or oil that has been recently produced. This is especially the case when there is a large demand for the lighter oils, fresh oils producing a larger percentage of the lighter products than old oil. These averages, it should be understood, are not true averages—that is, averages which consider the price and the quantity sold at that price—but they are averages of the prices obtained for certificates or for oil at the primary markets from day to day. It is probable that the true average prices would be slightly under the averages obtained by averaging the prices. The figures given in the following table are, under the circumstances, the only ones that can be ascertained, and do not vary much from the true average:

Monthly and yearly average prices of pipe-line certificates of crude petroleum at wells from 1860 to 1894.

[Per barrel.]

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly.
1860	$19.25	$18.00	$12.62½	$11.00	$10.00	$9.50	$8.62½	$7.50	$6.62½	$5.50	$3.75	$2.75	$9.59
1861	1.00	1.00	1.00	.62½	.50	.50	.50	.25	.20	.10	.10	.10	.49
1862	.10	.15	.22½	.50	.85	1.00	1.25	1.25	1.25	1.75	2.00	2.25	1.05
1863	2.25	2.50	2.62½	2.87½	2.87½	3.00	3.25	3.37½	3.50	3.75	3.85	3.95	3.15
1864	4.00	4.37½	5.50	6.56	6.87½	9.50	12.12½	10.12½	8.87½	7.75	10.00	11.00	8.06
1865	8.25	7.50	6.00	6.00	7.37½	5.62½	5.12½	4.62½	6.75	8.12½	7.25	6.50	6.59
1866	4.50	4.40	3.75	3.95	4.50	3.87½	3.00	3.75	4.50	3.39	3.10	2.12½	3.74
1867	1.87½	1.85	1.75	2.07½	2.35	1.90	2.62½	3.15	3.40	3.55	2.50	1.87½	2.41
1868	1.95	2.00	2.55	2.82⅛	3.75	4.50	5.12½	4.57½	4.00	4.12½	3.75	4.35	3.62½
1869	5.75	6.95	6.00	5.70	5.35	4.95	5.37½	5.57½	5.50	5.50	5.80	5.12½	5.63¾
1870	4.52½	4.52½	4.45	4.22½	4.40	4.17½	3.77½	3.15	3.25	3.27½	3.22½	3.40	3.86
1871	3.82½	4.38	4.25	4.01	4.60	3.85½	4.79	4.66	4.65	4.82½	4.25	4.00	4.34
1872	4.02½	3.80	3.72½	3.52½	3.80	3.85	3.80	3.58½	3.25	3.15	3.83½	3.32½	3.64
1873	2.60	2.20	2.12½	2.30	2.47½	2.22½	2.00	1.42½	1.15	1.20	1.25	1.00	1.83
1874	1.20	1.40	1.60	1.90	1.62½	1.32½	1.02½	.95	.95	.85	.55	.61½	1.17
1875	1.03	1.52½	1.75	1.36½	1.40	1.26½	1.09	1.13	1.33	1.32½	1.44	1.55	1.35
1876	1.80	2.60	2.01	2.02½	1.90½	2.01¾	2.24½	2.71⅜	3.81	3.37½	3.11	3.73	2.56¼
1877	3.53¼	2.70	2.67½	2.58	2.24	1.94⅝	2.07½	2.51	2.38	2.56¾	1.91	1.80	2.42
1878	1.43	1.65¼	1.59	1.37½	1.35¼	1.14	.98¾	1.01	.86⅝	.82½	.89⅜	1.16	1.19
1879	1.03	.98	.86¼	.78½	.76	.68⅜	.69⅞	.67⅛	.69⅜	.88⅛	1.05⅝	1.18⅓	.85⅞
1880	1.10¼	1.03⅛	.88¾	.78	.80	1.00	1.06¼	.91	.96	.96⅞	.91⅞	.91⅝	.94½
1881	.95½	.90⅜	.83⅜	.86¼	.81⅞	.81¼	.76⅞	.78⅛	.97⅛	.91¼	.85¼	.84⅜	.85⅞
1882	.83⅛	.84½	.81⅜	.78⅜	.71½	.54⅜	.57⅜	.58⅝	.72⅛	.93¾	1.14	.96	.78⅛
1883	.93¾	1.01	.97⅝	.94⅜	1.00⅛	1.16⅜	1.05⅞	1.08	1.12½	1.11⅛	1.14½	1.14¾	1.05¾
1884	1.11	1.04⅜	.98⅛	.94	.85⅝	.68⅝	.63½	.81⅞	.78	.71⅛	.72½	.74⅜	.83½
1885	.70⅞	.72⅜	.80⅜	.78½	.79	.82	.92½	1.00¼	1.00¾	1.05½	1.04⅜	.89⅝	.87⅞
1886	.88⅜	.79⅞	.77¼	.74⅛	.70	.66½	.66	.62⅛	.63⅜	.65⅛	.71⅝	.70⅝	.71¼
1887	.70	.64⅝	.63⅜	.64⅞	.64⅓	.62⅝	.59¼	.60⅛	.67	.70⅞	.73⅞	.80¾	.66¾
1888	.91¼	.91⅝	.98⅝	.82⅝	.86¾	.75⅞	.80⅝	.90⅛	.93⅝	.90⅝	.85⅜	.89¼	.87⅝
1889	.86⅝	.89¼	.90⅞	.88	.83⅛	.83⅞	.95⅛	.99½	.99⅛	1.01⅜	1.08½	1.04⅓	.94⅛
1890	1.05¾	1.05⅛	.90	.82⅝	.88⅞	.89¼	.89⅛	.89¼	.81⅞	.80⅛	.72⅜	.67¼	.86¾
1891	.74¼	.78⅜	.74¼	.71½	.69¾	.68⅛	.66½	.64	.58½	.60½	.58¾	.59⅝	.67
1892	.62⅜	.60¼	.57⅛	.57⅞	.57⅜	.54⅛	.52½	.55	.54⅜	.51⅜	.52	.53¼	.55⅝
1893	.53½	.57⅜	.65¼	.68¾	.58¾	.60¼	.57⅝	.58⅞	.64⅝	.70¾	.73⅞	.78¼	.64
1894	.79¾	.80⅝	.82	.84¼	.86	.89⅜	.83⅛	.81	.83	.83	.83	.91½	.83⅞

From the above table it will be seen that the average price of petroleum in 1894 was higher than it has been in any year since 1890, while the price of oil in December, 1894, was the highest average price of any month since February, 1890. From that date—that is, February, 1890—

when oil was quoted at \$1.05$\frac{1}{8}$, there has been, on the whole, a gradual decrease until October, 1892, during which month the average price stood at 51$\frac{5}{8}$ cents per barrel. From this date there has been a gradual increase, oil touching 70$\frac{3}{4}$ cents in October, 1893, and 91$\frac{1}{2}$ cents in December, 1894. In the last fifteen years the average price of oil for the entire year has been above the average price for 1894 during eight years, and the same or less than the price of 1894 for seven years. For the reasons stated previously—namely, a consumption very much in excess of production, resulting in a great reduction in stocks—it is very probable that the price of petroleum in 1895 will be very much in excess, at least during part of the year, of any prices that have ruled possibly since 1872, when the average price was \$3.64. In 1876 the price was \$2.56$\frac{1}{4}$, and in 1877 \$2.42. Since 1877 the average price of oil has been above the dollar mark only in two years. In one of these years, 1878, it was \$1.19, and in the other year, 1883, it was but \$1.05$\frac{3}{4}$ a barrel.

WELL RECORDS IN THE APPALACHIAN OIL FIELD.

In the following table will be found statements showing the well records in the Appalachian field—that is, the number of wells completed in the Appalachian field during each month of 1894 by months and districts, and the wells completed in each year from 1891 to 1894 by months, as well as the initial daily production of new wells by months and districts for 1894, and by months from 1891 to 1894:

Total number of wells completed in the Appalachian oil fields in 1894.

Months.	Bradford.	Allegany.	Middle field.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Macksburg.	Total entire field.
January	8	2	7	34	38	91	9	189
February	7	3	9	29	27	95	6	176
March	14	3	8	40	34	103	15	217
April	19	5	20	42	50	125	17	278
May	27	6	18	59	64	133	17	324
June	27	6	25	63	85	143	21	370
July	32	7	18	68	57	137	23	342
August	25	10	22	81	69	134	18	359
September	32	9	28	78	82	133	19	381
October	33	12	24	97	81	126	21	394
November	30	6	23	72	84	153	22	390
December	30	13	13	68	84	108	27	343
Total	284	82	215	731	755	1,481	215	3,763

The increase in the number of wells completed in each month during the last year will be noted. In Bradford but 8 wells were completed in January, while 30 were completed in December. In Allegany 2 were completed in January and 13 in December. While the other districts show a much larger number of wells completed than in the two named, the percentage of increase is not as great.

In order that the comparative work done in this field in 1893 and 1894 may be observed, we give the following table:

Total number of wells completed in the Appalachian oil field in 1893 and 1894.

Districts.	Wells completed.	
	1893.	1894.
Bradford	52	284
Allegany	41	82
Middle field	91	215
Venango and Clarion	243	731
Butler and Armstrong	298	755
Southwest	1,065	1,481
Macksburg	190	215
Total	1,980	3,763

It will be noticed from this comparative table, as has been suggested elsewhere, that the great activity in drilling wells in the Appalachian oil field has been in the old districts. The number of wells completed in the Bradford district in 1894 was five and one-half times the number completed in 1893; in Allegany it was double; in the Middle field more than double; in the Venango and Clarion district three times; in the Butler and Armstrong two and one-half times, while in the Southwest district the increase was but 40 per cent, and in the Macksburg district only 13 per cent. The increase in the entire field was 90 per cent.

The following table, giving a statement of the number of wells completed in the Appalachian oil field for each month during the years 1891 to 1894, will make still more evident the great activity in drilling wells in 1894. The number of wells completed in 1894 is nearly 400 greater than in 1891, and nearly 1,800 greater than in 1892 or 1893.

Number of wells completed in the Appalachian oil field each month from 1891 to 1894, by months and years.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891	310	243	275	288	314	304	334	333	281	246	255	205	3,388
1892	182	180	149	174	174	162	179	143	146	160	174	145	1,968
1893	135	99	143	146	196	228	219	163	179	154	144	174	1,980
1894	189	176	217	278	324	370	342	359	381	394	390	343	3,763

The tables given do not include any wells drilled in the Franklin lubricating oil district of Pennsylvania, nor the wells drilled in the Volcano and Burning Springs districts of West Virginia that produce lubricating oil, nor in the Macksburg district, Ohio; nor will the statement given below include any of the initial production of the wells drilled in these several districts.

The districts, not only in the above table, but in the one given subsequently regarding the initial daily production, have been described in other parts of this report. Here it may be said, briefly, that the Bradford district includes a portion of Cattaraugus County, N. Y., and forms, with the Allegany (N. Y.) district, the Northern or Bradford field. The Middle field is chiefly in Warren and Forest counties, Pa., though the Lower field includes also a portion of Warren County. The Venango and Clarion and the Butler and Armstrong fields are the chief districts of what is known as the Lower field, all of which is in Pennsylvania. The Southwest field includes the wells in Allegheny, Washington, Beaver, and other southwestern counties of Pennsylvania, as well as those in West Virginia and eastern Ohio, except those in the neighborhood of Macksburg; that is, the Southwest district includes the Sistersville, Eureka, Mannington, Mount Morris, and other fields in West Virginia and eastern Ohio. The Macksburg district includes the wells in the vicinity of this well-known oil town.

In the following table is given the initial daily production of new wells in the Appalachian oil field in 1894 by districts and months. By initial daily production is meant the production of the well when it is first drilled into the sand and begins producing:

Initial daily production of new wells in the Appalachian oil field in 1894.

[Barrels of 42 gallons.]

Months.	Bradford.	Allegany.	Middle field.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Macksburg.	Total entire field.
January	110	3	130	224	764	7, 293	143	8, 667
February	98	0	39	128	282	5, 317	50	5, 914
March	199	20	106	189	598	4, 914	74	6, 100
April	181	25	251	239	1, 276	5, 440	172	7, 584
May	415	27	199	366	806	5, 371	246	7, 430
June	188	27	256	386	2, 312	8, 051	223	11, 443
July	212	36	144	391	1, 351	6, 613	262	9, 009
August	232	38	195	490	1, 561	4, 943	232	7, 691
September	143	24	231	336	1, 471	4, 527	180	6, 912
October	227	45	175	426	1, 717	4, 780	468	7, 838
November	188	18	114	345	2, 397	4, 230	215	7, 507
December	103	63	113	295	2, 057	2, 885	433	5, 949
Total	2, 296	326	1, 953	3, 815	16, 592	64, 364	2, 698	92, 044

For comparison we give below a statement showing the initial daily production of all the producing wells drilled in the Appalachian oil field in 1893 and 1894:

Initial daily production of new wells in the Appalachian oil field in 1893 and 1894.

Districts.	1893.	1894.
	Barrels.	*Barrels.*
Bradford	410	2, 296
Allegany	100	326
Middle field	744	1, 953
Venango and Clarion	1, 533	3. 815
Butler and Armstrong	6, 345	16, 592
Southwest	76, 633	64, 364
Macksburg	2, 610	2, 698
Total	88, 375	92, 044

From the above table it will be seen that though there was an increase of 1,783 in the number of wells completed in this field in 1894 over

1893, the increased initial production was but 3,669 barrels; that is, the initial production of each producing well completed in 1893 was 44.6 barrels and in 1894 24.4 barrels, a reduction of 20.2 barrels per well.

The tables given above, especially the last, show the difference in the producing capacity of the wells in the several districts, and also the changes in production. There is a remarkable regularity in the initial daily production of new wells in the old districts in the two years covered by the report, while there is a great variation in what may be termed the newer districts. How great this variation is will be seen from the following table, which gives the average initial daily production of each well in each district for the years 1893 and 1894:

Average daily production of new wells in the Appalachian oil field in 1893 and 1894, by districts.

Districts.	1893.	1894.
	Barrels.	*Barrels.*
Bradford	8	8
Allegany	2.2	4
Middle field	8.2	9
Venango and Clarion	6.3	5.2
Butler and Armstrong	21.3	22
Southwest	72	43.5
Macksburg	13.7	12.5
Total	44.6	24.4

With the exception of the Allegany field, and this is of but little importance as an oil producer, there is but little variation in the average daily initial production of the new wells drilled in any of the older districts, the average being, as a rule, less than one barrel. In the Southwest district, which is a new district, however, the average in 1893 was 72 barrels a day and in 1894 43½ barrels, a difference of nearly 30 barrels a day in initial production, while the average initial production per well in the entire field was 44.6 barrels in 1893 and 24.4 in 1894, a difference of some 20 barrels.

The total daily initial production of new wells completed in the Appalachian oil field from 1891 to 1894, as far as it could be ascertained, is as follows:

Total daily initial production of new wells in the Appalachian oil field, from 1891 to 1894, by months.

[Barrels.]

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1891	13,361	6,618	7,751	7,710	7,875	5,263	6,543	13,536	18,118	46,748	33,660	15,538
1892	12,249	9,992	8,661	6,751	7,793	9,585	10,669	7,861	6,347	8,833	6,932	7,580
1893	5,910	6,982	7,650	6,962	8,176	10,815	7,662	8,733	6,640	4,510	6,495	7,840
1894	8,667	5,914	6,100	7,584	7,430	11,443	9,009	7,691	6,912	7,838	7,507	5,949

In the following table will be found a statement of the number of dry holes drilled in the Appalachian oil field in 1894, by months and districts. By "dry holes" is meant wells that are drilled that produce neither gas nor petroleum. If, in drilling for oil, gas is found, the well is not regarded as a dry hole:

Total number of dry holes drilled in the Appalachian oil field in 1894.

Months.	Bradford.	Allegany.	Middle field.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Macksburg.	Total.
January	0	1	1	6	11	14	3	36
February	1	3	3	7	5	20	2	41
March	2	0	1	8	8	27	8	54
April	3	2	2	6	17	31	7	68
May	1	2	1	6	21	31	5	67
June	5	1	2	9	26	32	9	84
July	6	1	1	11	14	26	8	67
August	1	5	2	14	18	32	8	80
September	6	4	3	13	28	41	7	102
October	4	2	5	25	15	32	8	91
November	7	2	8	11	21	40	11	100
December	10	5	2	8	20	31	9	85
Total	46	28	31	124	204	357	85	875

This table, taken in connection with the table showing the number of wells drilled, is interesting as showing to some degree the probabilities of finding oil in the different districts. This statement is made with some reservation in view of the fact that "wildcatting" is common in all districts, and therefore the number of dry holes will depend somewhat upon the amount of testing of territory done in each district.

A comparison of the number of dry holes drilled in the Appalachian oil field in the years 1893 and 1894 is of considerable interest. It is as follows:

Number of dry holes drilled in the Appalachian oil field in 1893 and 1894.

Districts.	1893.	1894.
Bradford	8	46
Allegany	22	28
Middle field	17	31
Venango and Clarion	56	124
Butler and Armstrong	88	204
Southwest	206	357
Macksburg	46	85
Total	443	875

It will be seen that while the number of wells completed in 1893 and 1894 were 1,980 and 3,763, respectively, the number of dry holes increased from 443 in 1893 to 875 in 1894; that is, on the average the percentage of increase of dry holes did not differ greatly from the percentage of increase in the number of wells.

It will be noted that of the 52 wells completed in the Bradford district in 1893, 8, or 15 per cent, were dry, while of the 284 drilled in this same district in 1894, 46, or some 16 per cent, were dry—practically the same average. In the Southwest district, however, the number of dry wells to the total number of wells completed in 1893 was about 20 per cent, whereas in 1894 it was 24 per cent.

In the following table will be found a statement of the number of dry holes drilled in each month from 1891 to 1894:

Dry holes drilled from 1891 to 1894.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891	46	61	52	59	48	72	67	66	41	50	59	43	664
1892	37	36	38	40	48	33	43	31	40	37	40	39	462
1893	39	24	36	28	41	48	40	40	43	35	28	41	443
1894	36	41	54	68	67	84	67	80	102	91	100	85	875

The activity with which drilling is being prosecuted in the various fields and districts at any given time is better shown by the number of rigs and derricks building and wells drilling than by the number of wells completed. In times of great prosperity and bright outlook for the future there is great activity in building rigs and drilling wells. Therefore the reports of rigs building and wells drilling at a given time show better what the oil producers regard as the outlook for the future than wells completed.

In the following table will be found a statement of the number of rigs and derricks in the course of construction at the close of each month of 1894 for each of the districts of the Appalachian field:

Rigs building in the Appalachian oil field in 1894.

Months.	Bradford.	Allegany.	Middle field.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Macksburg.	Total.
January	7	1	10	26	20	93	9	166
February	10	2	14	25	33	83	13	180
March	10	2	13	25	34	90	13	187
April	17	6	25	27	51	98	9	233
May	17	8	21	32	42	104	13	237
June	21	4	13	42	63	82	13	238
July	21	5	22	39	54	86	18	245
August	19	6	20	48	53	128	18	292
September	18	0	20	41	56	104	15	254
October	21	4	14	47	55	101	27	269
November	16	2	10	52	57	92	19	248
December	17	5	12	43	64	90	17	248
Average ..	16	4	16	37	49	96	15	233

This table shows a decided increase in the number of rigs building at the close of 1894, as compared with the number building in January in all the districts except the Southwest, where there has been a falling off, there being but 90 rigs building at the close of the year, as compared with 93 at the beginning of the year. On the other hand, in 1893 the number of rigs building in the Southwest district at the close of the year was 30 per cent greater than the number at the beginning of the year.

In the following table will be found a statement of the number of rigs building in the entire Appalachian oil field at the close of each month from 1891 to 1894:

Rigs building in the Appalachian oil field, 1891 to 1894.

Years.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1891	233	195	218	186	208	234	182	188	131	156	142	112	182
1892	110	132	111	100	108	89	96	74	98	108	130	122	107
1893	108	107	132	159	144	135	116	114	91	110	143	193	129
1894	166	180	187	233	237	238	245	292	254	269	248	248	233

In the following tables will be found statements regarding the number of wells drilling but not completed at the close of each month of 1894, by districts, and also in the entire Appalachian oil field for each month from 1891 to 1894. This, compared with the statement given above of the number of rigs building, shows some interesting features, as, for example, in the Southwest district, though there were fewer rigs building by 3 in December than in January, there were 39 more wells drilling. At the close of the year there were 456 wells drilling, as compared with 233 drilling in December, 1893, and 188 drilling in January, 1893:

Wells in process of drilling in the Appalachian oil field in 1894.

Months.	Bradford.	Allegany.	Middle field.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Macksburg.	Total.
January	9	1	9	27	37	175	11	269
February	10	2	11	23	56	176	4	282
March	21	5	12	27	72	174	19	330
April	27	4	16	32	78	183	5	345
May	32	3	25	33	103	197	17	410
June	30	9	24	44	79	229	15	430
July	22	9	31	45	116	257	18	498
August	32	10	34	44	116	230	18	484
September	37	13	27	48	120	228	16	489
October	34	12	25	46	122	215	15	469
November	28	11	21	54	123	195	19	451
December	23	7	21	49	120	214	22	456
Average	25	7	21	40	95	206	15	409

Number of wells drilling in the Appalachian oil field at the close of each month from 1891 to 1894, by months and years.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1891	407	410	401	387	380	407	420	406	397	386	351	286	386
1892	264	273	251	230	233	258	204	244	236	246	228	238	242
1893	188	214	206	269	291	305	266	248	233	219	277	233	246
1894	269	282	330	345	410	430	498	484	489	469	451	456	409

PENNSYLVANIA–NEW YORK OIL FIELD.

PRODUCTION.

In the statistics of production, shipments, stocks, etc., of the Appalachian oil field previously given are included the statistics of Pennsylvania and New York as well as West Virginia and eastern Ohio, these four localities making up the Appalachian field. It is both interesting and important, so far as it can be done, however, to give the statistics of production for each of these States. This is especially necessary regarding Pennsylvania and New York, as for many years the statistics of petroleum in the United States were practically those of the production in these two States. Therefore, a comparison of the increase or decrease in production should be made on the basis of the ascertained statistics of production of these two States. What has been stated already regarding the difficulty of ascertaining the exact figures for the several States separately for certain items should be recalled. There is but little difficulty in ascertaining the production of the several States, but it has been found impossible in some cases to separate the stocks, shipments, etc., of the four States comprising this field.

In the following table is given a statement of the production of crude petroleum in New York and Pennsylvania in 1894 by districts and months:

Production of crude petroleum in Pennsylvania and New York in 1894 by districts and months.

[Barrels of 42 gallons.]

Districts.	January.	February.	March.	April.	May.	June.	July.
Allegany, N. Y	56, 704	49, 075	61, 971	58, 166	57, 660	60, 108	56, 813
Bradford, Pa	278, 342	248, 035	299, 654	280, 599	294, 175	299, 976	289, 663
Middle district	95, 380	84, 038	96 766	91, 746	100, 712	104, 715	103, 034
Tiona	29, 815	24, 327	29, 470	25, 281	27, 071	26, 050	25, 784
Tidioute and Titusville	18, 190	15, 852	16, 688	16, 810	16, 903	16, 756	14, 500
Grand Valley	4, 500	3, 500	4, 500	4, 000	4, 000	4, 000	4, 000
Second Sand	21, 922	20, 871	25, 737	24, 025	28, 729	26, 902	33, 018
Clarendon and Warren	28, 316	22, 489	28, 878	25, 813	27, 143	26, 900	30, 022
Lower district	426, 096	392, 924	447, 907	422, 911	457, 649	485, 998	486, 583
Washington County	155, 307	143, 903	166, 338	171, 302	154, 107	156, 086	141, 954
Beaver County	35, 383	34, 462	43, 537	39, 798	39, 650	40, 642	36, 417
Greene County	5, 960	5, 490	4, 539	4, 430	6, 213	3, 643	6, 509
Allegheny County, Pa	418, 302	382, 906	430, 750	366, 850	409, 256	407, 076	390, 624
	1, 574, 217	1, 427, 872	1, 656, 735	1, 531, 731	1, 623, 268	1, 658, 852	1, 618, 921
Franklin district	4, 985	4, 161	5, 642	5, 550	4, 663	4, 894	5, 628
Smiths Ferry district	218	218	218	219	218	218	218
Total	1, 579, 420	1, 432, 251	1, 662, 595	1, 537, 500	1, 628, 149	1, 663, 964	1, 624, 767

Districts.	August.	September.	October.	November.	December.	Total.
Allegany, N. Y	54, 750	48, 908	55, 390	48, 968	48, 332	656, 845
Bradford, Pa	290, 399	262, 538	284, 394	262, 011	270, 049	3, 359, 835
Middle district	102, 461	96, 335	105, 032	94, 711	94, 698	1, 169, 628
Tiona	25, 495	20, 793	28, 751	25, 671	30, 103	318, 611
Tidioute and Titusville	14, 000	13, 000	14, 194	14, 032	12, 500	183, 425
Grand Valley	4, 000	4, 000	3, 500	3, 000	3, 000	46, 000
Second Sand	26, 703	26, 170	29, 151	26, 226	26, 270	315, 724
Clarendon and Warren	30, 779	26, 715	33, 681	27, 350	30, 484	338, 570
Lower district	510, 472	490, 560	532, 475	526, 230	580, 769	5, 760, 574
Washington County	129, 841	122, 861	136, 865	117, 952	124, 264	1, 720, 780
Beaver County	37, 079	34, 259	41, 677	40, 448	43, 438	466, 790
Greene County	4, 344	4, 338	5, 849	6, 589	6, 272	64, 176
Allegheny County, Pa	377, 608	357, 453	364, 202	330, 218	324, 097	4, 559, 342
	1, 607, 931	1, 507, 930	1, 635, 161	1, 523, 406	1, 594, 276	18, 960, 300
Franklin district	4, 062	3, 967	5, 603	4, 127	3, 788	57, 070
Smiths Ferry district	219	219	218	219	218	*a* 2, 620
Total	1, 612, 212	1, 512, 116	1, 640, 982	1, 527, 752	1, 598, 282	19, 019, 990

a This production only represents dump oil, the pipe-line runs of this district being included in runs of Beaver County.

The production of New York includes all the oil produced in the Allegany district and about 8½ per cent of that produced in the Bradford district, this percentage being the production of Cattaraugus County, N. Y. On this basis the total production of crude petroleum in the State of New York would be 942,431 barrels.

The remainder of the 19,019,990 barrels of production shown in the previous table should be credited to Pennsylvania, which makes the total production in this State, including the Franklin district and Smiths Ferry dump oil, 18,077,559 barrels.

The table shows a falling off in production of every district in this field except Tiona, Second Sand, Clarendon and Warren, and the Lower district, and the increases in these districts are not marked. The great falling off is in the Allegheny County district, Pennsylvania, the production of 1893 being 5,488,792 barrels as compared with 4,559,342 barrels in 1894.

In the following table is given the total production of crude petroleum in the Pennsylvania and New York oil fields for the twenty-four years from 1871 to 1894:

Total product of crude petroleum in the Pennsylvania and New York oil fields from 1871 to 1894, by months and years.

[Barrels of 42 gallons.]

Years.	January.	February.	March.	April.	May.	June.	July.
1871	418, 407	372, 568	400, 334	385, 980	408, 797	410, 340	456, 475
1872	583. 575	462, 985	461, 590	462, 090	537, 106	491, 130	517, 762
1873	632, 617	608, 300	665, 291	641, 520	776, 364	793, 470	867, 473
1874	1, 167, 243	8[illegible]5, 492	883, 438	778, 740	895, 745	621, 750	1, 033, 447
1875	852, 159	719, 824	789, 539	675, 060	696, 508	696, 210	788, 361
1876	712, 225	668, 885	718, 177	701, 490	735, 351	723, 600	763, 623
1877	842. 890	783, 216	901, 697	972. 810	1, 127, 594	1, 130, 790	1, 189, 005
1878	1, 203, 296	1, 094, 856	1, 208, 380	1, 195, 890	1, 264, 862	1, 217, 250	1, 283, 865
1879	1, 369, 921	1, 261, 935	1, 499, 315	1, 530, 450	1, 644, 922	1, 675, 650	1, 637, 767
1880	1, 904, 113	1, 870, 008	2, 015, 992	2, 015, 700	2, 228, 931	2, 158, 440	2, 248, 430
1881	2, 244, 090	1, 913, 128	2, 274, 532	2, 205, 780	2, 393, 293	2, 377, 860	2, 372, 678
1882	2, 353, 551	2, 131, 332	2, 482, 170	2, 402, 790	2, 486, 572	2, 825. 940	3, 258, 162
1883	1, 948, 319	1, 756, 188	1, 830, 674	1, 816, 530	1, 962, 052	1, 977, 900	2, 020, 394
1884	1, 825, 838	1, 880, 650	2, 052, 262	2. 065, 860	2, 381, 854	1, 862, 190	2, 059, 950
1885	1, 652, 176	1, 437, 884	1, 638, 133	1, 780, 290	1, 771, 371	1, 767, 210	1, 775, 804
1886	1, 748, 958	1, 604, 848	1. 928, 448	1, 938, 360	2, 178, 373	2, 335, 380	2, 418, 961
1887	1, 990, 851	1, 827, 924	2, 007, 196	1, 960, 860	1, 993, 517	1, 912, 860	1, 899, 525
1888	1, 155, 937	1, 290, 718	1, 338, 877	1. 349, 403	1, 473, 362	1, 450, 703	1, 394, 847
1889	1, 542, 806	1, 332, 482	1, 628, 661	1, 635, 933	1, 821, 776	1, 811, 485	1, 954, 168
1890	2, 108, 248	2, 055, 424	2, 313, 189	2. 328, 870	2, 378, 382	2, 370, 001	2, 524, 206
1891	2, 830, 081	2, 287, 320	2, 360, 011	2, 337, 498	2, 288, 656	2, 316, 988	2, 289, 089
1892	2, 786, 528	2, 703, 663	2, 657, 432	2, 574, 814	2, 485 040	2, 439, 346	2, 360. 886
1893	1, 723, 918	1, 671, 620	1, 900, 363	1, 682, 271	1, 763, 655	1, 780, 836	1, 720, 088
1894	1, 579, 420	1, 432, 251	1, 662, 595	1, 537, 500	1, 628, 149	1, 663, 964	1, 624, 767

Total product of crude petroleum in the Pennsylvania and New York oil fields from 1871 to 1894, by months and years—Continued.

Years.	August.	September.	October.	November.	December.	Total.
1871	462, 582	461, 940	485, 243	464, 610	477, 958	5, 205, 234
1872	549, 909	500, 430	442, 432	638, 610	645, 575	6. 293, 194
1873	936, 138	954, 270	942, 493	991, 470	1, 084, 380	9, 893, 786
1874	931, 519	840, 630	919, 739	861, 060	858, 142	10, 926, 945
1875	718, 766	698, 940	731, 073	700, 200	720, 874	8, 787, 514
1876	782, 223	780, 600	809, 162	786, 480	787, 090	8, 968, 906
1877	1, 273, 759	1, 214, 910	1, 269, 326	1, 173, 420	1, 256, 058	13, 135, 475
1878	1, 341, 928	1, 315, 710	1, 369, 797	1, 348, 950	1, 318, 678	15, 163, 462
1879	1, 892, 302	1, 856, 700	1, 836, 378	1, 710, 480	1, 769, 356	19, 685, 176
1880	2, 341, 027	2, 346, 300	2, 385, 636	2, 274, 420	2, 238, 634	26, 027, 631
1881	2, 331, 727	2, 193, 420	2, 323, 171	2, 266, 830	2, 480, 000	27, 376, 509
1882	3, 104, 495	2, 620, 380	2, 297, 658	2, 192, 940	1, 897, 510	30, 053, 500
1883	1, 879 437	1, 913, 370	2, 076, 659	1, 958, 340	1, 988, 526	23, 128, 389
1884	2, 099, 165	1, 948, 260	1, 961, 866	1, 811, 700	1, 822, 614	23, 772, 209
1885	1, 705, 961	1, 712, 790	1, 874, 105	1, 761, 660	1, 898, 657	20, 776, 041
1886	2, 413, 206	2, 418, 540	2, 408, 111	2, 222, 790	2, 181, 625	25, 798, 000
1887	1, 848, 877	1, 779, 930	1, 843, 291	1, 125, 450	1, 288, 602	*a* 21, 478, 883
1888	1, 382, 077	1, 273, 080	1, 304, 518	1, 442, 405	1, 582, 741	16, 488, 668
1889	1, 964, 227	1, 867, 610	1, 959, 169	1, 913, 871	2, 055, 247	21, 487, 435
1890	2, 514, 968	2, 584, 949	2, 750, 698	2, 575, 941	2, 626, 035	*b* 29, 130 910
1891	2, 473, 398	2, 837, 562	3, 575, 911	3, 834, 262	3, 578, 460	33, 009, 236
1892	2, 328, 596	2, 125, 511	2, 072, 022	1, 950, 553	1, 937, 986	28, 422, 377
1893	1, 691, 652	1, 614, 021	1, 616, 391	1, 533, 555	1, 616, 143	20, 314, 513
1894	1, 612, 212	1, 512, 116	1, 640, 982	1, 527, 752	1, 598, 282	19, 019, 990

a Not including 877,310 barrels dump oil and oil shipped by private lines.
b Pipe-line runs.

As is stated elsewhere, the total production and pipe-line runs or receipts are not the same, and hence it will be found that the statistics of production in the above table do not agree with statements of so-called production which are frequently published, these latter being simply pipe-line runs. A similar statement may also be made here regarding what is called the total production of the United States. This usually means only the production of the Appalachian field and the Lima-Indiana field, little or no account being taken of the production west of the Mississippi and on the Pacific Coast.

In the following table is given a statement of the average daily production of crude petroleum in the Pennsylvania and New York oil fields for each month from 1871 to 1894. We desire to repeat that this table is not the same as the daily average receipts published by the pipe lines, but the daily average production, the total production including some oil that is not reported in the daily returns of the pipe lines. The averages are obtained by dividing the product of each month in the table given elsewhere by the number of days in each month, and the production of the year by 365 or 366, as the case may be:

Average daily product of crude petroleum in the Pennsylvania and New York fields each month for the years 1871-1894, by months and years.

[Barrels.]

Years.	January.	February.	March.	April.	May.	June.
1871	13,497	13,306	12,914	12,866	13,187	13,678
1872	18,825	15,965	14,890	15,403	17,326	16,371
1873	20,407	21,725	21,461	21,384	25,044	26,449
1874	37,653	29,839	28,598	25,958	28,895	30,725
1875	27,489	25,708	25,469	22,502	22,468	23,207
1876	22,975	23,065	23,167	23,383	23,721	24,120
1877	27,190	27,979	29,087	32,427	36,374	37,693
1878	38,816	39,102	38,980	39,863	40,802	40,575
1879	44,191	43,515	48,365	51,015	53,062	55,855
1880	61,423	64,552	65,032	67,190	71,901	71,948
1881	72,390	68,326	73,372	73,526	77,203	79,262
1882	75,921	76,119	80,070	80,093	80,212	94,198
1883	62,849	62,721	59,054	60,551	63,292	65,930
1884	58,898	64,850	66,202	68,862	76,834	62,073
1885	53,296	51,353	52,843	59,343	59,141	58,907
1886	56,418	57,316	62,208	64,612	70,283	77,846
1887	64,221	65,283	64,716	65,372	64,307	63,762
1888	37,228	44,508	43,190	44,980	47,528	48,357
1889	49,768	47,589	52,537	54,531	58,767	60,382
1890	68,008	73,408	74,619	77,629	76,722	79,000
1891	91,293	81,690	76,129	77,917	73,828	77,233
1892	89,888	93,230	85,724	85,827	80,163	81,312
1893	55,610	59,701	61,302	56,076	56,505	59,361
1894	50,949	51,152	53,632	51,250	52,521	55,465

Years.	July.	August.	September.	October.	November.	December.	Yearly averages.
1871	14,725	14,922	15,398	15,653	15,487	15,418	14,261
1872	16,702	17,739	16,681	14,272	21,287	20,825	17,194
1873	27,983	30,198	31,809	30,403	33,049	34,980	27,106
1874	33,337	30,049	28,021	29,669	28,702	27,682	29,937
1875	25,431	23,186	23,298	23,583	23,340	23,254	24,075
1876	24,633	25,233	26,020	26,102	26,216	25,390	24,505
1877	38,335	41,089	40,497	40,946	39,114	40,518	35,988
1878	41,415	43,288	43,857	44,187	44,965	42,538	41,544
1879	56,057	61,042	61,890	59,238	57,016	57,076	54,206
1880	72,530	75,517	78,210	76,956	75,814	72,214	71,114
1881	76,538	75,217	73,114	74,941	75,561	80,000	75,004
1882	105,102	100,145	87,346	74,118	73,098	61,210	82,338
1883	65,174	60,627	63,779	66,989	65,278	64,146	63,365
1884	66,450	67,715	64,942	63,286	60,390	58,794	65,129
1885	57,284	55,031	57,093	60,455	58,722	61,247	56,921
1886	78,031	78,426	80,618	77,681	74,093	70,375	70,679
1887	61,275	59,641	59,321	61,822	37,515	41,568	58,846
1888	44,995	44,661	42,436	43,694	48,080	51,057	45,058
1889	63,037	63,362	62,254	63,199	63,796	66,298	58,869
1890	81,426	81,128	86,165	88,732	85,865	84,710	79,810
1891	73,842	79,787	94,585	115,352	127,809	115,434	90,436
1892	76,158	75,116	70,850	66,839	65,018	62,516	77,657
1893	55,487	54,569	53,801	52,142	51,119	52,133	55,656
1894	52,412	52,007	50,404	52,935	50,925	51,557	52,110

NOTE.—Yearly average is the total product divided by the number of days in the year, not an average of monthly averages.

SHIPMENTS OF PETROLEUM FROM PENNSYLVANIA AND NEW YORK.

The following table gives a statement of the number of barrels of crude petroleum, or, in the early history of the oil field, refined petroleum reduced to its equivalent, shipped out of the New York and Pennsylvania oil regions, either by pipe lines, river, or railway, from 1871 to 1894, inclusive. In some years, especially in the earlier ones covered by this table, a considerable portion of the oil was shipped as refined. When the tables were prepared for these years the oil shipped was reduced to its equivalent in crude, a barrel of crude being regarded as yielding three-fourths of a barrel of refined, or a barrel of refined was regarded as being produced from $1\frac{1}{3}$ barrels of crude:

Shipments of crude petroleum and refined petroleum, reduced to crude equivalent, out of the Pennsylvania and New York oil fields, for the years 1871–1894, by months and years.

[Barrels of 42 gallons.]

Years.	January.	February.	March.	April.	May.	June.	July.
1871	437, 691	347, 718	383. 890	389, 147	587, 375	501, 754	541, 137
1872	476. 966	407, 606	276, 220	428, 512	510, 417	529, 228	591, 238
1873	573. 124	527, 440	668, 374	708, 191	768, 176	696, 414	814, 449
1874	843, 663	501, 220	518, 246	803, 409	899, 027	815, 413	940, 281
1875	453, 095	327, 776	693, 918	729, 581	681 679	745, 986	904 537
1876	677, 289	519, 193	623, 762	603, 037	646, 150	921, 862	1, 228. 539
1877	743. 461	484, 904	913, 919	903, 526	1, 234, 324	1, 391, 124	1, 096, 951
1878	775, 791	774, 234	3, 741, 512	846, 632	960, 894	1, 135, 119	1, 330, 454
1879	663, 998	702, 729	973, 879	1, 136, 188	1, 331, 469	1, 369, 314	1, 625, 035
1880	1, 650, 409	1, 395, 151	1, 613, 371	842, 268	1, 095, 259	975, 083	1, 231, 611
1881	1, 061, 617	915, 028	1, 276, 746	1, 348, 398	1, 563, 436	1, 729, 697	1, 925. 532
1882	1, 657, 067	1, 787, 909	1, 718, 956	1, 678, 134	1, 827, 356	2, 172, 685	2, 402, 970
1883	1, 357, 815	1, 250, 824	1, 641, 899	1, 908, 379	1. 995, 634	1, 747, 789	1, 634, 407
1884	1, 686, 961	1, 723, 261	1, 873, 890	1, 643, 336	1, 899, 329	1, 827, 553	1, 740. 021
1885	1, 804, 028	1, 895, 021	1, 887, 034	1, 823, 726	2, 097, 099	2, 034, 025	1, 961, 152
1886	1, 991, 561	2, 032, 794	2, 055, 750	2, 070, 468	2, 032, 672	2, 117, 489	2, 418, 961
1887	2, 312, 067	1, 995, 757	2, 332, 324	1, 938, 278	2, 328, 564	2, 165, 439	2, 000, 173
1888	2, 265, 109	2, 163, 957	1, 979, 753	1, 928, 435	1, 773, 994	1, 956, 115	2, 098, 531
1889	2, 388, 609	2, 272, 060	2, 263, 009	2, 236, 004	2, 256, 120	2, 268, 280	2, 949, 597
1890	2, 637, 339	2, 146, 108	2, 148, 977	2, 317, 410	2, 474, 966	2, 486, 205	2, 640, 668
1891	2, 421, 419	2, 133, 068	2, 384, 720	2, 123, 461	2, 022, 510	2, 086, 985	2, 212, 908
1892	2, 363, 380	2, 391, 162	2, 534, 230	2, 314, 082	2, 246. 579	2, 017, 080	2, 261, 716
1893	2, 910, 650	2, 534, 311	2, 808, 577	2, 643, 906	2, 965, 269	3, 025, 473	3, 264, 391
1894	3, 106, 572	2, 613, 677	2, 880, 354	2, 824, 620	2, 788, 972	2, 869, 592	2, 890, 581

Years.	August.	September.	October.	November.	December.	Total.
1871	528, 134	551, 075	505, 071	480, 977	410, 822	5, 664, 791
1872	621, 954	541, 607	607, 468	477, 945	430, 786	5, 899, 947
1873	864, 768	952, 955	1, 010, 852	959, 589	955, 443	9, 499, 775
1874	793, 865	1, 014, 570	543, 341	546. 117	602, 348	8, 821, 500
1875	882, 089	1, 109, 392	871, 917	671, 066	871, 902	8, 942, 938
1876	1, 203, 402	1, 154, 549	524, 190	871, 496	1, 190, 983	10, 164. 452
1877	1, 425, 943	1, 563. 797	1, 268, 971	1, 205, 634	600, 019	12, 832, 573
1878	1, 655, 651	1, 434, 225	1, 747, 390	1, 281, 410	992, 688	13, 676, 000
1879	1. 808, 239	1, 627, 120	1, 662, 269	1, 453, 645	1, 532, 585	15, 886, 470
1880	1, 394, 129	1, 252, 635	1, 665, 933	1, 226, 030	1, 335, 613	15, 677, 492
1881	2, 214, 877	2, 131, 950	2, 080, 467	2, 066, 906	1, 969, 581	20, 284, 235
1882	2, 047, 545	1, 992, 171	2, 089, 428	1, 404, 640	1, 121, 453	21, 900, 314
1883	2, 086, 478	2, 325, 574	2, 215, 421	2, 065, 602	1, 749, 547	21, 979, 369
1884	2, 000, 371	2, 292, 087	2, 510, 283	2, 078, 261	2, 382, 244	23, 657, 597
1885	2, 049, 099	2, 116, 659	2, 050, 150	1, 857, 080	2, 138, 253	23, 713, 326
1886	2, 059, 299	2, 157, 323	2, 441, 848	2, 724, 796	2, 550, 891	26, 653, 852
1837	2, 220, 768	2, 342, 227	2,'573, 008	3, 462, 082	2, 608, 341	27, 279, 028
1888	2, 223, 263	2, 289, 486	1, 558, 115	2, 503, 491	2, 397, 782	25, 138, 031
1889	2, 625, 825	2, 567, 459	2, 747, 284	2, 393, 131	2, 671, 518	29, 638, 898
1890	2, 538, 224	3, 648, 418	2, 725, 341	2, 662. 898	2, 889, 525	30, 116, 075
1891	2, 445, 092	2, 648, 522	2, 740, 859	2, 539, 848	2, 725, 993	28, 485, 385
1892	2, 582, 075	2, 717, 104	2, 759, 516	2, 860, 266	2, 925, 671	29, 972, 861
1893	3, 200, 585	2, 962, 345	3, 269, 325	3, 039, 318	3, 105 047	35, 729, 197
1894	3, 268, 909	2, 938, 593	3, 222, 241	3, 160, 448	3, 246, 019	35, 750, 578

This table is not accurate, as it includes some oil shipped from West Virginia and eastern Ohio. Possibly three-fourths of a million barrels would cover the oil so shipped. For the latter years covered in the above table the shipments are pipe-line deliveries and do not include any dump oil or oil delivered to refiners or other parties without passing through the pipe lines.

DRILLING WELLS IN THE PENNSYLVANIA AND NEW YORK OIL REGIONS.

In the following table will be found a statement of the number of drilling wells completed in each month from January, 1872, to the close of 1894, in Pennsylvania, New York, Ohio, and West Virginia, by months and years. It has not been possible to separate the wells drilling in West Virginia in all cases from those drilling in Pennsylvania and Ohio:

Number of drilling wells completed in the Pennsylvania, New York, and northern West Virginia oil fields each month from 1872 to 1894, by months and years.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1872	37	120	89	121	135	84	128	118	82	100	64	105	1,183
1873	93	94	100	105	102	130	114	120	106	101	100	98	1,263
1874	102	104	110	113	109	101	121	107	104	120	106	120	1,317
1875	190	187	195	186	172	190	200	210	201	220	217	230	2.398
1876	240	231	242	200	202	261	248	270	209	273	272	272	2,920
1877	281	241	291	269	320	403	317	255	322	467	391	382	3,929
1878	274	226	211	409	470	269	203	186	174	229	248	165	3,064
1879	136	132	238	270	402	330	327	283	210	232	227	261	3,048
1880	320	230	367	500	426	310	338	368	356	364	336	302	4,217
1881	222	220	271	316	406	374	336	332	312	322	363	406	3,880
1882	347	340	385	432	469	340	185	253	164	117	150	122	3,304
1883	125	126	142	209	231	228	261	309	321	321	302	272	2,847
1884	229	227	256	298	311	244	268	145	89	59	73	66	2,265
1885	64	62	82	116	213	242	217	283	356	397	384	345	2,761
1886	270	280	291	328	343	365	357	313	253	272	221	185	3,478
1887	158	162	138	160	148	162	159	142	134	100	101	96	1,660
1888	57	52	56	49	56	97	82	96	132	229	307	302	1,515
1889	284	288	353	401	431	537	549	508	478	559	540	471	*a*5,435
1890	553	482	522	556	534	571	555	579	571	567	520	348	6,358
1891	310	243	275	288	314	304	334	333	281	237	245	197	3,361
1892	175	171	137	167	170	154	174	141	142	158	160	143	1,892
1893	125	84	130	127	172	213	193	145	158	139	137	167	1,790
1894	180	170	202	261	307	349	319	341	362	373	368	316	3,548

a Including 36 wells drilled in Franklin district, data for which by months were not obtainable.

WEST VIRGINIA OIL FIELD.

The oil fields of West Virginia are extensions of those of New York and Pennsylvania, and the conditions under which the oil is found, not only in West Virginia but in eastern Ohio, are similar to those under which it occurs in southwestern Pennsylvania. It is also true, as a rule, that the character of the petroleum is identical with that from Pennsylvania, except a portion of that from the Volcano and Burning Springs districts, where a lubricating oil of high grade is produced.

As nearly as can be ascertained the production of West Virginia in 1894 was 8,577,624 barrels, of which 8,563,954 barrels is classed as illuminating and 13,670 barrels as lubricating oil. The total value of this product was $7,221,717, an average of 84 cents a barrel. The average value per barrel of the illuminating oil is given as 83⅞ cents and the lubricating as $2.85.

The production of crude petroleum in West Virginia, by months, from 1890 to 1894 is shown in the following table:

Total production of crude petroleum in West Virginia, by months, from 1890 to 1894.

Months.	1890.	1891.	1892.	1893.	1894.
January	38,644	48,902	195,512	577,933	838,400
February	38,061	123,841	186,455	468,794	684,532
March	44,842	229,966	185,468	630,877	754,398
April	39,804	226,020	181,708	594,190	688,458
May	39,160	232,076	206,142	705,714	742,701
June	35,610	223,734	261,900	682,040	699,498
July	34,096	221,127	328,485	724,494	767,728
August	31,505	238,451	411,114	843,706	717,844
September	50,342	219,528	420,882	847,558	674,791
October	46,387	220,076	451,157	792,719	694,187
November	45,062	207,477	467,446	757,170	654,887
December	49,065	215,020	513,817	820,217	660,200
Total	492,578	2,406,218	3,810,086	8,445,412	8,577,624

It will be seen from the above table that while the production of 1894 was in excess of that of 1893, there was, on the whole, a gradual decline in the production for each month during the year, the production of January being 838,400 barrels, while that of December was 660,200 barrels.

In previous issues of Mineral Resources we have, as far as possible, divided the production into districts, but as in the last two or three years this has been impossible—the production dividing itself practically into but two districts, the illuminating and the lubricating-oil districts—we have discontinued the attempt to secure the production of oil by districts except as it divides itself into lubricating and illuminating oils.

OHIO.

THE FOUR DISTRICTS.

The oil-producing territory of Ohio can be divided into four distinct districts. These districts, naming them in the order of their importance as producers, are (1) the Lima; (2) the Eastern Ohio; (3) the Mecca, and (4) the Belden. As the production of the two latter districts is quite small, for statistical purposes they are united and known as the Mecca-Belden district.

The first and most important of these is the Lima or Northwestern, which includes the remarkable developments in the section of country of which Lima may be regarded as the commercial center, the field extending in a southwesterly direction into Indiana. The oil in these districts is found in the Trenton limestone, quite a number of distinct pools having been noted in this territory. The oil in these different pools varies somewhat in character, some having more of the sulphur compounds, which distinguish this oil, than others.

Oil was discovered in the Lima field in May, 1885, the first well drilled being on the bank of the Ottawa River, the casing having an elevation of about 850 feet above tide water. The lower limestone was reached at a depth of about 1,250 feet, or 400 feet below tide water. As the well was drilled for gas there was considerable disappointment when the drill struck the Trenton limestone and a deposit of gas was not found, though the disappointment was somewhat relieved by the discovery of oil where gas was looked for. It having failed as a gas well it was treated as an oil well. It was shot, tubed, packed, and pumped. During the first six days it yielded more than 200 barrels of oil, carrying some salt water. It was dark in color, low in gravity, and offensive in odor.

In the fall of 1885 oil was found in a second well, near the first. This yielded the first regular, persistent supply of oil from the Trenton limestone in Ohio, the pioneer well meeting with a series of misfortunes that left it useless. This second well, known as the Citizens' well, began to produce at first 40 to 45 barrels a day. In December, 1885, it yielded 1,450 barrels of oil, and in the first three months of 1886, 26 barrels per day. It was the oil from this well that was first sent to the refineries of the country to be tested on a large scale. From this time the development of the Lima field became rapid. According to Prof. Edward Orton, State geologist of Ohio, to whose various reports we are indebted for much of the information regarding the Lima or Northwestern oil field, in April, 1886, 14 wells had been drilled; on May 1, there were 22 wells; on June 1, 34 wells; July 1, 57; September 1, 128; October 1, 139, and November 1, 165 producing wells. Of the 165 producing wells on November 1, 19 were flowing and the rest pumping wells of various capacities. Professor Orton estimates the daily yield of September, 1886, at 4,500 barrels; in October, 6,000 barrels; November, 8,300 barrels; December, 9,500 barrels; January, 1887, 8,500 barrels; February, 11,700 barrels, and April, 10,400 barrels. The number of wells that had been drilled up to April, 1887, was 424. Of the 20 wells drilled in April but one was dry. The average daily production of these 20 wells was 81½ barrels each.

According to Professor Orton, the geological section of the Lima field is as follows: Drift beds cover the entire surface at a depth varying from 8 to 100 feet. The surface rock is the water lime or Lower Helderberg limestone. The rock is extremely compact, strong, and darker blue in color than is usual. Underneath the water lime the Niagara limestone, the Niagara shale, and the Clinton limestone and shale are found in all the wells, constituting, with the first-named stratum, the so-called "upper limestone" of the drillers. The whole series is commonly called by the drillers the "Niagara" limestone, and is here from 350 to 400 feet thick. The Medina shale appears as a blue and hard slate, the thickness of which can not be given with precision. The Hudson River shales are blue and gray, the entire series being from 500 to 550 feet thick. The Utica shale is dark brown, verging at its base into black, and is about 300 feet in thickness. The entire shale formation is from 840 to 850 feet thick.

Below the Utica shale comes the Trenton limestone. It is not generally penetrated more than from 15 to 25 feet in the Lima wells. The porosity of the oil rock, which is very marked, is due to the imperfect interlocking of the dolomitic crystals of which it consists. It is entirely crystalline in structure, and no fossils have been detected in this part of the stratum when it holds the dolomitic character above referred to.

The Lima oil rock, like the Trenton throughout the Northwest generally, is a magnesian limestone containing from 24 to 39 per cent carbonate of magnesia.

Professor Orton generalizes the geological series near Lima as follows:

Generalized geological section near Lima, Ohio.

		Feet.
Drift		18
Upper Silurian limestones	Water lime Niagara limestone Niagara shale Clinton limestone Clinton shale	400
Medina and Hudson River shales		450
Utica shale		350

Of course it is not possible always to clearly make out the subdivisions of the several elements. An approximate general section for the Lima district would probably be about as follows:

General section of the Lima district, Ohio.

	Feet.
Water lime	100 to 500
Niagara limestone and shale	250
Clinton limestone and shale	100
Medina shale	50
Hudson River shale	550
Utica shale	250 to 300
Trenton limestone.	

Underneath the shales, and separating them as clearly as a chalk mark on a blackboard, lies the Trenton limestone. Its depth below the surface is 1,200 to 1,250 feet.

Regarding the geological structure of this district, Professor Orton points out that the thickness of the drift deposits in different localities correspond to the inequalities of the surface of the water lime and not to the dip of this water lime. He states that as established by the numerous wells in the Lima district the Trenton limestone lies as nearly level as any sheet of rock is ever found. There is a slight general declination to the northward, but there are many miles in which this feature scarcely shows itself. In 1 square mile, for example, in which 50 or more wells have been drilled, the extreme range of depth at which the Trenton was found is only 16 feet, and excluding one well, only 9 feet. "We find, therefore," Professor Orton remarks, "that the Trenton limestone in the productive portion of the Lima field occurs as a flat-lying terrace with fairly well-marked boundaries of steeper descent on the east, west, and north. The southern boundary is not yet clearly determined, but the Trenton has not been found productive thus far where it is less than 370 feet below sea level."

While the above description of the Lima district may not apply in all its details to other districts in this Lima-Indiana field, the description is sufficient to indicate geologically the character of this Lima or Northwestern field.

The second district in point of production, the Eastern Ohio district, includes the wells along the extreme eastern boundary of Ohio contiguous to Pennsylvania and West Virginia. The geological features of this district, as well as the character of the oil, are similar to those of West Virginia and Pennsylvania, and need not be repeated here. Most of the oil produced in this district, when Macksburg was the center of production, was from the Berea grit. The more recent discoveries of oil, however, have been in the sand rocks, which have been such large producers in western Pennsylvania and West Virginia.

As the Macksburg oil field has been the district which has been the oil producer in this Eastern Ohio oil field for many years, a word about the history of oil production there may not be amiss, our authority being Professor Orton. The first wells drilled in what may be termed the Macksburg field were the Newton well at Cow Run, in Lawrence Township, and the Dutton well at Macksburg. The oil in the latter well was found at a depth of 59 feet below the bed of Duck Creek and in the Newton well at 137 feet below the bed of Cow Run. The oil in the Newton well came from a sand rock which belongs to the Lower Barren Coal Measures. The oil from the Dutton well, which was of 28° B. gravity and a lubricating oil, was probably a surface accumulation. The result of these discoveries was the leasing and putting down of quite a number of wells, oil being found at different depths in what were known as the "140-foot sand," the "300-foot sand," and the "700-foot sand." Prior to 1864 the only points in Washington County that could be called productive territory were the Macksburg and Cow Run localities. In 1865 a speculative era began, and nearly all the lands in Washington and Noble counties and in the neighboring counties of West Virginia were leased for oil purposes. Wells were drilled in some cases to the depth of 1,200 feet and even in one case to a depth of 2,100 feet. The yield of oil in the Cow Run field up to the close of 1885 is estimated at 751,519 barrels.

In the spring of 1868 the West Virginia Transportation Company, of Parkersburg, laid a 2-inch pipe line from the Cow Run district to the Ohio River, 5½ miles distant. This line was sufficient to carry the entire production of the field. The point of delivery on the river was 3 miles below Newport, and from there the oil was carried in bulk boats to the refineries at Marietta and Parkersburg.

While work was being prosecuted vigorously at Cow Run, operations at Macksburg were almost entirely suspended until 1872, when Mr. George Rice, of Burning Springs, W. Va., began operations and continued them, with varying success, until the fall of 1878, when well No. 14 was put down for gas, but resulted in the production not only of gas, but of 15 barrels per day of an amber-colored oil of 39° gravity. This was the beginning of the great developments of this region from 1878 to 1885. It is impossible for us to follow the developments of this field. The chief source of oil here until recently has been the Berea grit, though oil was at first found at a depth of from 200 to 300 feet in the Upper Mahoning sandstone. At 1,300 feet the Berea grit was found, holding a stock of oil large enough to make the Macksburg field a factor in the general market. As is stated elsewhere, however, the recent large finds in the Eastern Ohio field are not in the Berea grit, but in the same horizons as those in which oil is found in western Pennsylvania and West Virginia, among the chief sources being the Big Injun sand, I described in connection with the report on Pennsylvania oil.

The third field, the Mecca, lies in Trumbull County, in northeastern Ohio, near the town of the same name. The territory in which oil has been found in paying quantities can probably be included in a tract 5 miles long by 3 miles wide, on which thousands of wells have been drilled. The oil is a heavy one, its gravity being from 26° to 28° B. gravity. It endures an excellent cold test and is adapted to the highest uses as a lubricator. The wells are shallow, not exceeding 50 feet in depth. The total expense of drilling is covered by a production of from 50 to 60 gallons of oil. The oil-bearing strata is the Berea grit. It is always overlain by a thin but very black fossiliferous bed of the Berea shale. The Mecca field is a very interesting one, but it can never be relied upon as much of a producer. The wells are seldom pumped for more than three months after they are drilled, and a total production of 3,000 barrels for any well is regarded as excessive.

The fourth field, the Belden, or, as it is sometimes called, the Grafton oil field, is a shallow oil field of a type similar to the Mecca. The sources of the oil is the Berea grit, which lies very near the surface, all the oil in this field having been obtained at a depth of from 120 to 140 feet. The production in this district has at times reached 2,000 barrels a year, but the wells are small producers, a good average at the best being from 3 to 5 barrels a day. The oil is a lubricating oil of from 25° to 32° gravity, but hardly equal to the Mecca oil. The oil rock carries quite a strong brine instead of fresh water, as at Mecca. But little oil was produced here in 1894.

PRODUCTION OF PETROLEUM IN OHIO.

The total amount of petroleum produced in Ohio in 1894, as will be seen from the following table, was 16,792,154 barrels, as compared with 16,249,769 barrels in 1893. The production of the Lima district in 1894 was 13,607,844 barrels, as compared with 13,646,804 barrels in 1893. Macksburg and eastern Ohio produced 3,183,370 barrels in 1894, as compared with 2,601,394 barrels in 1893, while the production of the Mecca-Belden district fell from 1,571 barrels in 1893 to 940 barrels in 1894.

The total value of the production of oil in 1894 was $9,206,293, as compared with $8,124,342 in 1893. The average price per barrel of Lima oil for 1894 was 48 cents, being three-fourths of a cent higher than in 1893. The average price per barrel of eastern oil advanced from 64 cents in 1893 to 83⅞ cents in 1894, while the value of the Mecca-Belden oil fell from $7.21½ to $4.76 per barrel in 1894. The average price of all the oil produced in this State in 1894 was 54.8 cents a barrel, as compared with 50 cents in 1893.

The total amount and value of crude petroleum produced in Ohio from 1889 to 1894, inclusive, is shown in the following table:

Total amount and value of crude petroleum produced in Ohio from 1889 to 1894.

Districts.	1889.			1890.		
	Total. production.	Total value.	Price per barrel.	Total production.	Total value.	Price per barrel.
	Barrels.			*Barrels.*		
Lima	12,153,189	$1,822,978	$0.15	15,014,882	$4,504,465	$0.30
Macksburg	317,037	340,683	$1.07\frac{1}{2}$	1,108,334	1,127,730	$1.01\frac{3}{4}$
Eastern Ohio	....	....	....	....	....	....
Mecca-Belden	1,240	10,334	$8.33\frac{3}{8}$	1,440	12,000	$8.33\frac{1}{3}$
Total	12,471,466	2,173,995	$.17\frac{3}{8}$	16,124,656	5,644,195	.35

Districts.	1891.			1892.		
	Total production.	Total value.	Price per barrel.	Total production.	Total value.	Price per barrel.
	Barrels.			*Barrels.*		
Lima	17,315,978	$5,281,373	$0.30\frac{1}{2}$	15,169,507	$5,555,832	$0.36\frac{6}{10}$
Macksburg } Eastern Ohio }	400,024 } 22,859 }	283,332	.67	197,556 } 992,746 }	662,106	$.55\frac{6}{10}$
Mecca-Belden	1,440	12,000	$8.33\frac{1}{3}$	3,112	21,101	6.78
Total	17,740,301	5,576,705	$.31\frac{4}{10}$	16,362,921	6,239,039	.38

Districts.	1893.			1894.		
	Total production.	Total value.	Price per barrel.	Total production.	Total value.	Price per barrel.
	Barrels.			*Barrels.*		
Lima	13,646,804	$6,448,115	$0.47\frac{1}{4}$	13,607,844	$6,531,765	$0.48
Macksburg, Eastern and Southern	2,601,394	1,664,892	.64	3,183,370	2,670,052	$.83\frac{7}{8}$
Mecca-Belden	1,571	11,335	$7.21\frac{1}{2}$	940	4,476	4.76
Total	16,249,769	8,124,342	.50	16,792,154	9,206,293	$.54\frac{6}{10}$

In the following tables will be found statements of the total production of crude petroleum in Ohio from 1890 to 1894, by months and districts. In determining the total by months an average production for each month in the Mecca-Belden district has been assumed:

Total productions of crude petroleum in Ohio, from 1890 to 1894, by months and districts.

[Barrels of 42 gallons.]

Months.	Lima.	Eastern and southern Ohio and Macksburg.	Mecca-Belden.	Total.
1890.				
January	911,947	36,713	....	948,780
February	888,978	40,712	....	929,810
March	955,620	53,193	....	1,008,933
April	1,040,924	60,729	....	1,101,773
May	1,142,954	80,167	....	1,223,241
June	1,175,821	98,268	....	1,274,209
July	1,354,672	118,182	....	1,472,974
August	1,411,998	132,173	....	1,544,291
September	1,559,473	140,634	....	1,700,227
October	1,660,069	138,224	....	1,798,413
November	1,495,099	113,664	....	1,608,883
December	1,417,327	95,675	....	1,513,122
Total	15,014,882	1,108,334	1,440	16,124,656

Total production of crude petroleum in Ohio, from 1890 to 1894, etc.—Continued.

Months.	Lima.	Eastern and southern Ohio and Macksburg.	Mecca-Belden.	Totals.
1891.				
January	1, 471, 858	89, 061	....	1, 561, 039
February	1, 355, 734	40, 620	....	1, 396, 474
March	1, 455, 628	28, 297	....	1, 484, 045
April	1, 470, 661	29, 361	....	1, 500, 142
May	1, 446, 284	28, 935	....	1, 475, 339
June	1, 491, 228	25, 014	....	1, 516, 362
July	1, 514, 607	30, 571	....	1, 545, 298
August	1, 509, 262	28, 828	....	1, 538, 210
September	1, 492, 115	31, 591	....	1, 523, 826
October	1, 499, 834	27, 536	....	1, 527, 490
November	1, 271, 189	28, 428	....	1, 299, 737
December	1, 337, 578	34, 641	....	1, 372, 339
Total	17, 315, 978	422, 883	1, 440	17, 740, 301
1892.				
January	1, 090, 173	33, 762	....	1, 124, 194
February	1, 127, 481	32, 894	....	1, 160, 634
March	1, 200, 305	42, 371	....	1, 242, 936
April	1, 128, 253	45, 439	....	1, 173, 952
May	1, 165, 750	50, 407	....	1, 216, 416
June	1, 210, 523	55, 930	....	1, 266, 712
July	1, 300, 197	69, 678	....	1, 370, 135
August	1, 461, 020	111, 377	....	1, 572, 657
September	1, 422, 534	151, 543	....	1, 574, 336
October	1, 379, 909	206, 005	....	1, 586, 173
November	1, 328, 548	188, 391	....	1, 517, 198
December	1, 354, 814	202, 505	....	1, 557, 578
Total	15, 169, 507	1, 190, 302	3, 112	16, 362, 921
1893.				
January	1, 037, 358	189, 874	....	1, 227, 363
February	985, 620	209, 948	....	1, 195, 698
March	1, 161, 384	238, 133	....	1, 399, 648
April	1, 072, 850	217, 001	....	1, 289, 982
May	1, 179, 808	204, 151	....	1, 384, 090
June	1, 213, 521	206, 106	....	1, 419, 758
July	1, 231, 010	213, 431	....	1, 444, 572
August	1, 258, 289	221, 865	....	1, 480, 285
September	1, 181, 493	220, 589	....	1, 402, 213
October	1, 154, 641	242, 353	....	1, 397, 125
November	1, 084, 324	222, 428	....	1, 306, 883
December	1, 086, 506	215, 515	....	1, 302, 152
Total	13, 646, 804	2, 601, 394	1, 571	16, 249, 769
1894.				
January	1, 116, 979	209, 225	....	1, 326, 282
February	974, 091	213, 721	....	1, 187, 891
March	1, 177, 837	253, 979	....	1, 431, 894
April	1, 099, 453	268, 736	....	1, 368, 268
May	1, 203, 229	283, 371	....	1, 486, 678
June	1, 165, 190	273, 876	....	1, 439, 144
July	1, 131, 081	267, 144	....	1, 398, 304
August	1, 212, 090	275, 360	....	1, 487, 528
September	1, 090, 626	278, 704	....	1, 369, 409
October	1, 165, 938	303, 441	....	1, 469, 457
November	1, 146, 686	278, 162	....	1, 424, 926
December	1, 124, 644	277, 651	....	1, 402, 373
Total	13, 607, 844	3, 183, 370	940	16, 792, 154

The following table gives the production of petroleum in Ohio from the beginning of operations in that State to the close of 1894:

Production of petroleum in Ohio.

Years.	Barrels.	Years.	Barrels.
Previous to 1876	200,000	1886	1,782,970
1876	31,763	1887	5,018,015
1877	29,888	1888	10,010,868
1878	38,179	1889	12,471,466
1879	29,112	1890	16,124,656
1880	38,940	1891	17,740,301
1881	33,867	1892	16,362,921
1882	39,761	1893	16,249,769
1883	47,632	1894	16,792,154
1884	90,181		
1885	650,000	Total	113,782,343

LIMA DISTRICT.

In the following table is given the production of petroleum in the Lima oil field from 1886 to 1894. It will be seen that the highest point of production in this field was in 1891, when 17,315,978 barrels were produced. There has been a gradual decline in the production of the field since this date. The production of 1893 and 1894 differ but slightly.

The production of petroleum in the Lima, Ohio, oil fields from 1886 to 1894 is as follows:

Production of petroleum in the Lima, Ohio, district from 1886 to 1894.

Years.	Barrels.	Years.	Barrels.
1886	1,064,025	1891	17,315,978
1887	4,650,375	1892	15,169,507
1888	9,682,683	1893	13,646,804
1889	12,153,189	1894	13,607,844
1890	15,014,882		

In the following table is found the production of petroleum in the Lima, Ohio, field from 1887 to 1894, by months, so far as the same was obtainable:

Production of petroleum in the Lima, Ohio, field, from 1887 to 1894.

[Barrels of 42 gallons.]

Months.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
January	131,011	422.125	....	911,947	1,471,858	1,090,173	1,037,358	1,116,979
February	206.026	479,824	....	888.978	1,355,734	1,127,481	985,620	974,091
March	303,084	586,781	....	955.829	1,455.628	1.200,305	1,161,384	1,177 837
April	352,798	629,932	....	1,040,924	1,470.661	1,128,253	1,072,850	1,099,453
May	449,062	745.896	....	1,142,954	1,446.284	1,165,750	1,179,808	1,203,229
June	474,535	862,106	....	1,175,821	1,491.228	1,210,523	1,213,521	1,165,190
July	389,997	905,218	....	1,354,672	1,514,607	1,300,197	1,231,010	1,131,081
August	490,862	995,938	....	1,411,998	1,509,262	1,461,020	1,258,289	1,212.090
September	465,743	979,943	....	1,559,473	1,492,115	1,422.534	1,181,493	1,090,626
October	444,941	1,036.712	....	1,660,069	1,499,834	1,379,909	1,154,641	1,165,938
November	458,612	988.997	....	1,495,099	1,271,189	1,328,548	1,084,324	1,146,686
December	483,704	1,049,211	....	1,417,327	1,337,578	1,354,814	1,086,506	1,124,644
Total	4,650,375	9,682,683	12,153,189	15,014,882	17,315,978	15,169.507	13,646,804	13,607,844

It will be seen from the above table that the production of petroleum in the Lima field in 1894, by months, was quite regular.

THE PIPE-LINE RUNS IN THE LIMA-INDIANA FIELD.

There are no statements of the pipe-line runs and shipments in the Lima-Indiana field that distinguish between oil produced in Ohio and that produced in Indiana. Therefore the following statement of pipeline runs and shipments, which are those of the Buckeye Pipe Line, will include reports for both Lima and Indiana. As has been so often stated in this report, pipe-line runs are not production. This is especially true of the Lima-Indiana field. The production of petroleum in the Lima-Indiana field, distributed between the States, is quite accurately given in our statement of production:

Pipe-line runs, Lima-Indiana field, from 1887 to 1894.

[Barrels of 42 gallons.]

Years.	January.	February.	March.	April.	May.	June.	July.
1887	164, 474	207, 026	303, 084	352, 798	449, 062	474, 535	389, 997
1888	359, 860	428, 008	534, 588	587, 043	705, 045	774, 710	896, 034
1889	973, 980	800, 828	830, 559	845, 377	932, 067	843, 844	805, 744
1890	683, 750	622, 799	676, 175	842, 416	887, 590	916, 289	1, 105, 885
1891	1, 241, 154	1, 147, 947	1, 255, 611	1, 202, 583	1, 191, 147	1, 207, 884	1, 236, 291
1892	971, 607	1, 008, 069	1, 083, 801	1, 042, 087	1, 064, 478	1, 099, 145	1, 190, 015
1893	1, 049, 778	974, 944	1, 163, 641	1, 074, 290	1, 187, 939	1, 245, 880	1, 289, 991
1894	1, 265, 267	1, 106, 493	1, 353, 591	1, 295, 619	1, 424, 182	1, 402, 417	1, 366, 310

Years.	August.	September.	October.	November.	December.	Total.	Average.
1887	490, 162	465, 743	444, 941	458, 613	483, 704	4, 684, 139	390, 345
1888	975, 235	868, 826	939, 468	891, 999	938, 188	8, 899, 004	741, 584
1889	968, 449	875, 201	850, 077	774, 073	755, 553	10, 255, 752	854, 646
1890	1, 149, 877	1, 289, 577	1, 342, 158	1, 215, 960	1, 186, 434	11, 918, 910	993, 243
1891	1, 240, 841	1, 252, 375	1, 257, 986	1, 070, 131	1, 211, 820	14, 515, 770	1, 209, 648
1892	1, 346, 949	1, 232, 385	1, 264, 536	1, 209, 953	1, 244, 712	13, 657, 737	1, 138, 145
1893	1, 390, 894	1, 315, 933	1, 302, 295	1, 230, 658	1, 224, 952	14, 451, 195	1, 204, 266
1894	1, 469, 372	1, 325, 352	1, 405, 042	1, 334, 334	1, 326, 371	16, 074, 350	1, 339, 529

SHIPMENTS FROM THE LIMA-INDIANA FIELD.

In the following table is given the statement of the shipments of crude petroleum from the Lima-Indiana field as reported by the Buckeye Pipe Line Company from 1887 to 1894, by months and years. Here also it should be remarked that pipe-line shipments and consumption are not the same:

Shipments of crude petroleum from the Lima-Indiana field, from 1887 to 1894.

[Barrels of 42 gallons.]

Years.	January.	February.	March.	April.	May.	June.	July.
1887		10, 957	32, 613	77, 900	101, 306	104, 440	174, 824
1888	81, 569	207, 040	243, 964	210, 725	159, 620	179, 192	227, 707
1889	367, 524	862, 807	391, 026	340, 889	309, 238	352, 886	361, 694
1890	156, 085	111, 604	123, 125	115, 223	169, 662	700, 422	874, 121
1891	968, 887	837, 928	330, 448	336, 854	1, 078, 489	923, 605	997, 681
1892	1, 355, 362	1, 346, 541	1, 532, 606	1, 512, 358	1, 427, 753	1, 492, 543	1, 389, 501
1893	1, 306, 612	1, 270, 595	1, 390, 646	1, 205, 748	1, 321, 782	1, 235, 843	1, 152, 374
1894	1, 199, 752	1, 109, 110	1, 247, 295	1, 210, 391	1, 150, 298	1, 303, 957	1, 023, 316

Shipments of crude petroleum from the Lima-Indiana field, etc.—Continued.

Years.	August.	September.	October.	November.	December.	Total.	Average.
1887	20,019	30,944	43,168	78,827	76,327	751,325	68,302
1888	401,175	301,316	370,378	287,934	382,448	3,053,068	254,422
1889	464,325	626,207	715,386	759,702	750,244	5,801,928	483,494
1890	846,360	813,817	723,725	657,614	907,548	6,199,306	516,609
1891	1,166,054	1,260,598	1,408,343	1,391,400	1,454,578	12,154,865	1,012,905
1892	1,342,949	1,125,335	1,315,994	1,323,204	1,340,734	16,504,880	1,375,407
1893	1,040,860	1,038,819	1,196,018	1,262,130	1,230,216	14,651,643	1,220,970
1894	1,238,183	1,023,232	1,198,801	1,285,861	1,463,566	14,453,762	1,204,480

STOCKS OF CRUDE PETROLEUM IN THE LIMA-INDIANA, FIELD.

In the following table is given a statement of the stocks of crude petroleum in the Lima-Indiana field at the close of each month from 1887 to 1894, as reported by the Buckeye Pipe Line Company:

Total stocks of crude petroleum in the Lima-Indiana field at close of each month, from 1887 to 1894.

[Barrels of 42 gallons.]

Years.	January.	February.	March.	April.	May.	June.	July.
1887	....	847,817	1,118,288	1,393,186	1,740,942	2,111,037	2,326,211
1888	4,367,355	4,588,323	4,949,446	5,367,401	5,980,283	6,593,165	7,282,088
1889	10,415,880	10,852,202	11,288,793	11,792,707	12,413,137	12,902,628	13,344,795
1890	14,104,018	14,180,090	14,241,340	14,153,259	14,298,966	14,513,553	14,744,004
1891	21,233,645	21,537,789	21,957,948	22,319,191	22,424,364	22,704,034	22,930,048
1892	21,692,318	21,350,912	20,896,185	20,425,914	20,062,639	19,668,894	19,467,900
1893	18,355,492	18,059,846	17,877,265	17,747,249	17,616,527	17,642,117	17,779,733
1894	18,565,823	18,566,158	18,675,275	18,763,242	19,041,624	19,142,598	19,504,651

Years.	August.	September.	October.	November.	December.	Average.
1887	2,632,828	2,957,900	3,359,674	3,739,459	4,148,469	2,397,801
1888	7,852,705	8,392,493	8,920,086	9,499,482	9,810,714	6,966,962
1889	13,846,765	14,092,706	14,224,747	14,554,662	14,105,149	12,819,514
1890	19,086,736	19,843,950	20,442,065	20,967,258	20,971,395	16,795,553
1891	22,993,496	22,975,470	22,722,465	22,375,030	22,103,705	22,456,438
1892	19,505,399	19,150,058	18,800,715	18,687,464	18,604,442	19,859,403
1893	18,129,767	18,408,814	18,527,901	18,499,669	18,497,340	18,095,143
1894	19,736,628	20,040,748	20,246,989	20,295,461	20,158,266	19,394,788

WELL RECORDS IN THE LIMA DISTRICT.

The number of wells completed in the Lima district in 1894 was 2,472, an average of 206 a month, as compared with 1,569 in 1893, 1,446 in 1892, and 1,575 in 1891. All of the counties showed increased activity as compared with 1893. The number of wells completed in Allen County increased from 20 in 1893 to 63 in 1894; in Auglaize County from 214 in 1893 to 348 in 1894; in Hancock County from 80 in 1893 to 340 in 1894; in Sandusky from 428 in 1893 to 543 in 1894; in Wood County from 760 in 1893 to 885 in 1894; in Mercer County, which was not reported separately in 1893, 247 wells were drilled in 1894, while the wells completed in the miscellaneous districts fell from 67 in 1893 to

46 in 1894, this falling off being due to the removal of Mercer County from the list of miscellaneous counties:

Total number of wells completed in the Lima, Ohio, district in 1894.

Months.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Mercer.	Miscellaneous.	Total.
January	1	11	20	25	57	16	0	130
February	2	19	26	32	74	19	3	175
March	0	19	24	39	70	22	5	179
April	0	39	25	46	75	12	8	205
May	2	39	30	65	84	24	4	248
June	6	38	28	62	77	15	4	230
July	9	34	32	48	85	21	4	233
August	6	29	33	44	83	19	5	219
September	9	32	37	40	66	15	5	204
October	11	31	29	44	76	33	2	226
November	8	30	32	48	69	25	2	214
December	9	27	24	50	69	26	4	209
Total	63	348	340	543	885	247	46	2,472

From the following table it will be seen that the total initial daily production of the 2,472 wells completed in 1894 was 70,111 barrels, or 28 barrels a day, while the total initial daily production of the 1,569 wells completed in 1893 was 71,763 barrels, or 46 barrels a day. From this it will be readily inferred that the wells drilled in the Lima region in 1894 were not as great producers as those drilled in 1893, and the same is true of 1892. This reduction in initial daily production is manifest in all districts, no one district in this respect being in advance of the others, the wells of every county showing a falling off in the initial daily production:

Initial daily production of wells completed in the Lima, Ohio, district in 1894.

Months.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Mercer.	Miscellaneous.	Total.
January	0	405	767	815	1,533	333	0	3,853
February	25	318	630	945	1,575	418	300	4,211
March	0	743	715	1,200	1,303	350	175	4,486
April	0	1,095	545	1,651	1,802	363	130	5,586
May	25	953	640	2,840	2,275	448	110	7,291
June	30	789	516	3,075	1,681	165	135	6,391
July	285	678	725	1,422	2,145	362	20	5,637
August	107	665	795	1,198	2,372	384	121	5,642
September	107	825	1,270	1,280	1,143	310	85	5,020
October	140	832	552	1,533	1,854	1,045	35	5,991
November	155	676	648	6,376	1,619	985	5	10,464
December	125	542	1,070	949	1,917	890	46	5,539
Total	999	8,521	8,873	23,284	21,219	6,053	1,162	70,111

It will be seen from the following table that of the 2,472 wells completed in the Lima district in 1894, 384 were dry holes; in 1893 of the 1,569 wells completed 203 were dry holes; in 1892 of the 1,446 wells completed 183 were dry holes. It appears from this that the proportion of dry holes to wells completed in the last three years has differed greatly.

Total number of dry holes drilled in the Lima, Ohio, district in 1894.

Months.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Mercer.	Miscellaneous.	Total.
January	1	0	0	3	8	5	0	17
February	0	7	6	6	15	6	1	41
March	0	2	6	3	15	10	1	37
April	0	1	4	2	16	2	2	27
May	1	1	8	3	15	4	0	32
June	4	8	5	4	12	6	2	41
July	1	3	3	6	9	6	2	30
August	0	4	4	6	16	3	1	34
September	2	6	10	3	9	3	2	35
October	1	4	3	3	10	6	0	27
November	1	5	8	1	11	1	1	28
December	2	9	7	7	3	5	2	35
Total	13	50	64	47	139	57	14	384

The number of rigs building and wells drilling in the Lima, Ohio, district at the close of each month in 1894 is shown in the two following tables. These show a marked increase in activity in the Lima oil field in 1894, as compared with 1893. At the close of 1894 there were 110 rigs building in this field, as compared with 69 at the close of 1893, while at the close of 1894 there were 140 wells drilling, as compared with 114 at the close of 1893. The average number of rigs building at the close of each month in 1894 was 87, as compared with an average of 66 in 1893. The average number of wells drilling at the close of each month in 1894 was 131, as compared with 99 in 1893:

Total number of rigs building in the Lima, Ohio, field in 1894.

Months.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Mercer.	Miscellaneous.	Total.
January	0	6	6	9	28	11	0	60
February	0	8	6	12	43	14	0	83
March	0	21	7	20	28	9	5	90
April	0	8	6	25	37	9	3	88
May	1	7	12	19	30	12	4	85
June	2	8	10	16	31	7	2	76
July	5	8	13	13	23	4	2	68
August	4	5	14	20	40	8	4	95
September	3	12	10	20	27	9	5	86
October	4	7	11	17	30	18	5	92
November	5	11	9	23	44	17	3	112
December	4	11	15	21	39	15	5	110
Average	2	9	10	18	34	11	3	87

Total number of wells drilling in the Lima, Ohio, field in 1894.

Months.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Mercer.	Miscellaneous.	Total.
January	2	16	16	25	50	11	0	120
February	0	9	16	23	46	15	4	113
March	0	17	15	34	51	9	1	127
April	1	16	19	32	59	8	3	138
May	6	17	18	25	51	8	2	127
June	3	22	22	32	45	8	7	139
July	2	15	16	24	45	8	7	117
August	6	23	17	27	48	11	6	138
September	6	17	13	27	51	18	4	136
October	5	21	21	24	45	14	6	136
November	9	16	20	23	44	19	7	138
December	7	13	21	26	48	22	3	140
Average	4	17	18	27	49	12	4	131

In the following tables are given the well records in the Lima, Ohio, district from 1890 to 1894:

Number of wells completed in the Lima, Ohio, district, from 1890 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1890 ..	44	62	......	......	147	165	224	271	307	319	243	187	1,969
1891 ..	142	123	129	156	116	143	144	138	157	134	104	88	1,574
1892 ..	67	82	93	93	93	121	134	166	171	174	147	105	1,446
1893 ..	100	85	163	135	128	160	152	133	131	120	132	130	1,569
1894 ..	130	175	179	205	248	230	233	219	204	226	214	209	2,472

Initial daily production of new wells in the Lima, Ohio, district, from 1890 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1890 ..	......	......	......	......	......	......	......	18,944	16,309	17,426	13,779	8,424	14,976
1891 ..	5,858	5,474	4,428	6,543	4,411	6,667	8,461	8,427	7,855	8,033	5,592	2,989	6,228
1892 ..	2,853	4,485	3,973	4,665	4,750	8,314	11,648	14,631	12,908	13,772	7,554	4,907	7,872
1893 ..	5,510	4,809	6,241	5,477	6,858	9,701	9,588	5,124	6,752	4,223	4,205	3,275	5,980
1894 ..	3,853	4,211	4,486	5,586	7,291	6,391	5,637	5,642	5,020	5,991	10,464	5,539	5,843

Total number of holes drilled in the Lima, Ohio, district, from 1890 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1890 ..	3	2	......	......	4	11	10	23	30	32	37	41	193
1891 ..	28	27	23	28	14	18	22	14	26	20	17	13	250
1892 ..	9	9	8	13	10	18	16	18	27	22	18	15	183
1893 ..	12	15	20	24	18	19	18	12	14	16	13	22	203
1894 ..	17	41	37	27	32	41	30	34	35	27	28	35	384

Number of wells drilling in the Lima, Ohio, district, at the close of each month, from 1890 to 1894.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1890 ..	47	59	......	......	135	188	237	182	238	294	148	111	164
1891 ..	90	105	94	82	79	90	90	93	85	88	67	53	85
1892 ..	61	78	76	51	64	95	101	112	120	114	106	81	88
1893 ..	72	78	88	92	117	119	103	101	89	102	118	114	99
1894 ..	120	113	127	138	127	139	117	138	136	136	138	140	131

Rigs building in the Lima, Ohio, district, from 1890 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1890 ..	56	69	......	......	173	239	248	212	210	194	149	109	166
1891 ..	120	137	155	117	115	123	137	120	117	106	91	99	120
1892 ..	95	115	106	112	113	104	128	126	121	112	112	49	108
1893 ..	62	70	63	58	90	72	52	52	61	76	66	69	66
1894 ..	60	83	90	88	85	76	68	95	86	92	112	110	87

EASTERN OHIO DISTRICT.

In this district is included the old Macksburg field and the new developments in the territory adjacent in West Virginia and western Pennsylvania, and includes, in addition to Macksburg, the Corning, Steubenville, and Marietta districts.

The production of the Eastern Ohio district for the last nine years is given in the following table:

Production of petroleum in the Eastern Ohio district, from 1885 to 1894.

Years.	Barrels.	Years.	Barrels.
1885	661, 580	1890	1, 108, 334
1886	703, 945	1891	422, 883
1887	372, 257	1892	1, 190, 302
1888	291, 585	1893	2, 601, 394
1889	317, 037	1894	3, 183, 370

Prior to 1891 the figures given in the above table are chiefly the production of the Macksburg field.

In the following table the pipe-line runs and the shipments from the Macksburg district are given from 1886 to 1894:

Pipe-line runs in the Macksburg district, from 1886 to 1894.

[Barrels of 42 gallons.]

Years.	January.	February.	March.	April.	May.	June.	July.
1886	54, 806	46, 694	58, 795	64, 137	58, 596	65, 379	56, 966
1887	37, 134	28, 514	33, 995	29, 796	30, 601	29, 586	22, 413
1888	16, 257	18, 861	17, 283	21, 187	21, 349	21, 511	21, 785
1889	18, 174	16, 239	19, 676	20, 144	20, 283	18, 536	16, 705
1890	29, 872	34, 022	45, 362	53, 905	72, 158	90, 827	111, 584
1891	86, 058	45, 618	23, 055	25, 070	24, 263	21, 689	24, 858
1892	24, 801	27, 620	39, 010	40, 424	43, 569	50, 007	64, 107
1893	183, 781	211, 658	235, 177	211, 102	199, 929	146, 626	148, 622
1894	138, 172	121, 627	150, 095	190, 677	239, 912	228, 267	221, 999

Years.	August.	September.	October.	November.	December.	Total.	Average.
1886	57, 492	48, 918	46, 937	41, 359	40, 578	640, 657	53, 388
1887	26, 659	22, 903	20, 458	19, 902	17, 079	319, 040	26, 587
1888	18, 558	22, 058	18, 809	20, 802	20, 950	239, 410	19, 951
1889	16, 607	16, 875	21, 555	25, 415	28, 567	238, 776	19, 898
1890	121, 349	138, 310	129, 717	106, 552	87, 955	1, 021, 613	85, 134
1891	24, 432	27, 006	23, 428	23, 073	28, 682	377, 232	31, 436
1892	106, 082	135, 353	212, 470	176, 852	196, 852	1, 117, 147	93, 096
1893	152, 912	156, 124	149, 773	134, 923	144, 488	2, 075, 115	172, 926
1894	249, 472	202, 364	220, 557	199, 787	199, 774	2, 362, 703	196, 892

Shipments of crude petroleum and refined petroleum reduced to crude equivalent from Macksburg district, from 1886 to 1894.

[Barrels of 42 gallons.]

Years.	January.	February.	March.	April.	May.	June.	July.
1886	60, 119	42, 525	32, 277	23, 578	28, 986	40, 211	28, 832
1887	52, 065	23, 908	17, 593	16, 558	16, 002	17, 384	16, 504
1888	40, 076	30, 045	4, 122	14, 920	15, 275	15, 630	9, 083
1889	11, 847	16, 168	23, 939	8, 611	9, 027	8, 934	15, 269
1890	44, 306	38, 898	35, 041	30, 975	13, 070	22, 851	46, 394
1891	54, 363	27, 160	1, 040	2, 094	1, 060	41, 725	820
1892	2, 594	2, 200	1, 763	1, 600	252	37, 989	1, 834
1893	7, 174	6, 556	8, 218	5, 906	2, 338	1, 123	1, 025
1894	3, 366	3, 932	2, 874	2, 272	1, 998	959	2, 569

Years.	August.	September.	October.	November.	December.	Total.	Average.
1886	45, 882	47, 992	53, 156	51, 608	49, 260	504, 426	42, 036
1887	27, 719	35, 030	37, 978	34, 508	39, 654	334, 903	27, 909
1888	6, 989	32, 698	47, 572	47, 066	26, 940	290, 416	24, 201
1889	14, 507	22, 669	50, 447	47, 924	47, 090	276, 432	23, 036
1890	107, 175	73, 469	57, 780	54, 540	53, 704	578, 203	48, 184
1891	2, 318	3, 283	3, 040	2, 700	2, 236	141, 839	11, 820
1892	1, 555	2, 102	3, 773	4, 358	6, 443	66, 463	5, 539
1893	586	1, 964	2, 524	4, 538	2, 563	44, 515	3, 710
1894	2, 309	3, 839	4, 377	4, 264	3, 999	36, 758	3, 063

In the following table will be found certain figures regarding stocks of crude petroleum in eastern Ohio at the close of each month from 1886 to 1894. This by no means represents all the stocks of crude petroleum produced in this district, but they are the best statement we can get as to stocks held by pipe lines that derived most of their oil from eastern Ohio:

Total stocks of crude petroleum in the Macksburg district at close of each month from 1886 to 1894, by months and years.

[Barrels of 42 gallons.]

Years.	January.	February.	March.	April.	May.	June.	July.
1886	324, 483	332, 322	362, 923	407, 212	440, 329	467, 599	468, 796
1887	404. 315	408, 926	425, 325	438, 562	453, 162	465, 363	472, 273
1888	380, 551	386, 293	400, 602	407, 086	413, 858	420, 631	434, 573
1889	363, 620	357, 527	360, 121	364, 796	376, 052	397, 718	387, 089
1890	296, 413	291, 536	301, 856	324, 786	388, 874	451, 851	517, 042
1891	685, 120	503, 284	480, 618	480, 364	453, 809	433, 773	401, 358
1892	461, 616	468, 861	460, 750	462, 383	475, 768	447, 685	457, 176
1893	410, 715	418, 513	397, 127	404, 951	407, 715	421, 222	413, 935
1894	390, 977	388, 341	379, 037	376, 883	325, 664	294, 427	271, 801

Years.	August.	September.	October.	November.	December.	Average.
1886	456, 621	461, 842	437, 299	427, 950	419, 248	417, 219
1887	471, 214	459, 085	441, 563	426, 957	404, 382	439, 261
1888	444, 006	427, 797	394, 807	365, 873	351, 128	402, 267
1889	389, 189	383, 393	354, 498	331, 939	310, 848	364, 732
1890	531, 215	596, 056	660, 573	703, 031	698, 129	480, 113
1891	378, 857	388, 855	431, 450	461, 037	454, 232	462, 730
1892	462, 306	441, 494	434, 560	432, 283	422, 142	452, 252
1893	426, 552	443, 669	458, 692	446, 503	415, 900	422, 124
1894	241, 439	197, 660	179, 867	152, 200	147, 318	278, 801

In the following tables are given the well records in the Macksburg district from 1891 to 1894:

Number of wells completed in the Eastern Ohio district, from 1891 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891	......	......	......	......	......	......	......	......	......	9	10	8	27
1892	7	9	12	7	4	8	5	2	4	2	14	2	76
1893	10	15	13	19	24	15	26	18	21	15	7	7	190
1894	9	6	15	17	17	21	23	18	19	21	22	27	215

Initial daily production of new wells in the Eastern Ohio district, from 1891 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891	......	......	......	......	......	......	......	......	......	36	265	70	371
1892	60	152	393	65	291	25	43	2	0	20	117	0	1, 168
1893	209	168	109	254	350	210	323	398	240	234	37	78	2, 610
1894	143	50	74	172	246	223	262	232	180	468	215	433	2, 698

Total number of dry holes drilled in the Eastern Ohio district, from 1891 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891	......	......	......	......	......	......	......	......	......	5	5	4	14
1892	2	3	4	4	4	5	1	0	4	1	4	2	34
1893	0	2	4	3	8	2	7	3	7	4	4	2	46
1894	3	2	8	7	5	9	8	8	7	8	11	9	85

Number of wells drilling in the Eastern Ohio district at the close of each month from 1891 to 1894.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1891	......	......	......	......	......	......	......	......	......	15	14	10	13
1892	15	15	12	9	14	9	6	6	6	10	7	9	10
1893	14	10	15	15	13	15	13	19	12	8	9	12	13
1894	11	4	19	5	17	15	18	18	16	15	19	22	15

Rigs building in the Eastern Ohio district from 1891 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1891	......	......	......	......	......	......	......	......	......	20	20	4	15
1892	18	17	14	13	21	10	8	11	13	16	13	13	14
1893	16	17	23	11	4	9	12	9	13	9	13	13	12
1894	9	13	13	9	13	13	18	18	15	27	19	17	15

In the following table is given the well statement, showing the wells completed, the initial production, the dry holes, wells drilling, and rigs building in the Macksburg district of the Eastern Ohio field in 1894:

Well record in the Macksburg, Ohio, district in 1894.

Months.	Wells completed.	Initial production.	Dry holes.	Wells drilling.	Rigs building.
		Barrels.			
January	9	143	3	11	9
February	6	50	2	4	13
March	15	74	8	19	13
April	17	172	7	5	9
May	17	246	5	17	13
June	21	223	9	15	13
July	23	262	8	18	18
August	18	232	8	18	18
September	19	180	7	16	15
October	21	468	8	15	27
November	22	215	11	19	19
December	27	433	9	22	17
Total	215	2,698	85	*a* 15	*a* 15

a Average.

It should be noted that the above well records, pipe-line runs, etc., include only those of the Macksburg district of the Eastern Ohio field. The well records of the other districts of the Eastern Ohio district are included in the Southwest district of the Appalachian oil field report.

MECCA-BELDEN DISTRICT.

As has been stated, the wells in this district are located near Mecca, in Trumbull County, and Belden, in Lorain County. The oil is a lubricating oil produced from a few shallow wells. There were but 13 wells producing at the close of 1892, 10 at the close of 1893, and 9 at the close of 1894.

In the following tables are given the production and stocks and value of the crude petroleum in this district in 1892, 1893, and 1894:

Production and value of crude petroleum in the Mecca-Belden district of Ohio in 1892, 1893, and 1894.

	1892.			1893.			1894.		
	Barrels of 42 gallons.	Value.	Price per barrel.	Barrels of 42 gallons.	Value.	Price per barrel.	Barrels of 42 gallons.	Value.	Price per barrel.
Lorain County, Belden district	1,732	$9,280	$5.36	1,120	$8,014	$7.15	740	$3,276	$4.43
Trumbull County, Mecca district	1,380	11,821	8.57	451	3,321	7.36	200	1,200	6.00
Total	3,112	21,101	6.78	1,571	11,335	7.21½	940	4,476	4.76

Stocks at wells in the Mecca-Belden district of Ohio.

Years ending December 31—	Barrels.
1891	4,048
1892	161
1893	403
1894	225

INDIANA.

With the exception of a small amount of oil produced near Terre Haute, Vigo County, the oil produced in Indiana is from an extension of the Lima district in Ohio. The chief producing wells are in Blackford, Jay, Wells, and Adams counties.

As the conditions under which oil is found are similar to those under which it occurs in the Lima field of Ohio, it is unnecessary here to repeat what has been said regarding the Trenton limestone as an oil producer.

In the following tables will be found a statement of the production of petroleum in Indiana from 1889 to 1894:

Production of petroleum in Indiana, from 1889 to 1894.

	1889.	1890.	1891.	1892.	1893.	1894.
Total production (barrels of 42 gallons)	33,375	63,496	136,634	698,068	2,335,293	3,688,666
Total value at wells of all oils produced, excluding pipage	$10,881	$32,462	$54,787	$260,620	$1,050,882	$1,774,260
Value per barrel	$0.32⅝	$0.51⅛	$0.40	$0.37	$0.45	$0.48

It is hardly necessary to call attention to the remarkable increase in production in Indiana not only since the earliest date shown in the table above, 1889, but also during the last year, the production increasing from 2,335,293 barrels in 1893 to 3,688,666 barrels in 1894, an increase of more than 50 per cent.

In the following table is shown the total production of petroleum in Indiana by months from 1891 to 1894. The largest production in any one month seems to have been in August, 1894, when 345,031 barrels were produced:

Total production of petroleum in Indiana, by months, from 1891 to 1894.

Months.	1891.	1892.	1893.	1894.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
January	6, 171	15, 841	111, 824	259, 000
February	5, 981	18, 946	96, 025	232, 107
March	5, 159	24, 794	134, 549	282, 376
April	4, 973	26, 184	146, 493	287, 330
May	5, 757	31, 033	186, 939	321, 502
June	8, 136	40, 888	209, 616	333, 479
July	10, 809	49, 203	221, 666	327, 349
August	11, 603	56, 109	248, 353	345, 031
September	16, 500	66, 034	245, 615	319, 588
October	19, 029	95, 699	252, 568	339, 424
November	20, 801	129, 270	245, 607	304, 030
December	21, 715	144, 067	236, 038	337, 450
Total	136, 634	698, 068	2, 335, 293	3, 688, 666

In the following tables are given statistics of the total number of producing wells drilled, total number of new wells completed, total number of dry holes, and total number of wells drilling and rigs building in the Indiana oil fields for each month in 1894:

Total number of wells completed in Indiana in 1894, by counties.

Months.	Blackford.	Jay.	Wells.	Adams.	Miscellaneous	Total.
January	8	16	54	12	0	90
February	12	13	78	0	0	103
March	4	17	66	15	1	103
April	3	14	54	6	3	80
May	5	20	66	15	4	110
June	6	22	67	8	4	107
July	3	23	50	6	2	84
August	3	36	63	19	2	123
September	7	21	61	10	1	100
October	8	27	57	13	2	107
November	8	25	52	7	5	97
December	5	23	45	8	4	85
Total	72	257	713	119	28	1, 189

Initial daily production of wells completed in Indiana in 1894, by counties.

Months.	Blackford.	Jay.	Wells.	Adams.	Miscellaneous.	Total.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
January	50	261	1, 390	660	0	2, 361
February	205	380	2, 350	0	0	2, 935
March	185	540	2, 270	400	0	3, 395
April	45	355	2, 565	210	0	3, 175
May	100	670	3, 065	575	40	4, 450
June	83	1, 280	3, 095	413	15	4, 886
July	60	800	2, 275	365	30	3, 530
August	53	967	1, 846	563	6	3, 435
September	235	555	1, 999	310	50	3, 149
October	175	825	2, 050	360	45	3, 455
November	172	950	1, 776	275	150	3, 323
December	210	763	1, 363	220	98	2, 654
Average	1, 573	8, 346	26, 044	4, 351	434	40, 748

Total number of dry holes drilled in Indiana, in 1894, by counties.

Months.	Blackford.	Jay.	Wells.	Adams.	Miscellaneous.	Total.
January	5	6	8	0	0	19
February	1	2	11	0	0	14
March	1	6	12	4	1	24
April	0	7	4	1	2	14
May	0	3	5	3	2	13
June	1	3	5	1	3	13
July	0	6	3	0	0	9
August	0	11	6	3	1	21
September	2	6	6	1	0	15
October	0	5	5	4	0	14
November	1	5	2	0	0	8
December	1	8	5	3	0	17
Total	12	68	72	20	9	181

Total number of wells drilling in Indiana in 1894, by counties.

Months.	Blackford.	Jay.	Wells.	Adams.	Miscellaneous.	Total.
January	5	9	44	5	0	63
February	2	9	50	5	5	71
March	2	5	22	4	4	37
April	5	11	32	4	4	56
May	7	13	32	6	2	60
June	3	15	39	2	2	61
July	2	22	40	7	0	71
August	4	11	41	7	1	64
September	2	9	42	4	1	58
October	2	17	35	5	3	62
November	2	15	38	4	3	62
December	2	10	35	5	6	58
Average	3	12	38	5	3	60

Total number of rigs building in Indiana in 1894, by counties.

Months.	Blackford.	Jay.	Wells.	Adams.	Miscellaneous.	Total.
January	0	9	22	5	0	36
February	0	13	20	6	0	39
March	0	7	24	3	0	34
April	0	12	17	9	2	40
May	1	6	24	2	2	35
June	1	5	21	2	1	30
July	1	7	20	2	2	32
August	2	5	23	4	1	35
September	1	6	21	4	3	35
October	8	9	37	2	1	57
November	1	9	20	5	3	38
December	3	8	17	1	3	32
Average	2	8	22	4	2	37

In the following tables are given the well records in the Indiana oil fields from 1891 to 1894:

Number of wells completed in the Indiana oil fields, from 1891 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891	......	......	......	......	......	......	6	6	15	15	15	8	65
1892	11	13	18	13	17	19	17	30	25	52	33	47	295
1893	20	30	31	36	45	47	47	55	27	72	56	76	542
1894	90	103	103	80	110	107	84	123	100	107	97	85	1, 189

Initial daily production of new wells in Indiana oil fields from 1891 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	Bbls.	*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*	*Bbls.*
1891	......	......	......	......	......	......	253	135	875	330	390	175	2,158
1892	342	250	289	316	505	545	595	1,295	2,145	4,155	3,050	3,160	16,647
1893	1,020	913	2,805	4,135	3,155	5,595	3,880	4,184	2,055	3,442	2,305	2,968	36,457
1894	2,361	2,935	3,395	3,175	4,450	4,886	3,530	3,435	3,149	3,455	3,323	2,654	40,748

Total number of dry holes drilled in Indiana oil fields from 1891 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891	......	......	......	......	......	......	0	2	5	4	3	1	15
1892	2	6	6	2	3	4	2	3	3	18	6	21	76
1893	7	10	10	6	14	6	11	9	5	14	10	9	111
1894	19	14	24	14	13	13	9	21	15	14	8	17	181

Number of wells drilling in the Indiana oil fields at the close of each month from 1891 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1891	......	......	......	......	......	......	5	13	12	8	4	12	9
1892	17	15	11	12	13	16	11	16	23	23	26	24	17
1893	24	19	22	18	20	28	29	45	27	50	36	50	31
1894	63	71	37	56	60	61	71	64	58	62	62	58	60

Rigs building in the Indiana oil fields from 1891 to 1894, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1891	......	......	......	......	......	......	7	2	12	8	6	6	7
1892	8	18	23	23	17	21	16	15	29	31	39	19	22
1893	12	15	17	14	17	26	32	28	9	25	27	30	21
1894	36	39	34	40	35	30	32	35	35	57	38	32	37

COLORADO.

All of the oil produced in Colorado is from what is known as the Florence field. This field extends from near Canyon City, 8 miles above Florence, to as yet an undetermined distance southeast of Florence. Until quite recently the productive field has been confined to a small area about 2 miles square in the vicinity of Florence, in the valley of the Arkansas River and on the adjacent mesas or table-land. Recently, however, oil has been found in some quantities southeast of this field, and it is supposed that the oil field may extend some distance down the Arkansas River toward Pueblo.

The geological conditions of the oil fields of Colorado were described on pages 643, 644 of Mineral Resources of the United States, 1892.

In 1894 there were four companies at work in this field, namely, the Florence Oil and Refining Company, the Triumph Oil Company, the United Oil Company, and the Rocky Mountain Oil Company. These companies had 130 producing wells at the close of 1894, the largest number being owned by the United Oil Company. The two last named companies, the United and Rocky Mountain, have recently been consolidated as one.

The total production of oil in Colorado in 1894 was 515,746 barrels. The total value of this oil was $303,652, or $58\frac{7}{8}$ cents a barrel.

In the following table will be found a statement of the production of crude oil in Colorado from 1887 to 1894:

Product of crude oil in Colorado from 1887 to 1894.

Years.	Barrels.	Years.	Barrels.
1887	76,295	1891	665,482
1888	297,612	1892	824,000
1889	316,476	1893	594,390
1890	368,842	1894	515,746

CALIFORNIA.

The localities in which oil had been found in California up to the date of its publication, as well as the character of the oil and the conditions under which it occurs, are quite fully discussed in the Mineral Industries volume of the Eleventh Census, as well as in the volume Mineral Resources of the United States, 1892.

With the exception of the Santa Clara field, which is located in the county of the same name just south of San Francisco, the oil fields of California from which oil is produced in commercial quantities are all in the southern part of the State, in the counties of Santa Barbara, Ventura, and Los Angeles, which form a tier of counties extending due east from Point Conception, where the coast turns to the east. Oil has also been found in Kern County, at Bakersfield, which is due north from Ventura County. The topography of California in this oil region is somewhat interesting. Not only does the coast turn due east at Point Conception, but the Coast mountains, which to the north of the oil fields have a northwest and southeast trend, also turn in Santa Barbara County to the east and run in a general east and west direction.

The oil from the Southern California field as a rule has asphaltum as a base instead of paraffin, though some oils from this district are paraffin oils and yield a high percentage of illuminants, the so-called asphaltum oils as a rule being comparatively low in the illuminating hydrocarbons.

The only oil produced in Kern County is by the Jewett & Blodget Oil Company, whose wells are located some 35 miles southwest of Bakersfield. Two kinds of so-called "oils" are produced, one a liquid asphalt with a gravity of 14.7° B., of which they were producing, in August, 1894, some 80 barrels a day, selling it in casks, on board cars, for $25 a ton. The wells producing this liquid asphalt are shallow and inexpensive, having an average depth of about 100 feet, the asphalt being found in shale and the wells averaging 2½ barrels of the liquid asphalt a day. Thirty-two wells were in operation in 1894 producing this liquid asphalt, giving a production in 1894 of some 29,200 barrels, worth $25 a ton. Underlying the shale formation in which this asphalt is found is an oil sand. This company had three wells of an average depth of 1,200 feet, producing 30 barrels daily, or 10,950 barrels a year, of a heavy green oil of 17.8° B. gravity. This oil is sold for 15 cents a gallon for lubricating purposes, and it is stated that it contains no asphalt.

The only wells in Santa Clara County, some six in number, are owned by the Moody Gulch Petroleum Company, and produced in 1894 3,600 barrels, valued at $2.50 a barrel, or a total value of $9,000. The oil is of 46° B. gravity, light green in color, and is sold for the production of illuminating gases. The wells are from 800 to 1,000 feet deep. The sand is said to be 100 feet thick and the wells to cost from $8,000 to $20,000.

According to the returns received at this office, the total production of oil in California in 1894 was 705,969 barrels. All but 3,600 barrels of this was from the Southern oil field. The total value of this oil was $823,423, or $1.17 a barrel. It will be noted that this differs some from the production of southern California given in the table in the report of Professor Peckham.

In the following table will be found a statement of the production of petroleum in California from 1876 to 1894, inclusive. It will be noticed from this that the production in 1894, which is 705,969 barrels, is the largest in the history of the State, the nearest approach to it being in 1888, when 690,333 barrels, some 15,600 barrels less, were produced:

Production of petroleum in California.

Years.	Barrels.	Years.	Barrels.
Previous to 1876	175,000	1885	325,000
1876	12,000	1886	377,145
1877	13,000	1887	678,572
1878	15,227	1888	690,333
1879	19,858	1889	303,220
1880	40,552	1890	307,360
1881	99,862	1891	323,600
1882	128,636	1892	385,049
1883	142,857	1893	470,179
1884	262,000	1894	705,969

A large portion of the oil produced in southern California is used for fuel purposes. At the Midwinter Fair Mr. A. M. Hunt, of San Francisco, who had charge of the power plant, made thorough tests as to the value of this oil as fuel. These were made at the works of the Edison Light and Power Company, of San Francisco, and were as follows: Evaporation with California oil, 13.1 pounds of water to 1 pound of oil; evaporation with Peruvian oil, 12.1 pounds of water to 1 pound of oil; evaporation with coal, 6.68 pounds of water to 1 pound of coal.

The California oil used weighed 320 pounds to the barrel. The Peruvian oil used weighed 294 pounds to the barrel. One pound of California oil was equivalent, therefore, to 1.96 pounds of coal, and 1 pound of Peruvian oil was equivalent to 1.81 pounds of coal. Assuming coal to be worth $6 a ton, the equivalent value of California oil would be $1.68 a barrel, and of Peruvian oil $1.426 a barrel.

In view of the fact that Prof. S. F. Peckham, who had charge of the report on the production of petroleum at the Tenth Census, had recently made a thorough investigation of the conditions under which oil is produced in southern California and the character of the same, he was requested to prepare for this report a statement of the results of his investigations and inquiries, which is given in full.

PETROLEUM IN SOUTHERN CALIFORNIA.

By S. F. Peckham.

The petroleum production of southern California is of little commercial interest outside the State, as it is either consumed or manufactured within the State. The upper Santa Clara Valley has ceased to be a producing center. The northern limit of the section at present yielding oil is found in the eastern end of the Ojai ranche and the adjacent canyons of the Sulphur Mountain. These canyons commence on the west with Wheelers Canyon and extend eastward through the Adams, Santa Paula, Sespe, and Piru canyons, all of which border the Santa Clara Valley of Ventura County on the north side. On the south side of this valley, opposite the Sespe Canyon, the formation yielding petroleum first appears at Bardsdale, and extends along the western slope of the San Fernando Mountains, through the Torrey, Tappo, Pico, and other canyons to a point east of the San Fernando Pass. Much the larger part of this area lies in Ventura County, the remainder in Los Angeles County.

No productive area has yet been developed in the San Fernando plain, but the outcrops again appear in the mountains along its southern border, south of which lies the plain upon which stands the city of Los Angeles. Many attempts have been made to obtain oil by boring at several points upon this plain during the last thirty years, but it is only within the present year that any considerable measure of success has attended these efforts. Early in the year wells were drilled on some of the city lots upon the northwestern outskirts of the city, near Westlake Park. The first wells drilled are reported to have yielded 150 barrels of oil a day. No very definite estimate of their production could be obtained, as in all cases a large amount of water was pumped with the oil, and also a considerable percentage of the oil was consumed as fuel for pumping the wells and for drilling others. The success of these wells, however, led to the drilling of many others, until at the close of the year a wide area had been and was being drilled over, the wells in almost every instance proving successful.

Southeast of Los Angeles the well-known Puente district has continued to produce throughout the year.

At Summerland, on the coast below Santa Barbara, a well was dug early in the year that yielded so much oil that others were drilled. The production of some of these wells was reported as high as 50 barrels a day. The material is really maltha, of a density at or below 14° B., and contains a large amount of water, from which it is separated with the difficulty that usually attends the removal of water from maltha. This material has not yet been made available for commercial purposes outside the immediate locality.

The Union Oil Company of California, with headquarters at Santa Paula, is the largest producer of crude petroleum in southern California. Its oils are also produced over the largest area and in the greatest variety. Those produced at the east end of the Ojai ranche are black in color, and consist of dense petroleums and light malthas. On the opposite side of the Sulphur Mountain the oils obtained in Wheelers Canyon are green. They flow from tunnels that have been driven into the Sulphur Mountain at various dates since 1865. The first tunnel driven by Wheeler, in the fall of 1865, is still yielding a small quantity of oil, amounting in the aggregate to a number of barrels per month. The next canyon, and parallel with Wheelers, is the Adams Canyon. Here wells are yielding a small amount of green and brown oils. The so-called Saltmarsh Canyon is a branch of the Adams Canyon. One of the most productive wells drilled in southern California, situated in this canyon, has yielded 140,000 barrels of petroleum.

In the Sespe canyon, next east of the Santa Paula canyon, several localities have been very successfully exploited for oil. The oil produced here is black and for the most part of comparatively high specific gravity. Still farther east the Buckhorn ranch, operated by the Fortuna Oil Company, produces a very dense maltha in considerable quantities. These localities are all on the north side of the Santa Clara Valley.

On the opposite, or south side, the most western locality producing oil in the vicinity is Bardsdale. Here a dozen or fifteen wells have been uniformly successful as producers of a brown oil of high specific gravity. A few miles east of Bardsdale is the Torrey canyon, where about 15 more wells are producing a dark brown oil of medium density. These different properties are united under the management of the Union Oil Company of California. Their average production during 1894 has been about 20,000 barrels per month. This production has been gathered into tanks at Santa Paula and Ventura and used in the refinery at Santa Paula, or distributed in tank cars for fuel purposes. A considerable amount of the mixed Fortuna, Torrey canyon, and Bardsdale oils are loaded from a rack near Piru Station, on the Southern Pacific Railroad. The remainder of the Bardsdale, with the Sespe and Ojai and Wheeler and Adams canyon oils is gathered at Santa Paula or piped to Ventura, as required. Santa Paula is the principal loading station of the company for crude oil. Here also is their refinery. This is a small affair with a very inadequate equipment for producing the best grades of articles; yet with skillful manipulation some very superior articles are now turned out. The oil is received at the refinery in separate tanks for different purposes. All of the green oil from Wheeler's canyon, and much of the Brown oil from the Adams canyon is preserved separately for special uses. The least dense black oils are also preserved separately from the remaining black oils, which are used for fuel purposes. The green oils are largely used in the preparation of a reduced petroleum, which is sold under the name of "skid oil." These green oils also furnish distillates from which the best grades of lubricating oils may be prepared. The usual method of procedure consists in placing the petroleum in a still and first removing the crude naphtha, the amount of which varies with the variety of oil and the season of the year. It has been demonstrated, both by experiment and practical experience, that at the average temperature of that climate a very large part of the light distillates obtained in the winter months is in summer evaporated from the oil while in transit from the wells to the refinery. The crude naphtha is refined by treatment and distillation in a steam still. The lightest distillate has an average specific gravity of 74° B., and is wholly consumed in gasoline stoves. The next heavier grade of distillate is of about 68° B., gravity and is sold for various purposes under the name of benzine.

No illuminating oil is manufactured, as, after innumerable attempts extending over thirty years, the conclusion reached in 1865 has been confirmed, viz, that illuminating oil of superior quality can not be made from California petroleum. The distillate that corresponds in specific gravity to illuminating oil is sold for enriching illuminating gas and for use in petroleum motors. The next heavier distillate that comes off between the gas oil and the crude lubricating distillate is also sold as gas oil. Some of it is redistilled, furnishing gas oil on the one hand and light lubricating distillate on the other. A varying amount of crude lubricating distillate is obtained as the petroleum is run to an asphaltic residuum of several grades of hardness. These asphaltic residuums, while they are sold under the technical names of "asphalt" and "asphaltum," are quite different from the natural substances known under those names. They are entirely free from oils volatile at a moderate temperature, and also from water. They have been found very valuable for use in the preparation of paints and for coating paper; also for covering pipes, technically known as "pipe dipping." No statistics of the amounts of the various products manufactured by the company have been furnished.

The territory available for oil purposes in the Tappo canyon is being operated by the Eüreka Oil Company. This company is only a producer. It has drilled three wells, which have been brought in during the year 1894. The larger part, if not all, of their production during the year has been sold to the Union Oil Company of California. It has amounted to about 100 barrels a day. A circumstance of some interest may be noted in reference to the wells in the Tappo canyon. In 1865 Dr. Letterman, then superintendent of the operations of the Philadelphia and California Petroleum Company, drilled a well near an asphalt bed and at a depth of 117 feet struck maltha so dense that further drilling was found to be impossible. In May, 1866, I saw this well and listened to the discouraging story of the Doctor concerning it. I have been told that one of the most successful wells of the Eureka company is located only 150 feet from the site of the well of 1865–1866.

East of the Tappo canyon is the Pico canyon, in and about which wells have been drilled since 1866. Here was located the noted Pico spring, which was one of the two original springs that produced petroleum in southern California. Here the Pacific Coast Oil Company have been operating for many years. The wells in this vicinity have been their main source of supply, while the remainder has been obtained from wells along a line extending several miles to the eastward. Their oil is nearly all shipped to San Francisco, where it is worked up into various products similar to, but generally lighter in specific gravity than, those made by the Union Oil Company of California.

The production around Los Angeles has for the most part been consumed as fuel. A small portion has been distilled into gas oil and asphaltum by the Oil Burner and Supply Company of Los Angeles. The production at Puente has all been consumed for fuel purposes in and around Los Angeles. At the close of the year the Union Oil Company of California was completing arrangements for drilling several wells near Fullerton, southeast of Los Angeles, and in the neighborhood of the Puente district.

The best estimate that can be made, from information deemed reliable, of the production of oil in California during 1894 is as follows: Wells at Summerland capable, if pumped to full capacity, of yielding 150 barrels per day; actual yield fluctuating and uncertain, as the oil is consumed locally and in Santa Barbara for fuel; possible production for the year, 1,500 barrels. Wells of the Union Oil Company of California, in Ventura County, yielding an average of 20,000 barrels per month; drilling nearly suspended; yield decreasing. Wells of the Eureka Oil Company averaging about 100 barrels a day. Wells of the Pacific Coast Oil Company averaging about 15,000 barrels a month.

Wells in and around Los Angeles estimated to average 15,000 barrels a month.

Summary of production of petroleum in southern California in 1894.

	Barrels.
Summerland	1,500
Union Oil Company of California	240,000
Eureka Oil Company	36,500
Pacific Coast Oil Company	180,000
In and around Los Angeles	180,000
Total	638,000

No sketch of this interest would be complete without mention of the peculiar condition at present prevailing upon the Pacific Coast. Until about the beginning of 1893 the Union Oil Company of California and the Pacific Coast Oil Company had nearly absolute control of the crude-oil trade of the Pacific Coast, and a large share of the trade in refined products exclusive of illuminating oil. Since this period the low prices prevailing on the Atlantic Coast for lubricating oils have made the introduction of large quantities of high grade Eastern oils possible. Also since this period the development of the Puente and other fields not controlled by these corporations has led to the production of crude petroleum in the vicinity of Los Angeles somewhat in excess of the local demand. All of these influences have together served to depress prices.

A short time prior to the close of the year a movement was set on foot to import Peruvian petroleum into the Pacific Coast ports, to be offered at prices low enough to compete with the California product. Large tanks were in process of erection at Santa Monica, San Francisco, Cal., and Portland, Oreg., and the report was very generally deemed authentic that a sufficient number of tank steamers had been secured to bring to the Coast from Peru a supply adequate to meet all demands. This movement has been met by a reduction in the price of crude oil by the Union Oil Company of California to less than 50 per cent of that formerly demanded. I do not believe that the importation of Peruvian petroleum can be permanently maintained at a profit. Meantime the low prices resulting from this movement will greatly extend the use of the crude oil, creating a much greater demand for it. Especially to be observed are the preparations now being made by the two great railroad systems of the Coast, the Santa Fe and Southern Pacific, to burn petroleum instead of coal upon locomotives.

TENNESSEE.

Between 1860 and 1870, shortly after the drilling of the Drake well, at Titusville, in Pennsylvania, oil was searched for in most of the States in the Union. In many cases, especially in the districts on the western slopes of the Appalachian Mountains, oil was found in considerable quantities as the result of these explorations; but the conditions of transportation were such that the product could not be marketed at a profit, and hence the wells were allowed to fall into disuse. With the southward extension, however, of the Appalachian field, and especially in view of the ease with which oil can now be transported through pipe lines from territory that would otherwise be inaccessible, attention is now being directed to those localities which give promise of being paying territory.

In central and eastern Tennessee, especially in Overton and Putnam counties, quite a number of wells were drilled twenty-five to thirty years ago and a great deal of oil found. Near Algood, Putnam County, on what was known as the Douglas property, considerable lubricating oil was found. Quite a number of wells were put down and a number of thousands of barrels hauled to the then nearest railroad. In the southwestern corner of Overton County is a group of shallow wells drilled from twenty-five to thirty years ago which were reported to be very prolific producers. These wells were drilled very close together, the oil being found at a depth of from 60 to 80 feet. Other wells were drilled in various parts of this section of Tennessee, but abandoned for the reasons stated above. Recently, however, attention has again been directed to this district; leases are being taken up and the country is being tested with the prospect that oil in paying quantities will be found. No production, however, is reported in this district in 1894.

ALABAMA.

The oil fields of northern Alabama have been described by Dr. C. Willard Hayes, of the United States Geological Survey, in Mineral Resources, 1893, pages 509, 510.

KANSAS.

The earliest district in Kansas to attract any attention as a producer of petroleum was Miami County, as described on pages 510, 511, of Mineral Resources, 1893.

The most extensive field, however, was developed in 1883 and 1884 in Wilson, Neosho, and Montgomery counties, some 40,000 barrels having been produced in these three counties within a radius of some 20 miles from Neodesha, in Wilson County, in 1894. The oil is reported to be free from sulphur, of 36° B. gravity, and of a dark-green color. It is found at a depth of about 750 to 900 feet, sometimes in a brown sand, sometimes in a white sand, and is from 10 to 30 feet thick. None of the oil produced has yet been refined. There were 34 wells in operation, all of which were drilled in 1894. The initial production of the wells is from 10 to 35 barrels a day.

The total product of oil in Kansas, so far as records have been obtained, is as follows:

Production of petroleum in Kansas.

	Barrels.
1889	500
1890	1,200
1891	1,400
1892	....
1893	18,000
1894	40,000

KENTUCKY.

From a very complete and very interesting report on the occurrence of petroleum, natural gas, and asphalt rock in western Kentucky, by Prof. Edward Orton, we condense the following brief statement regarding the production of petroleum:

Practically but two divisions of the geological scale constitute the surface rocks of western Kentucky, namely, the sub-Carboniferous and the Carboniferous. Both of these series, but especially the former, abound in one or another form of petroleum. In the Coal Measures proper there is comparatively little evidence of the existence of bituminous matter outside of the coal seams and the black shale they contain, but when tested with the drill the underlying strata, namely, the Devonian shale, the Devonian and Upper Silurian limestones, and the Hudson River group, has been proved, in some part of its extent, to be petroliferous in an important sense. In these are found not only petroleum and the gas derived from it, but the tar and asphalt that result from the oxidation of the petroleum.

One of the most interesting petroleum districts, historically at least, is what is known as the Cumberland County oil field. At Burksville, in this county, in the valley of the Cumberland River, the first flowing oil well ever opened in this country was struck in 1829. The well was drilled for salt water and was, through its entire depth, in strata of the Hudson River age. It was drilled but 300 feet deep. The drilling tools were lifted out of the well by the force of the gas, and a column of oil was thrown to the top of the trees above the derrick. The escaping oil flowed into the Cumberland River, covering its surface for many miles. This oil was ignited at a point some 40 miles below Burksville, and the burning river presented an astonishing sight. The quantity of oil that escaped was large, but the exact amount is not known. The well ceased to flow some three weeks after it was struck, but remained full of oil, and many years afterwards was pumped for the purpose of obtaining oil to be bottled and sold for medicinal use. Though a good deal of drilling has since been done in and around Burksville, nothing at all comparable to this early experience has been encountered, though small oil wells have been found.

In Allen County oil springs have been known to exist from its earliest occupation, being found in the lower part of the St. Louis limestone. From one of these springs in the valley of the Trammel Fork of Drakes Creek, a branch of the Barren River, a few miles to the southwest of Scottville, oil had been collected in a small way for many years after the Indian fashion, by spreading a blanket over the surface of the spring and wringing out the oil absorbed. A barrel of this oil was shipped to Pittsburg some time before 1850. During the war of the rebellion several shallow wells were drilled near the springs in this county, several of the wells yielding from 5 to 6 barrels of heavy oil, and all the oil that could be secured was wagoned across the country and shipped to Memphis. In 1867, on the Uriah Porter farm, to the southwest of Scottville, a well drilled to the depth of probably 75 feet turned out to be a large producer. Estimates of the production range from 100 to 500 barrels a day, anyone of which was in excess of the actual production. A quantity of oil, possibly 200 or 300 barrels, was shipped to Louisville and St. Louis for refining, but was charged with sulphur and could not be deodorized, while transportation was too expensive. Other wells were drilled in this vicinity and some gas and oil found, but production was never carried on on a commercial scale.

These exhaust what Professor Orton calls the early history of petroleum in this district. A new chapter begins in 1887, following the discovery of oil in the Trenton limestone.

The largest oil field in the western half of Kentucky, but still a very small oil field, is in Barren County. Its early history agrees quite closely with that of Allen County, already given. Systematic drilling seems to have begun in this territory around Glasgow immediately after the war. The first well drilled was in the immediate vicinity of a spring on Boyds Creek, 4½ miles southeast of Glasgow. Oil was obtained here at a shallow depth in promising quantities. Quite a number of wells were drilled in 1866–1868 which proved to be flowing wells, one being credited with a production of 100 barrels a day for some time. These wells and others that were afterwards put down near them constitute an oil field of small proportion. From 1866 up to the present time this field has maintained a steady though small production. The oil is black, with a specific gravity of from 40° to 42° B. It does not contain an excessive amount of sulphur compounds. The surface rocks at this point are the lowest beds of the Keokuk group, and the oil is derived from strata 177 feet below the valley level. The oil rock seems to be a sandstone.

Professor Orton gives the following as the total production of this Glasgow field from 1872 to 1888:

	Barrels.
1872–1874	13,000
1874–1876	7,300
1876–1878	3,600
1878–1884	14,600
1884–1888	4,500
Total	43,000

Since 1887, as noted above, exploration for oil has been conducted in a number of localities in Kentucky. The important ones, however, and the only ones that have resulted in any considerable production of oil, have been in the neighborhood of Glasgow; indeed, the Glasgow district may be regarded as the only district in Kentucky that has produced oil in commercial quantities. Considerable of the oil from this district has been refined. A test of the oil made by Prof. W. Dicore, of Cincinnati, Ohio, shows that the oil had a specific gravity of 0.870 of 43½° B. and produced, on distillation, 5 per cent light oil boiling below 130° F., 18 per cent boiling at 130–300° F., and 34 per cent of illuminating oil of 48° B. After these there was taken off a lubricating oil of 28° B., which on further heating yielded oil of 39° B., out of which 17 per cent of heavy lamp oil of 43° B. can be produced, increasing the total of lamp oil to 51 per cent.

The total production of oil in Kentucky, so far as we have been able to ascertain the same with any details, is as follows:

Production of petroleum in Kentucky 1883–1894.

Years.	Production.	Years.	Production.
	Barrels.		*Barrels.*
1883	4,755	1889	5,400
1884	4,148	1890	6,000
1885	5,164	1891	9,000
1886	4,726	1892	6,500
1887	4,791	1893	3,000
1888	5,096	1894	1,500

TEXAS.

Conditions similar to those found in Kansas, Missouri, and the southern part of California exist in Texas. Springs, known locally as "tar springs," are found scattered over various portions of the State, especially in the northeast, southeast, and central portions. The oil wells of Kansas and Missouri are found a little east of the ninety-fifth meridian of longitude west of Greenwich. The Texas springs are a little to the east of the ninety-fourth meridian, and some are also found on the ninety-third and east of it. The petroleum produced in Texas is from Bexar County, near San Antonio, about midway between the ninety-eighth and ninety-ninth meridians. The product of these springs is known locally as petroleum, and is in this report so classified, though some geologists, especially those who have been connected with the geological survey of California, insist on calling it maltha. At present, however, they acknowledge that this so-called maltha and petroleum are similar substances. Chemically they may be; practically they are not.

The Texas oil is a natural lubricator of from 28° to 30° gravity, and is said to be found in a conglomerate. The wells are shallow, the oil being struck in various parts of the State at from 125 to 350 feet. The Bexar County wells, which produced the petroleum reported from this State, are about 300 feet deep. As there is but a limited demand for the oil, there is no effort to produce it in large quantities. The producing wells, which are on the ranch of Mr. George Dulnig, were wells that had been drilled originally for water. They were found to yield small quantities of oil and gas. The production of these two wells in 1889 was about 4 barrels a month. The annual production is from 50 to 75 barrels.

Outside of the oil produced in Bexar County none seems to have been produced in the State on a commercial scale, though reports as to the discovery of oil at various points in Texas are frequent. At Sulphur Springs, in Hopkins County, there are certain so-called "sour wells," which produced a few gallons of oil. In 1887 and 1888 considerable excitement was occasioned by the reported striking of oil in Nacogdoches County. The locality was some 80 miles southwest of Shreveport. The wells were driven wells, and some oil was obtained at the depth of 85 feet; in other cases at a depth of 300 feet. Quite a number of wells were driven in 1887 and 1888, but no petroleum was produced in 1889. The oil produced in Bexar County was used for lubrication.

The production of petroleum in this State since 1889 has been as follows:

Production of petroleum in Texas, 1889 to 1894.

Years.	Barrels.
1889	48
1890	54
1891	54
1892	45
1893	50
1894	60

ILLINOIS.

The only oil produced in Illinois on a commercial scale is a natural lubricating oil from Litchfield, Montgomery County. Some oil occurs with the gas at the wells of the Sparta Natural Gas and Oil Company at Sparta, Ill., but not in sufficient quantities to be considered in the statistics of production.

The Litchfield oil is lubricating, dark, almost black, in color, and of 22° B. gravity. The cold test is remarkable, the oil remaining fluid at 22° below zero F. It is largely used by the factories in the neighborhood of Litchfield, and is sold to consumers at near-by points for lubricating purposes, bringing from 8 to 10 cents per gallon in bulk, according to quantity. In all there have been 30 wells bored in the neighborhood of Litchfield, chiefly for gas. The depth of these wells ranges from 640 to 670 feet. All save five were abandoned years ago, and one of these has since been abandoned, so that in 1894 but four were producing. These wells continue to produce the character of petroleum mentioned above. The average production is about 1 barrel a day. They are pumped by heads, and one man attends to them all.

The production of petroleum in this State since 1889 has been as follows:

Production of petroleum in Illinois, 1889 to 1894.

Years.	Barrels.
1889	1,460
1890	900
1891	675
1892	521
1893	400
1894	300

INDIAN TERRITORY.

Petroleum is found in Indian Territory in the Cherokee Nation, some 50 miles south of the Neodesha field in Wilson and adjacent counties, Kansas, which are referred to in the report on Kansas. Eight wells were put down in the district of Cooweescoowe in this field, oil being found at various depths in each, from 33 to 260 feet. The wells are pumping wells and would yield from one-half to 12 barrels a day. The total production in 1894 was 30 barrels. Near Chelsea, also in the Cherokee Nation, are 6 wells producing a similar oil to that noted above. The total production of oil in this Territory in 1894 was 130 barrels, worth $810, or $6.23 a barrel. The oil is a lubricating oil.

The total production since 1891 has been as follows:

Production of petroleum in Indian Territory, 1891 to 1894.

Years.	Barrels.
1891	30
1892	80
1893	10
1894	130

MISSOURI.

The conditions under which petroleum is found in Missouri are similar to those that exist at Paola, Kans., which are described quite fully in the statement regarding petroleum in Kansas, in the report of 1889–90. All of the oil produced in Missouri has come from Bates County, near the Kansas State line and southeast from Paola. The oil comes from a sand, and is found at a depth of 220 feet. The well is pumped by a windmill, and yields but a small amount of oil, similar to the Paola oil.

The product of this State since 1889 is as follows:

Production of petroleum in Missouri, 1889 to 1894.

Years.	Barrels.
1889	20
1890	278
1891	25
1892	10
1893	50
1894	8

A contract was made early in 1895 for drilling a well near Red Hill in the hope of finding petroleum. It will be drilled 2,000 feet if necessary.

WYOMING.

For the first time Wyoming appears in this report as a producer of oil on a commercial scale, 2,369 barrels, of a total value of $15,920, or $6.72 a barrel, having been produced in this State in 1894 in the Salt Creek Basin, in Natrona County, by the Pennsylvania Oil Syndicate, from three wells, one of which was drilled in 1894, the other two having been drilled prior to that date. Of the total amount of oil produced 1,990 barrels were sold, leaving a balance of some 500 barrels, of which a small amount was carried over from the previous year. These wells are some 44 miles north of Casper, which is the nearest railroad station, the oil having to be hauled to that point in wagons. From Casper it is shipped in large iron drums holding some 50 gallons each. The price received for the oil, f. o. b. at Casper, in car-load lots, is stated to be $10 a barrel, the price of $6.72 a barrel being this price less the cost of hauling. Shipments of oil only began on September 27, 1894, the total amount shipped to the 1st of January, 1895, being, as stated above, 1,990 barrels. Additional wells were in process of drilling at the beginning of 1895, which, it is understood, have since been completed, showing a production of some 60 barrels a day.

The oil is stated to be a fine lubricant, amber or green in color. One statement shows the specific gravity to be 23.4° B. (=1.194). The following is an analysis of this oil made by Mr. Wilbur C. Knight, State geologist:

Analysis of Salt Creek oil, Wyoming.

No. of fraction.	Products.	Per cent.	Specific gravity.	Flashing point.	Cold test.
				°F.	°F.
1	Benzine	1. 200	0. 7390	29	32
2	Illuminant	2. 000	. 7740	81	32
3	....do	2. 900	. 8520	101	32
4	....do	2. 933	. 8035	127	32
5	....do	4. 300	. 8630	149	32
6	Lubricating	18. 833	. 8685	184	32
7	....do	16. 922	. 8775	254	32
8	....do	22. 700	. 8888	278	32 thick.
9	Cylinder	18. 240	. 9028	326	Fluid.
	Coke	3. 0075			
	Ash	0. 1480			
	Loss	6. 4816			

NOTE.—Specific gravity of crude oil, 0.9150. Flashing point of crude oil, 221° F.

From the above it will be seen that 76.695 per cent are heavy oils, the light oils being but 1.2 per cent, while the illuminants are but 12 per cent.

This Natrona County oil is found in Salt Creek Basin, in the northeastern corner of the county, Salt Creek running northward into the Powder River.

There are two other districts in the State concerning whose petroleum resources some information has been gathered, one known as the "George B. Graff oil-mining district," in the county of Fremont, in the western part of the State, not far from Dallas, and at the base of the Wind River Mountain, and the other known as the "Stockdale oil mining district," in Weston County, in the extreme northeastern part of the State, near the Black Hills and New Castle. The first district, the "George B. Graff," is named for the late Dr. George B. Graff, of Omaha, who developed the property. The amount of oil in this district is indicated from the fact that there are about 50 open oil springs in Fremont County, 14 within a radius of 20 miles of Lander. In 1885 four wells were sunk to the upper oil-bearing sands. The depth of these wells and their product as given at that time are as follows:

Depth and flow of Wyoming oil wells.

Wells.	Depth.	Flow per day.
	Feet.	*Barrels.*
No. 1	85	85
No. 2	100	100
No. 3	350	325
No. 4	1, 200	825
Total		1, 335

It is probable the production of these wells as given is too great. Several statements received from this district are to the effect that three of the wells which were drilled about this time were shut in or "packed;" that if they were allowed to flow, or (to use the local expression) "let loose," they would produce some 200 barrels per day per well; and that in the neighborhood of these wells a lake, 300 yards long by 30 yards wide, was made to receive their overflow, and it is estimated that in this lake there was stored for some time 15,000 barrels that was produced in 1886. Nothing has been done in the way of development or production in this district since this date. Regarding this oil field, Mr. L. D. Ricketts states: "These wells are cased and supplied with valves to prevent the oil from escaping, but owing to the great gas pressure a leakage can not be prevented. The pressure is so great that upon suddenly opening the valves the oil spurts up 75 feet into the air, like some black-watered geyser. After the pipe thus clears itself the steady flow of oil is resumed, which, as variously estimated, will aggregate from 600 to 1,000 barrels per twenty-four hours." The oil is found in two strata, the upper, a "black sand," averaging about 70 feet in thickness, and the other, a "black pebble" or "dark conglomerate," varying in thickness, according to different authorities, from 400 to 800 feet. The oil in this district is low in illuminants, averaging about 25 per cent.

Regarding the second district, the "Stockade Oil-Mining district," which is located in the Black Hills, near New Castle, in Weston County, but little information has been obtained. A large quantity of Government land supposed to contain oil has been located in this district—some 376 locations of 160 acres each, amounting to 60,160 acres. So far as has been learned, no amount of oil has ever been produced in this district, though indications are very favorable to the securing of a large supply.

NEW MEXICO.

Information has been received of a very small production of a heavy lubricating oil in Bernalillo County, on sec. 11, T. 16 N., R. 16 W. This oil flows naturally from the rocks containing it. The product is stated to be a barrel a day, which is probably in excess of the actual production. It is sold in small quantities to consumers in the immediate vicinity. The larger proportion of the production is wasted and lost. It is also reported that there are several places on the Navajo Indian Reservation where petroleum exudes from the crevices in bituminous sandstone, and there is no doubt that at many places in New Mexico the same phenomena that are noticed in Colorado and Wyoming will be found to exist.

CANADA.

While oil in small quantities is found at many points in Canada, most of the commercial oil produced in the Dominion is from Lambton County, Ontario, from what is generally known as the "Petrolia field," though oil is produced from two distinct pools, one the Oil Springs and the other the Petrolia, both in the township of Enniskillen, in the county above named. The larger, the Petrolia field, has an area of some 26 square miles. The smaller, the Oil Springs field, covers about 2 square miles. According to the report of Mr. H. P. H. Brumell, of the geological survey of Canada, to which we are indebted for many of the facts of this statement, these pools are divided by a very distinct synclinal structure. The oil horizon of Petrolia lies at a depth of from 450 to 480 feet beneath the surface of the main part of the town of this name, the oil being pumped in all instances from what is known as the lower vein, at a point about 65 feet in the Corniferous limestone. The following record may be taken as typical of the wells sunk in the Petrolia field:

Well sunk near the Imperial refinery, Petrolia, Ontario.

Character of beds.	Feet.	Formation.
Surface	104	Hamilton.
Limestone (upper lime)	40	
Shale (upper soapstone)	130	
Limestone (middle lime)	15	
Shale (lower soapstone)	43	
Limestone (lower lime)	68	
Limestone, soft	40	Corniferous.
Limestone, gray	25	

Wells have been sunk deeper, in the expectation of finding oil; in all cases, however, without success.

At Oil Springs the petroleum is found at some 370 feet from the surface, or about 60 feet below the summit of the Corniferous limestone. The following record is given by Mr. Brumell as illustrating the geology of the wells in the Oil Springs pools:

Record of a well sunk in the Oil Springs pools, Ontario.

Character of beds.	Feet.	Formation.
EAST SIDE OF FIELD.		
Surface	60	Hamilton.
Limestone (upper lime)	35	
Shale (upper soapstone)	101	
Limestone (middle lime)	27	
Shale (lower soapstone)	17	
Limestone (lower lime)	130	
WEST SIDE OF FIELD.		
Surface	80	Hamilton.
Shale (upper soapstone)	116	
Limestone (middle lime)	27	
Shale (lower soapstone)	17	
Limestone (lower lime)	130	

In a very interesting paper read by Prof. Charles F. Mabery before the Franklin Institute on the composition of the sulphur petroleums of Ohio and Canada, he points out that while in a general way the petroleum deposits in Canada are similar to those of the Lima, Ohio, field, yet, unlike the oil-bearing limestone in Ohio, the deposits at Petrolia and Oil Springs, in Canada, occupy, at comparatively shallow depths, the Corniferous limestone far above the Trenton formation, which lies at depths of more than 2,000 feet. He states also that "the two fields in Canada are contained in parallel anticlinals approximately 10 miles apart and extending in a direction at right angles to the northeasterly direction of the oil fields in Ohio. The oil territory in Petrolia is about 5 miles in its greatest length and somewhat less than 2 miles in its average width, with an area of 8 square miles. The area of productive territory at Oil Springs is 2 square miles." It will be noted that Professor Mabery's statement of the extent of the Petrolia field differs from that given above, which is the estimate of the Canadian geological survey, made some years since.

Professor Mabery continues: "In the early days some of the Canadian wells yielded an enormous flow of oil, but at present the pressure is slight and no oil is obtained without pumping." The average depth of the wells, of which at present there are some 8,000—6,000 of these being in Petrolia—is 465 feet. At Oil Springs the average depth is but 380 feet. The yield from individual wells is very small, the total production of these 8,000 wells being only something like a million barrels a year, but this small yield is offset by their long life. Some wells now in operation have produced oil steadily for thirty years. The petroleum is a dark brown, heavy oil, ranging in gravity from 31.5° to 35° B., the heavier oil being obtained in the Petrolia field, while the lighter is produced at Oil Springs and from the small pool in Euphemia Township. The wells in the latter township are small producers, the largest flow from any well not exceeding a barrel a day. The field is also circumscribed in extent.

The oil from Canada belongs to what is known as the sulphur petroleums. Regarding the distillates from the Canadian oil Professor Mabery, whose paper has been referred to, states, treating in general of petroleum:

In a general examination of these petroleums with reference to specific gravity, bromine absorption, proportions that distill at different temperatures, specific gravities of the distillates, and their bromine absorption, it is found that the Ohio oil stands between the Pennsylvania and Caucasus oils, and the Canadian oil is between the Ohio and Caucasus. Below 120° 19.7 per cent of Pennsylvania oil distills, 0.5 per cent of Caucasus; below 110° 9.75 per cent of Ohio oil, and below 115° 2.75 per cent of Canadian oil. Above 320° the residue in Pennsylvania oil is equivalent to 35.54 per cent, and in Caucasus oil to 53 per cent. Above 350° the residue of Ohio oil is 43 per cent, and of Canadian oil 70.75 per cent.

The crude Ohio and Canadian oils are so unstable that decomposition can only be prevented by distillation in vacuo with the exclusion of the air and a corresponding reduction in temperature. The distillates were purified and the determinations made in the same manner as Ohio oil was treated, it being found that the same butanes, pentanes, hexanes, heptanes, octanes, and the same nonane were recognized. The same representatives of the aromatic series, both of the series C_nH_{2n-6} and of the series C_nH_{2n}, were found. But benzole and its homologues were found to be present in much smaller quantity in the Canadian than in the Ohio oil.

Canadian oil seems to be refined in the usual manner, except that certain chemicals are used to deprive it of its sulphur odor. Much gas is evolved in distillation, which is used in heating the retorts. In crude stills gasoline and burning oil are run off up to 37° B. and the residue is then transferred to the tar still, from which heavy oils are run off up to 30.5° B. and the residue is coked. The last distillate is again distilled and the residue coked as before. The character of the refined oil depends largely upon the skill of the operator. With careful treatment and the use of an alkaline solution of plumbic oxide a burning oil of good quality is prepared. Professor Mabery states:

From Petrolia crude 2 per cent of naphtha is obtained and from Oil Springs crude 7 per cent. The yield of burning oil from either source is 40 per cent, the quantity of tar 30 per cent of the crude oil, from which the yield of heavy oil is 20 per cent, with a residue of coke equivalent to 10 per cent of the original crude.

Returns of the refiners made to the Canadian Government show the amount of the various products which the crude yields. The following is the results of refining in 1889. The other results can be obtained by calculation from the reports given elsewhere as to the total results of refining in the several years:

Percentage of products obtained in refining Canadian petroleum in 1889.

Products.	Per cent.
Illuminating oils	38.7
Benzine and naphtha	1.6
Paraffin and other oils (including gas, paraffin black, and other lubricating oils, and paraffin wax)	25.3
Waste (including coke, tar, and heavy residuum)	34.4
Total	100.00

The statistics of the production of petroleum in the Petrolia, Ontario, oil field are not at all satisfactory. In the following table will be found a statement of the shipments of petroleum from Petrolia, Ontario, for each month for the years 1893 and 1894. These statements are by no means satisfactory, part of the oil being shipped as crude and part as refined. The refined shipped is reduced to crude or its crude equivalent and added to the amount of oil shipped as crude, giving the total crude equivalent. The shipments are given in barrels of 35 imperial gallons, this being practically the equivalent of the American barrel of 42 Winchester gallons. It will be noted that this statement of shipments shows a production in excess of the statement compiled by the geological survey department of Canada, and would indicate that these reports of shipments are in excess of the actual production from year to year, probably the result of duplications:

Shipments of crude petroleum and refined petroleum reduced to crude equivalent from Canada in 1893 and 1894.

Months.	1893.			1894.		
	Crude.	Refined.	Crude equivalent.	Crude.	Refined.	Crude equivalent.
January	23, 671	28, 834	96, 756	25, 575	32, 605	107, 087
February	22, 905	19, 809	77, 070	20, 295	22, 355	76, 182
March	17, 891	22, 405	73, 903	16, 935	17, 490	60, 660
April	16, 131	16, 532	57, 460	15, 125	19, 335	63, 463
May	19, 031	19, 476	67, 721	18, 756	19, 445	67, 369
June	16, 023	16, 793	58, 025	15, 655	16, 870	57, 830
July	16, 945	19, 510	67, 520	20, 536	19, 620	69, 586
August	17, 511	26, 860	84, 661	18, 420	27, 170	86, 345
September	19, 109	35, 967	109, 027	18, 135	36, 735	109, 973
October	23, 407	49, 266	146, 573	26, 575	51, 835	156, 162
November	26, 455	39, 766	125, 870	23, 675	39, 535	122, 513
December	25, 685	30, 354	100, 570	23, 375	27, 640	92, 475
Total	244, 763	325, 572	1, 066, 155	243, 057	330, 635	1, 069, 645

From Mr. James Kerr, secretary of the Petrolia Oil Exchange, we have the following statement regarding the shipments and production of oil in 1894. After stating that it is not easy to get exact facts regarding the stocks, production, and shipments of crude oil on account of trade interests and jealousies, he says the railroad shipments for the year 1894, in barrels of 35 gallons each, by months, are as follows:

Shipments of crude petroleum from the Petrolia, Ontario, oil field in 1894.

Months.	Barrels of 35 imperial gallons each.
January	101, 570
February	76, 183
March	60, 661
April	73, 463
May	67, 369
June	57, 830
July	69, 586
August	86, 345
September	109, 973
October	156, 163
November	122, 513
December	97, 170
Total	1, 078, 826
Shipped by pipe line	10, 000
Total	1, 088, 826
Stocks in tanks—	
January 1, 1894	77, 000
December 31, 1894	40, 000
Decrease in stocks	37, 000
Approximate production	1, 051, 826

The great decrease in sales on the exchange for the last two years will be noted. This does not imply a decrease of actual business in the oil field, but simply that the petroleum went direct to the refiners instead of being sold through the brokers on exchange. The exchange prices, however, show the value of the petroleum in the markets.

Mr. Kerr states:

I believe the foregoing estimate is too great by at least 10 per cent on the shipments which, are estimated from refined and converted into crude equivalent. By products are liable to be duplicated in such a calculation. I would therefore estimate that the total net production in 1894 would be as follows, allowing 10 per cent reduction on shipments:

Estimated production of petroleum in Canada in 1894, by Mr. James Kerr.

	Barrels.
Shipped by road	970, 943
Shipped by pipe line	10, 000
Total	980, 943
Less reduction of stocks	37, 000
Making the production	943, 943

In the following table is given a statement of the production of petroleum in Canada in the years 1886 to 1894, and the value of the same. These figures, it is stated, are calculated from the official inspection returns, and the values are computed at the average yearly price per barrel of 35 imperial gallons.

Production and value of petroleum in Canada from 1886 to 1894.

[Barrels of 35 imperial gallons.]

Years.	Production.	Value.
1886	486, 441	$437, 797
1887	763, 933	595, 868
1888	733, 564	755, 571
1889	639, 991	612, 101
1890	765, 029	902, 734
1891	755, 298	1, 004, 596
1892	779, 753	982, 489
1893	798, 406	834, 344
1894	829, 104	835, 322

The average closing prices of petroleum for each year from 1885 to 1894 at the Petrolia Oil Exchange, together with the total sales for the year on this exchange, are as follows:

Average price and sales of crude petroleum in the Petrolia Oil Exchange from 1885 to 1894.

Years.	Price.	Sales.
1885	$0. 82$\frac{1}{4}$	871, 500
1886	. 86$\frac{3}{4}$	782, 570
1887	. 78	406, 203
1888	1. 02$\frac{3}{4}$	516, 007
1889	. 92$\frac{3}{4}$	400, 932
1890	1. 18	394, 924
1891	1. 33$\frac{3}{4}$	377, 453
1892	1. 26$\frac{1}{4}$	165, 315
1893	1. 09$\frac{1}{2}$	20, 941
1894	1. 00$\frac{3}{4}$	32, 348

In the following table will be found a statement of the average closing prices for crude oil on the Petrolia Oil Exchange for each month in 1892, 1893, and 1894:

Average closing price of crude petroleum on the Petrolia Oil Exchange in 1892, 1893, and 1894, by months.

Months.	1892.	1893.	1894.
January	\$1.29¼	\$1.18¼	\$1.01¼
February	1.29	1.18¾	1.01
March	1.27¾	1.19	1.01
April	1.26¼	1.19	.99½
May	1.25¾	1.07	.92
June	1.27½	1.07	.92¾
July	1.26¾	1.06	.94
August	1.26	1.05	.96
September	1.26	1.04½	.98
October	1.26¾	1.04	1.06
November	1.25	1.04	1.12¼
December	1.18½	1.02	1.13½
Average	1.26¼	1.09½	1.00¾

The stocks of petroleum on hand in warehouse tanks were as follows: December 31, 1893, 77,000 gallons; December 31, 1894, 40,000 gallons.

As a matter of interest the following statement is included of the operations of the refineries of Canada for the years 1890 to 1894:

Production of Canadian oil refineries in 1890 to 1894.

[Imperial gallons.]

Products.	1890.		1891.	
	Quantity.	Value.	Quantity.	Value.
Illuminating oils ....gallons..	11,129,277	\$1,264,677	10,427,040	\$1,170,241
Benzine and naphtha ....do....	636,247	37,026	603,971	36,790
Paraffine oils ....do....	446,888	64,713	622,287	75,772
Gas and fuel oils ....do....	4,246,447	84,752	3,373,720	89,267
Lubricating oils and tar ....do....	2,877,388	130,349	2,500,000	101,752
Paraffine wax ....pounds..	913,730	56,903	741,611	60,687
Total	....	1,638,420	....	1,534,509

Products.	1892.		1893.		1894.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Illuminating oils..galls..	10,806,806	\$1,176,720	11,100,810	\$1,073,738	11,289,741	\$1,003,973
Benzine and naphtha, gallons	793,263	60,130	721,192	54,760	645,031	54,515
Paraffine oils...gallons..	1,051,163	127,351	1,243,924	116,233	1,282,749	118,053
Gas and fuel oils...do....	6,343,589	202,047	7,559,489	217,740	7,323,374	197,193
Lubricating oils and tar, gallons	3,177,853	133,336	1,876,653	92,616	1,801,174	74,309
Paraffine wax..pounds..	876,570	82,781	1,659,167	120,697	1,950,172	119,091
Total	....	1,782,365	....	1,675,784	....	1,567,134

At the refineries producing the above amount of oil in 1894, 486 persons were employed, the total wages paid being \$279,930.

The following table shows the amount of Canadian oils and naphtha inspected, together with the amount of crude that is assumed as the equivalent of the refined oils and the ratio of crude to refined:

Canadian oils and naphtha inspected, and corresponding quantities of crude oil.

Fiscal years.	Refined oils inspected.	Crude equivalent calculated.	Ratio of crude to refined.
	Gallons.	*Gallons.*	
1881	6,406,783	12,813,566	100:50
1882	5,910,787	13,134,998	100:45
1883	6,970,550	15,490,111	100:45
1884	7,656,011	19,140,027	100:40
1885	7,661,617	19,154,042	100:40
1886	8,149,472	21,445,979	100:38
1887	8,243,962	21,694,637	100:38
1888	9,545,895	25,120,776	100:38
1889	9,462,834	24,902,195	100:38
1890	10,121,210	26,634,763	100:38
1891	10,270,107	27,026,597	100:38
1892	10,370,707	27,291,334	100:38
1893	10,618,804	27,944,221	100:38
1894	11,027,082	29,018,637	100:38

Petroleum has been discovered in some of the other provinces of Canada, but at present it is not produced in commercial amounts. It is reported, however, that near Parsons Pond, in Newfoundland, wells are being drilled, with every prospect of opening up a large and productive petroleum territory.

PERU.

The petroleum fields of Peru have recently assumed considerable importance. The oil is of good grade, and the refined is displacing that from the United States in many of the Pacific Coast markets. Recently some of the most extensive producers of southern California have entered the Peruvian field, and the oil from this district is being sent in quantities to California for fuel.

While petroleum is found in a number of localities in Peru, the most important deposits, and the ones so far explored to any extent, are in the Department of Piura. The area of the field is estimated at some 12,350 square miles. These fields are in a sandy belt along the seashore, a well having been sunk at Negritos, near Paita, only some 50 meters (161 feet) from the shore, which threw up a stream of oil 25 meters high.

A description of the Peruvian fields, by Mr. J. C. Tweddle, jr., was given on page 516 of the report last year.

Refineries have been established at Zorritos, Heath, and Talara. Connected with the Zorritos refineries there are 30 wells, with the Talara 14 wells, making a total of 44 wells connected with these two refineries out of a total of 49 for the entire region. These are the figures obtained early in 1895, since which we have had no additional information. The total production of these 49 wells in 1892, according to the statement of the Peruvian consul in France, was 2,113,438 gallons. The refineries above noted are built according to the latest plans and are operated on the most approved methods. At Talara there is a still with a capacity of 34,342 gallons. This refinery also has large tanks, and a steamboat to transport its product with railways, telegraphs, telephones, electric lights, etc.

As near as can be ascertained, the production of oil in 1890 in Peru was some 350,000 barrels. In 1892, as stated above, the product was 2,113,438 gallons, which would indicate a production of only 50,320 barrels, which must, however, be an error, or refer only to the production of a limited area and not to the whole field.

RUSSIA.

Though crude petroleum, or "naphtha," as it is termed in Russia, has been found in quantities in a number of localities in that country, chiefly in the Caucasian region, it is only near Baku, on the Caspian Sea, that it is produced in large amounts, and it is only the oil from this district that at present comes into competition, outside of Russia, with oil from the United States. More than 90 per cent of all the oil produced in Russia and all the exports are from Baku.

EXTENT OF THE BAKU OIL FIELDS.

The Baku oil fields, so called from the chief city of the district, though no oil is found at Baku, are on the Apsheron Peninsula, a bold promontory that thrusts itself out some 50 miles into the Caspian Sea, near its southwestern shores. This peninsula, which is some 20 miles wide, is the eastern terminus of the Caucasus Mountains, which here pass under the waters of the Caspian. The chief producing localities in this field are two, one near and in the clustered villages of Balakhany, Saboontchy, and Romany, some 10 miles northeast of Baku, and the second at Bibi-Eibat, some 6 miles southeast of Baku. The oil-producing territory in the first field, which has been well defined, does not exceed 1,496 acres (544 dessiatines), while the Bibi-Eibat district is less than 300 acres. From this small area of less than 1,800 acres all of the enormous production of the Baku field has been derived.

CHARACTER OF RUSSIAN PETROLEUM.

From the report on the Mineral Industries of Russia, prepared for the World's Columbian Exposition, the following statement of the production of Russian oil, when distilled in the usual manner, without cracking, is given:

Products of Russian crude petroleum.

Products.	Per cent.
Light oils	5 to 7
Kerosene (illuminating oils)	27 to 30
Solar (heavy illuminating oil)	13 to 15
Lubricating oils:	
Spindle	7
Machine	18 to 25
Cylinder	2 to 5
Vaseline	1

When the petroleum is refined for the purpose of producing illuminating oil the following is said to be the result:

Products of Russian petroleum when refined for illuminating oil.

Products.	Per cent.
Kerosene	35.00
Residuum	55.00
Light oils and waste	10.00
Total	100.00

PRODUCTION.

The data regarding the production of crude petroleum in Russia is only approximately correct. Statements made by different authorities differ considerably. I have taken the figures of the Council of the Congress of Russian Petroleum Producers, which are given in millions of poods. In reducing these to barrels I have assumed that the average gravity of Russian oil is 0.875, and that an American barrel of 42 gallons contains 10.18 poods. Two distinct statements of production of Russian crude petroleum are given, one known as "total production," which includes not only the crude collected and refined or sold as fuel oil, but also an estimate of the oil wasted or not collected, as well as that used for fuel for pumping the wells. The second statement shows "profitable production," that is, the amount of crude oil put into tanks or reservoirs.

The total production of crude petroleum on the Apsheron Peninsula and the shipments of the chief petroleum products from Baku from 1880 to 1894 have been as follows:

"Total production" of crude petroleum on the Apsheron Peninsula and shipments of petroleum products from Baku from 1880 to 1894.

Years.	Production.	Shipments from Baku.				
		Illuminating.	Lubricating.	Residuum.	Crude oil.	Total.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
1880	2,455,000	785,000	....	697,000		1,482,000
1881	3,929,000	1,257,000	....	913,000		2,170,000
1882	4,911,000	1,326,000	30,000	1,768,000		3,124,000
1883	5,893,000	1,473,000	112,000	1,846,000		3,431,000
1884	8,841,000	2,161,000	147,000	2,868,000	....	5,176,000
1885	11,394,000	2,946,000	157,000	3,330,000		6,433,000
1886	14,734,000	3,438,000	167,000	3,555,000		7,160,000
1887	16,208,000	4,322,000	226,000	4,076,000		8,624,000
1888	18,860,000	4,911,000	255,000	5,746,000		10,912,000
1889	20,137,000	6,002,000	324,000	8,703,000	413,000	15,442,000
1890	23,477,000	6,611,000	452,000	9,538,000	638,500	17,239,500
1891	28,290,000	7,269,000	501,000	10,157,000	1,139,500	19,066,500
1892	29,273,000	7,730,000	551,000	11,473,000	1,149,300	20,903,300
1893	33,104,126	8,438,000	570,000	14,096,267	1,198,400	24,302,667
1894	30,383,104	6,994,106	528,684	19,017,682	1,611,000	28,251,472

This table gives the total production and the total shipments from Baku, both to Russian ports and to other countries, and may be regarded as showing the total production of crude and refined oils and residuum in the district in the years made.

The "profitable production" for the last six years is shown in the following table:

"Profitable production" of crude petroleum in the Apsheron Peninsula from 1889 to 1894.

[Barrels of 42 gallons.]

Years.	Production.
1889	18, 889, 000
1890	22, 229, 000
1891	26, 974, 000
1892	28, 143, 000
1893	31, 894, 000
1894	29, 223, 967

The divisions of this profitable production among the four subfields on the Apsheron peninsula are as follows:

"Profitable production" of the several fields of the Apsheron Peninsula from 1889 to 1894.

Fields.	Production in barrels.					
	1889.	1890.	1891.	1892.	1893.	1894.
Balakhany	6, 768, 000	6, 218, 000	7, 289, 000	5, 648, 000	5, 677, 000	5, 795, 677
Saboontchy	10, 373, 000	14, 096, 000	16, 060, 000	15, 196, 000	14, 371, 000	14, 047, 151
Romany	....	147, 000	1, 277, 000	4, 027, 000	7, 180, 000	6, 060, 904
Bibi-Eibat	1, 748, 000	1, 768, 000	2, 348, 000	3, 272, 000	4, 666, 000	3, 320, 235
Total	18, 889, 000	22, 229, 000	26, 974, 000	28, 143, 000	31, 894, 000	29, 223, 967

WELLS AND THEIR PRODUCTION.

There are two classes of so-called wells in the Baku district, "pumping" and "flowing," or wells worked by "bucketing," and those that flow. In the former, pumping is by means of large, deep buckets or pumps, with valves which are operated by windlass or steam and which bring to the surface at a "stroke" as much as a barrel of crude oil and water. This empties itself into a gutter and the oil, after separation from the water, is conducted into reservoirs. A shift of workmen at these wells is never less than three.

The flowing wells are the well-known Baku fountains, some of which have given and continue to give some hundred thousand poods a day, say 10,000 barrels.

The production of crude petroleum from pumping and flowing wells in the last six years is as follows:

Production of crude oil from pumping and flowing wells in Russia from 1889 to 1894.

Years.	Pumping.	Flowing.
	Barrels.	*Barrels.*
1889	14, 705, 000	4, 184, 000
1890	17, 347, 000	4, 882, 000
1891	23, 123, 000	3, 851, 000
1892	20, 707, 000	7, 436, 000
1893	21, 168, 000	10, 726, 000
1894	23, 153, 240	6, 070, 727

The total number of wells that produced crude petroleum during any part of the years named was as follows:

Number of producing wells on the Apsheron Peninsula from 1889 to 1894.

Years.	Wells.
1889	278
1890	356
1891	458
1892	448
1893	458
1894	532

The statement of the number of producing wells for each of the months in 1893 and 1894 is as follows:

Number of producing wells in Russia in 1893 and 1894, by months.

Months.	Number of wells.	
	1893.	1894.
January	322	332
February	326	337
March	332	347
April	323	355
May	325	366
June	310	369
July	307	373
August	294	400
September	298	413
October	310	420
November	316	425
December	322	440
Total	458	532

It should be understood that these figures represent the number of wells in operation during any one month, the total representing the total number of wells that were operated at any time during the year.

The number of wells drilling during each month of 1892, 1893, and 1894, and the number completed during year were as follows:

Number of wells drilling and completed in Russia in 1892, 1893, and 1894, by months.

Months.	1892.	1893.	1894.
January	141	62	59
February	131	57	60
March	127	69	62
April	117	64	72
May	94	69	81
June	84	73	79
July	44	69	75
August	45	64	73
September	52	58	73
October	45	59	69
November	50	58	71
December	58	59	75
Total completed	200	175	204

In the following table is given a statement of the deep wells drilled in each year from 1890 to 1894, together with the total depth, in sagenes of 7 feet, that the wells were drilled, and the average depth of the wells in feet:

Total number of wells and deep wells drilled in Russia from 1890 to 1894, with length in sagenes and average depth in feet.

Years.	Total number of wells.	Number of deep wells.	Total length in sagenes.	Average depth in feet.
1890	231	50	14, 810	449
1891	292	87	19, 980	479
1892	200	111	11, 670	408
1893	175	102	10, 984	439
1894	204	101	12, 859	441

REFINING STATEMENT.

The latest complete statement regarding refining petroleum in Russia is as follows:

Statement of the number of petroleum refineries, their products, etc., in Russia in 1890 and 1891.

At the Apsheron Peninsula.	1890.	1891.
Total number of works	149	135
Number of works active	103	100
Number of works inactive	46	35
Amount of crude treated at these works in barrels	21, 611, 000	24, 263, 000
Amount of naphtha obtained at these works in barrels	50, 000	50, 000
Amount of kerosene of different kinds, barrels	6, 876, 000	7, 760, 000
Amount of lubricating oil obtained	541, 000	609, 000
Total production of distillation products	7, 467, 000	8, 419, 000
Percentage of distillation products obtained	34. 5	34. 7

Price of Russian refined oil in bulk at Batoum from 1890 to 1894, by months.

[Cents per gallon.]

Months.	1890.	1891.	1892.	1893.	1894.
January	5. 14	3. 92	2. 97	2. 95	....
February	5. 03	3. 53	2. 94	2. 84	....
March	4. 86	3. 53	3. 13	2. 95	....
April	4. 89	3. 44	2. 80	....	....
May	4. 57	3. 28	2. 62	....	....
June	4. 55	3. 20	2. 46	2. 63	....
July	4. 66	2. 88	2. 47	2. 71	....
August	4. 77	2. 67	2. 50	2. 63	....
September	5. 21	2. 63	2. 77	2. 66	....
October	4. 73	2. 73	2. 71	2. 63	....
November	4. 55	2. 92	2. 65	2. 63	....
December	4. 29	....	2. 85	2. 68	....

Though, as has been stated heretofore, almost all of the petroleum produced in Russia is from the Baku field, there are a number of other fields which promise largely in the way of production.

GERMANY.

Petroleum occurs in Germany only in small quantities. The largest production is in Alsace; smaller quantities are produced in the province of Hanover, in Prussia, in Hildesheim (Peine), and Luneberge.

Petroleum is quite extensively distributed in the last-named districts from Holstein, on the coast of the East Sea, to the south of Hanover, but it occurs in such small quantities that it does not pay to work it. Asphalt occurs in connection with the petroleum, and is mined. The petroleum is of a heavy gravity and is used chiefly for lubricating purposes.

The following statement gives the amount of petroleum produced in Germany from 1890 to 1893 inclusive, the figures being in metric tons:

Production of petroleum in Germany from 1890 to 1893 inclusive.

Years.	Tons.
1890	15,226
1891	15,315
1892	14,527
1893	13,974

Of the petroleum produced in 1891, 2,498 tons were Hildesheim and Luneberge and 12,817 tons from Alsace.

Just how many gallons or barrels there is to a ton of German petroleum would be difficult to state. The only statement we have seen recently as to the gravity of this oil was that the Hildesheim and Luneberge oil was about 0.888 specific gravity. This equals about 28° B., and would be 7.38 pounds to the gallon. On this basis the production of petroleum in Germany in 1890 would be 4,548,406 gallons, 108,295 barrels of 42 gallons each. On this basis of 7.38 pounds to a gallon the production of Germany in the four years named above would be as follows:

Production of petroleum in Germany from 1890 to 1893 inclusive, in barrels of 42 gallons each.

Years.	Production.
1890	108,295
1891	108,927
1892	103,323
1893	99,395

THE OCCURRENCE, MODE OF WORKING, AND ORIGIN OF PETROLEUM IN LOWER ALSACE.

Mr. L. van Werveke states that in the Lower Alsace district petroleum has been proved to exist by borings at various levels to a depth of over 1,000 feet. The winning of petroleum in the district is an industry of great antiquity, and was already referred to as ancient by a writer of the fifteenth century. It used to be carried on by mining, but is now worked by borings in the usual manner. The production of crude oil in Lower Alsace in 1894 was 15,632 metric tons; the refined petroleum produced amounts to 4,000 metric tons a year, or 1⅓ per cent of the consumption of Germany. The author quotes the different opinions expressed by various authorities regarding the origin of petroleum, and adduces evidence in support of the view held by Andreae and Schumacher that the original petroleum-bearing stratum belongs to the Tertiary, for both in Upper and Lower Alsace the oil occurs at a particular horizon; that it was a lagoon and delta formation, and that with the decomposing plants, which have yielded the brown coals as well as bitumen and oil, were mingled animal remains from which the nitrogen in the oil is derived.

ITALY.

There are in Italy three petroliferous districts, one between Voghera and Imola, in Emilia, another in the valley of Pescara, and the third in the Liri Valley, near San Giovanni, Incarico. A fourth basin has lately been discovered at Vallega, near Piacenza, where there are about 40 wells in active operation. Besides these sources of petroleum, naphtha is distilled from the asphaltic or bituminous shales, but this product is used for lubrication and carburizing gas. Emilia supplies by far the best petroleum. It is stated to be opal colored and to yield 50 per cent of illuminants. The oil is sold retail for 65 centesimi per liter (60 cents per gallon), of which sum the Government duty amounts to 50 centesimi, while the cost of carriage is 10 centesimi, leaving only 5 centesimi for profit. The total product in 1893 was 2,652 tons, say 18,764 barrels. The principal refinery is in Parma.

Production of petroleum in Italy from 1887 to 1894.

[Barrels.]

Years.	Production.
1887	1,456
1888	1,218
1889	1,239
1890	2,919
1891	8,085
1892	....
1893	18,764
1894	....

GREAT BRITAIN.

The Mineral Statistics of the United Kingdom give the production of petroleum from 1886 to 1893 as follows:

Production of petroleum in Derbyshire, England, from 1886 to 1893.

Years.	Tons.
1886	43
1887	66
1888	35
1889	30
1890	35
1891	100
1892	218
1893	260

The occurrence of petroleum in Great Britain was briefly described on page 527 of the report of 1893.

Prior to 1894 all of the production in England noted in the above table was from North Staffordshire. In 1893, however, crude petroleum was discovered on the Ashwick estate in Somersetshire. This deposit has been examined by Mr. Boverton Redwood, the well-known petroleum expert, and Mr. Topley, a Government geologist.

SCOTCH SHALE OIL.

While the shale oil of Scotland is not petroleum in the sense in which we have used the term in this report, it being a product distilled from shale instead of crude petroleum found naturally as such, still the Scotch shale oil industry has had such an important influence on the petroleum industry of the world that some description of it, with the amount of shale oil produced, is an important addendum to any statement regarding crude petroleum, and should be given here. The bituminous shale from which the so-called Scotch shale oil is extracted by a process of distillation is found chiefly in Edinboroughshire and Linlithgowshire from seams in the calciferous sandstone at the base of the Carboniferous rocks. This industry began and was an important one before the discovery of petroleum in the United States. Up to 1883, the time when Russian oil made its appearance in the English market, the companies engaged in the mining of the shale and the production of the oil had been exceedingly prosperous. In 1883 the Scotch works were turning out some 39,000,000 gallons of crude oil from 1,232,000 tons of shale. This crude yielded 15,900 gallons of illuminating oil, 24,500 gallons of lubricating oil, and 15,320 tons of paraffin. At that time these refineries were paying 25 per cent dividends, and their shares, with a par value of $7,500,000, were quoted at $12,500,000. Since 1883, however, the largely increased imports of oil into the United Kingdom has seriously interfered with the prosperity of these companies. In 1883 these imports were 70,467,180 gallons, which was not quite one-half of the Scotch output. In 1893 these imports had increased to 181,000,000 gallons, or more than three times the output of Scotch oil in 1893. The production of Scotch shale oil at present can be put at 52,000,000 gallons of crude oil from 2,000,000 tons of shale. Twenty years ago Scotch shale illuminating oil sold at 34.2 cents a gallon. It now realizes but 10½ cents a gallon. While improved processes and great economies have been introduced into the manufacture of shale oil—indeed it has only been by these improvements and economies that this industry has maintained its existence—yet even with these improvements it is far from being the profitable industry it was a few years ago. According to the report made by Mons. M. G. Chesneau to the French Government, published recently in the Annales des Mines, the value of the total products from a ton of shale was $3.29, but the process of extraction cost $3.04. This investigation of M. Chesneau was undertaken with the view of ascertaining the prospects of the French shale oil industry. The chief works treating shale are at Autun, in France, and Buxieres, which treat about 210,000 tons of shale a year, producing not over 5,000,000 gallons of oil and selling it at a profit of about a cent a gallon.

The quantity of oil shale produced in Scotland in the last five years and the value of the same have been as follows:

Production and value of oil shale in Scotland, from 1890 to 1893.

Years.	Production.	Value.
	Tons.	
1890	2, 212, 250	£608, 369
1891	2, 361, 119	707, 177
1892	?, 089, 937	522, 484
1893	1, 956, 520	489, 130

BURMAH.

Probably the oldest petroleum fields in the world are those of Yenangyoung (earth oil) Creek, a small tributary of the Irawady River. For an unknown period the whole of Burmah and portions of India have been supplied with illuminating oil from this source, particularly those regions which are reached by the Irawady and its tributaries. The wells were described on page 527 of the last report.

The production of petroleum in India from 1889 to 1891 was as follows:

Production of petroleum in India from 1889 to 1892.

Years.	Production.
	Gallons.
1889	3, 298, 737
1890	4, 931, 093
1891	6, 136, 495
1892	8, 725. 331

The petroleum industry in Burmah appears to be an increasing one. The quantity produced at Arrakan rose from 219,633 gallons in 1892 to 308,091 gallons in 1893, and in Pakokku and Magive it rose from 3,753,581 gallons in 1892 to 8,390,333 gallons in 1893, making the production in 1892 3,973,214 gallons and in 1893 8,698,424 gallons.

JAPAN.

Mr. Jinzoo Adachi furnished a very clear statement relative to the occurrence of petroleum in Japan, which was published in Mineral Resources, 1888, page 474. As the petroleum regions of Japan are assuming some importance, Mr. Adachi's statement is here supplemented with a recent statement by Mr. K. Wakashina, geologist of the geological survey of Japan, regarding the situation in connection with petroleum in the early part of 1894:

The use of petroleum is yearly increasing in Japan, but the limited nature of its field and the primitive style of its working supplies only a small proportion of the demand for oil. This is chiefly supplied from American and Russian sources. The yearly amounts of importation from these two sources were:

Imports of petroleum oils into Japan.

Years.	Quantity.	Declared Value.
	Gallons.	*Yen.*
1891	40, 482, 160	4, 535, 720
1890	42, 663, 580	4, 950, 256
1889	36, 998, 843	4, 587, 135
1888	28, 507, 767	3, 519, 255
1887	21, 058, 865	1, 871, 428

The native production for the year 1890 was as follows:

Native product of petroleum in Japan.

Provinces.	Prefectures.	Quantity.
		Gallons.
Ishikari	Hokkaido	1, 213
Ugo	Akita	11, 400
Do	Yamagata	7, 341
Echigo	Niigata	1, 858. 950
Shinano	Nagano	45, 670
Totomi	Shizuoka	92, 542
		2, 017, 116

Since the recent introduction of drilling machines into Echigo the production has greatly increased. The utmost depth attained by the old method of working did not exceed 600 or 700 feet, while by the new method of boring there are wells drilled more than 1,000 feet in depth. Present indications are that the production of petroleum by the application of the new methods of boring may become a useful industry in the future.

The occurrence of petroleum in Japan is confined to the rocks of the Tertiary system, the strata being usually composed of alternations of sandstone and shale, both being more or less tenacious, and sometimes having associate conglomerate. These rocks probably belong to the Pliocene series and perhaps extend to the upper portion of the Miocene. In the rocks of other geological ages not even a trace of its occurrence is recorded. Nay, even in the Tertiary system, one of the widely distributed rocks in Japan, the petroleum-bearing region appears to be confined to certain regions, among which Ishikari, Ugo, Echigo, Shinano, and Totomi are especially well known. It is worth while to notice that excepting Totomi the petroleum localities hitherto known are all in the inner zone of north Japan—characterized by the unusual development of the Tertiary or volcanic rocks—occurring in the Tertiary rocks not far from the coast line of the Japan Sea.

Drilling by the recently introduced method of rope boring has been tried only in one or two localities of Echigo, but it ought to be experimented with in other regions in future. It should be said, however, that the hope of meeting large and rich fields seems to be improbable in this country. The development of the petroleum fields in Japan shows that they are not only variable in extent but in production as well as in thickness of strata. The oil is of different density in different zones of the Tertiary system, in which the strata is of undetermined thickness and indefinite distribution.

ISHIKARI.

Sporadic traces of petroleum are found in different localities of Hokkaido; among others, Atsita, Niikup, and Kutaru are said to be promising. The locality that seems to be most important is the field of Atsita, situated a little northeast of Ishikari, near the sea coast. Special surveys were made on its different oil-yielding localities, the result of which appears in the Report of the Survey of Useful Deposits in Hokkaido (published in Japanese, with many explanatory maps, by the department of geological survey of Hokkaido, in Hokkaidochio, 1891). Referring to this report, in this region the utmost thickness of measured oil-bearing strata reaches 650 feet. Over its wide area some wells were sunk in each mining claim. In Shunbetsu, east-northeast 4.5 ri (1 ri=3,927.27 meters) from Ishikari, in the town of Shatsukarigana, the Tertiary strata are composed of dark grayish shale or sandy shale, sometimes inclosing nodules of marl, with general strike trending northwest and dropping southwest, with angle of nearly 20°; here out of ten wells drilled to a depth varying from 6 to 200 feet only three wells now yield petroleum, one producing daily 23 sho (1 sho=0.397 gallon), the other two producing daily 2 to 3 sho. In Shatsukari, nearly 5,000 feet southwest of Shunbetsu, one well sunk in 1881 reached nearly 300 feet depth, but after almost four years working it has been abandoned by reason of the presence of water. During its life it yielded about 125 koku (1 koku=39.703 gallons) of oil. On the coast of Furatomari, northeast 2.5 ri from Ishikari, where the oil-bearing strata dips 11° to 37° southeast, three wells were sunk, of which one proved successful, the depth of which is a little over 500 feet, and is now producing only from 20 to 30 sho per week.

UGO.

In Ugo many outcroppings of petroleum are known in the region extending from a little north of Akita town down to the environs of Chokaisan (a volcano rising nearly 2,200 feet above sea level), the longest line of outcrop traceable extending nearly 20 ri along the seacoast. The survey of the northern half of this wide region has been finished by the geological survey of Akita section, and its result has been made public in the geological report of Akita section (by the lamented S. Miura, a geologist of the geological survey of Japan, who met a memorable death while visiting the late eruption of Azumasan in Fukushimaken). In this northern portion the petroleum-bearing Tertiary rocks consist of alternations of tufa-shale, tufa and sandstone, with general strike toward north-northeast, and repeatedly folded in dipping direction. Here outcrops are visible occasionally for a distance of above 3 ri in east and west direction. Some wells were formerly sunk, the best oil yielding daily 20 sho, but none are now working, at least satisfactorily. In the neighborhood of Abukawa petroleum occurs with asphalt.

The southern portion of the oil region of Ugo is included in the Honjio section of the geological survey, which has been surveyed also by S. Miura, but his death before completing his report makes it necessary to survey it again next summer. Here, it appears, four or five lines of outcropping can be traced, running north-northeast, but working is on a very small scale, as elsewhere.

ECHIGO.

The oil-bearing Tertiary, which is seen in Hokkaido and Ugo, occurs most widely developed in Echigo. Outcrops are widely distributed and have been known for a long period in the folded Tertiary strata of this province. Among these now most important localities are said to be Urase and Izumosaki or Amaze. Urase is situated a little east of Nagaoka town on the east side of Shonanogawa. The daily yield of wells of this place is said to reach some koku continuously. All wells are sunk by the old method, and there are two rich wells now existing, each probably of 100 feet depth. The production of Urase at present ranks first of all wells of Echigo, or, in other words, in the whole petroleum industry of Japan.

Amaze is situated by the seacoast of Izumosaki. Here, in 1890, the boring machines made by the Pierce Artisan and Oil Well Company of New York have been applied with promising result. This place is the first to apply boring to the working of petroleum in Japan. The oil-bearing stratum is composed of shale and sandstone, running in the anticlinal with axis trending Northeast. The deepest well bored through reaches above 1,000 feet, the production seemingly increasing with the depth. The utmost daily yield may reach above 100 koku, but generally the quantity diminishes to a few koku within a few days or weeks. The limit of yielding depth is not yet actually known.

Also at Gochi, by the shore of Naoyetsu, boring is said to be now in progress, but its success seems still not well known. In the environs of Gendoji, Aburaden, Matsunoyama, Seto, etc., are other working localities.

SHINANO.

The petroleum-bearing Tertiary of Echigo continues to Shinano, extending to the west of Chikumagawa, through Nagano town down to the bank of Saigawa. The geological structure of this region has been studied by me and its result is shown in the geological report of Nagano section, with special explanatory maps (in Japanese). The wells sunk formerly in this tract yielded oil, and some proved hopeful, the depth being generally from 120 to 300 feet, but probably none are working at present. The new method of boring is highly recommended to be applied in this tract.

TOTOMI.

The petroleum-bearing Tertiary of Totomi extends between Oigawa and Cape Omayesaki, facing the Pacific Ocean. Here the Tertiary strata are folded many times, with axis running parallel in a northeast direction. The working has been mainly done along anticlinal axes, of which what proved to be the most important was at Sugigaya, northwest of Sagara. In this place many hundreds of wells were sunk within a narrow valley, of which those of 300 to 400 feet depth are especially common, the daily yield from each good well being commonly from 10 to 50 sho. The deepest well sunk by the old method probably reached 750 feet or more. Some authors say that the thickness of the oil strata of this region may attain 120 meters. For particulars of this, reference may be had to the geological report of Shizuoka section, surveyed and compiled by me (in Japanese) about seven years ago.

Production of petroleum in Japan, from 1881 to 1890.

Years.	Production.	Years.	Production.
	Gallons.		*Gallons.*
1881	703,217	1886	535,210
1882	814,076	1887	350,394
1883	859,501	1888	1,429,971
1884	246,647	1889	1,960,924
1885	290,699	1890	2,017,116

JAVA.

But little information can be secured regarding the occurrence of petroleum, or indeed the occurrence of any other minerals, in the Dutch possessions in the East Indies. It is well known, however, that petroleum is found in considerable quantities in these possessions. The most important workings in Java are by the Dordtsche Petroleum Maatschappij. This company possesses drilling rights in Java over a large territory, chiefly in the residencies of Soerabaya and Rembang. The chief workings at present are in Soerabaya. The oil is obtained from a number of wells, which are drilled to depths varying from 100 to 800 feet, at a village situated 4 miles from Wonakrona. The oil comes from the Tertiary strata, and is stated to yield from 60 to 75 per cent of good merchantable illuminating oil, although the specific gravity is between 23° and 40° B. The oil is conveyed to the refinery in pipes. At Gogoa there are wells which produce both gas and oil. The deepest well in this district is 1,850 feet and produces gas at a pressure of 438 pounds to the square inch. A Chinese company is reported as having concessions to the amount of 438 acres. The wells of this company vary from 75 to 350 feet in depth. Quite a number of wells are also drilled in other portions of Java.

As stated above, it is exceedingly difficult to secure information regarding mineral production in Java. In a letter dated June, 1894, the Dordtsche Petroleum Maatschappij states that their production at that time was about 38,000 cases of refined oil per month; that they had two refineries, one in Soerabaya and the other in Rembang. It is also stated in the letter that not only is refined oil made at Soerabaya, but refined lubricating oil was produced from the residuum that seems to be perfectly free from paraffin, and the gasoline produced is used quite extensively for street lamps, while the residuum is used as fuel. In a letter from this company dated June, 1895, it is stated that a new refinery was opened by them in October, 1894, in the residency of Rembang, which is said to be very promising territory. The production there in 1894 was only 22,000 cases of refined oil, but during the the first half of 1895 the production was 20,000 cases a month, which was expected to be increased to 60,000 cases a month before the close of the year. In the residency of Soerbaya their production in 1894 was 429,264 cases of refined oil, 7,814 cases of benzine, and 3,058 cases of lubricating oil.

It is also stated that the Chinese company referred to is producing 400 liters of oil of 17° B. a day. If the latter figure be regarded as referring to crude and the former to refined on the basis of 4 liters to the gallon and a yield of 60 per cent of refined, the production of the Chinese company would be about 3,000 gallons a month, and of the former company 584,000 gallons a month, a total of 587,000 gallons a month, or 14,000 barrels, or 168,000 barrels a year.

SUMATRA.

During the year 1893 the journals of Europe, and especially those of Holland and England, contained occasional references to a new petroleum field that had been discovered near Langkat, on the island of Sumatra. A Dutch syndicate, known as the Royal Netherlands-India Petroleum Company of Sumatra, obtained concessions, it is reported, covering a territory of some 320 square miles, the field being situated on the seaboard and producing an oil yielding a large quantity of illuminating oil by distillation, differing in this respect from the petroleum of the neighboring island of Java, which was a heavy oil giving but a small quantity of illuminating oil and large quantities of heavy oils and paraffin. Near the close of 1893 it was reported that this company was producing 1,600 cases of refined oil daily, the crude coming from three wells and being refined near the wells.

BORNEO.

In working the coal fields in Labuan in Borneo, which is one of the smallest and least known of the British colonies, petroleum is frequently met with, though as yet it is of little importance commercially. The oil so far has been found in connection with coal developments, yet samples of the petroleum from the oil springs at Labuan have been submitted for analysis to Mr. Boverton Redwood, who states that the oil is a heavy petroleum of a dark brown color with little odor, of specific gravity of 0.964 at 60° F., with a flashing point at 250° F. Mr. Redwood states that from the results obtained by him it is clear that the oil would not yield either burning oil or naphthas, and it could not be regarded as a source of solid paraffin, though it would yield a good lubricating oil and would be well adapted in its crude state for use as a liquid fuel or as a source of gas for illuminating purposes.

GALICIA.

According to the report of the minister of agriculture of Austria-Hungary for 1893, the total production of petroleum in Galicia in 1893 was 963,312 metric quintals of 220,462 pounds each, or 212,373,690 pounds. As the Galician petroleum ranges in gravity from 0.870 to 0.885, the average number of pounds in a gallon would be 7.3. The total number of gallons of oil produced would therefore be 29,092,286 gallons, or 692,273 barrels of 42 gallons each. The production in 1892 was 898,713 metric quintals, say 27,141,388 gallons, or 646,223 barrels of 42 gallons each. This indicates an increased production in 1893 over 1892 of a little over 7 per cent. The total value of the oil produced in 1893 was 3,008,819 florins, which, at 48 cents to the florin, would be $1,444,233, or $2.23 a barrel. Most of the crude oil was refined in Galicia near the wells, there being 40 small refineries, the largest having a production in 1893 of but 63,693 metric centners or 1,234,615 pounds, the total product being 7,863,633 pounds. If this refined oil had a gravity of, say, 45° B., a gallon would weigh 6.66 pounds, which would make the total production of the largest refinery in Galicia 1,182,227 gallons, or 28,148 barrels of 42 gallons.

There were 3,071 persons employed in the production of crude petroleum, including 51 women and 6 children.

The production of ozocerite in 1893 was 56,248 metric quintals, or 12,400,547 pounds, valued at 1,268,335 florins ($608,800), or $10.92 per ton of 2,240 pounds. There were 3,377 men and 312 women employed in the production of ozocerite.

NATURAL GAS IN 1894.

By Joseph D. Weeks.

INTRODUCTION.

The questions relative to the origin, occurrence, composition, and history of natural gas have been so thoroughly discussed in the reports of the geological surveys of the several States in which natural gas occurs, and in the reports of the United States Geological Survey, and especially in the report on the Mineral Industries in the United States at the Eleventh Census, 1890, that it is not necessary to more than epitomize in this report the information on these subjects contained in the reports referred to. The investigator who desires to study this subject thoroughly is referred to the reports of the Pennsylvania geological survey, especially those of Prof. John F. Carll and the late Dr. Charles A. Ashburner; to the reports of the Ohio geological survey, especially those of Prof. Edward Orton, who has done so much to extend our knowledge of the geological occurrence of natural gas; to Professor Orton's report to the Kentucky geological survey on petroleum and natural gas in that State; to the Indiana geological survey reports, especially those of Mr. S. S. Gorby; to the reports of Mr. Jordan, the State gas inspector of Indiana; to the reports of the State mineralogist of California; to the monographs of the United States Geological Survey, especially the report on Ohio natural gas by Professor Orton, and on Indiana natural gas by Dr. A. J. Phinney, and to the several volumes of the Mineral Resources of the United States. Reference should also be had to the summary of this information in the Mineral Industries volume of the Eleventh Census. For the composition of natural gas those interested are referred to the report of Prof. Francis Phillips, of the Western University of Pennsylvania, made for the Pennsylvania geological survey, and to the paper published by him in May, 1893, on the analyses of natural gas.

It is proper, however, to refer briefly to the several questions above noted and to epitomize the information available on these several questions, though this report will be chiefly devoted to the statistical facts regarding natural gas.

"Natural gas," as the word is popularly used, is the gas that escapes from so-called gas springs or from the surface of the earth, or that is procured by drilling wells through certain geological strata, chiefly to the sandstones of the Upper Coal Measures of New York, Pennsylvania, and West Virginia, and to the Trenton limestones of western Ohio and Indiana. Chemically, natural gas is methane (CH_4), the lowest member of the paraffin series of hydrocarbons, the well-known marsh gas, the fire damp of the miner, with an unimportant percentage of carbonic acid and traces of other substances, ammonia and hydrogen sulphide being found occasionally associated with natural gas as impurities. Quite a number of analyses of natural gas show the presence of free hydrogen, but the examinations by Professor Phillips, above mentioned, failed to show the presence of the least trace of free hydrogen in the natural gas of western Pennsylvania. In his examinations Professor Phillips caused a stream of gas to flow through solutions of palladium chloride for periods varying from ten days to three months without the least trace of hydrogen being discovered. Even dry pure palladium chloride failed to show its presence. The tests made, as the gas used was taken from the mains of the Allegheny Heating Company, represented an enormous volume of gas, and may, therefore, be regarded as settling adversely the question of the presence of free hydrogen in natural gas.

GEOLOGICAL DISTRIBUTION AND LOCALITIES IN WHICH NATURAL GAS IS FOUND.

Natural gas has been found in the United States in the strata of every geological age from the Drift down to the Potsdam. It is chiefly in the Paleozoic strata of the Upper Coal Measures of Pennsylvania and in the Trenton limestone of Ohio and Indiana that the great deposits of natural gas have been struck. The highest stratum in which any considerable quantity has been found in Pennsylvania is the Homewood sandstone, the highest of the three recognized members of the Pottsville conglomerate. The lowest are the Kane sand and the sand of the Roy and Archer gas pool in Elk County. According to Mr. Carll, the geological position of the latter sand is 1,800 feet below the horizon of the Murrysville sand.

As to the localities in which natural gas is found, it may be said in a general way that this substance has been found in varying quantities from the Hudson River on the east to California on the west. In Alabama, California, Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Missouri, New York, Ohio, Pennsylvania, South Dakota, Tennessee, Utah, West Virginia, Wisconsin, and Wyoming its existence is reported. In some of these States, however, it has not been found in commercial quantities. A shallow well, frequently a well put down for water, has shown the existence of gas, usually in the drift. In many cases also so-called gas springs have been found, from which a small supply of natural gas, usually marsh gas, is reported. In 1889 gas in commercial quantities was reported as having been produced in Arkansas, California, Illinois, Indiana, Kansas, Kentucky, Michigan, Missouri, New York, Ohio, Pennsylvania, South Dakota, Texas, and Utah. At the present time the important gas fields are those of western Pennsylvania, western New York, northwestern Ohio, and eastern central Indiana. It was the development of these districts that caused the excitement in connection with natural gas which was so manifest in 1888 and to a less degree in 1889. The most important gas fields in these territories are those in the gas district of Pennsylvania in the neighborhood of Pittsburg, including the Murrysville and Grapeville fields of Westmoreland County, and the several Washington county fields. In McKean and Venango counties there was also a large production of gas, and considerable from Elk County. In Ohio the most important field is what has been called the Findlay, situated in Hancock County, while in Indiana the chief fields are in the neighborhood of Anderson, Kokomo, Marion, and Muncie. Each of these districts, as well as the other localities in which gas is found, will be discussed in connection with the report on the several States.

THE ACCUMULATION AND NATURAL STORAGE OF NATURAL GAS.

It has not been considered necessary to discuss the question of the origin of natural gas. This is, strictly speaking, a chemical question. It can be said, however, that the general belief is that the gas, as well as petroleum, of the Pennsylvania and adjacent oil field is of vegetable origin, while the gas of the Indiana oil field is of animal origin. In a word, the gas stored in the sand rocks of western Pennsylvania is derived from vegetable matter, while the gas stored in the limestone is of animal origin. Nor has it seemed necessary to discuss whether natural gas was produced in the years or ages past and stored for present use, or whether it is still being produced. Possibly both suggestions are correct, and it is also probable that the very large amount of gas which the drill has brought to the surface of the earth in the last few years was formed years ago and has been stored in the natural reservoirs until the drill found it. No doubt some gas is still being produced; especially is this true of the shallower wells. Whatever, then, may have been the origin of natural gas there are certain conditions necessary to its accumulation and storage, and if any one of these is absent no large supply can be expected. Small amounts of gas can exist without the presence of one or more of these conditions; but these pockets will yield but a small supply, and that supply will very soon be exhausted. These vital conditions are three: (1) reservoir, (2) cover, and (3) structure.

Gas is not stored, as is often supposed, in cavities or caves in the strata of the earth's surface, but chiefly in porous sandstones and limestones, gas as well as oil being found in the small interstices between the grains or in the pores.

The reservoir rock in western Pennsylvania is almost always a sand rock. The storage reservoir in Ohio is the Berea grit and the Clinton and Trenton limestones. Some little oil is found in shale, but the two great reservoirs in which the natural gas supply of the United States is stored are the sand rocks of western Pennsylvania and the Trenton limestone of northwestern Ohio and eastern central Indiana. When the "sand" in which an oil or gas is found is named, a sand rock or sandstone is meant, not sand in separate grains.

It is evident at once that were the whole structure above these reservoir rocks permeable, either through its entire structure or at points, by reason of the breaks and fissures in the strata, the gas would constantly escape from the reservoir and it would soon be drained out. This is a phenomenon that is constantly noticed in connection with gas springs. The gas is leaking from the reservoir; hence it is evident that there must be a cover or cap to this reservoir to hold the supply in place, and that this cap must be impervious to the gas, or practically so, either from the absence of porosity or the absence of breaks and fissures. This cover is usually a shale, and in every important gas territory the reservoir rock is capped by a shale cover, which has retained the gas in place until the cover has been tapped by the drill. In Ohio, for example, the Cuyahoga and Berea shales cover the Berea grit, the Niagara shale the Clinton group, and the Utica shale the Trenton limestone. As a rule, of course with limitations, the deeper the storage rock and the closer to it the shale or cover the larger the deposits of gas and the greater the chance for their permanence.

A third factor comes in here, which is termed structure, or the arrangement of the rock that contains the gas. The existence of arches and troughs, or, in geological language, of anticlines and synclines, has long been noticed in connection with drilling for petroleum, and recently in drilling for natural gas, as well as their influence upon the storage of these hydrocarbons. The most effective statement of this influence of structure, or, as it may be called, the "anticlinal theory," was made by Prof. I. C. White, of Morgantown, W. Va. Though his statements were called in question, his theory commended itself to practical men, and its adoption led to the location of a considerable number of natural gas wells far in advance of the developments of the drill. This theory simply asserts that oil, and more especially gas, is to be found stored most largely in the apex of these anticlines. The great reservoir of the Trenton limestone gas in the Ohio field is found in an enormous anticline, as is noted in discussing the Trenton limestone in connection with the report on Ohio.

A fourth necessary condition which will be discussed under the next head is pressure. It may be briefly said here that salt water is found in the outer boundary of gas and oil fields, and it is to the presence of this water that the pressure of oil and gas is ascribed by most of the geologists of Ohio and Indiana, though some of the Pennsylvania geologists question its sufficiency. Dr. Phinney, of Indiana, holds that the initial pressure of many gas wells is about that of the weight of a column of water equal in height to the depth of the well.

PRESSURE OF NATURAL GAS.

The statements as to the pressure of the early gas wells were usually estimates based upon no accurate observations; indeed, there was no method of accurately arriving at this pressure available to the drillers of the first wells. Very soon, however, proper gauges were prepared and observations and measurements made, but even under these circumstances no uniform system was adopted, so that though a statement as to the pressure or production of a given well might be a fairly correct approximation as to that well under the condition of the test, yet a comparison of the results at this well with those from another well made under different conditions would be without the least value.

In a general way it may be said that the highest actually observed and measured pressure has been in the neighborhood of 800 pounds to the square inch, closed pressure, the pressure being allowed to accumulate for a minute. In the first wells in the Findlay field the registered pressure was about 450 pounds; in the Murrysville field it reached 500 pounds; in the Indiana field the pressure was 400 to 500 pounds. It has been observed that with some few exceptions there is a pressure that is normal to each district, and that all wells in the same district ultimately show the same closed pressure; that is, the pressure measured when the well is closed and gas not escaping. Wells are sometimes measured by their flowing pressure; that is, the pressure shown on the gauge attached to the pipe through which the well is discharging gas into the air or into mains. Often when a well is first struck, owing to local causes, the pressure and production will be greater than the normal pressure of the district, but it is ultimately reduced to the normal figure. It is not to be inferred from this, however, that all wells of the same diameter and with the same ultimate pressure and located in the same district have the same production. Quite the contrary. In some wells the normal pressure, say 500 pounds, will be reached within a minute after the wells are closed; in others the normal pressure of the district will not be reached for days. It is evident that the well which reaches the normal pressure in a minute will be a greater producer than the one requiring hours to reach this pressure. All the wells in the vicinity of Pittsburg had originally about the same normal closed pressure—that is, 500 pounds—but the wells in the several subdistricts in that vicinity show a great difference in the time required to reach this pressure, and consequently show great difference as producers.

The original pressure in the Pittsburg district, as stated above, was about 500 pounds. In the Washington district, in the original wells, the pressure was about the same, but it has been found that gas from the different horizons, there being four in the Washington district, gives different pressures. In the Murrysville district the pressure is about the same as in the Pittsburg district. In the Wilcox district, in McKean County, Pa., the first pressure was about 575 pounds; in Butler County, 450 pounds; in Allegany County, N. Y., 450 pounds.

A copy of a paper read at the meeting of the American Philosophical Society by Prof. J. P. Lesley, State geologist of Pennsylvania, gives the following data concerning the gas pressures of the Grapeville field, from which it will appear that wells struck in February, 1886, had a pressure of 460 pounds. The same wells on February 2, 1891, had a pressure of 65 to 70 pounds, while the initial pressure of wells struck in January, 1889, was 75 pounds.

Pressure at various dates at Grapeville, Pa., gas wells, after closing for one minute.

[Pounds.]

No.	Name.	Depth.	Struck gas.	At first.	Apr. 27, 1889.	Dec. 16, 1889.	May 26, 1890.	Nov. 3, 1890.	Dec. 1, 1890.	Jan. 5, 1891.	Feb. 2, 1891.
		Feet.									
1	Klingensmith	1,100	Feb. 13, 1886	460	390	250	180	100	95	75	65
2	Henry	1,133	June, 1886	460	380	260	170	105	100	75	70
3	Moore	1,149	do	460	390	260	175	100	95	75	65
4	Welker	1,144	Oct., 1886	460	380	260	170	105	100	......	......
5	Brown	1,224	May, 1887	460	390	260	180	100	95	75	65
6	Ferree	1,312	Aug., 1887	460	380	240	170	100	100	75	70
7	Minsinger	1,466	Nov. 21, 1887	410	390	240	170	95	85	55	40
8	Shutts	1,468	Feb. 13, 1889	380	390	250	165	100	85	70	60
9	Kipple	1,360	Nov. 30, 1889	260	......	260	165	100	95	75	65
10	Sylvis	1,357	Jan. 13, 1890	235	......	......	170	105	......	75	75
11	Truxel	1,267	Feb. 20, 1890	225	......	......	180	100	......	75	75
12	Byers	1,350	Oct., 1890	125	......	......	......	......	......	65	60
13	Agnew	1,420	Jan., 1891	75	......	......	......	......	......	......	65

Calculating the average rate per day of the observed decrease, it is found to be as follows:

From April 27, 1889, 646 days, 321 pounds, 2.012 pounds per day.
From December 16, 1889, 413 days, 188 pounds, 2.197 pounds per day.
From May 26, 1890, 252 days, 107 pounds, 2.355 pounds per day.
From November 3, 1890, 91 days, 36 pounds, 2.528 pounds per day.
From December 1, 1890, 63 days, 30 pounds, 2.1 pounds per day.
From January 5, 1891, 28 days, 7 pounds, 4 pounds per day.

A similar statement may be made regarding the decline of pressure in the Trenton limestone gas districts of Ohio and Indiana. For example, the actually observed daily production of four wells in the Findlay, Ohio, district, as given by Professor Orton, is as follows:

Observed daily production of gas wells in Findlay, Ohio.

	Cubic feet.
Karg well	12,080,000
Cory well	3,318,000
Briggs well	2,565,000
Jones well	1,159,200

It will be noted from this that though these wells were in the same district and close together, and must have had consequently the same original rock pressure, and, if we are correctly informed, the wells were of the same diameter, yet the production varied greatly.

According to Professor Orton, who has paid more attention to this subject of rock pressure than any other of our geologists, there has been a great decline of the pressure in Findlay. He found the rock pressure in the original pioneer well in the Findlay, Ohio, district to be 450 pounds. In 1886 the pressure reached little, if any, above 400 pounds; during 1887 the fall was very gradual, the gauges marking 370 and 380 pounds; in May, 1889, the pressure had fallen to 250 pounds in independent wells, and in August of the same year it did not exceed 200 pounds. The wells in the city fell as low as 170 pounds at one time. Professor Orton's tabulated statement of the pressure of the wells in Findlay is as follows:

Rate of decline in pressure of Findlay, Ohio, gas wells.

	Pounds.
1885 (original)	450
1886	400
1887, August	360 to 380
1889, May 1	250
1890, May 1	170 to 200

In the Stuartsville district the decline was as follows:

	Pounds.
1888	450
1889, June	385
1889, August	365
1889, October	325
1890, May	275

In Bloomdale the rock pressure in 1887 was 400 to 465 pounds; in July, 1889, it had dropped to 375 and 390 pounds.

In the Indiana gas fields, in which the amount of gas stored was probably greater than in any other of the gas fields of the United States, and which has maintained its supply as well as its production and rock pressure better than any other of the fields, this pressure is rapidly falling off. According to the last report of State Gas Inspector Jordan, which was made early in 1894, the average field pressure, which was originally 320 pounds, has now declined to 240 pounds. Regarding the pressure of the wells in Indiana, Mr. Jordan states:

The following is the pressure found in different localities during the year 1893. At many of the places, however, the pressure given was obtained only from new wells at a distance of from 2 to 4 miles from the towns, the wells in the towns and immediate vicinity showing far less pressure, and many wells being practically exhausted:

Pressure of Indiana natural gas wells in 1893.

	Pounds.		Pounds.
Greenfield, Hancock County	250	Summitville, Madison County	300
Carthage, Rush County	120	Chesterfield, Madison County	290
Noblesville, Hamilton County	240	Muncie, Delaware County	240
Sheridan, Hamilton County	240	Albany, Delaware County	280
Kokomo, Howard County	250	Eaton, Delaware County	290
Marion, Grant County	250	Hartford City, Blackford County	260
Gas City, Grant County	300	Montpelier, Blackford County	250
Fairmount, Grant County	300	Camden, Jay County	225
Elwood, Madison County	300	Dunkirk, Jay County	275
Frankton, Madison County	300	Greensburg, Decatur County	175
Anderson, Madison County	240	Fountaintown, Shelby County	210
Alexandria, Madison County	300	Waldron, Shelby County	225

These pressures were found in the most instances in new wells. In their immediate neighborhood are found older wells showing a much less pressure, even below 100 pounds.

The wells connected with the pipe lines conveying gas to Indianapolis, Crawfordsville, Frankfort, La Fayette, Logansport, Peru, Wabash, Huntington, Bluffton, Fort Wayne, Decatur, Portland, and Shelbyville show pressures from 225 to 260 pounds.

The wells and the pipe lines leading to Chicago and Richmond are better, showing 280 to 290 pounds pressure. These companies, in order to keep up the necessary supply of gas, are compelled to drill many new wells each year to take the place of those that have become exhausted. Each year these companies have been compelled to acquire new leases and extend their lines, until there is but very little territory to be obtained. If, in drilling these new wells, the pressure of the original wells could be obtained there might be some hope of perpetuity of the gas. But such is not the case. The new wells are coming in with a constantly decreasing pressure, and of a necessity will be much shorter lived than the original wells. All this goes to prove that the field is slowly but surely becoming exhausted. This exhaustion will be in an accelerated ratio as we approach the final end.

The gravity of the situation can only be understood when it is known that from 225 to 250 pounds pressure at the head of the main lines is absolutely necessary to force the gas to the different cities that lie outside but are obtaining their fuel from the gas field, with sufficient pressure to distribute it through the low-pressure city lines to the consumer. And this pressure, too, is needed when all the reducing stations and district valves are wide open and every facility afforded for free circulation.

There remains now but a small average margin above the limit of low pressure. At the annual rate of pressure reduction, and by a continuance of the present extravagant and wasteful method of consumption, this small margin will be spent or exhausted in a very short time. When this shall have happened artificial pressure by means of pumps will be resorted to for the purpose of distribution. It has been the experience of the gas areas of other States that when the initial pressure must be supplemented by artificial means the end is very near at hand. A careful study of the conditions of the fields in Indiana as they exist to-day will show that we have almost reached that point.

TRANSPORTATION OF NATURAL GAS.

While in some instances natural gas is used close to the point of production, as a rule gas has to be conveyed to considerable distances from the wells to the points of consumption. The conduits used are iron pipes. For the smaller conduits wrought-iron welded pipes are used; for the larger, in some cases, riveted wrought-iron pipes, and in others cast-iron pipes. Various methods have been adopted to prevent leakage but these need not be detailed here.

At first the initial pressure of the gas as it entered the pipes to be conducted from the wells was sufficient not only to drive the gas to points of consumption but in many cases companies were required for purposes of safety to reduce the pressure of the gas in the pipes upon entering the borders of cities and towns. As the pressure in many fields has gradually decreased, it has been found necessary to supplement this pressure by artificial means in order to overcome the friction of resistance of the pipes and to convey the gas from the point of production to the point of consumption. The air compressor is particularly adapted to this work. The first company to try this method was the People's Company, of Pittsburg, operating in the Murrysville field. This company had two complete pumping plants constructed and put in operation in the winter of 1890–91, and thoroughly demonstrated the practicability of pumping gas.

Quite a number of pumping plants have been erected recently, until now there is hardly a company of any importance, especially in the fields east of Indiana, that is not compelled to use pumps to force their gas to the points of consumption.

THE CONSUMPTION OF NATURAL GAS.

It is impossible to give in cubic feet the consumption of natural gas in the United States. Meters are used, but as a rule only for measuring the gas in small quantities, and in many cases no attempt is made to measure it at all. At many large works, using 1,000,000 cubic feet an hour, no meter has ever been applied; indeed, no single meter has ever been invented that would measure the gas, though Young's proportionate meter, made by the Pittsburg Supply Company, Limited, has been used quite successfully for measuring gas in fairly large quantities. The only statement, therefore, that can be made as to the consumption of gas must be an average one, and the only complete statement that has ever been compiled was prepared by the author for the Mineral Industries of the United States at the Eleventh Census.

Based on the figures mentioned, and others, the consumption of natural gas in 1889 was estimated as follows:

Total consumption of natural gas in the United States in 1889.

	Cubic feet.
Iron and steel mills	171, 500, 000, 000
Glassworks	18, 750, 000, 000
Other industrial establishments	236, 900, 000, 000
Heating and cooking	62, 500, 000, 000
Pumping oil	7, 500, 000, 000
Drilling and operating oil and gas wells	30, 000, 000, 000
Other uses	25, 000, 000, 000
Total	552, 150, 000, 000

These figures are to be taken only as the best approximation possible, and are to be accepted under the conditions expressed in the discussion preceding.

This total is enormous, and shows how wastefully natural gas has been used. It is assumed, roughly, that 30,000 cubic feet of gas is equal in heating power to 1 ton of Pittsburg coal. This is not correct, but it is near enough for comparison. On this basis the natural gas consumed in the United States, as given above, would equal in heat value 18,405,000 tons of coal. The actual fuel displacement, as reported, is in round numbers 10,000,000 tons. As natural gas is burned most wastefully, perhaps more than double the amount actually needed to do a given work being used, it is probable that our estimate is not too large.

These figures are given only as an indication as to what was the consumption of natural gas, in cubic feet, at a time when the consumption was the largest. In 1894 it had been very much reduced, though as improved appliances for using the gas had been introduced the actual efficiency of that burned was relatively much greater; that is, half the amount of gas would give the same efficiency.

VALUE OF NATURAL GAS CONSUMED IN THE UNITED STATES.

No statement as to the actual production of natural gas in cubic feet has been obtained, nor is it obtainable. Certain wells have been measured and the production of these wells for a brief period has been ascertained, and from this production, so found, an estimate of the total production of these wells and of the field in which they are located has been determined. But it is evident that this is only an estimate concerning which it is impossible to say it is even approximate. The production of a well varies, not only from month to month and week to week, but from hour to hour, so that what would be a fair estimate of the production for a given minute would not be at all a correct estimate for an hour later.

On the basis, then, of the best information obtainable, the conclusion is reached that the total value of natural gas consumed in the United States in 1894 was $13,954,400, as compared with $14,346,250 in 1893, and $14,800,714 in 1892. It may be said here that the consumption of natural gas in the United States in 1894, measured in cubic feet, was considerably less than the amount consumed in 1893; yet, notwithstanding the fact that in many cases much higher prices were charged for gas in 1894 than in 1893, the difference in the value of the gas, or the amount received for it in 1894, as compared with 1893, is not as great as the difference in actual consumption in cubic feet.

In the following table is given the total value of natural gas consumed in the United States from 1885 to 1894, by States:

Value of natural gas consumed in the United States, 1885 to 1894.

Localities.	1885.	1886.	1887.	1888.	1889.
Pennsylvania	$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
Indiana	....	300,000	600,000	1,320,000	2,075,702
Illinois	1,200	4,000	....	....	10,615
Kentucky	....	....	....	....	2,580
Kansas	....	6,000	....	....	15,873
Michigan	....	12,000	....	....	....
Missouri	....	....	....	....	35,687
Arkansas	....	....	....	....	375
Texas	....	....	....	....	1,728
Utah	....	....	....	....	150
South Dakota	....	....	....	....	25
California	....	....	....	....	12,680
Elsewhere	20,000	20,000	15,000	75,000	1,600,000
Total	4,857,200	10,012,000	15,817,500	22,629,875	21,107,099

Localities.	1890.	1891.	1892.	1893.	1894.
Pennsylvania	$9,551,025	$7,834,016	$7,376,281	$6,488,000	$6,279,000
New York	552,000	280,000	216,000	210,000	249,000
Ohio	4,684,300	3,076,325	2,136,000	1,510,000	1,276,100
West Virginia	5,400	35,000	500	123,000	395,000
Indiana	2,302,500	3,942,500	4,716,000	5,718,000	5,437,000
Illinois	6,000	6,000	12,988	14,000	15,000
Kentucky	30,000	38,993	43,175	68,500	89,200
Kansas	12,000	5,500	40,795	50,000	86,600
Missouri	10,500	1,500	3,775	2,100	4,500
Arkansas	}	250	100	100	100
Texas	} 6,000	....	100	50	50
Utah	}		....	500	500
Colorado	}	....	....	....	12,000
California	33,000	30,000	55,000	62,000	60,350
Elsewhere	1,600,000	250,000	200,000	100,000	50,000
Total	18,792,725	15,500,084	14,800,714	14,346,250	13,954,400

From this table it appears that the value of natural gas consumed in the United States was greatest in 1888, when the value was $22,629,875. From that time to 1891 the decrease in value was rapid. Since 1891, however, it has been quite gradual, owing to the fact noted that meters are being used, the amounts consumed measured, and payments made on amounts used. The following are the net meter rates, per 1,000 feet, charged in the cities named: Detroit, Lima, Piqua, Dayton, Springfield, Toledo, Buffalo, and Columbus, 25 cents; Pittsburg, Allegheny, and Erie, 22½ cents; Jamestown and Corry, 21.6 cents; Fostoria and Logansport, 20 cents; Indianapolis, Richmond, and Fort Wayne, when sold to manufacturers by meter, 10 cents.

CONSUMPTION AND DISTRIBUTION OF NATURAL GAS.

There are a great many details regarding the production of natural gas in the United States that would be exceedingly interesting could they be secured. Unfortunately, however, many of the natural-gas companies keep their records in such a way that it is impossible for them to give any information other than the amount of money received for the gas consumed. They do not even know the number of consumers. From quite a number of companies, however, 204 in all, very interesting statistics have been received, which are given in the following table. It should be distinctly understood that this does not indicate all of the companies from which reports have been received, but only includes the reports from the companies in the three States of Pennsylvania, Indiana, and Ohio which have furnished the Survey with all of the information asked. From many other companies the information covers a portion of the items named in the table:

Natural gas records in 1893 and 1894.

	Pennsylvania.		Indiana.		Ohio.	
	1893.	1894.	1893.	1894.	1893.	1894.
Amount received for sale of gas or value of gas consumed	$3,609,394	$3,558,276	$920,786	$1,143,353	$239,227	$213,905
Value of coal or wood displaced	$3,991,968	$3,341,916	$1,400,128	$1,513,912	$376,643	$281,868
Domestic fires supplied	119,500	103,580	53,566	49,542	14,226	7,204
Iron and steel works supplied	34	13	1	7	....	....
Glass works supplied	43	28	15	21	....	....
Other establishments supplied	197	269	210	266	53	48
Total establishments supplied	274	310	226	294	53	48
Total wells producing January 1	771	816	359	429	157	194
Total producing wells drilled	160	149	114	88	62	26
Total wells producing December 31	817	867	442	480	211	189
Total feet of pipe laid	12,211,765	12,484,307	5,406,873	6,446,877	1,296,310	1,301,378
Total establishments reporting	48	48	120	120	36	36

The above table covers reports from 204 companies, these 204 companies reporting concerning all of the items included in the table, both in 1893 and 1894. From this table it seems that the amount actually received for gas by these 204 companies in 1894 was $4,915,534, and in 1893 $4,769,407, an increase of $146,127 in 1894 as compared with 1893. This increase was in Indiana, the Pennsylvania and Ohio reports showing quite a reduction.

Although these 204 companies reported an increase in amount received for gas in 1894 as compared with 1893, the value of coal or wood displaced shows a decrease of $631,043. In Pennsylvania the reduction was $650,052; in Ohio it was $94,775, while in Indiana there was an increase of $113,784. A comparison of the Pennsylvania figures will show that though there was a falling off of $650,052 in the value of the coal or wood displaced, there was but $51,118 less received for the sale of gas in 1894 than 1893, the value of the natural gas consumed, or the amount received for it, being greater than the value of coal or wood displaced by it. In Indiana and Ohio, however, the value of gas consumed was less than the value of coal or wood displaced.

An examination of the statement regarding the number of domestic fires supplied shows an interesting feature. In Pennsylvania the number has been materially reduced, falling from 119,500 in 1893 to 103,580 in 1894, a reduction of 15,920, or 13⅓ per cent; the reports of Indiana show a reduction of 4,024, or about 10 per cent, while the reports of Ohio show a decrease of nearly 50 per cent; the total number of fires in 1893 being 14,226, and in 1894 but 7,204. The total number of establishments supplied with gas by these 204 companies shows an increase in Pennsylvania and Indiana and a decrease in Ohio, the number in Pennsylvania increasing from 274 in 1893 to 310 in 1894, in Indiana, from 226 in 1893 to 294 in 1894. while the number in Ohio decreased from 53 in 1893 to 48 in 1894.

The number of producing wells owned by the companies reporting on the 1st of January, 1894, in Pennsylvania, was 816; at the close of the year it had increased to 867. In Indiana, at the beginning of the year, the number of producing wells was 429; at the close of the year it was 480. Ohio showed a decrease in producing wells in 1894 of from 194 at the beginning of the year to 189 at its close.

The number of feet of pipe laid shows an increase in every case. In Pennsylvania the number of feet of pipe laid by the companies reporting at the close of 1893 was 12,211,765. This had increased to 12,484,307 feet at the close of 1894. At the beginning of 1894, in Indiana, the amount of pipe laid by the ompanies reporting was 5,406,873. This increased to 6,446,877 feet at the close of the year. In Ohio the amount of pipe laid increased from 1,296.310 feet at the close of 1893 to 1,301,378 feet at the close of 1894.

The above statements refer only to the number of companies included in the table, and only to those companies who made full reports for 1893 and 1894, so that comparisons could be made. While complete figures have not been received from all companies as to the number of wells, works supplied, feet of pipe laid, etc., the figures we have received are of sufficient value to justify us in publishing them. From most of the companies we received statements giving value of the gas consumed. We have not received statements from all companies. With this understanding we give below the results of the investigation in 1894 as to the number of companies reporting in each State, the amount received for sale of gas, or the value of the gas consumed, the value of coal or wood displaced by this gas, the uses to which natural gas was put, such as the number of fires for cooking and heating, and the number of establishments supplied, the record of wells, and the total number of feet of pipe used in the transportation of gas on the 31st of December, 1894.

In the following table is given the amount received for salé of gas, or the value of the gas consumed in the United States in 1894, as reported by 577 companies or individuals in the several States named, together with the value of the coal or wood displaced by this gas.

Value of natural gas consumed in the United States in 1894, by States, and the value of coal or wood displaced by same, as reported by 577 persons, firms, and corporations.

States.	Companies or individuals reporting.	Amount received for sale of gas, or value of gas consumed.	Value of coal or wood displaced by gas.
Pennsylvania	108	$4, 178, 116	$3, 977, 784
Indiana	316	2, 211, 649	2, 933, 845
Ohio	89	812, 368	1, 112, 888
New York	17	127, 048	150, 860
Kentucky	11	73, 995	79, 205
Kansas	9	69, 075	86, 575
California	11	43, 285	50, 357
Illinois	5	12, 448	14, 448
Missouri	9	3, 540	4, 825
Texas	1	20	20
Arkansas	1	100	100
Total	577	7, 531, 644	8, 410, 907

In the following table is given a statement of the uses to which natural gas produced in the United States in 1894 was put, as reported by 577 companies or individuals, namely, the number of domestic fires supplied, number of iron-rolling mills, steel works, glass works, and other establishments supplied, including machine shops, brick works, potteries, planing mills, etc.:

Uses to which natural gas produced in the United States in 1894 was put, as reported by 577 persons, firms, and corporations.

States.	Companies or individuals reporting.	Domestic fires supplied.	Establishments supplied.				
			Iron mills.	Steel works.	Glass works.	Other establishments.	Total.
Pennsylvania	108	120, 571	6	11	31	332	380
Indiana	316	93, 455	16	2	51	577	646
Ohio	89	45, 397		1	1	91	93
New York	17	6, 062				5	5
Kentucky	11	7, 273				4	4
Kansas	9	3, 458				10	10
California	11	1, 707				3	3
Illinois	5	652				9	9
Missouri	9	70				1	1
Texas	1	1				0	0
Arkansas	1	0				1	1
Total	577	278, 646	22	14	83	1, 033	1, 152

In the following table is given a statement of the number of natural gas wells producing in the United States at the beginning and close of 1894, together with the number drilled in 1894, and the total number of feet of pipe laid December 31, 1894, as reported by 577 companies or individuals.

Record of wells and amount of pipe line as reported by 577 persons, firms, and corporations in 1894.

States.	Companies or individuals reporting.	Wells.			Total pipe laid Dec. 31, 1894.
		Producing Dec. 31, 1893.	Drilled in 1894.	Producing Dec. 31, 1894.	
					Feet.
Pennsylvania	108	1,056	209	1,132	15,741,362
Indiana	316	903	168	1,016	14,300,368
Ohio	89	439	59	437	4,080,473
New York	17	198	33	189	828,486
Kentucky	11	59	10	69	336,680
Kansas	9	42	25	57	350,920
California	11	14	1	15	61,800
Illinois	5	30	13	30	47,560
Missouri	9	11	....	10	2,330
Texas	1	1	....	1	100
Arkansas	1	2	....	2	....
Total	577	2,755	518	2,958	35,750,079

SUBSTITUTES FOR NATURAL GAS.

A great deal of attention has been paid during the past year to the production of a fuel gas that will answer the same purposes as natural gas and that can be turned into the pipes and used either for the purpose of supplementing failing supplies of natural gas or giving an increased production in very cold weather when there is a greatly increased demand for gas. The conditions are such as to indicate very clearly what must be the character of this gas. It must be a fixed gas or it will not carry in the pipes; it must be one that will mix readily with natural gas or there will be a great inequality in the character of the gas; it must be high in heat units or it will not pay to distribute it; it cannot contain large quantities of nitrogen or inert matter, but the entire gas must be combustible, or, at least, the percentage of inert matter, as carbonic acid and nitrogen, must be very small.

Two methods have been devised for furnishing such an additional supply of gas; one is actually in operation, the other will be before the close of 1895. The first is the erection of an auxiliary gas plant for making a fuel gas; the other is the use of the excess gas, or at times the entire gas, from by-product coke plants. The first of these is in operation at the works of the Kentucky Heating Company at Louisville, Ky. This company was organized for the purpose of bringing natural gas from Meade County, Ky. For a while the supply was ample, but with the exhaustion of the field the supply was not sufficient for cold weather. It was decided to erect an auxiliary plant, and the Rose-Hastings process of the National Heat and Power Construction Company, of Philadelphia, was adopted. It hardly falls within the limits of this report to describe this process more than to say that it uses soft coal and has what are known as cumulative generators. The plant in operation at Louisville can be described as having four upright retorts or generators and one superheater, all set in a circle. Soft coal is charged into three of these retorts and coke into the fourth. Air is driven through the three coal chambers, burning a portion of the coal, and heating them to a high temperature, the resulting hot gases being in the meantime carried down through the coke, in this way heating it up without burning it. The heat necessary to start the blast and also that required to bring the coke to the finishing temperature is gained by a short blast upward through the coke. When the machine has been brought to the right heat and before the blast is stopped a charge of soft coal is dumped into each one of the coal chambers. The blast is then stopped and steam turned under each of the coal chambers and oil turned in at the top of the coke chamber. The result is that water gas is produced in each of the coal chambers, and, mingling with the coal gas distilled off from the fresh charge of soft coal, passes over to the coke chamber, down through the red-hot coke, where it has the vapors of oil changed into fixed gases, and up through the superheater, where this process is thoroughly completed. When oil is used the resultant gas contains some 640 to 650 B. H. units per cubic foot; without oil, 410 B. H. units.

Regarding the operation of this plant as an auxiliary to augment the supply of natural gas on cold days, Mr. Donald McDonald, president of the Kentucky Heating Company, stated that they have continued to maintain their pressure and give satisfactory service to their customers notwithstanding the long continued and bitter cold weather.

I have been favored with a statement as to the actual amount of the several materials used in actual practice to make over 10,000,000 cubic feet of 20 candlepower gas at these Louisville works and reproduce it as follows:

Materials used to make 10,596,000 cubic feet of Rose-Hastings gas.

Oil	gallons	21,325
Soft coal slack	pounds	328,503,900
Coke	do	60,932,175
Boiler coal	do	87,954,270

Average per 1,000 cubic feet.

Oil	gallons	2.01
Coal	pounds	31.00
Coke	do	5.75
Boiler coal	do	8.30

From the above it will be very easy to estimate the cost per thousand at any given point, the cost of materials being known. Take a location where oil is 2 cents a gallon, coal $1.20 a ton, and coke $2.40 a ton. Then the cost of materials per 1,000 cubic feet will be as follows:

	Cents.
Oil, 2.01 gallons, at 2 cents	4.02
Coal, 31 pounds, at $1.20 per ton	1.86
Coke, 5.75 pounds, at $2.40 per ton	.67
Boiler coal, 8.3 pounds, at $1.20 per ton	.38
Total	6.93
Add for labor	1.60
Total	8.53

We do not intend it to be understood that the above is the cost at Louisville. All of the materials at Louisville are much higher than the prices given, and the cost at Louisville was therefore in excess of the cost named, but where oil is 2 cents a gallon, coal $1.20, and coke $2.40 a net ton, the cost will be as given. The actual costs at a given point of these materials may be substituted for those we have assumed, and the results will be the actual cost of materials and labor.

Regarding the second process proposed, that is, the erection of by-product coke ovens and the use of a portion or all of the gas from these ovens as a fuel gas, it may be said that these by-product coke ovens are practically gas retorts 24 to 33 feet long, 14½ to 26 inches wide, and 6 to 7 feet high. The coking chamber is closed and the coal is coked by burning the gases in flues in the side walls of the ovens. All of the gas is driven off as in the illuminating gas process, and after being deprived of its tar, ammonia, and benzole, is returned to the ovens and burned in the flues as noted above. This gas is practically illuminating gas, containing about the same relative amount of hydrogen and marsh gas as is contained in illuminating gas. The quantity of gas required to coke the coal varies with the amount of gas produced, being from one-half to two-thirds of the total gas with a coal like the Connellsville coal, producing 10,000 cubic feet of gas per ton. The probability is that 4,000 to 5,000 cubic feet will be sufficient to coke the coal, leaving an excess with Connellsville coal of 5,000 or 6,000 cubic feet per ton of coal charged that would be available for fuel purposes. If it was deemed best, the coal could be coked by burning producer gas in the flues, the producer gas being of a character that will not stand transportation and in this case leaving the entire amount of gas produced by the coke ovens to be used for supplementing the natural-gas supply. The excess gas from these ovens, of which some 3,000 are in operation in Europe, is used to a great extent for fuel purposes, and it is understood that the Philadelphia Company, of Pittsburg, the largest supplier of natural gas in the United States, is to erect a trial plant of these ovens for use in 1895.

THE RECORD BY STATES.

PENNSYLVANIA.

It was in this State that natural gas first began to be used extensively as a domestic and industrial fuel. Indeed, it was the drilling of the Westinghouse well at Homewood, a suburb of Pittsburg, that led to the great extension of its use that marked the years 1885 and 1886.

Regarding the geological horizons in which natural gas has been found in Pennsylvania it may be said that these are practically the same as those in which petroleum has been found. They have been treated of very thoroughly in connection with the report on petroleum, to which reference should be made. The gas pools are very nearly coextensive with the petroleum fields of Pennsylvania.

In the following table is given the value of natural gas consumed in Pennsylvania in the years from 1885 to 1894:

Value of natural gas consumed in Pennsylvania from 1885 to 1894.

Years.	Value of gas consumed.	Years.	Value of gas consumed.
1885	$4,500,000	1890	$9,551,025
1886	9,000,000	1891	7,834,016
1887	13,749,500	1892	7,376,281
1888	19,282,375	1893	6,488,000
1889	11,593,989	1894	6,279,000

OHIO.

There are four distinct geological formations that are at the present time supplying more or less gas to the people of Ohio for fuel and light. Naming them in descending order, they are, the Berea grit, the Ohio shale, the Clinton group, the Trenton limestone.

The Ohio shale, which crops out on the shore of Lake Erie, extending westward from the Pennsylvania line as far as the mouth of the Huron River and passing southward from this point to the Ohio Valley, consisting of a series of beds of shale, black, blue, or gray in color, with an average breadth of from 12 to 16 miles, constitutes the surface rock. This formation has been known to be a source of petroleum and gas ever since the country has been inhabited, and weak outflows of oil or gas occur all along the line and have been noted alike by the uncivilized and the civilized occupants. Along the shore of Lake Erie there are scores, and probably hundreds, of shale gas wells. The wells are shallow, rarely exceeding 300 or 400 feet in depth. It costs but little to drill a shallow well, and the gas flow is in many instances kept up with remarkable persistency. A well will yield a few hundred or a few thousand feet of gas a day and maintain its production for a score or more of years. The pressure of the gas is low, scarcely rising to and rarely exceeding 30 or 40 pounds to the inch.

As the Berea grit, which outcrops at many points in northern Ohio, dips to the southward and eastward it becomes a repository of gas, oil, and salt water, until, when it has descended far enough to take 800 feet or more of cover, it becomes, under proper conditions, a reservoir of high-pressure gas and oil. While the Berea grit does not yield a large amount of fuel, it is still a producer in some regions near Cadiz, Barnesville, Macksburg, Marietta, Brilliant, and East Liverpool.

Some gas has also been found in the Clinton limestone, wells some 30 miles distant from Columbus having been drilled into this formation, and gas has been furnished to such towns as Columbus, Newark, and Lancaster. The field seems to extend from Lancaster to Newark in a northeasterly direction, and with a length of about 25 miles and a maximum breadth of 2 or 3 miles. The gas rock is neither regular in structure nor uniform in production, and the field is a spotted one.

The Trenton limestone as a source of supply for gas and petroleum has already been described in the report on petroleum. It was the opening up of this strata as a source of gas that marks the beginning of the history of natural gas in northwestern Ohio and in Indiana. Up to this time all the oil and gas rocks previously known are sandstones, but the Findlay gas rock is a magnesian limestone. Up to its discovery no rock of an earlier age had been found productive in petroleum or its derivatives but the Devonian, but the horizon of the new rock is near the bottom of the Lower Silurian. Owing to the thoroughness of the description of this field already given in connection with petroleum it is not necessary to reproduce it here.

In the following table will be found a statement of the value of the natural gas consumed in Ohio from 1885 to 1894:

Value of natural gas consumed in Ohio from 1885 to 1894.

Years.	Value of gas consumed.	Years.	Value of gas consumed.
1885	$100,000	1890	$4,684,300
1886	400,000	1891	3,076,325
1887	1,000,000	1892	2,136,000
1888	1,500,000	1893	1,510,000
1889	5,215,669	1894	1,276,100

INDIANA.

While prospecting for natural gas by the drilling of wells in nearly every county in the State of Indiana has progressed rapidly during 1893 and 1894, outside of the areas heretofore regarded as gas-producing territories no developments have been made of any commercial importance. The boundaries of the natural gas belt have been more clearly defined. Notwithstanding that the drill has developed no new territory, the most important gas territory in the United States is that of Indiana. It is estimated that this State possesses 2,500 square miles of what may be regarded as gas territory, that territory in which gas has been or probably will be obtained in paying quantities. The supply of gas in this State is also holding out better than that of Ohio and Pennsylvania, and yet there is no doubt that the supply is limited, that it has been and is being wasted, that the pressure and production are declining, and that the exhaustion of the fields is rapidly approaching.

The great reservoir of natural gas in Indiana is the Trenton limestone. The chief structural feature of the State is the Cincinnati arch, which, while it does not make itself manifest on the surface, is no less an arch. It is claimed by Dr. Phinney that the portion of the arch in Indiana is the continuation of the main body, while the Findlay arch of Ohio is the smaller fork or branch. This arch is confined to the Trenton limestone and underlying formations. It is from 25 to 50 miles wide on its summit, and its slopes dip gradually away on either side.

From the large number of wells sunk in different portions of the State the general topographic configuration of the surface of the Trenton can readily be conceived. As may be inferred from the preceding statements, its upper surface rises into a broad elongated dome trending northwest and southeast across the State, from near its southeastern portion to its northwestern, with several subordinate ridges setting off from it, and perhaps a few subordinate domes or ridges that hardly merit the term anticlinal distributed about its apex. The principal dome inclines at first gently, then on its flanks more rapidly, and about its base once more gently to the northeast and southwest, and in still gentler slopes to the northwest.

Area of Indiana gas field.

Counties.	Square miles.	Producing wells.	Aggregate daily flow.	Counties.	Square miles.	Producing wells.	Aggregate daily flow.
			Cubic feet.				*Cubic feet.*
Blackford	180	8	21, 700, 000	Miami	20	13	24, 000, 000
Jay	150	16	22, 000, 000	Wabash	10	5	6, 000, 000
Delaware	350	55	97, 000, 000	Henry	90	22	20, 000, 000
Randolph	80	9	6, 000, 000	Rush	40	4	1, 500, 000
Wayne	3	5	2, 000, 000	Shelby	20	8	3, 000, 000
Madison	445	40	114, 000, 000	Decatur	40	25	5, 000, 000
Grant	325	22	80, 825, 000	Franklin	2	4	500, 000
Howard	160	28	80, 000, 000	Dearborn	2	2	1, 500, 000
Tipton	120	13	38, 000, 000	Dekalb		3	2, 000, 000
Hamilton	200	82	200, 000, 000				
Hancock	200	9	15, 000, 000	Total	2, 507	399	779, 525, 000
Marion	70	26	40, 000, 000				

In the following table will be found a statement of the value of the natural gas consumed in Indiana from 1886 to 1894:

Value of natural gas consumed in Indiana from 1886 to 1894.

Years.	Value of gas consumed.	Years.	Value of gas consumed.
1886	$300, 000	1891	$3, 942, 500
1887	600, 000	1892	4, 716, 000
1888	1, 320, 000	1893	5, 718, 000
1889	2, 075, 702	1894	5, 437, 000
1890	2, 302, 500		

KENTUCKY.

The chief source of supply in Kentucky is from Meade County, in what is known as the Brandenburg district. Some gas has also been found in Henderson, Breckinridge, and Daviess counties. The first well drilled in Kentucky which produced gas in any considerable quantity was the Moreman well, drilled in 1863 on the Moreman farm, near Brandenburg, Meade County, not far from the Ohio River. In 1872 the gas from this well was utilized to make salt. This consumed but a small portion of the production, however, and it was not until the discoveries of 1885 and 1886 in southern Ohio and Indiana that interest in searching for natural gas in Kentucky was stimulated.

From that date until the present time natural gas from Meade County has been utilized in Louisville. The gas is a shale gas from the black or Ohio shale. Unlike the Ohio shale gas, however, the Meade County gas is a reservoir or high-pressure gas. Its wells have obtained a maximum of 2,000,000 cubic feet a day.

The gas from Meade County is failing, as it is in other sections of the country. Pumps have been used to force the gas to Louisville, and, as stated elsewhere in this report, a Rose-Hastings fuel-gas plant has been erected to supplement the deficiency of the supply of natural gas.

The production of natural gas in Kentucky from 1889 to 1894 was as follows:

Value of natural gas consumed in Kentucky from 1889 to 1894.

Years.	Value of gas consumed.
1889	$2,580
1890	30,000
1891	38,993
1892	43,175
1893	68,500
1894	89,200

WEST VIRGINIA.

The gas formations of West Virginia are similar to those of New York, Pennsylvania, and eastern Ohio, and need no description here.

ILLINOIS.

A small amount of gas is produced in Illinois. The rocks in which it is found are the same as those in Indiana. In Sparta, where most of the gas is produced, the wells have been drilled to an average depth of 855 feet. The pressure, which was 300 pounds six years ago, has been reduced to 60 pounds.

The production of natural gas in Illinois from 1889 to 1894 was as follows:

Value of natural gas consumed in Illinois from 1889 to 1894.

Years.	Value of gas consumed.
1889	$10,615
1890	6,000
1891	6,000
1892	12,988
1893	14,000
1894	15,000

KANSAS.

Natural gas has been found in Kansas in two or three sections, principally in the neighborhood of Paola, Fort Scott, Coffeyville, and Cherry Vale. None of the fields have as yet assumed sufficient importance to justify a detailed description. The larger number of wells are at Coffeyville and Cherry Vale. The wells are from 600 to 700 feet deep and the rock pressure some 200 pounds. The gas seems to be found in sand and shale.

The production of natural gas in Kansas from 1889 to 1894 was as follows:

Value of natural gas consumed in Kansas from 1889 to 1894.

Years.	Value of gas consumed.
1889	$15,873
1890	12,000
1891	5,500
1892	40,795
1893	50,000
1894	86,600

CALIFORNIA.

Natural gas, though found in all the bituminous formations of California, has attracted most attention in the Sacramento and San Joaquin valleys, from its use in the city of Stockton, Joaquin County. In Stockton there are more than 20 wells of commercial value. Any boring of 2,500 feet gives a tolerable yield.

The Asylum well, No. 3, was commenced in 1892, and bored 1,992 feet. The casing, of No. 14 iron, is 15 inches to 854 feet depth, thence 13½ inches to 1,422 feet, 12 inches to 1,671 feet, 10½ inches to 1,775 feet, 8 inches to 1,780 feet, 7 inches to 1,786 feet, and 6 inches to 1,979 feet.

The Central gas well is owned and used by a private company. In 1893 it reached a depth of about 1,500 feet, when, tools being lost in it and sufficient gas obtained, it was capped and used. The casing is 13 inches to 800 feet, thence 11 inches to 1,100 feet, 9 inches to 1,150 feet, and 6 inches to 1,500 feet.

In November, 1893, work on the Grant Street well was suspended, in order that the Stockton Natural Gas Company, which owns it, might use it during the winter.

The following table will give an idea of the yield and cost of boring of Stockton wells. The yield from the Asylum wells was estimated by a field assistant at a time when it was said that no gas was being used from this source:

Name of well.	Yield of gas in 24 hours.	Cost of well and plant.	Depth of well.	Monthly saving effected by the use of gas.	Owners and remarks.
Asylum well:	*Cu. ft.*		*Feet.*		
No. 1			1,750		
No. 2	34,000		1,992	$500	
Court-house well	30,000	$12,000	1,917	300	
St. Agnes well:					
No. 1			960		
No. 2	20,000	10,000	1,720	100	
Jackson well:					
No. 1	16,700		1,665		Gas sold to Stockton Gas Light and Heat Company.
No. 2	14,000	12,000	1,400		
Haas well:					
No. 1	80,000		*3,000		Stockton Natural Gas Company, whose rates are $1 per 1,000 feet or less, and 50 cents for each additional 1,000 feet. Payable weekly.
No. 2	43,000		2,000		
Citizens' well	50,000	26,000	2,061		Private company, whose rates are $1 per each 1,000 feet up to 5,000, and 60 cents per each 1,000 feet in excess of 5,000 feet. Payable monthly.
Central well	19,400	15,000	1,500		Used by stockholders of the company.

* Reported to be nearly 3,000 feet.

To ascertain whether such a supply of gas as that found at Stockton was to be looked for by boring in other portions of the Central Valley, including the valleys of Sacramento and San Joaquin, the mining bureau instituted a comparison of the geological conditions of that city with those prevailing throughout the Sacramento and San Joaquin valleys. In the Sacramento Valley the gas-yielding rocks were found to be Cretaceous, and in the San Joaquin both Cretaceous and Tertiary, the gas being stored in more recent porous strata underlying sheets of clay which reach to near the surface, and there probably augmented from organic remains. These porous formations are, under the San Joaquin Valley, several thousand feet thick, and are thought to be coextensive with the central portion of the valley, whose sides are connected with the gas-yielding rocks by sandy or isolated from them by clayey strata. From the relative richness of the rocks in hydrocarbons the conditions seem more favorable in the San Joaquin Valley than in the Sacramento. At Stockton the average thickness of the gas-yielding strata for wells 1,600 to 1,700 feet deep is 150 feet, and below 1,700 feet practically all the porous strata yield gas.

In nearly all the wells water has been struck. This decreases the yield of the gas by impeding its flow and lowers the quality by diluting it with nitrogen drawn down when the water sinks into the ground. For the gas found in the Central Valley of California the State mining bureau has found the following values as compared with coke carrying 10 per cent ash:

1,000 cubic feet of average Stockton gas equals 50 pounds of coke.
1,000 cubic feet of gas from old well at Sacramento equals 34 pounds of coke.
1,000 cubic feet of gas from spring on Barker ranch equals 58 pounds of coke.
1,000 cubic feet of gas from well, Sunset oil district, Kern County, equals 53 pounds of coke.

Other cities than Stockton in the San Joaquin Valley could doubtless obtain supplies of gas at less than 3,000 feet, and practical quantities might, too, be found at places in the Sacramento. It is a significant fact that the gas-yielding formations of these valleys are near to the mines of the Sierra, to beds of pottery clay, and to sand suitable for glass manufacture, the localities of the principal wells possessing water communication with San Francisco.

The Humboldt Land and Oil Company's well, Humboldt County, was sunk during the summer of 1893 in the Upper Matole country, in T. 4 S., R. 2 E., through gray shale, with an occasional seam of some harder clay rock, to a depth of 800 feet, when it was capped, oil sand poor in oil having been reached at 695 feet. Casing $7\frac{1}{8}$ and $5\frac{5}{8}$ inch was used to the oil sand only. Some gas came up at 135 feet, and at 700 feet a strong flow. To the east the coarse gray oil sand crops out, showing 20 feet and dipping 60 degrees northeast.

The Sacramento Natural Gas and Water Company have bored two wells in that city. One went to a depth of 876 feet, through clay, gravel, cement, and quicksand, the lower portion being a hard, porous, sandy cement. Water was struck at 281 feet and gas at 392 feet, the flow of both increasing with depth. In twenty-four hours this well yielded some 2,000 feet of gas. In March, 1893, another was commenced near by, and bored 965 feet through much hard rock, when a sand pump became lodged in the bottom. It yields water and gas.

In August, 1893, a well was commenced on the Prather ranch, owned by the Shasta Land and Cattle Company, near Montague, in Siskiyou County, in search of flowing water, gas, and oil. It was undertaken by the Shasta Land and Development Company, of Oakland. The well borer, C. W. Fox, states as follows:

The formation penetrated consists principally of grayish sandstone interstratified with black sand and white quartz pebbles. At the depth of 88 feet an auriferous cemented gravel was encountered, which is about 18 feet in thickness. At 138 feet a few fossil shells were brought up by the sand pump. At 280 feet about 4 miner's inches of fresh water flowed from the casing. At 400 feet inflammable gas was struck, and it burned with a flame about 18 inches above the top of the casing. The gas increased as the well was bored deeper, and at a depth of about 1,300 feet it burned with a flame about 7 feet above the top of the casing. This well is 10 inches for the first 500 feet; then it was reduced to 8 inches.

Inflammable gas is said to have been discovered arising from a saline spring on the Evarts ranch, in the Capay Valley of Yolo County.

The facts given above are obtained from the Twelfth Annual Report of the State Mineralogist of California.

The production of natural gas in California from 1889 to 1894 is as follows:

Value of natural gas consumed in California from 1889 to 1894.

Years.	Value of gas consumed.
1889	$12,680
1890	33,000
1891	30,000
1892	55,000
1893	62,000
1894	60,350

COLORADO.

The most of the gas found in Colorado is in the neighborhood of Florence, and is found in connection with the oil production of the district.

The town of Florence, Colo., gets the main part of its gas supply from two companies—the United Oil Company, which has 84 wells, and the Florence Oil and Refining Company, with 45 wells. The Rocky Mountain Oil Company, which is farther from town, has gas in most of its 36 wells, and the Triumph Oil Company has some gas which is piped into town for domestic use. The three first-mentioned companies, in the order named, have bored from 50 to 84 oil wells each, and natural gas is found in most of them. The average pressure is from 4 to 6 pounds, but some have run as high as 40 pounds. The largest well in this district was struck in December, 1894, by the United Oil Company. This well is said to be sufficient to supply three towns the size of Florence.

Some years ago gas was found at Rockvale, 4 miles west of Florence, and since that time the use of natural gas here has increased. It is used for lighting and fuel, although good lump coal is delivered in the city at $2.75 per ton.

ASPHALTUM.

By Edward W. Parker.

Total product in 1894, 60,570 short tons; total value, $353,400.

VARIETIES.

The varieties, qualities, and values of the several bitumens or hydrocarbons which have asphalt for a base are so widely different that they might very properly be treated as separate minerals. Unlike the petroleums, or hydrocarbons having paraffin for a base, they belong to no regular series of chemical compounds, but each variety seems to possess a composition or a mixture of chemical compounds peculiarly its own. Physically, the asphaltic bitumens vary from a very hard, glistening variety similar in appearance to anthracite coal to a liquid form known as maltha or brea, not unlike some of the heavier petroleums in appearance. Such forms as gilsonite, elaterite, uintite, albertite, wurtzilite, and grahamite are hard and brittle at ordinary temperatures. From these they grade down to the viscous, semifluid maltha and the liquid form so similar to petroleum. One variety of asphaltum known as ozokerite is very similar in appearance, when refined, to ordinary beeswax, and is known in the trade as mineral wax. While some of the asphaltums are found in a comparatively pure state, the bulk of the product consists of either a sandstone or limestone thoroughly impregnated with the bitumen, and these are known commercially as bituminous sandstone or bituminous limestone, as the case may be.

OCCURRENCE.

Asphaltum in some of its varied forms occurs in a number of States along the eastern slope of the Appalachian range, but none has been mined on a commercial scale during the last decade or since the first volume of Mineral Resources was published. Some little grahamite has been mined in West Virginia, but more for cabinet specimens than anything else. It is known locally as Ritchie mineral, from Ritchie County, in which it is found. On the western slope of the Alleghanies it occurs in Grayson, Breckinridge, and Hardin counties, in Kentucky, and in Ohio. In both of these States it occurs as bituminous sandstone, and considerable quantities have been mined, particularly in Kentucky, where operations are now being carried on, over 5,000 short tons having been produced there in 1894. By far the largest deposits, however, are west of the Mississippi River. The principal localities are in Kern, Santa Barbara, Santa Cruz, San Luis Obispo, and Ventura counties, Cal.; in Uinta County, Utah; in Pickens County, Okla.; in

Montague, Henderson, and Uvalde counties, Tex., and in Montana. The asphaltums of California consist of hard asphaltum, bituminous sandstone, and liquid asphaltum. They have been thoroughly described in previous volumes of Mineral Resources, particularly in that for 1893, page 629. Utah produces the purest form of asphaltum found in the United States, if not in the world. This is known as gilsonite, or gum asphaltum, and contains over 90 per cent of pure bitumen. The applications of this material for commercial purposes are given in Mineral Resources in 1893, page 636. In Pickens County, Okla., the substance occurs in bituminous sandstone, and while some development work has been done on these properties there has been no product mined for the market. In Texas a peculiar form of asphaltum is found in Uvalde County, to which has been given the name of "lithocarbon." It occurs in a bed of limestone shells thoroughly saturated with the bitumen. The bitumen itself is hard at an ordinary temperature and possesses peculiar elastic qualities, which make it quite valuable as a covering for metal sheathing where it is subjected to bending. Other large deposits of bituminous sandstone have been found in the same county, but they have not yet been thoroughly exploited. None of the other deposits in Texas have been worked on a commercial scale. The Montana asphaltum, which is a bituminous sandstone, has not been mined for market. Dr. William C. Day, of Swarthmore College, Pennsylvania, has been making a study of the various bitumens, and the result of his investigation of the Montana material will be found on a subsequent page. Asphaltum deposits have also been noted in Arizona, Idaho, Nevada, New Mexico, Wyoming, Oregon, and Washington.

PRODUCTION.

The total amount of asphaltum and bituminous rock produced in the United States in 1894 was 60,570 short tons, valued at $353,400. Compared with 1893 this shows an increase in product of 12,791 short tons, but a decrease in value of $18,832. The increased production was due to greater activity at the bituminous sandstone mines, both in California and Kentucky, while a decrease in the production of the purer forms of asphaltum in California and Utah is accountable for the comparative falling off in value. There was no bituminous limestone mined in Utah during 1894. The product, therefore, was limited to bituminous sandstone and hard, or gum, and liquid asphaltum. The production of these materials in 1894 is shown in the following table:

Production of asphaltum and bituminous rock in 1894.

Products.	Short tons.	Value.
Asphaltum	9,790	$195,800
Bituminous rock	50,780	157,600
Total	60,570	353,400

Divided by States, the product was as follows:

Production of asphaltum, etc., in 1894, by States.

States.	Short tons.	Value.
California	51,187	$251,991
Kentucky	5,383	21,409
Utah	1,000	35,000
Texas	3,000	45,000
Total	60,570	353,400

The following table shows the annual production of asphaltum and bituminous rock in the United States since 1882:

Production of asphaltum and bituminous rock since 1882.

Years.	Short tons.	Value.	Years.	Short tons.	Value.
1882	3,000	$10,500	1889	51,735	$171,537
1883	3,000	10,500	1890	40,841	190,416
1884	3,000	10,500	1891	45,054	242,264
1885	3,000	10,500	1892	87,680	445,375
1886	3,500	14,000	1893	47,779	372,232
1887	4,000	16,000	1894	60,570	353,400
1888	50,450	187,500			

CALIFORNIA.

The asphaltum deposits of California have been thoroughly discussed in previous volumes of Mineral Resources, particularly in the volume for 1883 and 1884, by Mr. E. W. Hilgard, and the information concerning them brought up to date in the volume for 1893. Mr. S. F. Peckham contributes the following in regard to the asphaltum deposits of Southern California:

Since the appearance of Mineral Resources for 1893 no new discoveries of asphaltum have been made in this region. The proprietors of the deposit at Santa Maria, in San Luis Obispo County, have taken out a small quantity of asphaltic sandstone which has been successfully used in Denver, Colo.

The California Petroleum and Asphalt Company, with mines at La Patera, above Santa Barbara, on the coast, and works for extracting maltha from the sand at Carpenteria, on the coast below Santa Barbara, has supplied a moderate demand for its products, but during the year has been largely engaged in introducing approved machinery and other appliances for more extensive operations in the future. At Asphalto, in Kern County, the extensive deposits of asphaltum described in Mineral Resources for 1893 have been further explored and further evidence obtained to show the enormous extent of the deposit. As in previous years, the Standard Asphalt Company has disposed of an output of moderate amount, the greater part, if not all, of which has been refined in the plant at Asphalto.

The total amount of hard and liquid asphaltum produced in California during 1894 was 5,790 short tons, and of bituminous rock 45,397 short tons, the aggregate value of which was $251,991.

UTAH.

The product from Utah includes the very pure form of bitumen known as gilsonite, or gum asphaltum, and a bituminous limestone. None of the latter was mined during 1894, while the product of gilsonite or gum asphaltum was 1,000 tons, valued at $35,000. In the production of gilsonite the operators labor under the disadvantage of having to haul the product from 60 to 90 miles in wagons to railroad transportation. Owing to the very pure nature of the material there is a good demand for it, even at the great cost occasioned by heavy transportation expenses. Gilsonite is used in the manufacture of black Japan and other varnishes and insulating compounds of various kinds. It is especially useful for covering iron plates on ship bottoms, for a cement for sea walls of brick or masonry, and for covering piling subjected to teredo and other salt-water insects. It is also useful as a lining for chemical tanks and sinks, for preserving iron pipes from corrosive action of acids, rust, etc., and for covering wood or metal liable to decay upon exposure to the atmosphere. It is also valuable as an insulator for electric wires, one-eighth of an inch insulation of gilsonite having stood a current of 1,200 volts.

TEXAS.

The commercial product in Texas in 1894 was from the lithocarbon properties in Uvalde County, mention of which has been made in previous volumes of Mineral Resources. Other properties are being developed, however, in particular some very extensive deposits of bituminous sand stone, but, owing to the complications likely to arise in, the acquirement of title, the owners will not furnish any information for publication.

KENTUCKY.

The entire product of Kentucky is bituminous sandstone, all of which is used for street paving in the interior cities. The product in 1894 was 5,383 short tons, valued at $21,409, against 1,129 short tons, valued at $6,570, in 1893.

MONTANA.

A considerable deposit of asphalt has been noticed in Park County, Mont. The material is unusually pure, as is shown by the following examination by Dr. William C. Day, of Swarthmore College. The material is not solid at ordinary temperatures, but liquid enough to pour slowly. The ash contained in it amounts to 0.69 per cent. The asphalt contains quite a mass of foreign material, such as leaves and the claws and feathers of birds and fragments of insects, which must have been caught in the material.

DETERMINATION OF MATTER SOLUBLE IN CARBON BISULPHIDE.

This was done by treating a weighed sample in a flask with carbon bisulphide and filtering. The treatment with carbon bisulphide was repeated until everything soluble was perfectly extracted. The carbon bisulphide solution was then evaporated upon a water bath and the residue weighed. Percentage of material soluble in carbon bisulphide (bitumen), 95 per cent.

The material thus found soluble in carbon bisulphide is the bitumen contained in the asphalt. The Bermudez asphalt contains 97.22 per cent bitumen, which is a higher figure than has been found for Trinidad asphalt. In that the Montana material compares favorably in the bitumen contained in it with Bermudez asphalt, which, according to the report of experts in Philadelphia (who have recently made comparative tests on Bermudez and Trinidad asphalts), is better than the Trinidad for paving purposes.

DETERMINATION OF MATERIAL SOLUBLE IN GASOLINE.

The method of treatment was the same as that employed with carbon bisulphides. Percentage of material soluble in gasoline (petrolene), 80.

The insoluble material, like that from the carbon bisulphide, consisted of leaves, bugs, feathers, flies and other insects, so that had these materials not been present the percentage of petrolene would have been higher.

A combustion of the material gave the following result as to total carbon and hydrogen:

Percentage of carbon found	79.81
Percentage of hydrogen found	9.29

The percentage of sulphur was 2.83.

The following distillation experiments were made:

Seventy-four grams of the substance were introduced into a distilling flask by aid of a filter pump; the viscosity of the material was such that it took several hours to transfer about 100 cubic centimeters to the flask.

A Bunsen flame was applied directly to the flask; the material frothed considerably, giving a gas which was collected and measured. The gas given off at this stage amounted to 2,250 cubic centimeters. When a thermometer placed with the bulb in the vapor (i. e., a little below the side tube of the distilling flask) showed 98° C. the frothing ceased and a liquid distilled over between 98° and 110°; the weight of this fraction was 6.75 grams. The second fraction was taken between the limits 110° and 170°; its weight was 2.3 grams. The third fraction was taken between 170° and 225°; its weight was 8.75 grams. The last fraction was from 225° to the limit of the thermometer; it weighed 22.5

grams. The last fraction was accompanied by the more rapid evolution of gas which had decreased at 98°. Between 98° and 225°, 1,000 cubic centimeters of gas were produced.

The amount of gas evolved at this final stage was 2,500 cubic centimeters, thus making in all 5,750 cubic centimeters of what, on burning, proved to be a good illuminating gas. The residue left in the retort after distillation looked like valuable material for paving, being at ordinary temperatures hard and brittle, with a lustrous conchoidal fracture.

IMPORTS.

The imports of asphaltum into the United States include hard asphaltum from Cuba, Trinidad asphaltum from the Island of Trinidad, off the coast of Venezuela, South America, and bituminous limestone from Neufchatel and Val de Travers, in Switzerland, and Seyssel, in France.

The following table shows the imports of crude asphaltum since 1867:

Asphaltum imported into the United States from 1867 to 1894.

Years ended—	Quantity.	Value.	Years ended—	Quantity.	Value.
	Long tons.			*Long tons.*	
June 30, 1867	....	$6,268	June 30, 1881	12,883	$95,410
1868	185	5,632	1882	15,015	102,698
1869	203	10,559	1883	33,116	149,999
1870	488	13,072	1884	36,078	145,571
1871	1,301	14,760	1885	18,407	88,087
1872	1,474	35,533	Dec. 31, 1886	32,565	108,528
1873	2,314	38,298	1887	30,808	95,735
1874	1,183	17,710	1888	36,494	84,045
1875	1,171	26,006	1889	61,952	138,163
1876	807	23,818	1890	73,861	223,368
1877	4,532	36,550	1891	102,433	299,350
1878	5,476	35,932	1892	120,255	336,868
1879	8,084	39,635	1893	74,774	196,314
1880	11,830	87,889	1894	102,505	313,680

STONE.[1]

By William C. Day.

VALUE OF VARIOUS KINDS OF STONE PRODUCED IN 1893 AND 1894.

The following table shows the production of the various kinds of stone in the United States in the years 1893 and 1894:

Value of different kinds of stone produced in the United States during the years 1893 and 1894.

Kinds.	1893.	1894.
Granite	$8, 808, 934	$10, 029, 156
Marble	2, 411, 092	3, 199, 585
Slate	2, 523, 173	2, 790, 324
Sandstone	5, 195, 151	3, 945, 847
Limestone	13, 947, 223	16, 512, 904
Bluestone	*a*1, 000, 000	*a* 900, 000
Total	33, 885, 573	37, 377, 816

a Estimated.

An inspection of this table shows a gain of $3,492,243 for the year 1894 for all the kinds of stone considered. Production of granite, marble, slate, and limestone has increased, while a falling off is evident in the cases of sandstone and bluestone.

The gain in granite output is due to the increased business of quite a small number of important producers, chiefly in New England. Many small producers have not, however, enjoyed prosperity; in not a few instances, indeed, quite the reverse has been true, even to the extent of a complete shutting down of all operations on the part of some, owing to the depression which has been felt by all commercial enterprises during the past two years.

The increase in marble output is due to increased activity in Georgia and New York.

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[1] To Mr. William A. Raborg, of the United States Geological Survey, I am especially indebted for the intelligence and unremitting zeal with which he has cooperated in the difficult work of securing and tabulating the statistics of this report.

It is almost unnecessary to state that the statistical data of this report are obtained by direct individual correspondence with the stone producers of the United States. To the thousands of quarrymen who have courteously and promptly replied to the inquiries addressed to them in connection with this and former reports, my grateful acknowledgments are due. The feeling of cooperation shown by quarrymen in contributing to the value of the report by their replies, and the interest which they have always shown in the published results, make the duty of distributing among them copies of this article a gratifying one.

In the preparation of this report I have been aided by a number of the technological articles and items which have appeared from time to time in the journal "Stone," and which are elsewhere individually credited, and also by the courteous cooperation of the editor of that journal in calling the attention of stone producers to the importance of replying promptly and fully to the inquiries addressed to them.

In the consideration of the constituent minerals of the granitic rocks, I have followed, in general, the classifications adopted in the Tenth Census Report on the Building Stones of the United States.

The slate industry during the past year has been recovering lost ground to some extent, but the activity shown in 1894 is very noticeably less than that which has characterized the early part of the present year, 1895.

For reasons given further on in connection with the sandstone article, the production of sandstone has fallen off very decidedly.

Limestone shows a very marked increase, but this may be accounted for in part by the exceptionally thorough and searching canvass of the limestone producers which has been made in compiling the statistical data for 1894.

The figure for bluestone is an estimate, but is made on satisfactory evidence of a general character and is probably quite close to the truth in showing, as it does, a falling off in valuation. Prices for bluestone have been declining for sometime past.

VALUE OF STONE PRODUCED IN 1894, BY STATES.

The following table shows the values of the different kinds of stone produced in 1894, by States:

Value of various kinds of stone produced in 1894, by States.

States.	Granite.	Sandstone.	Slate.	Marble.	Limestone.	Total.
Alabama		$18,100			$210,269	$228,369
Arizona					19,810	19,810
Arkansas	$28,100	2,365			38,228	68,693
California	307,000	10,087	$5,850	$13,420	288,900	625,257
Colorado	49,302	69,105			132,170	250,577
Connecticut	504,390	322,934			204,414	1,031,738
Delaware	173,805					173,805
Florida					30,639	30,639
Georgia	511,804	11,300	22,500	724,385	32,000	1,301,989
Idaho		10,529		3,000	5,315	18,844
Illinois		10,732			2,555,952	2,566,684
Indiana		22,120			1,203,108	1,225,228
Iowa		11,639			616,630	628,269
Kansas		30,265			241,039	271,304
Kentucky		27,868			113,934	141,802
Maine	1,551,036		146,838		810,089	2,507,963
Maryland	308,966	3,450	153,068	175,000	672,786	1,313,270
Massachusetts	1,994,830	150,231			195,982	2,341,043
Michigan		34,066			336,287	370,353
Minnesota	153,936	8,415			291,263	453,614
Missouri	98,757	131,687			578,802	809,246
Montana	5,800	16,500			92,970	115,270
Nebraska					8,228	8,228
Nevada	1,600					1,600
New Hampshire	724,702					724,702
New Jersey	310,965	217,941	1,050		193,523	723,479
New Mexico		300			4,910	5,210
New York	140,618	450,992	44,542	501,585	1,378,851	2,516,588
North Carolina	108,993					108,993
Ohio		1,777,034			1,733,477	3,510,511
Oregon	4,993					4,993
Pennsylvania	600,000	349,787	1,620,158	50,000	2,625,562	5,245,507
Rhode Island	1,211,439				20,433	1,231,872
South Carolina	45,899				25,100	70,999
South Dakota	8,806	9,000			3,663	21,469
Tennessee				231,796	188,664	420,460
Texas		62,350			41,526	103,876
Utah		15,428			23,696	39,124
Vermont	893,956		658,167	1,500,399	408,810	3,461,332
Virginia	123,361	2,258	138,151		284,547	548,317
Washington	166,098	6,611			59,148	231,857
West Virginia		63,865			43,773	107,638
Wisconsin		94,888			798,406	893,294
Wyoming		4,000				4,000
Total	10,029,156	3,945,847	2,790,324	3,199,585	16,512,904	*a* 37,377,816

a Includes $900,000, the value of production of bluestone.

THE GRANITE INDUSTRY.

THE TERM "GRANITE" AS USED IN THIS REPORT.

The term "granite," as it is used in this report, might more properly, from the strictly scientific standpoint, be replaced by the designation "crystalline siliceous rocks." Since, however, the report is of interest chiefly as a statistical production, and is intended to give to those interested in the commercial aspects of the subject information bearing upon not only the true granites, but also upon those rocks whose general properties and industrial applications are the same as those of true granites, it has been thought wiser to use the term "granite" as it is understood by quarrymen. Most of the material included under this head is really true granite, but some of it is granite only in the commercial sense of the term. The tables giving the values of granite output in the various States of the country show, therefore, no distinction between true granites, syenites, trap rocks, gneisses, and crystalline schists.

COMPONENTS OF GRANITE.

The essential components of the true granites are quartz and feldspar. Quite a number of other minerals are, however, to be found in the granites, and these have been classified by Mr. G. P. Merrill, in the Tenth Census report on stone, as follows:

Essential.

Quartz.
Feldspar.
- Orthoclase.
- Microcline.
- Albite.
- Oligoclase.
- Labradorite.

Characterizing accessories.

Mica.
- Muscovite.
- Biotite.
- Phlogopite.
- Lepidolite

Hornblende.
Pyroxene.
Epidote.
Chlorite.
Tourmaline.
Acmite.

Microscopic accessories.

Sphene.
Zircon.

Microscopic accessories—Continued.

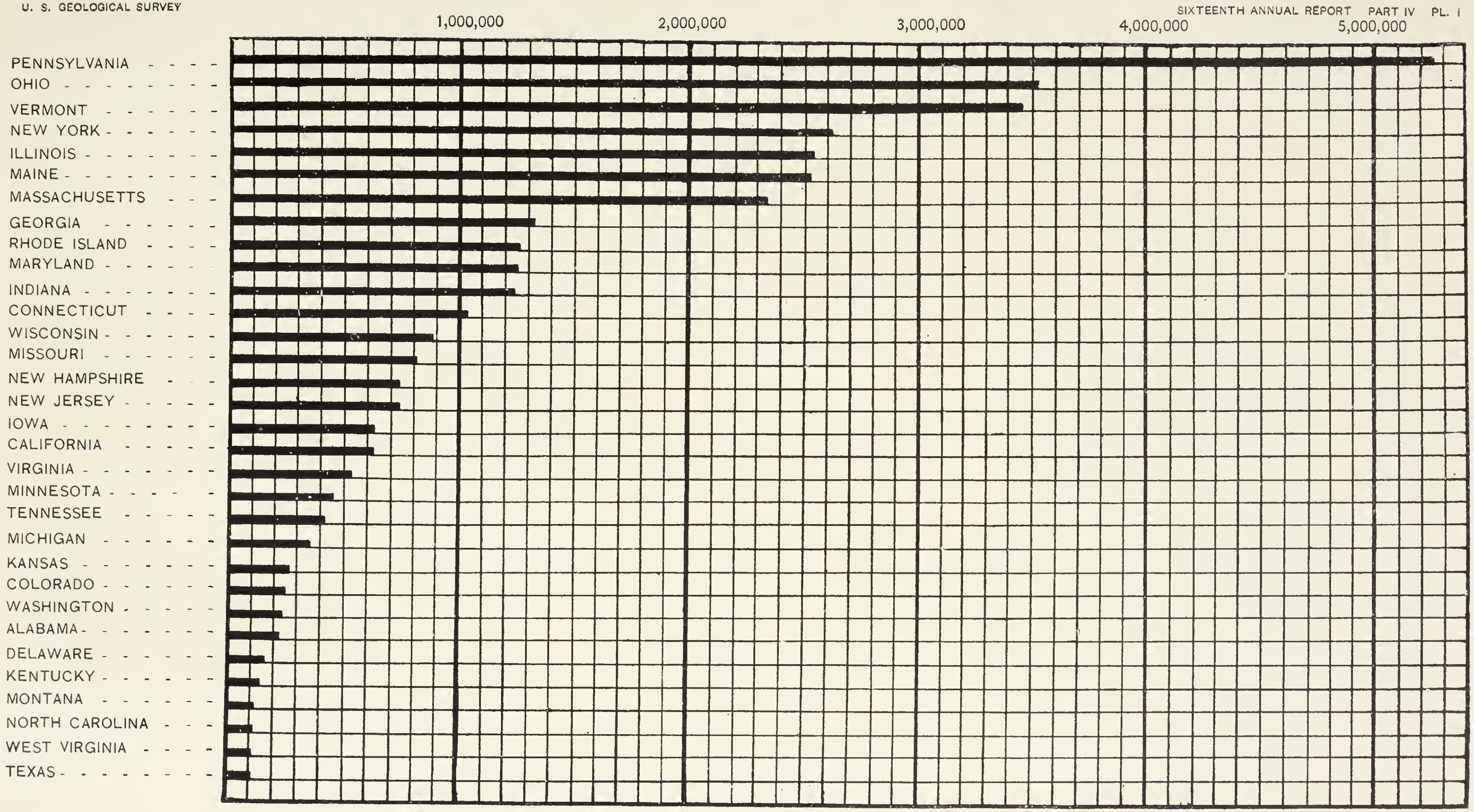
Garnet.
Danalite.
Rutile.
Apatite.
Pyrite.
Pyrrhotite.
Magnetite.
Hematite.
Titanic iron.

Decomposition products.

Chlorite.
Epidote.
Uralite.
Kaolin.
Iron oxides.
Calcite.
Muscovite.

Inclosures in cavities.

Water.
Carbon dioxide.
Sodium chloride.
Potassium chloride.



VALUE OF THE DIFFERENT KINDS OF STONE PRODUCED IN THE VARIOUS STATES DURING THE YEAR 1894.

(In millions of dollars.)

The following statements relative to the minerals to be found in granites is a condensed abstract of matter contained in the Tenth Census report on stone, referred to above:

Of the two essential minerals, quartz and feldspar, the former is invariable in composition; but in the form of the particles and in appearance it is quite variable. As is evident from the enumeration of the various kinds of feldspar already given, there is much latitude for differences in granites, due to the feldspathic constituent. According to the kinds of feldspar present, the granite shows a number of variations in color, which may due to the color of the feldspar itself or to its transparent or semitransparent character, and its consequent effect upon light. Red and pink granites owe their color to the feldspars contained in them; dark effects in granite are sometimes caused by the absorption of light effected by transparent crystals of feldspar. While the hardness of quartz is always much the same, that of the feldspars is subject to considerable variation in its resistance to the stonecutter's tools.

The variation in the amounts and the kinds of accessory ingredients is great, and these determine very largely the character of the stone as to its resistance to disintegrating agencies, its strength, its color, and its susceptibility to ornamentation or polish. Of these accessories mica is the most common. White muscovite gives a light effect to the stone, but if it appears in the form of black biotite the granite is dark in general tone. Much interest attaches to mica as a granitic constituent, for, while its color effect may be very attractive, it does not polish so well as the other constituents, nor does it retain polish so well, frequently becoming dull on exposure. In stone for polishing the manner of occurrence of the mica particles is of importance as well as their amount. Numerous fine particles are less objectionable, if scattered promsicuously, than are occasionally occurring larger crystals.

Mica is frequently replaced wholly or in part by the minerals hornblende and pyroxene. Both minerals are frequently present in the same rock. Hornblende is more desirable than mica as a constituent of granite, having cleavage in two planes instead of one, as in mica, and polishing much more easily. Pyroxene is more brittle than hornblende, and is therefore liable to break out in polishing, leaving little pits which mar the surface. The presence of pyroxene in granite is sometimes a source of much vexation to the quarryman and stonecutter. Of the three minerals, mica, hornblende, and pyroxene, the second is, all things considered, the most desirable as a constituent of granite.

CLASSIFICATION OF UNITED STATES GRANITES.

According to the Tenth Census report on stone, the granites quarried throughout the United States may be classed as follows:

Muscovite granite, biotite granite, muscovite-biotite granite, hornblende granite, hornblende-biotite granite, epidote granite, granitel (or granite without any accessory). Lines of distinction between these varieties are by no means sharply drawn, one kind gradually merging into another in many cases.

Muscovite granite.—This variety is always light in color, from the nearly colorless character of the muscovite. Comparatively little is quarried in the United States. A highly important example is that produced at Barre, Vt.

Biotite granite.—The biotite granites are the most widespread of all the varieties named above. In color they vary from light to very dark, according to the amount of mica present and the color of the feldspar. Many of the red granites belong to this class, the red color being due to red feldspar. The granites of this class are, as a rule, tough and hard. Good examples are the granites from Dix Island, Maine, Westerly, R. I., and Richmond, Va.

Muscovite-biotite granite.—As the name implies, this granite stands between the two already considered. The essential constituents are quartz. orthoclase, muscovite, and biotite. The Concord, N. H., granite is a good example of this variety; similar to it is the stone from quarries at Allenstown, Sunapee, and Rumney.

Hornblende granite.—In addition to the hornblende contained in this granite as the characterizing accessory, black mica is in nearly all cases likewise to be found. Biotite is found as a microscopic constituent in many hornblende granites, and the name "hornblende granite" is, therefore, restricted to those in which no biotite is visible to the naked eye. Granite belonging to this class is quarried at Peabody, Mass., and also at Mount Desert, Me.

Hornblende-biotite granite.—Some of the most beautiful of our granites belong to this class, notably so-called black granite from St. George, Me., and some of that quarried at Cape Ann, Massachusetts, and at Sauk Rapids, Minn. The essential constituents are quartz, orthoclase, hornblende, and biotite. These granites are susceptible of fine and lasting polish.

Epidote granite.—The granites of this class in the United States are rare, an example being that quarried at Dedham, Mass. The rock works easily and takes a good polish.

Syenite.—The absence of quartz in a granite, or its presence only to the extent of forming an accessory constituent, determines its classification as a syenite. Fine syenites are known to occur, but they have not been extensively quarried.

Gneiss.—Stratification determines the classification of granite as gneiss. Its cleavage enables it to be quarried in the form of slabs suitable for curbing and similar uses in which slabs are desirable. The stratification is largely determined by the uniformity in the direction of the flat cleavage planes of the mica present in it. The terms "bastard granite" and "stratified granite" are commonly used in reference to gneiss. The only essential difference between granite and gneiss being in the matter of stratification in the latter, there is good reason for the use of the single term "granite" as applied to gneiss.

Mica schist.—The minerals present in this rock are essentially quartz and mica. It differs from gneiss in its lack of feldspar. This variety is easily quarried, and is well adapted to foundation construction and bridge work, but it is not in general favor for fine superstructures.

Diabase.—This term includes rocks commonly called trap rock and black granite. The essential minerals are augite and triclinic feldspar. Microscopic accessories are magnetite, titanic iron, and frequently apatite and black mica. These rocks are eruptive and occur in dikes. Examples of this variety are the products of quarries at Weehawken, N. J., and other localities in the same State, and in Pennsylvania and Virginia.

Basalt.—This rock differs from diabase in being of finer texture and of more recent origin. In California this rock is extensively employed in the manufacture of paving blocks.

Porphyry.—In this rock the constituent minerals, essentially quartz and orthoclase feldspar, are exceedingly minute, making the rock compact and close-grained. They are of eruptive origin and occur in dikes, like trap rocks. They show considerable variation in color, are almost indestructible, and take a fine polish. They are cut with difficulty and their hardness and lack of stratification constitute serious obstacles in quarrying. In this connection the reader is reminded of the interesting rediscovery of the ancient Egyptian quarries of porphyry described in the Report on Mineral Resources for 1893. Steps have been taken toward the reworking of these long-abandoned quarries by Messrs. Farmer and Brindley, of London. Quartz-porphyry is found at Fairfield, Pa.. and at Stone Mountain, Missouri.

GEOGRAPHICAL DISTRIBUTION OF THE VARIOUS CLASSES OF GRANITE.

The following list, from the writer's report on granite for the Eleventh Census, gives a general idea of the geographical distribution of granite, and indicates most of the particular kinds that have been or are now being quarried in the various localities mentioned:

ARKANSAS.

Hornblende-biotite granite	Pulaski County.
Elæolite syenite	Garland County.

CALIFORNIA.

Biotite granite	Placer County.
Hornblende-biotite granite	Placer and Sacramento counties.
Hornblende granite	Placer County.
Quartz diorite	Placer County.
Basalt	Solano, Sonoma, and Alameda counties.
Andesite	Shasta County.
Andesitic tufa	Solano County.
Quartz porphyry	San Bernardino County.
Basaltic tufa	Tehama County.

COLORADO.

Biotite granite	Clear Creek and Jefferson counties.
Muscovite gneiss	Clear Creek County.
Diorite	Chaffee County.
Rhyolite	Chaffee and Conejos counties.
Rhyolitic tufa	Douglas County.
Basalt	Jefferson County.

CONNECTICUT.

Biotite granite	Litchfield, New Haven, New London, and Fairfield counties.
Muscovite-biotite granite	Litchfield County.
Muscovite-biotite gneiss	Litchfield County.
Biotite gneiss	Litchfield, New Haven, New London, Windham, Tolland, and Hartford counties.
Hornblende-biotite gneiss	Middlesex and Fairfield counties.
Diabase	New Haven County.

DELAWARE.

Augite-hornblende gneiss	Newcastle County.

GEORGIA.

Muscovite granite	Dekalb County.
Hornblende-biotite gneiss	Fulton County.

MAINE.

Biotite granite	Knox, York, Washington, Lincoln, Waldo, Oxford, Kennebec, and Hancock counties.
Biotite gneiss	Lincoln, Franklin, and Androscoggin counties.
Muscovite-biotite granite	Kennebec, Waldo, and Franklin counties.
Hornblende-biotite granite	Penobscot and Knox counties.
Hornblende granite	Hancock County.
Olivine diabase	Washington County.
Diabase	Washington and Knox counties.

MARYLAND.

Biotite granite	Baltimore, Howard, and Montgomery counties.
Biotite gneiss	Cecil and Baltimore counties.
Gabbro	Baltimore County.

MASSACHUSETTS.

Hornblende granite	Norfolk and Essex counties.
Hornblende-biotite granite	Essex County.
Epidote granite	Norfolk County.
Biotite granite	Norfolk, Middlesex, Bristol, Worcester, and Plymouth counties.
Biotite-muscovite granite	Worcester and Berkshire counties.
Biotite gneiss	Franklin County.
Muscovite gneiss	Middlesex, Essex, Worcester, and Hampden counties.
Diabase	Middlesex and Hampden counties.
Melaphyre	Suffolk County.

MINNESOTA.

Hornblende granite	Sherburne, Benton, and Lake counties.
Hornblende-mica granite	Benton County.
Quartz porphyry	Lake and St. Louis counties.
Diabase	St. Louis County.
Olivine diabase	Chisago County.
Gabbro	St. Louis County.

MISSOURI.

Hornblende-biotite granite	Iron and St. François counties.
Granite	Iron County.
Olivine diabase	Iron County.

MONTANA.

Hornblende-mica granite	Lewis and Clarke County.

NEVADA.

Hornblende andesite	Washoe County.

NEW HAMPSHIRE.

Biotite-muscovite granite	Merrimack, Cheshire, Hillsboro, Grafton, Sullivan, and Strafford counties.
Biotite granite	Cheshire, Hillsboro, Grafton, and Rockingham counties.
Hornblende-biotite granite	Carroll County.
Muscovite-biotite gneiss	Cheshire and Hillsboro counties.
Biotite-epidote gneiss	Grafton County.

NEW JERSEY.

Biotite gneiss	Passaic County.
Hornblende granite	Morris County.
Diabase	Hudson County.

NEW YORK.

Biotite granite	Putnam County.
Hornblende-mica granite	Jefferson County.
Norite	Essex County.
Biotite gneiss	Westchester and Rockland counties.

NORTH CAROLINA.

Biotite granite	Warren, Franklin, Gaston, Granville, Alamance, Davidson, Mecklenburg, Iredell, Forsyth, Guilford, Richmond, and Anson counties.
Muscovite granite	Warren County.
Granite	Rowan and Orange counties.
Biotite-muscovite granite	Rowan County.
Hornblende-biotite granite	Mecklenburg County.
Biotite gneiss	Cleveland, McDowell, Caldwell, Wilson, Stokes, Iredell, Wake, and Guilford counties.
Hornblende gneiss	Burke County.

OREGON.

Granite	Jackson and Columbia counties.
Diabase	Linn County.
Basalt	Clackamas and Columbia counties.
Andesite	Multnomah County.

PENNSYLVANIA.

Biotite gneiss	Philadelphia and Delaware counties.
Muscovite gneiss	Philadelphia and Berks counties.
Biotite-muscovite gneiss	Delaware County.
Diabase	Adams, York, Berks, and Lancaster counties.
Diorite	Berks County.
Hornblende gneiss	Philadelphia County.

RHODE ISLAND.

Biotite granite	Washington, Kent, and Providence counties.
Granite	Washington County.
Biotite gneiss	Providence County.
Hornblende gneiss	Providence County.

SOUTH CAROLINA.

Biotite granite	Fairfield, Charleston, Aiken, Lexington, Richland, Edgefield, and Newberry counties.
Hornblende-biotite granite	Fairfield County.

SOUTH DAKOTA.

Granite	Minnehaha County.

TEXAS.

Biotite granite	Burnet County.
Diorite	El Paso County.

UTAH.

Hornblende-biotite granite	Salt Lake and Weber counties.

VERMONT.

Biotite granite	Washington and Essex counties.
Muscovite granite	Windsor County.
Biotite-muscovite granite	Caledonia County.
Gabbro.	

VIRGINIA.

Biotite granite	Dinwiddie, Chesterfield, and Henrico counties.
Muscovite granite	Spottsylvania County.
Biotite gneiss	Campbell County.
Biotite schist	Fauquier County.
Diabase	Loudoun and Fauquier counties.

WASHINGTON.

Granite	Stevens County.

WISCONSIN.

Granite	Marquette County.
Hornblende granite	Marathon County.
Quartz porphyry	Green Lake County.
Biotite gneiss	Jackson County.

The following list gives the same data as contained in the preceding one, except that the arrangement is by kinds of granite instead of by States:

Hornblende-biotite granite.—Pulaski County, Ark.; Placer and Sacramento counties, Cal.; Penobscot and Knox counties, Me.; Essex County, Mass.; Iron and St. François counties, Mo.; Carroll County, N. H.; Mecklenburg County, N. C.; Fairfield County, S. C.; Salt Lake and Weber counties, Utah.

Elæolite syenite.—Garland County, Ark.

Quartz diorite.—Placer County, Cal.

Basalt.—Solano, Sonoma, and Alameda counties, Cal.; Jefferson County, Colo.; Clackamas and Columbia counties, Oreg.

Biotite granite.—Placer County, Cal.; Clear Creek and Jefferson counties, Colo.; Litchfield, New Haven, New London, and Fairfield counties, Conn.; Knox, York, Washington, Lincoln, Waldo, Oxford, Kennebec, and Hancock counties, Me.; Baltimore, Howard, and Montgomery counties, Md.; Norfolk, Middlesex, Bristol, Worcester, and Plymouth counties, Mass.; Cheshire, Hillsboro, Grafton, and Rockingham counties, N. H.; Putnam County, N. Y.; Warren, Franklin, Gaston, Granville, Alamance, Davidson, Mecklenburg, Iredell, Forsyth, Guilford, Richmond, and Anson counties, N. C.; Washington, Kent, and Providence counties, R. I.; Fairfield, Charleston, Aiken, Lexington, Richland, Edgefield, and Newberry counties, S. C.; Burnet County, Tex.; Washington and Essex counties, Vt.; Dinwiddie, Chesterfield, and Henrico counties, Va.

Andesite.—Shasta County, Cal.; Multnomah County, Oreg.

Andesitic tufa.—Solano County, Cal.

Quartz porphyry.—San Bernardino County, Cal.; Lake and St. Louis counties, Minn.; Green Lake County, Wis.

Basaltic tufa.—Tehama County, Cal.

Diorite.—Chaffee County, Colo.; Berks County, Pa.; El Paso County, Tex.

Rhyolite.—Chaffee and Conejos counties, Colo.

Rhyolitic tufa.—Douglas County, Colo.

Muscovite-biotite granite.—Litchfield County, Conn.; Kennebec, Waldo, and Franklin counties, Me.

Muscovite-biotite gneiss.—Litchfield County, Conn.; Cheshire and Hillsboro counties, N. H.

Biotite gneiss.—Litchfield, New Haven, New London, Windham, Tolland, and Hartford counties, Conn.; Lincoln, Franklin, and Androscoggin counties, Me.; Cecil and Baltimore counties, Md.; Franklin County, Mass.; Passaic County, N. J.; Westchester and Rockland counties, N. Y.; Cleveland, McDowell, Caldwell, Wilson, Stokes, Iredell, Wake, and Guilford counties, N. C.; Philadelphia and Delaware counties, Pa.; Providence County, R. I.; Campbell County, Va.; Jackson County, Wis.

Hornblende-biotite gneiss.—Middlesex and Fairfield counties, Conn.; Fulton County, Ga.

Diabase.—New Haven County, Conn.; Washington and Knox counties, Me.; Middlesex and Hampden counties, Mass.; St. Louis County, Minn.; Hudson County, N. J.; Linn County, Oreg.; Adams, York, Berks, and Lancaster counties, Pa.; Loudoun and Fauquier counties, Va.

Augite-hornblende gneiss.—Newcastle County, Del.

Muscovite granite.—Dekalb County, Ga.; Warren County, N. C.; Windsor County, Vt.; Spottsylvania County, Va.

Hornblende granite.—Placer County, Cal.; Hancock County, Me.; Norfolk and Essex counties, Mass.; Sherburne, Benton, and Lake counties, Minn.; Morris County, N. J.; Marathon County, Wis.

Olivine diabase.—Washington County, Me.; Chisago County, Minn.; Iron County, Mo.

Gabbro.—Baltimore County, Md.; St. Louis County, Minn.; Vermont.

Epidote granite.—Norfolk County, Mass.

Biotite-muscovite granite.—Worcester and Berkshire counties, Mass.; Merrimack, Cheshire, Hillsboro, Grafton, Sullivan, and Strafford counties, N. H.

Biotite-muscovite granite.—Rowan County, N. C.; Caledonia County, Vt.

Muscovite gneiss.—Clear Creek County, Colo.; Middlesex, Essex, Worcester, and Hampden counties, Mass.; Philadelphia and Berks counties, Pa.

Melaphyre.—Suffolk County, Mass.

Hornblende-mica granite.—Benton County, Minn.; Lewis and Clarke County, Mont.; Jefferson County, N. Y.

Granite.—Iron County, Mo.; Rowan and Orange counties, N. C.; Jackson and Columbia counties, Oreg.; Washington County, R. I.; Minnehaha County, S. Dak.; Stevens County, Wash.; Marquette County, Wis.

Hornblende andesite.—Washoe County, Nev.

Biotite-epidote gneiss.—Grafton County, N. H.

Norite.—Essex County, N. Y.

Hornblende gneiss.—Burke County, N. C.; Philadelphia County, Pa.; Providence County, R. I.

Biotite-muscovite gneiss.—Delaware County, Pa.

Biotite schist.—Fauquier County, Va.

METHODS OF QUARRYING, CUTTING, AND POLISHING GRANITE.

The following account of methods of quarrying, cutting, and polishing granite in the United States[1] is taken from the Eleventh Census report, for which it was prepared from field notes taken, under the writer's direction, by Mr. Walter B. Smith:

METHODS OF QUARRYING GRANITE.

STRUCTURE OF GRANITE IN PLACE.

The successful and economical working of granite quarries depends upon an intelligent application of a knowledge of the structure of the rock and its natural divisions in the mass, as well as upon improved methods, tools, and machinery for quarrying. The topographical location of the quarry and its relation to facilities for transportation are important factors that affect the productiveness and greatly modify the actual cost of operations in a given place.

In regions of great dynamic movement, such as most granite localities possess, very large rock masses without seams or fissures do not occur; but these fractures, extending as they do in certain definite directions to each other in the mass, form systems of inchoate joints, which divide it into roughly rectangular and rhombic forms, thus rendering valuable assistance to the quarryman. It is probable that the fissures were caused by pressure operating in certain directions during the origin or uplifting of the rock, and it is even possible for it to have been sufficient to change the molecular arrangement of the component minerals. Even those granites which are apparently normal, and which

[1] Methods of quarrying granite in foreign countries have been well described by H. Lundbohm, of Sweden, in the article on stone in the Report on Mineral Resources for 1893.

reveal no traces of stratification or parallel arrangement of mica or hornblende, are found by quarrymen and stonecutters to split more easily and with a smoother surface in one or more directions than in others. An unequal pressure operating on the mass would have caused certain directions or lines of weakness and account for this, or it may have produced the apparent rearrangement of the feldspar crystals, as found in a few of the granites.

In northern New England particularly most of the fissures, as revealed by quarry openings, are slightly curved, parallel partings conforming in general to the direction of the slope upon which the quarry may be located. They produce a sheeted arrangement of the rock, which bends in ridges or curves in hilltops like anticlinal or quaquaversal folds of sedimentary strata. In addition to these divisional planes there occur one or more systems of vertical joints, the joints of each system running approximately parallel to each other, though the systems cross at varying angles.

It is interesting to note that the direction of easiest cleavage, called by quarrymen the "rift," is parallel to the most numerous natural fractures, and that at right angles to this another direction of cleavage, called the "grain," is parallel to the system having the next greatest number of joints. When the rift of the rock in place is horizontal, or more nearly horizontal than perpendicular, it is customarily called the "lift." The grain, although important, is not generally an eminent feature, and its direction may remain unknown even for a long time after the quarry is opened. These systems of fracture, and the unequal ease of splitting in different directions, are points generally well understood and advantageously used by experienced granite workers.

OPENING THE QUARRY.

Granite quarries are nearly always started in natural outcroppings of the ledge, but as they are entirely open workings, and necessarily cover large areas, considerable development work is needed at first and from time to time, as the quarry is enlarged, in stripping or clearing away the timber and soil and in removing the weathered portions or cap rock. It sometimes happens, especially in the northeastern region, that a ledge is found showing sound granite at the top, ready for quarrying, having been ground smooth by glacier movement and left bare of soil; but usually long exposed outcroppings have a softer outer portion, called "sap," resulting chiefly from the partial decomposition of the feldspar. This also occurs to a less extent along the seams and fissures, and where the rock contains iron the sap is stained by its oxidation to a brownish or reddish color. The sap may be merely a thin coating, scarcely discernible, or it may be that the rock is rendered unsound for 30 feet or more in depth, as is the case with a certain coarse-grained granite occurring in the Rocky Mountains. The observation of such points in the field will serve as indications of the probable durability of the stone and the stability of its color.

BLASTING.

Owing to great diversity in the structure of the rocks classed here as granite, the operations of quarrying necessarily vary considerably, even in different openings of the same region. The object desired is, however, the same in all, namely, the removal of large rectangular blocks with the least outlay of time and labor compatible with keeping the quarry in good working shape and avoiding waste. Ordinarily, to break the rock into sizes which can be handled, blasting is necessary. In doing this the object is to direct the force of the powder so that it may break the rock in the desired direction without shattering either the piece removed or the standing rock, but it can be successful only when it is detached at the ends and bottom and has a chance to move out in front. As the rift in the rock in the majority of quarries approaches the horizontal the first breaks are obviously made either with or across the grain. The method most generally used for doing this is called "lewising," from the shape of the blast hole. A lewis hole is made by drilling close together holes about an inch and a half in diameter and in breaking down the partition between them by means of a flat steel bar, called a "set." This wide hole determines the direction of the required fracture. A "complex" lewis hole is the combination of three ordinary drill holes; a "compound" one, of four; but the latter is seldom used, for if a very long break is to be made a series of lewis holes is drilled at considerable distances apart, and after being charged are fired simultaneously by means of an electric battery.

Another process occasionally used in a few quarries is as follows: A single round hole having been drilled, the explosive is put in, and on top of it an inverted iron wedge, placed between two half-rounds, is carefully lowered; then the tamping is proceeded with in the usual way. When the powder is exploded, the wedge, which is driven forcibly up between the half-rounds, breaks the rock in a direction corresponding to its thin end. One of the worst results of this procedure is that considerable rock near the top of the hole is apt to be huffed or flaked up.

Within a few years past, the Knox system of blasting rock has been introduced and successfully used with general satisfaction in many of the larger quarries. The results obtained are those which were sought for by lewising, but the process is safer, quicker, takes less powder, and, as it never shatters the rock, not only gives good, sound blocks as the product of the blast, but also leaves the standing rock with a perfectly sound, clean face for future operations. A round hole is first drilled to the required depth, and into this is driven a reamer, which produces V-shaped grooves at opposite sides to the entire depth of the hole. The charge is then inserted, and the tamping is done in the usual manner, except that instead of driving the tamping down upon the top of the charge an air space or cushion is reserved between the charge of powder and the tamping and as far above the charge as possible. The explosive has therefore the greatest possible chance for expansion before actually breaking the rock, the tamping being put down only to a sufficient depth to insure firmness of position. The result of this method is that the force of the explosive is directed in the line of the grooves, and no shattering of the rock occurs if it be solid, such as is common in ordinary blasting operations, and, as a consequence, quarrymen are enabled to get out stone of rectangular shape without waste or loss of valuable rock.

Very large blasts or mines are sometimes fired in quarrying granite. A shaft is sunk to the required depth, and from it drifts are run in various directions. These chambers, or drifts, are then charged with explosives and fired. In 1887, at Granite Bend, Missouri, stone enough was broken with one blast to supply the demands of a firm for fifty years. The shaft, which was 85 feet deep, had chambers running in several directions from the bottom, and was charged with 32,700 pounds of black powder.

The explosive used for breaking out dimension stone is black blasting powder, as its action is somewhat slower than that of the various forms of nitroglycerin, and there is consequently less danger of shattering the rock or of weakening it by starting incipient fractures, that may not be detected until it is in place in a building; but for breaking up poor stone, or for getting out rock regardless of size or form, giant powder is frequently employed.

In a quarry having rather thin sheets and numerous vertical joints very good splits may be made with wedges driven between half-rounds (plug and feather) into small holes drilled a few inches apart along a prescribed line, every few feet a deeper hole of a somewhat larger dimension being drilled to guide the fracture; but this process is chiefly used for su dividing the blocks after they have been loosened by powder and for initial splits in quarries where the drift is vertical.

Drills driven either by steam or compressed air are in use for making blast holes in all the principal quarries. The drill is connected with the piston, which is supported by a portable iron tripod, carrying the necessary appliances for regulating its movements. A flexible pipe conveys the motive power in the form of compressed air or steam.

In smaller quarries these holes are drilled by the "jumper" drill, a long, flat-edged steel bar, which a man holds and turns as it rebounds slightly after each of the swinging blows dealt it by heavy sledges.

Steam channeling machines, common in large marble and sandstone quarries, are used on granite by a few quarriers chiefly for making end cuts in stone of exceptional structure, but only to a limited extent, since the great hardness of granite renders the process very slow and expensive.

The large blocks loosened by blasting are broken and split into sizes of the required approximate dimensions by the plug and feather method.

The holes, which are of small diameter, generally not more than three-fourths of an inch, and a few inches only in depth, are made by a drill and hand hammer. Into each hole is inserted two half-rounds or "feathers," tapering pieces of iron, flat on one side and rounded on the other, between which is placed a steel plug or wedge. The wedges are then driven in with a sledge till the strain is sufficient to split the rock.

METHODS OF CUTTING, POLISHING, AND ORNAMENTING GRANITE.

Only a small percentage of granite in rough blocks as it leaves the quarry proper is available for use in this form. Most of it has to be cut to the desired dimensions and brought to the degree of finish required for the special purposes for which it is to be used. Very large blocks and stone designed for uses not requiring fine finish are often worked in the open air, but most quarries have cutting sheds erected near the openings, in which the blocks are worked into their intended form. These sheds vary from merely a rough covering of boards to extensive buildings.

To produce good results great skill is needed by the stonecutter in the manipulation of his tools, and considerable artistic ability is required for the finer kinds of work. From the rough work of simply splitting a block or rudely spalling an ashlar face to the artistic working of highly embellished and complicated statuary carving, a knowledge of the rift and grain is important, as it indicates where heavy blows may be struck and where lighter ones are required.

Owing to the great obduracy of this stone, and the fact that the different minerals composing it vary greatly in hardness, the chief work of shaping it is still performed by hand, probably by much the same process that was used by Egyptian stonecutters more than three thousand years ago. Improvements and inventions have, however, been made from time to time in hand tools, and extensive machinery is now in use for producing certain forms and kinds of finish.

Recent improvements.—The most important improvements of the last decade include the more extended adoption of lathes for turning and polishing columns, urns, etc., and new devices in power machinery for plain polishing. Greater economy and speed are now obtained by the general use of chilled iron globules and crushed steel as abrasive materials and of the pneumatic tool for the ornamentation of surfaces.

Implements for cutting.—The implements used by stonecutters to produce common forms and ordinary finish are as follows:

Chisel.—Various forms and sizes are employed in cutting border drafts, moldings, letters, and ornamental work.

Point.—A piece of steel bar drawn out to a pyramidal end; used for "roughing out" surfaces and removing "bunches."

Hand drills, wedges, and half-rounds.—Used for splitting out blocks.

Hand hammer.—Used in one hand for driving chisels, points, and drills, which are held and guided by the other.

Spalling hammer.—A heavy square-cornered sledge, used for roughly reducing a block by breaking off large chips or spalls from the edges, thus bringing it closer to its intended form.

Pean hammer.—Shaped like a double-edged wedge, with a handle running parallel with the edges; used to remove irregularities by striking squarely upon a surface and wedging or bruising off small chips.

Bush hammer.—Made of rectangular steel plates brought to an edge, bolted together, and attached to a long handle; used in the same manner as the pean hammer, but produces a smoother surface, the degree of smoothness depending upon the number of steel plates in the particular hammer used. These hammers, which are all of the same thickness, are called 4-cut, 5-cut, 6-cut, 8-cut, 10-cut, and 12-cut, according to the number of plates used in their construction.

The size, shape, and finish of a stone depend upon the particular place it is to occupy in a building and the style of architecture. Fronts or walls are laid up in various kinds of ranges, usually designated as coursed range, broken range, broken ashlar, random range, and rubble work. The kind of finish given the face of the stone is called either bush hammered, pean hammered, pointed work, or rock face. These may or may not have a border draft chiseled around their margins. Other kinds of finish are chiseled moldings and carved or polished faces.

The usual process followed by stonecutters in shaping blocks may be generalized as follows: The block, having been split out to about the right size by the plug and feather method, is brought to a plane surface on one side, which is accomplished by knocking off overhanging edges and projections with the spalling hammer or spalling tool. Drafts or ledges are then chiseled along two opposite edges. One draft being completed, the workman lays upon it a wooden strip or rule having parallel edges. A second rule is then sunk in the draft made on the opposite side until the two drafts are in the same plane, which is determined by sighting across the upper edges of the rules. The whole face is then worked down to this plane with the tools necessary for the required fineness of finish, a straightedge being applied from time to time as the work progresses. The point is used for removing rougher projections. This is followed by the pean hammer, and, if a smoother surface is required, it is made by bush hammering, the hammer having the fewest number of plates being used first. The required size of the face being marked out upon this surface, the position of a second face may be determined by chiseling drafts across the ends of an adjacent surface, using for the purpose either a square or a bevel, depending upon the angle it is desired to make with the first face. The projecting rock between the drafts having been removed in the manner used in forming the first surface, a third face may be projected. A winding surface is formed by using in one draft a rule or strip having its edges not parallel, the amount of divergence depending upon the amount of warp required. This rule is sunk till its upper edge is even with the upper edge of the strip, having parallel edges placed upon the opposite edge of the stone.

A cylindrical surface is worked by using curved rules in one direction, and is not as hard a matter as might at first seem. Much difficulty is, however, encountered in laying out and working spiral, conical, and spherical surfaces, as it is first necessary to form plane and cylindrical faces on which to apply the necessary bevels and templets.

GRANITE FOR BUILDING PURPOSES.

By reference to the table giving the output of granite according to purposes, it will be seen that more stone was used for building than for any other purpose. A great amount of labor by the stonecutter is necessary to fit it for its destined place, but much of this work consists in merely squaring up or subdividing the large blocks as hauled from the quarry opening. Much more work is needed on the stone to be used for fronts, trimmings, and certain portions of superstructures, while for special parts, such as polished columns and ornate keystones and capitals, the greatest skill and longest time are required. The general processes of finer finish will, however, be mentioned further on in connection with cemetery, monumental, and decorative purposes, although all stone designed for superstructures, whether rough or finely wrought, has been tabulated under the heading "Building purposes."

GRANITE FOR STREET WORK.

PAVING BLOCKS.

Experience has demonstrated that the best and most enduring streets for heavy traffic in large cities are those paved with stone blocks of proper material and size laid upon a specially prepared bed. The very hard and tough rocks frequently used, though capable of withstanding a maximum amount of wear, soon become smooth and glazed under traffic, and are therefore inferior to a stone which, wearing roughly, affords a better foothold for horses. Many of the granitic rocks possess the right degree of hardness and brittleness, and are largely used for this purpose. This industry has increased largely since 1880, the number of granite blocks made in 1889 in the various States aggregating nearly 62,000,000.

Streets paved with the large-sized block used at first were found to be more difficult to keep in repair, worse for horses, and rougher on vehicles than pavements made of the smaller blocks now in general use. There is no uniform standard of size, as specifications of the various cities call for different sizes, but the variations are not great, and blocks 3½ to 4½ inches wide, 6 to 7 inches deep, and 8 to 12 inches long are generally preferred. In New York City, Brooklyn, and Philadelphia blocks a trifle longer are more commonly used, while in many of the Western and Southern cities the length does not exceed 10 inches. New Orleans, owing to the peculiar nature of its streets, takes blocks much larger.

The manufacture of paving blocks, though an important adjunct of the granite business, varies nevertheless for obvious reasons in many of its details from the ordinary methods of granite cutting. The high skill and fine workmanship of the stone mason are not needed, but a quickness in seeing and taking advantage of the directions of cleavage, as well as a deftness in handling the necessary tools, is requisite.

Specifications call for blocks so quarried or dressed as to present substantially rectangular faces with practically straight edges. The corresponding dimensions of opposite faces must not vary more than one-half inch, and the surface must be free from bunches, depressions, and inequalities exceeding one-half inch.

The tools used for making blocks are knapping hammers, opening hammers, hand hammers, reels, chisels, and, for initial splits, drills, wedges, and half-rounds. When the block maker quarries his own stock it is called "motion work," and the same process is used as in quarrying stone for other purposes, except that, as large blocks are not required, most of it can be done with plug and feather.

Slabs, having been split out in the usual manner to sizes that may be easily turned over and handled by one man, are subdivided into pieces corresponding approximately to the dimensions of the required blocks. This is done by striking repeated blows upon the rock along the line of the desired break with heavy knapping and opening hammers. When a break is to be made crosswise the grain, it is frequently necessary to chisel a light groove across one face, and commonly across the adjacent sides, to guide the fracture produced by striking on the opposite surface with the opening hammer. Good splits can, however, be made along either the rift or grain by the skillful use of the opening hammer alone. Blocks broken out in the manner described are trimmed and finished with the reel, which is a hand hammer having a long, flat, steel head attached to a short handle. Block breakers become very expert in the use of this instrument, and, without making any measurements, turn out in a surprisingly short time a large number of blocks. In Maine, which is far ahead of any other State in the number of blocks made, the entire product of many quarries is used for this exclusive purpose. This is also the case in California, which comes second, though the blocks are manufactured chiefly from the surface "bowlders" or detached masses of basalt so common in Sonoma County. Other quarries, however, in various parts of the country utilize only the "grout," small or irregular shaped pieces, for making paving blocks, and haul the stock to the breakers, who work in sheds; but the greatest number of blocks are made on the spot where the rock is quarried, the workmen being protected during the hottest months by a temporarily spread canvas fly.

Blocks are counted as they are thrown into the cart, which is usually needed to haul them to the shipping point. Several paving-block quarries in Maine are situated on steep mountain slopes so near water communication that blocks may be slid in long board chutes from the quarry directly into the hold of the vessel used for their transportation.

Paving breakers seldom work by the day, but are paid a certain sum per thousand for making the blocks, the price paid in 1889 ranging from $22 to $30, according to the size of block made, kind of stone used, locality, and whether the tools were furnished and the blocks quarried by their employers. Workmen using their own tools are commonly paid $1 more per thousand for the blocks made, and when they quarry the stock they use, from $2 to $5 per thousand is allowed in addition.

CURBING AND BASIN HEADS.

Next in importance to the manufacture of paving blocks, in the division of granite for street work, is the production of long granite slabs for curbstone. Granite having a free rift is preferred for this purpose on account of its better working qualities. The dimensions of ordinary curbstones are from 6 to 12 feet long, 6 to 8 inches thick, and about 2 feet deep. The top edge is made full and square and neatly bush hammered; the face is also bush hammered down about a foot from the top. The ends are dressed smooth, so as to make close joints, and the back of the stone, which is placed next to the sidewalk, is also dressed a few inches from the top.

OTHER USES.

Other applications of granite to street work are for flagstone, for cross walks laid at the intersection of streets, and for gutter stone, but these are dressed, when required, in the usual manner, and need no special comment here.

Granite is largely used for making macadam and telford roads and concrete and artificial stone pavements, though it is seldom quarried expressly for this purpose, but made of spalls, grout, and waste from other quarries. The pieces are broken with sledges where coarse stones are needed, or run through power rock breakers when a finer subdivision is required.

GRANITE FOR CEMETERY, MONUMENTAL, AND DECORATIVE PURPOSES.

A considerable portion of the stone for these uses, especially for small-sized monuments, tombstones, and grave markers, is shipped from the quarries in rough blocks, which are suitably shaped and finished by masons working in town shops or stone yards. Large monuments and large polished blocks for buildings, columns, pilasters, and statuary are generally worked at quarry sheds, polishing mills, or shops not far distant.

There has been a decided increase in the use of polished granite for cemetery purposes since the introduction of machinery for its polishing, which has greatly decreased the price for this kind of finish. For these, as well as for all purposes where a polished surface is desired, as bottom courses in buildings, columns, pilasters, wainscoting, etc., the red, pink, dark-gray, and black varieties are in high favor, since they have a richer look and present a much greater contrast between a hammered or chiseled surface and a polished one; but for granite statuary and ornately carved building blocks, and for all purposes where it is desirable to present fine detail, it is necessary that the granite be of a light color, fine grained, and easily worked to secure the best results.

POLISHED GRANITE.

The varieties of granite susceptible of the highest and most enduring polish are those containing the largest percentages of the hard minerals, quartz and feldspar, quartz being especially important. Hornblende, however, takes a fairly good polish, and contributes largely to the coloring of most dark granites. Pyroxene of the type occurring in the Quincy granites is rather bad, since, owing to its brittleness, it cracks out more or less and leaves small pits in the finished face. Much mica, especially in large plates, is objectionable, as it will not polish, but remains dull and lusterless except where the direction of its cleavage planes happen to coincide with the face of the stone.

After being prepared by bush hammering, the block is transported to the shop or mill to receive further smoothing and its final finish. The surface to be worked upon is brought to a horizontal position and ground smooth with an abrasive material mixed with water and moved about by a revolving iron or steel disk perforated with holes or made of concentric rings. This disk, which is 12 or 14 inches across, is revolved by an upright shaft, to the bottom of which it is fastened, and the power is communicated through a main shaft running overhead. Joints in the upright or counter shaft and its peculiar attachment to the main shaft allow its lower end to be swung over a considerable area, thus permitting the workman who guides it to move it over a surface of stone many times larger than the disk itself.

The abrasive material now almost exclusively used for grinding granite is either chilled-iron globules, steel emery, or crushed steel. A coarse grade is used at first, then a finer kind, and for the last grinding fine emery is often used. Polishing is done in much the same way as grinding, except that a felt-covered disk is used in place of an iron one, and putty powder mixed with a little water, instead of coarser grinding materials. Before the final polish, however, the surface is usually given a dull gloss or "skin coat" by the disk and water alone. A polish is sometimes produced by the use of oxalic acid instead of putty powder, but the polish thus made is less durable. Moldings are ground and polished by means of blocks fitting the grooves dragged back and forth either by power or hand.

Granite for columns, balusters, round posts, and urns is now worked chiefly in lathes, which, for the heaviest work, are made large enough to handle blocks 25 feet long and 5 feet in diameter. Instead of being turned to the desired size by sharp cutting instruments, as in ordinary machines for turning wood and metal, granite is turned or ground away by the wedge-like action of rather thick steel disks, rotated by the pressure of the stone as it slowly turns in the lathe. The disks, which are 6 to 8 inches in diameter, are set at quite an angle to the stone, and move with an automatic carriage along the lathe bed. Large lathes have four disks, two on each side, and a column may be reduced some 2 inches in diameter the whole length of the stone by one lateral movement of the carriages along the bed. The first lathes for turning granite cut only cylindrical or conical columns, but an improved form is so made that templets or patterns may be inserted to guide the carriages, and columns having any desired swell may be as readily turned. For fine grinding and polishing the granite is transferred to another lathe, where the only machinery used is to produce a simple turning or revolution of the stone against iron blocks carrying the necessary grinding or polishing materials.

Blocks are prepared for lathe work by being roughed out with a point, and by having holes chiseled in their squared ends for the reception of the lathe dog and centers. This principal of cutting granite by means of disks revolved by contact with the stone has been also applied to the dressing of plain surfaces, the stone worked upon being mounted upon a traveling carriage and made to pass under a series of disks mounted in a stationary upright frame.

Tracery and lettering for polished granite are usually first drawn upon paper which is firmly pasted to the surface and the design chiseled through to the requisite depth in the rock.

CARVED GRANITE.

Statues, capitals, keystones, and, in general, all highly ornamental designs, are worked out with chisels from detail drawings or plaster casts. It is necessarily a slow process, owing to the hardness of the rock, and the cost of such work is consequently great. The MacCoy pneumatic tool, however, which has been recently patented and successfully applied to this purpose, gives promise of superseding much of the tediousness of the hand process. This instrument is connected to a flexible pipe, supplying the compressed air or steam by which it is driven, and works at a remarkably high rate of speed. It may be moved to any part of a surface, and works with a celerity unapproached by other means.

The use of granite for sculpture is steadily increasing, particularly for outdoor statuary. The white fine-grained muscovite-biotite granite found at Hallowell, Manchester, and Augusta, in Maine, is particularly well adapted for this purpose. Statues made of the Hallowell granite are to be found in nearly every State, though possibly the stone is not superior to varieties found in other localities.

VALUE OF THE GRANITE PRODUCT, BY STATES.

The following table shows the value of the granite product, by States, for the year 1894:

Value of granite product in 1894, by States.

States.	Value.
Arkansas	$28,100
California	307,000
Colorado	49,302
Connecticut	504,390
Delaware	173,805
Georgia	511,804
Maine	1,551,036
Maryland	308,966
Massachusetts	1,994,830
Minnesota	153,936
Missouri	98,757
Montana	5,800
Nevada	1,600
New Hampshire	724,702
New Jersey	310,965
New York	140,618
North Carolina	108,993
Oregon	4,993
Pennsylvania	600,000
Rhode Island	1,211,439
South Carolina	45,899
South Dakota	8,806
Vermont	893,956
Virginia	123,361
Wisconsin	166,098
Total	10,029,156

The foregoing table shows a gain of $1,220,222 in the value of the product as compared with that of 1893. This gain was made in the following States, named in alphabetical order: Georgia, Maine, Maryland, Massachusetts, New Hampshire, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin. By far the most of the gain was made in Rhode Island alone, this State showing an advance of $701,640. It is thus apparent that for most of the States there has been a falling off in the total output. As was true for 1893, the financial depression is accountable for this state of affairs.

VALUE OF GRANITE PAVING BLOCKS MADE IN 1894, BY STATES.

In a number of the New England States there was an increased tendency toward the manufacture of paving blocks rather than the production of stone for building or other purposes. The following table shows the value of the granite paving-block industry in the various productive States:

Value of granite paving blocks made in 1894, by States.

States.	Value.	States.	Value.
California	$31,000	North Carolina	$107
Connecticut	32,100	Pennsylvania	258,777
Delaware	80,000	Rhode Island	115,000
Georgia	225,910	South Carolina	9,085
Maine	710,836	Vermont	32,711
Maryland	18,885	Virginia	42,000
Massachusetts	593,726	Wisconsin	20,450
New Hampshire	24,000		
New Jersey	60,000	Total	2,254,587

The following table gives the value of the granite output, by States, for the years 1890 to 1894:

Value of granite, by States, from 1890 to 1894.

States.	1890.	1891.	1892.	1893.	1894.
Arkansas	(a)	$65, 000	$40, 000	....	$28, 100
California	$1, 329, 018	1, 300, 000	1, 000, 000	$531, 322	307, 000
Colorado	314, 673	300, 000	100, 000	77, 182	49, 302
Connecticut	1, 061, 202	1, 167, 000	700, 000	652, 459	504, 390
Delaware	211, 194	210, 000	250, 000	215, 964	173, 805
Georgia	752, 481	790, 000	700, 000	476, 387	511, 804
Maine	2, 225, 839	2, 200, 000	2, 300, 000	1, 274, 954	1, 551, 036
Maryland	447, 489	450, 000	450, 000	260, 855	308, 966
Massachusetts	2, 503, 503	2, 600, 000	2, 200, 000	1, 631, 204	1, 994, 830
Minnesota	356, 782	....	360, 000	270, 296	153, 936
Missouri	500, 642	400, 000	325, 000	388, 803	98, 757
Montana	(a)	51, 000	36, 000	1, 000	5, 800
Nevada	(a)	....	....	3, 000	1, 600
New Hampshire	727, 531	750, 000	725, 000	442, 424	724, 702
New Jersey	425, 673	400, 000	400, 000	373, 147	310, 965
New York	222, 773	225, 000	200, 000	181, 449	140, 618
North Carolina	146, 627	....	150, 000	122, 707	108, 993
Oregon	44, 150	3, 000	6, 000	11, 255	4, 993
Pennsylvania	623, 252	575, 000	550, 000	206, 493	600, 000
Rhode Island	931, 216	750, 000	600, 000	509, 799	1, 211, 439
South Carolina	47, 614	50, 000	60, 000	95, 443	45, 899
South Dakota	304, 673	100, 000	50, 000	27, 828	8, 806
Texas	22, 550	75, 000	50, 000	38, 991	....
Utah	8, 700	....	15, 000	590	....
Vermont	581, 870	700, 000	675, 000	778, 459	893, 956
Virginia	332, 548	300, 000	300, 000	103, 703	123, 361
Washington	(a)	....	....	....	....
Wisconsin	266, 095	406, 000	400, 000	133, 220	166, 098
Total	14, 464, 095	13, 867, 000	12, 627, 000	8, 808, 934	10, 029, 156

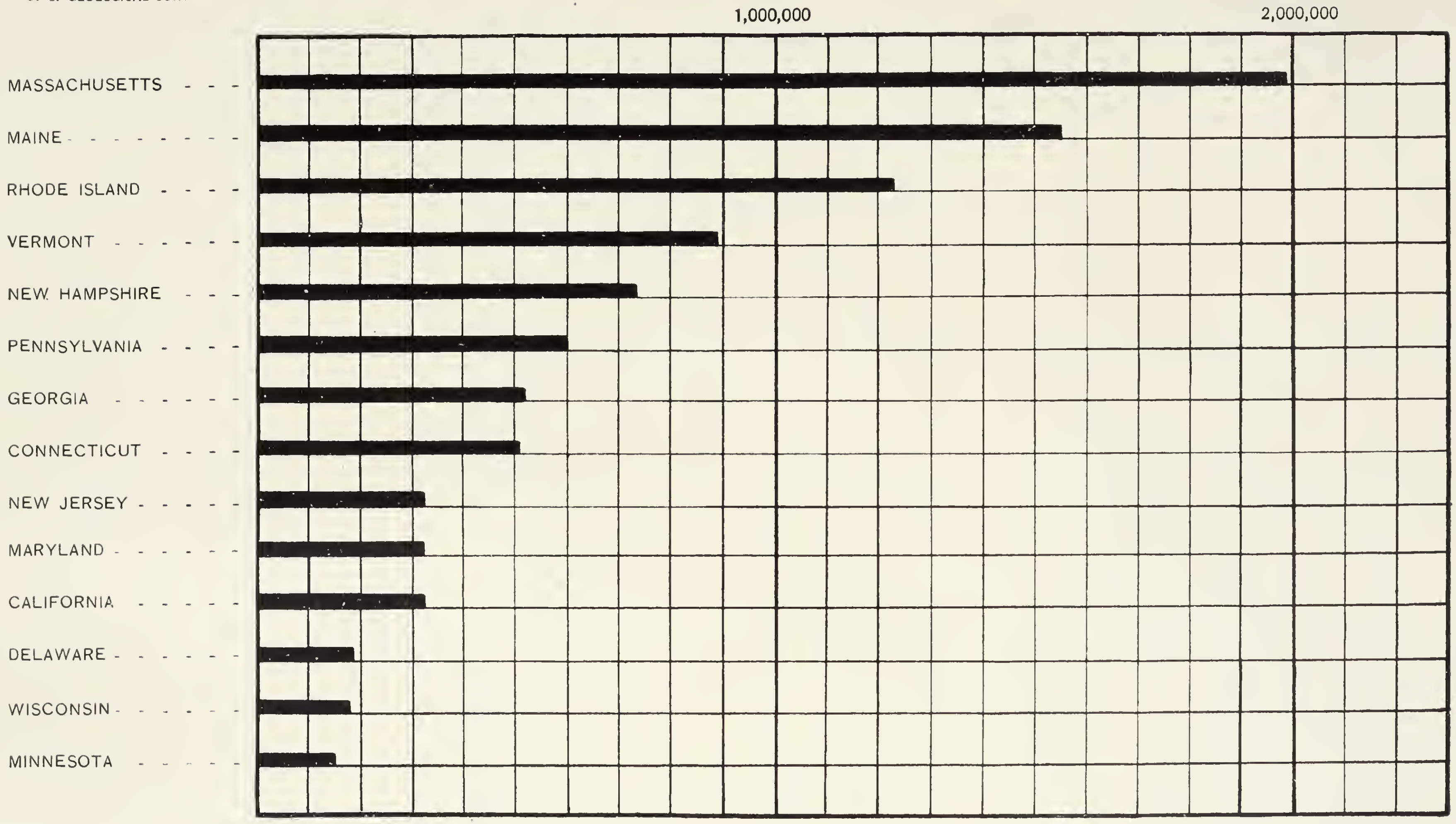
a Granite valued at $76,000 was produced in Arkansas, Montana, Nevada, and Washington together, and this amount is included in the total.

GRANITE INDUSTRY IN THE VARIOUS STATES.

Arkansas.—The value of the product in 1894 amounted to $28,100, while in 1893 very little, if anything, was accomplished in granite quarrying. The entire output comes from Pulaski County. Indications for 1895 are encouraging.

California.—The granite industry in this State for the last few years, but particularly for 1893 and 1894, has been at a low ebb. The value of the product for 1894 is $307,000, but included in this figure is an estimate as to the value of the output from the State prison quarries, which forms an important item of the total. Placer County is credited with an output valued at $103,443, Sonoma County $34,568, San Bernardino County $30,450, while smaller amounts were taken from quarries in Tulare, Sacramento, Madera, Fresno, Solano, Alameda, Riverside, and Marin counties. Almost every communication received from producers in this State emphatically reveals decline in the industry, due, it is believed, entirely to the financial depression. Many quarries discontinued work entirely, while others shut down for a part of the year or worked with reduced force of men.

Colorado.—The output for 1894 is valued at $49,302. Most of the stone was taken from quarries in Jefferson County, while smaller amounts



VALUE OF GRANITE PRODUCED IN THE VARIOUS STATES DURING THE YEAR 1894.

(In millions of dollars.)

came from Douglas, Gunnison, and Clear Creek counties. A little work was done in Chaffee, Larimer, and Boulder counties. A number of quarries discontinued operations entirely.

Connecticut.—The product for 1894 was valued at $504,390, while the corresponding figure for 1893 was $652,459. A decrease in product is evident. The general tone of replies from quarrymen indicates a falling off as compared with the preceding year. The productive counties in order of magnitude of output are New Haven, New London, Fairfield, Windham, Middlesex, Hartford, and Litchfield. The first two counties produced most of the entire output. Judging from a number of important contracts that have been awarded to Connecticut producers, 1895 will make a much better showing than the past year.

Delaware.—The value of the output in 1894, $173,805, is below that of 1893. All of the productive quarries are in Newcastle County.

Georgia.—As will be seen from the report on "marble," this State has very materially advanced in its marble output. The same can be said of the granite product, which has increased from $476,387 in 1893, to $511,804 in 1894. Of this amount $225,910 is the value of paving blocks. There is every reason to believe that with a revival in business there will be a still greater increase in the granite industry in this State. By far the most of the output comes from Dekalb County, in which are the important producing centers, Lithonia and Stone Mountain. Other productive counties are Hancock, Henry, Bibb, Elbert, Spalding, Rockdale, Jones, Oglethorpe, and Newton. The last seven of these counties produce very little as compared with the others.

Maine.—This State stands second among the granite-producing States in the value of its output. This has increased from $1,274,954 in 1893 to $1,551,036 in 1894. While the manufacture of paving blocks for use in the largest cities along the Atlantic coast has always been an important feature of the granite industry in Maine, it has become somewhat more so during the past year. In the census year 1889, the value of the paving-block product was 37 per cent of the whole, but in the year just past it was 45.8 per cent. The most productive counties are Hancock, Knox, Franklin, Waldo, Washington, Kennebec, and York; smaller amounts are quarried in Lincoln, Somerset, Penobscot, Androscoggin, and Oxford. Many small quarries have been temporarily abandoned, while others have been sold out to larger concerns. An improvement in the industry in this State is looked for during 1895.

Maryland.—The output in this State increased from a value of $260,855 in 1893 to $308,966 in 1894. The worst part of the year was the first half, after which, in the case of a number of concerns, business improved somewhat and became even better than the latter part of 1893. Indications are quite decided toward improvement in 1895.

Massachusetts.—This State seems to have prospered exceptionally well during 1894, considering the hard times. The value of the output increased from $1,631,204 in 1893 to $1,994,830 in 1894, and the State maintains first position among the granite-producing States of the country. Many complaints of financial depression are to be heard, of course, and in times of prosperity the output would have been much larger. Lower prices than in 1893 have been generally prevalent. The most productive counties in order of importance are Essex, Worcester, Norfolk, Middlesex, Bristol, and Hampden; small quantities were produced in Franklin and Hampshire counties.

As is true of other New England States, more attention than usual was devoted to the production of paving blocks, for which the demand was good, but lower prices prevailed than were received in 1893.

Minnesota.—The value of the output in 1894 was $153,936; the corresponding figure for 1893 was $270,296. The decrease is accounted for in the usual manner—hard times, resulting in the shutting down of operations entirely or operating with reduced force. The output comes from the following counties: Bigstone, Stearns, Sherburne, Pipestone, Rock, and Nicollet.

Missouri.—A falling off from $388,803 to $98,757 in 1894 marks the granite industry in this State. A few prominent concerns practically suspended operations, and their comparative inactivity accounts for the decrease. Indications for 1895 are much better. The productive counties of this State are Iron, Wayne, St. François, and Madison.

Montana.—Very little in the way of granite quarrying has ever been done in this State. A little quarrying was done in Lewis and Clarke County.

New Hampshire.—In this State a decided gain in output was made, namely, from $442,424 in 1893 to $724,702. A number of quite important contracts have been fulfilled during the year. Among most of the producers there is considerable complaint of dull trade, but in spite of the financial depression, business seems to have been markedly better on the whole than in 1893. The most productive counties are Carroll, Cheshire, Hillsboro, Merrimack, and Strafford; smaller amounts were taken from quarries in Grafton, Sullivan, and Rockingham counties. Quite a number of new firms have commenced business during the year. The outlook for 1895 is much better.

New Jersey.—Quarrying in New Jersey seems to have suffered from the prevailing business depression. The product fell off in value from $373,147 in 1893 to $310,965 in 1894. Considerable of the product is really trap rock, which, for reasons already given, is included with granite. Indications for 1895 are promising. The productive counties are Somerset, Hudson, Essex, Sussex, Passaic, Mercer, and Hunterdon. Small amounts were quarried also in Union and Morris counties.

New York.—This State has never yielded very large quantities of granite, although good stone is to be found there. The product of 1893 was valued at $181,449, while that of 1894 amounted to $140,618. The productive counties are Essex, Richmond, Orange, and Westchester.

North Carolina.—Although the value of the granite product in this State declined from $122,707 in 1893 to $108,993 in 1894, considering the comparative newness of the industry in the State its condition may be regarded as very satisfactory in view of the hard times. The productive counties were Gaston, Iredell, Rowan, Surry, and Wake.

Oregon.—Small quantities of granite were produced in Clackamas, Columbia, and Multnomah counties.

Pennsylvania.—A more thorough canvass of the granite producers in this State is in part accountable for the large reported increase from $206,493 in 1893 to $600,000 in 1894. The value of the stone devoted to paving purposes in 1894 amounted to $258,777, or nearly one-half of the total. Although there is no exceptionally fine granite in the State, there is an abundance of stone that serves ordinary uses very well, and it is steadily produced. The productive counties are Bucks, Chester, Allegheny, Delaware, Montgomery, Somerset, Adams, and Northampton.

Rhode Island.—The increase in the output of granite in Rhode Island over the preceding year, 1893, is nothing less than phenomenal. In 1889, the census year, the output was valued at $931,216; in 1893 at $509,799; and in 1894, at $1,211,439. A number of quite serious strikes have occurred among the Rhode Island quarries and works within the last three years, and it may be that contracts have been delayed on that account until the past year. In spite of the prosperity which appears to prevail, complaints of financial depression are to be heard in Rhode Island as in all other States. The smaller producers have been particularly affected and in some cases have had to shut down their operations. The bulk of the business is now in the hands of a small number of concerns.

The granite quarries and works located at Westerly, Washington County, have long been celebrated for the very fine ornamental stock produced. Most elaborately ornamented monuments and statues are turned out in great number. The plants for finishing and polishing are exceedingly well equipped, all the latest improvements in quarry tools being freely used. The stone is particularly well adapted for successful ornamentation and fine finish, and this accounts largely for the prominence of this branch of the granite industry in the State. In fine carving a pneumatic tool, striking exceedingly rapid blows and operated by heavy air pressure, is becoming popular among granite cutters. The rapidity with which fine work can be executed is very much increased by the use of this tool. Its value in connection with granite as well as with ornamental marble has already been satisfactorily demonstrated.

Rhode Island stands first among the States of the Union for its output of ornamental and monumental stock.

South Carolina.—The financial stringency made itself felt in South Carolina to the extent of reducing the output from a valuation of $95,443 in 1893 to $45,899 in 1894. The productive counties are Fairfield, Edgefield, and Richland.

Vermont.—In spite of dullness in business generally, the value of the output in Vermont has increased to the extent shown by the values $778,459 for 1893 and $893,956 for 1894. The productive counties are Washington, Windham, Orange, and Caledonia; small amounts have been quarried also in Chittenden, Orleans, and Windsor counties.

Among the most important developments of the last decade are those which have been made at Barre. At this point there is an enormous supply of granite of the finest quality, such that the product is well adapted not only to all the ordinary uses to which granite is put, but also for the finest kinds of monumental and decorative work, to which it is quite largely applied. The methods of quarrying are modern. In one of the quarries in this locality the Knox system of blasting is in very successful use. The application of this recent method of blasting granite is quite limited, and is not received with favor by a great many of the large producers of granite in this and other States. The objections to the system as applied to granite are probably, however, due more to the results of single, and in some cases unsuccessful, experiments than to long-continued and fair trials of it.

Virginia.—The output in Virginia in 1894 amounted in value to $123,361, while in 1893 the corresponding figure was $103,703. There has thus been a gain which though not large is very satisfactory when the falling off in many other States is considered. The productive counties are Chesterfield, Amherst, Henrico, Alexandria, Campbell, and Dinwiddie.

A number of the quarries in the vicinity of Richmond have been operated successfully for a number of years. The plants are comparatively well equipped, and while operations might be conducted upon a considerably larger scale they may be said to be prosperous. The stone from most of these quarries is of good quality and is generally well received.

Wisconsin.—The value of the granite output in 1893 amounted to $133,220, while in the year 1894 it reached $166,098. The output comes from Green Lake, Marinette, and Marquette counties. The granite industry in this State is comparatively new, but it bids fair to increase steadily under normal financial conditions.

THE MARBLE INDUSTRY.

Stone of one kind or another, suitable for building or other industrial use, is most abundantly distributed throughout the United States. One is apt therefore to look upon the operations of quarrying as practicable in almost any locality, and consequently to regard the industry of stone production as practically universal. This view is not far from correct when only the coarser kinds of stone are considered. Marble, however, is found in comparatively few localities, since only here and there have the metamorphosing influences of heat and pressure transformed the widely distributed limestone deposits into marble. Quarrying operations in the case of marble are still further restricted by the fact that by no means all marble is of sufficiently good quality to justify its production for the purposes to which marble as an ornamental product is applied. Marble must fulfill certain definite conditions as to strength, color, crystalline condition, freedom from flaws, etc., and, furthermore, must be fairly easy of access, before quarrying operations can be undertaken with a fair prospect of financial success.

Not only are marble and limestone very different in physical structure and purity, but the uses to which they are put are strongly contrasted, so that, even though closely related from the chemical standpoint, in that they are both carbonates of calcium or of calcium and magnesium together, they have in a commercial sense almost nothing in common, except in so far as waste marble replaces ordinary limestone for such uses as burning into lime, road ballast, or blast-furnace flux. In this report, therefore, ordinary limestone and marble are separately considered in so far as the uses to which they are applied are radically different.

VALUE OF THE MARBLE PRODUCT, BY STATES.

The following table shows the value of the marble output, by States, for the year 1894. Inspection of this table shows that only a small number of States produce marble, while from the report on limestone it is evident that a large number of our States yield ordinary limestone in abundance:

Value of marble production, by States, for the year 1894.

States.	Value.	States.	Value.
California	$13,420	Pennsylvania	$50,000
Georgia	724,385	Tennessee	231,796
Idaho	3,000	Vermont	1,500,399
Maryland	175,000		
New York	501,585	Total	3,199,585

From the foregoing table it appears that the product from Vermont, valued at $1,500,399, amounts to 47.6 per cent of the total. In the census year 1889, Vermont produced 62 per cent of the total. Large gains in production have been made during the past year in Georgia and New York. The total product in 1893 was valued at $2,411,092, so that for the marble industry as a whole there has been a gain of $788,493 in value of output for the entire country.

The following table shows the value, by States, of the marble produced during the years 1890 to 1894, inclusive:

Value of marble, by States, from 1890 to 1894.

States.	1890.	1891.	1892.	1893.	1894.
California	$87, 030	$100, 000	$115, 000	$10, 000	$13, 420
Georgia	196, 250	275, 000	280, 000	261, 666	724, 385
Idaho				4, 500	3, 000
Maryland	139, 816	100, 000	105, 000	130, 000	175, 000
Massachusetts			100, 000		
New York	354, 197	390, 000	380, 000	206, 926	501, 585
Pennsylvania		45, 000	50, 000	27, 000	50, 000
Tennessee	419, 467	400, 000	350, 000	150, 000	231, 796
Vermont	2, 169, 560	2, 200, 000	2, 275, 000	1, 621, 000	1, 500, 399
Scattering	121, 850	100, 000	50, 000		
Total	3, 488, 170	3, 610, 000	3, 705, 000	2, 411, 092	3, 199, 585

MARBLE INDUSTRY IN THE VARIOUS STATES.

The following is a consideration of the marble industry in the individual productive States:

California.—Although the output in this State increased in value from $10,000 in 1893 to $13,420 in 1894, the marble branch of the stone industry is not at present in a flourishing state, and owing to the depressed financial condition, operations have been much curtailed. It is believed, however, that with general improvement in business will come a prosperous revival of the quarrying operations throughout the State. The counties which at one time or another have produced marble are San Bernardino, Amador, Inyo, and San Luis Obispo. Most of the output has come from the first-named county.

Georgia.—The advances made in marble quarrying in Georgia during the past year are very remarkable. The value of the output in 1893 was $261,666, and in 1894, $724,385. The entire output came from Pickens County.

According to Bulletin No. 1 of the Geological Survey of Georgia, under direction of Mr. W. S. Yeates, entitled "A Preliminary Report on the Marbles of Georgia," by S. W. McCallie, assistant geologist, the quarrying of marble in this State dates back to 1840, when operations on a very small scale were undertaken near Tate. Very little was accomplished, however, until the organization of the Georgia Marble Company in 1884, with a capital of $1,500,000. There are now four flourishing firms in Pickens County, while another, operating in Cherokee County, will begin in 1895.

The marbles of Georgia follow a general line running in a northerly direction from Fannin County on the north, through Gilmer and Pickens counties, to Cherokee County on the south. "The Marietta and North Georgia Railroad runs parallel to the marble belt throughout its entire length, and at no point is the outcropping located more than 2 or 3 miles from this road." All the quarries at present operating are near the town of Tate, Pickens County.

The product of the quarries operated by the Georgia Marble Company varies somewhat in color. The Kennesaw quarry yields a limited quantity of white marble, the crystals of which are large and glistening, but very compactly united; and in addition there is a white marble clouded with light spots and lines of blue. The Cherokee quarry produces white and bluish-gray stock, both clouded with dark-blue spots. From the Creole quarries a marble having a white ground and exceedingly dark-blue mottlings is taken. This is used for monumental work and exterior decoration. A great variety of different shades of marble is to be found in the Etowah quarry, the principal colors being pink, salmon, rose, and dark green. These, with their combinations, produce very rich effects and are suitable for work in which high color and richness are desired. It finds its chief application in wainscoting, mantels, table tops, counters, panels, etc.

The following analysis was made by Mr. John C. Jackson, of Chicago:

Analysis of Georgia marble.

	Per cent.
Calcium carbonate	97.32
Magnesium carbonate	1.60
Silica	.62
Iron protoxide	.26
Alumina	.25
Total	100.05

The following tests by compression of the strength of three cubes of Georgia marble, made in 1886 by Capt. Marcus W. Lyon, United States Army, with the testing machine at Watertown Arsenal, Mass., serve to indicate the great crushing strength of this marble:

Mechanical tests of Georgia marble.

Test No.	Marks.	Dimensions.		Sectional area.	Ultimate strength.	
		Height.	Compressed surface.		Total pounds.	Pounds per square inch.
				Sq. inch.		
4337	Cherokee	6''.04	6''.01 by 6''.00	36.06	395,800	10,976
4338	Creole	6''.03	6''.00 = 5''.99	36.94	434,100	12,078
4339	Etowah	6''.03	6''.03 = 6''.01	36.12	384,400	10,642

The structure of the marbles from the various quarries is essentially the same, the difference being in color only. The nonabsorbent properties are indicated by the following experiments made by Prof. J. B. Johnson, of St. Louis, Mo.:

A 3-inch cube was soaked in water twenty-four hours and weighed. It was then dried over a steam coil at a temperature of about 215° F. for twenty-four hours and again weighed. The difference in the weight divided by the weight when dry showed that it had absorbed water to an amount expressed by six-hundredths of 1 per cent. The nonabsorbent qualities thus revealed enable the stone to withstand disintegration.

The following data are taken from the bulletin of the Georgia Geological Survey, already referred to:

Crushing tests of Georgia marble.(a)

Name.	Quarry.	Compressed surface in inches.	Position.	Actual crushing load in pounds.	Compressive strength per square inch in pounds.	Reduced to correspond to pressure per sq. in. on 2-in. cubes[b], in lbs. per. sq. inch.	Specific gravity.	Weight per cubic foot in pounds.
Kennesaw:								
No. 1	Kennesaw	.99 x .99	Bed	*c*10,000	10,204	12,244		
No. 2	do	1.00 x 1.00	do	*d*11,400	11,400	13,680	2.717	169.8
No. 3	do	1.00 x 1.00	do	*e*10,672	10,672	12,806		
Creole:								
No. 1	Georgia	1.00 x 1.00	do	*e*13,900	13,900	16,680		
No. 2	do	1.00 x 1.00	do	*e*13,100	13,100	15,700	2.763	172.6
No. 3	do	1.00 x 1.00	do	13,200	13,200	15,840		
Etowah:								
No. 1	do	1.00 x 1.00	do	13,200	13,200	15,840		
No. 2	do	.99 x .99	do	12,000	12,244	14,692	2.707	169.1
No. 3	do	.99 x .98	do	12,300	12,540	15,048		
Southern:								
No. 1	Southern	.99 x 1.00	do	11,300	11,414	13,696		
No. 2	do	.99 x 1.00	do	10,900	11,010	13,212	2.734	171.8
No. 3	do	.98 x 1.00	do	10,800	11,020	13,224		

a The survey is under obligations to Prof. Charles Ferris of the engineering department of the University of Tennessee, for valuable aid rendered in making the crushing and absorption tests.

b Gen. Q. A. Gillmer, in his report on the compressive strength of building stones of the United States, Appendix II, Annual Report of the Chief of Engineers for 1875, determined a general formula for converting the crushing strength of different cubes into each other. In applying this formula for 1 and 2 inch cubes, it is found that the crushing weight of the smaller cube should be increased by approximately one-fifth of itself in order to compare correctly the strength of the two cubes.

c Cracked on edge before bursting.

d Burst suddenly.

e Burst with explosion.

The following artificial weathering tests were made on unpolished cubes of Nos. 1, 3, and 6 and a polished cube of No. 1. They were suspended for several days in an atmosphere of hydrochloric, sulphurous, and carbonic acids:

Artificial weathering tests made on polished and unpolished Georgia marble.

	Original weight.	Final weight.	Loss.
	Grams.	*Grams.*	*Grams.*
No. 1. Polished	45.0868	44.9337	.1531
No. 1. Unpolished	45.9492	45.7793	.1699
No. 3. Unpolished	44.2569	44.1240	.1329
No. 6. Unpolished	42.1369	41.9943	.1426

It is noticeable that the unpolished cube of No. 1 was dissolved with considerable more readiness than the polished.

Chemical analyses of Georgia marble.

Marbles.	Calcium oxide.	Magnesium oxide.	Ferric oxide and alumina.	Insoluble siliceous matter.	Loss on ignition.	Total.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
No. 1	54.06	.90	.10	2.12	42.86	100.04
No. 2	32.73	19.37	.35	.73	46.58	99.76
No. 3	55.00	1.12	.15	.35	44.16	100.76
No. 4	31.53	21.30	.24	.10	47.26	100.43
No. 5	31.61	21.06	.78	1.01	46.49	100.95
No 6	54.41	.75	.32	1.62	43.13	100.23
No. 7	54.67	1.01	.42	.76	43.49	100.35
No. 8	52.77	.82	3.28	1.43	41.85	100.15
No. 9	24.07	17.24	.43	21.76	37.08	100.58
No. 10	30.42	19.86	.91	4.23	(*a*)	(*a*)
No. 11	31.89	19.64	.74	1.73	(*a*)	(*a*)

a Undetermined.

No. 1. A coarsely crystalline white marble, from the Cherokee quarry (Georgia Marble Company), Pickens County.

No. 2. A white fine-grained marble from J. P. Harrison's quarry, 2 miles east of Jasper.

No. 3. A coarse-grained black and white mottled marble, "Creole," of the Georgia quarries.

No. 4. A fine-grained gray marble, from the Dickey property.

No. 5. A fine-grained bluish-gray marble, from the Holt property.

No. 6. A coarse-grained flesh-colored marble, "Etowah," of the Georgia quarries.

No. 7. A coarse-grained gray marble, from the Eslinger farm.

No. 8. A coarse-grained brown marble, from the Haskins farm.

No. 9. A fine-grained light-gray marble, from the White property.

No. 10. A fine-grained black marble, from Six Mile Station.

No. 11. A fine-grained white marble, from Fannin County.

Maryland.—The value of the marble output in this State in 1894 was $175,000; in 1893, $130,000. The industry in Maryland is limited to a number of points near Baltimore on the line of the Northern Central Railroad and all in Baltimore County. The industry has been established for many years and is in a prosperous condition.

The product is used to some extent for cemetery work, and also largely for building purposes, particularly in Baltimore, where it enters into the construction of a number of the finest structures. It has also been used in Philadelphia and in the extension of the National Capitol. The Beaver Dam Marble Company is the most important firm, and has a well-equipped plant, including the modern improvements for quarrying and sawing. The most practical test which has been made of the strength of this marble was its use as material for the Washington Monument in Washington, the highest stone structure in the world.

New York.—A very striking advance in production was made in New York during 1894, namely, from a valuation of $206,926 in 1893 to $501,585 in 1894. The increase was due to very largely increased operations at Tuckahoe. The productive counties are St. Lawrence, Westchester, Columbia, and Warren.

The color of the St. Lawrence County marble varies from white to dark blue and green and mixtures of these shades, producing in these cases a mottled appearance. The marble is adapted to monumental and building purposes, but the greater part of the product of 1889 was used for the latter purpose. This stone, while too coarsely crystalline for fine carving, scroll work, or tracing, forms a fine contrast with the polished surface. It weighs 174 pounds to the cubic foot, and has a crushing strength of 12,000 pounds to the inch.

The product from Pleasantville is called, from its appearance, "snowflake marble," and is a dolomite, as is evident from the following analysis made at Columbia College:

Analysis of "snowflake" marble (dolomite) from Pleasantville, N. Y.

	Per cent.
Calcium carbonate	54.62
Magnesium carbonate	45.04
Iron carbonate	.16
Alumina	.07
Silica	.10
Total	99.99

This marble is especially adapted for use in the preparation of carbonic acid. Its weight per cubic foot is 180 pounds. The Tuckahoe marble was used for building, macadamizing roads, and for the preparation of soda water. Like the Pleasantville marble, it is a dolomite.

The product of Warren County, which comes from Glens Falls and its vicinity, consists of black marble, which is generally used for tiling and to some extent for other kinds of interior decoration, soda-water fountains, clock frames, etc. The stone is quite hard, and is quarried by light blasting, and some of it, owing to the looseness of the beds, can be removed by ordinary tools; the rougher stone is extensively burned into lime.

At Hudson, in Columbia County, and at Catskill, across the river in Greene County, are quarries of what is known as "shell marble," largely made up of fossil remains. The stone is so irregular that quarrying is largely done by blasting. It is of a dull, brownish color, and presents a beautiful appearance in finished surfaces; but owing to its character it can not now receive the fine finish given to other more perfectly metamorphosed marbles.

The product from the Tuckahoe quarries is now largely used for building, and a still further increase in production is looked for during the year 1895.

Oregon.—In Douglas County several thousand dollars' worth of marble was produced in 1894, most of the material being used for cemetery purposes. The Variety Marble Company, of Roseburg, is the principal producer. More extensive operations are predicted for 1895.

Tennessee.—The marble output of Tennessee increased from a valuation of $150,000 in 1893, to $231,796 in 1894. The industry has unquestionably suffered from the hard times, although evidently less in 1894 than in 1893. It comes mainly from Knox, Loudon, and Hawkins counties, although a small amount is produced in Hamblen, Blount, and Jefferson counties. The marble region is thus seen to be in the eastern part of the State, running in a northeasterly direction from Loudon

County at the south to Hawkins County at the northeast. The total value of the marble produced in 1880 was $173,600. The marble industry in this State is in a reasonably flourishing condition.

The marble in Tennessee is in general easily quarried, and this fact has caused a number of property owners in the past to undertake quarrying operations on a small scale. The methods of quarrying are generally somewhat crude, and only a few channelers and other improvements in quarry machinery are in use.

Six marble-producing concerns have within a few years united, forming a combination known as the Tennessee Producers' Marble Company, the object of which is to maintain prices and carry on business more economically.

Tennessee marble presents much variety of color, and its great beauty is well known. It is especially well adapted for purposes of interior decoration in buildings and for furniture tops, but the amount devoted to the latter purpose is much less than it was a few years ago.

The processes of metamorphosis have in much of this marble stopped short of the obliteration of fossil remains, the outlines of which are very plainly marked and present a pleasing variety in the surface of the polished slab. The colors run from a very light pink through various shades to a chocolate brown and a mixed brown, white, and pink.

The product of Hawkins County is highly esteemed, and its price is almost twice that of the product of Knox or Loudon County. As shown by the numerous outcrops of marble in this State, it disintegrates somewhat under the influence of atmospheric agencies, but this does not detract from its adaptability for interior decoration, to which it is largely applied.

Some of the finishing mills in the State are well equipped and operated in a thoroughly modern way. The average cost per cubic foot of producing the marble output of Tennessee in 1889 was 85.1 cents. Of this amount 80.8 per cent was paid for labor involved in taking marble from the quarry and putting it into the shape in which it was sold. Cost of transportation by wagon and railroad from the quarry to the mill is in many cases quite a serious item of expense.

Vermont.—The value of the marble output in 1893 was $1,621,000; the year 1894 shows a falling off to $1,500,399. This decrease is entirely due to the prevailing financial depression, and with the return of prosperous times the growth of the industry will proceed as steadily as it has done in the past.

The producing counties are, in the order of their importance, Rutland, Bennington, Franklin, and Addison. These counties are all in the western part of the State, and, interrupted only by Chittenden County, extend from the Dorset quarries in the southwest corner to the Champlain marbles at Swanton, in the extreme northern part. The quarries now operated are found in or near the towns of Manchester, Dorset, East Dorset, Wallingford, Rutland, West Rutland, Proctor, Pittsford, Brandon, Fair Haven, Middlebury, North Ferrisburg, and Swanton. Abandoned quarries are found all along the railroad line from Dorset to Middlebury. Most of the quarries are near railroad lines, but in some cases it is necessary to haul by wagon to the nearest railroad station. The longest distance of such transportation is 7 miles.

The marble lies in irregular beds, extending north and south, and having a slight dip toward the west, but at West Rutland the angle is very much increased, amounting to 80°, and the marble is worked to a depth of 300 feet. In most cases the upper layers are of little value. and the marble can only be used for purposes requiring rough stone, regardless of composition. Ten or twelve feet of surface rock must be thrown away before sound material is reached.

There is considerable variety in the color as well as in the texture of the stone. The pure white marble is rare, occurring in layers of very limited extent. Most of the stone is of a bluish-gray tone, and presents a mottled or clouded appearance, resulting from a more or less intimate mixture of blue and white. In some cases the blue is so predominant that the marble is known as "blue marble," and in cases where the blue is particularly pronounced it is called "extra dark blue." The pure white statuary marble is generally found at considerable depth. There is, however, no decided regularity in the relative arrangement of the different colors. The following analyses made at Yale University for the Columbian Marble Company may be regarded as representative of the marbles of the colors named:

Analyses of marble from Proctor, Vt.

DARK-COLORED MARBLE.

	Per cent.
Calcium carbonate	98.370
Magnesium carbonate	.790
Iron carbonate	.034
Oxides of manganese and aluminum	.005
Matter insoluble in acids	.630
Organic matter	.080
Total	99.909

LIGHT-COLORED MARBLE.

	Per cent.
Calcium carbonate	96.300
Magnesium carbonate	3.060
Iron carbonate	.053
Matter insoluble in acids	.630
Organic matter	.004
Total	100.047

The stone weighs on an average 170 pounds to the cubic foot, although it sometimes reaches 180 pounds.

METHODS OF QUARRYING AND MANUFACTURING MARBLE.

The following description of methods of quarrying and manufacturing is taken from the writer's report on marble for the Eleventh Census:

QUARRYING.

The method of quarrying is essentially the same in most marble quarries. With fine marble, blasting seems to be entirely out of the question, because of injury to the stone, which has been amply proved by past experiments in Italy. This injury has not always been apparent in freshly quarried stone, but has been revealed years after by disintegration. It has already been stated that the marble at Swanton, Vt., and at a few quarries in other States, is quarried by the Knox system of blasting; but the product is not used for purposes which would be injuriously affected by blasting, and, furthermore, the character of the stone in such cases admits of the application of this method. Experiments in blasting marble have also been recently tried in California, but the results have not yet been made public. A spot for opening a quarry is selected with the greatest care. If the surface indications are not sufficient to determine the quality of the underlying marble, it becomes necessary to drill a hole to a greater or less depth into the body of the stone. This is accomplished by means of an ordinary diamond drill for prospecting; that is, a hollow tool cutting a circle and leaving a core, which is taken out when a proper depth is reached. Lengths of 10 or 12 feet are thus frequently taken out without flaws. If the core presents satisfactory indications, the surface material is stripped by blasting, so as to make an opening for the quarry. Derricks are then placed in position, and channelers, drills, and gadders commence operating upon the comparatively level floor secured by the operations of stripping. A channeler then cuts two grooves or channels across the grain of the stone the width of the channeler apart (about 5 feet). The stone thus separated from the rest is called the key course. This is cut across at intervals to the same depth as the long channels, namely, the thickness of the bed operated upon. The key course is thus cut into blocks, which are held to the fixed marble only on the under side. To separate the blocks from the quarry, two different processes are in use. According to one of these, a block, called the "key block," is blasted out, destroying it, but also separating it at the bottom, thus giving space for operating upon the adjacent block to be taken out entire and in sound condition. Instead of blasting, the key block may be loosened at the bottom by means of wedges driven into the channels at one side and one end. A ring fastened into the center of the block forms a means of attachment to the derrick, which then lifts it from the floor. In the latter method more time is consumed, but the key block is saved. After the key block is removed, space sufficient for the introduction of the gadder is secured. The gadder, similar to the drill, bores horizontal holes 6 inches apart into the adjacent block at the bottom. Iron wedges, known as "gadding pins," are then driven into the holes, thus separating the block at the bottom. In order to avoid breaking a block at the edges the pins are a foot or more in length. When the key course has been removed, several courses parallel to it are channeled out and removed in a similar manner. The channelers require two men, a runner and his helper, and will cut 75 channel feet per day to a depth of about 5 feet.

The drills operate by striking rapid blows, and the diamond borer cuts by revolving, the cutting edge consisting of diamonds set into the end. The underlying marble is cut into successive floors, as in the case described, thus gradually sinking below the surface, until, as in the Rutland and Proctor quarries, depths of 200 to 300 feet have been reached. Steam is commonly employed in running the quarry machinery, but in some cases compressed air is used, and hoisting is done by derricks. The usual size of blocks taken out is 4 feet by 4 feet 6 inches by 6 feet 6 inches, but for special purposes considerably larger blocks are frequently removed.

MANUFACTURING.

If the marble quarried as above is to be sold in sawed or in finished condition the blocks are transported to the mills, where they are sawed into slabs of various thicknesses. The saws consist of strips of steel fastened to an oscillating frame. The cutting material is sand, which, mixed with water, continually flows over the block and into the cuts made by the saws, and is fed upon the block either by hand or automatically. In the automatic process of feeding the sand is first delivered from a hopper into a well conveniently located in the mill; from this the mixture of water and sand is pumped through a main pipe connected with various branches, which delivers the contents upon the blocks of stone.

After sawing, the blocks or slabs are placed upon a rubbing bed, consisting of a circular iron disk revolving horizontally and continually supplied with the same mixture of sand and water used in sawing. A rather smooth but dull surface is thus secured, and the stone is then ready for decorative work or for carving and polishing.

The polishing of large surfaces is accomplished by means of a buffer, which consists of a rapidly revolving wheel covered with flannel and charged with a so-called putty powder, and frequently with a mixture of putty and oxalic acid. This wheel is capable of a universal horizontal movement while revolving, so that it may reach all parts of the slab. Much of the polishing in Vermont mills is necessarily done by hand on account of the delicate nature of the work, owing to the intricacies of surface resulting from carving. In Tennessee mills, where large plain slabs for wainscoting and partitions are polished, the practice of machine polishing is much more general.

The light carving, or "skin work," as it is called, is largely done in the old-fashioned way, with mallet and hand-cutting tool; but a recently patented pneumatic tool, delivering a large number of light blows per second, is now being introduced. This is held in the hand and moved along the outline to be cut into the stone. Its work is very rapid, and it appears to be gaining in favor. It is used not only for the softer kinds of stone, but also for granite.

In the preparation of stone for architectural designs, such as moldings, cornices, etc., planers similar to iron planers are used. Monumental urns and turned architectural work are produced by means of lathes, which are used both for cutting and polishing the various forms.

THE SLATE INDUSTRY.

Clay slate consists of siliceous clay which has been hardened and otherwise changed by metamorphosing influences, such as heat, pressure, and in some cases oxidation.

Quite a variety of minerals, generally in an exceedingly fine state of division, have been found in varying proportions throughout the kaolin mass which constitutes the great bulk of the rock. Among such minerals may be mentioned quartz, feldspar, mica, tourmaline, organic material, and hydrated oxide of iron. Carbonaceous matter accounts for the black color of slate from quarries in Maine and Pennsylvania. In the red, purple, and green slates of Vermont and New York, carbonaceous material is wanting; the process of oxidation which converted compounds of iron into the ferric condition, thus giving the various shades of red and purple, may also have destroyed the carbonaceous material characteristic of black slate.

USES TO WHICH SLATE IS PUT.

The property of slate which renders it useful as a roofing material is its cleavage, in virtue of which it may be readily split into thin sheets of suitable area. The great bulk of all the slate quarries in the United States goes for roofing, but the number of other uses to which slate is put is already large and is continually increasing. Such uses are the following:

Slate is used locally in a comparatively rough state for sidewalks, curbstones, hitching posts, underpinning, cellar walls, and door steps. As a manufactured article, after going through the mill, it is offered for the following purposes: Billiard-table beds, mantels, fireboards, register frames, radiator tops, steps and risers, platforms, tiles, wainscoting, moldings, thresholds, window sills, lintels, brackets, laundry tubs, washbowl tops, cisterns, sinks, urinals, refrigerators, blackboards, mangers, curriers' slabs, imposing stones, grave boxes, grave covers, headstones, grave markers, vault doors, water tables, belting courses, counter tops, brewers' vats, greenhouse shelves, chimney tops, switch boards, and panels for electric work. In the marbleizing process it is susceptible of considerable ornamentation, which makes it more desirable still for many of the above uses and also extends the list of its uses as follows: Table tops, stand tops, card receivers, soda-water fountains, checkerboards, door plates, signs, and paper weights.

METHODS OF QUARRYING SLATE.

Slate quarrying having been for hundreds of years an exceedingly important industry in Wales, it naturally happens that the industry in this country is largely carried on under the direction and superintendence of Welsh quarrymen who have learned the art by years of experience in their native land. Owing to the peculiarities of the slate itself, methods of quarrying applicable to other kinds of stone are not suitable to the production of slate. A successful slate quarryman has almost invariably learned his art by years of experience under competent and skilled supervision in quarries operated upon a liberal scale. While in this work general principles are recognized and applied, no rule-of-thumb methods of application will suffice, but the operator must be in possession of such trained judgment as will enable him to meet continually changing conditions both in the nature of the slate and in its environment. What might have been otherwise a fine and profitable quarry may readily be spoiled by the exercise of poor judgment in the initial steps of opening the quarry. A large amount of débris must be disposed of in connection with slate quarrying and the proper disposition of this, so as not to interfere with future developments, is frequently a matter involving careful consideration and good judgment. That serious mistakes may be made even by skilled workmen is testified to by the large number of abandoned quarries in Vermont and Pennsylvania which indicate unsuccessful operations.

Blasting is liberally resorted to in slate quarrying, and in this part of the art there is much room for the exercise of good judgment, so as to take advantage of the position of the rock as determined by the cleavage grain and natural joints, and to direct the blast so that just the desired effects may be produced. To an on-looker the skill of a quarryman in producing already planned for and predicted effects is sometimes quite wonderful.

Aside from this mental work and judgment involved in the successful development of a quarry, the mechanical operations are comparatively simple, and there is room for the employment of a considerable amount of unskilled labor. In some of the largest quarries of Pennsylvania Italians are freely employed in stripping and similar work. The tools used are of simple character. In the production of roofing slates the operations of manufacture, which consist in splitting and trimming to the proper thickness and size, are carried on at the edge of the quarry by men who are trained and skilled in this specialty and are known as "splitters." Their work involves a thorough knowledge of slate as to its cleavage, and in many cases the most successful workmen have followed the calling from boyhood up, having started as assistant to some one else in this work. Frequently a father brings up his sons in the same line of work, and in some cases this practice has been followed through a number of generations.

MANUFACTURE OF MILLED STOCK.

A long enumeration of the articles other than roofing slate into which slate is manufactured has already been given. In the mills devoted to this work there has been much opportunity for the exercise of mechanical ingenuity in inventing labor-saving devices and in adapting slate to new uses. While the Welsh enjoy quite a monopoly of the skilled work in quarrying and in making roofing slate, their particular skill is much less in demand in the mill itself, where all other articles of slate are produced. In the production of milled stock improvements have been rapidly made and American inventiveness has made itself felt. Much of the work involved in the production of milled stock consists in the making of slabs having smooth surfaces. Slate will not take a polish, but it may be made quite smooth by planing and rubbing with sand and emery. The planers are similar to those used for planing iron. At some localities in Pennsylvania the slate is so hard that it has to be cut with black diamond saws. In the manufacture of billiard table tops much care must be exercised to secure perfectly smooth and level surfaces, and for this purpose slate has no superior.

Slate is well adapted for ornamental purposes after it has gone through the process of marbleizing. Quite a variety of stones and wood are thus imitated in a very successful manner. The following is a list of different kinds of stone which are thus imitated: Gray granite, Mexican onyx, fossil limestone, Devonshire marble, Tennessee marble, Circassian, Egyptian, and Pyrenees marble; and in fact all the better-known varieties of variegated marble; also blue agate, red granite, red serpentine, the various kinds of woods, and petrified wood of California. As the industry progresses the number of different kinds of imitation increases. The slab to be marbleized is first rubbed by hand with fine sand, using a wooden block covered with cloth. The marbleizing process is done in two ways. The marble having fine veins and lines running through it like Spanish marbles, is colored on a "float," as it is called; that is to say, a large vat of water is sprinkled with the different oil paints required. The effect desired on the stone is thus produced on the surface of the water, and is then transferred to the slab by simply immersing the slab and leaving the representation on it. The other method is by hand, brushes, sponges, and feathers being used to smear on the paint. In this process water colors are used.

At this stage the slab is baked overnight, the temperature of the oven or kiln varying from 175° F. to 225° F. After this first baking the slab is varnished and the baking is then repeated. Next it is scoured with ground pumice dust, varnished, and baked again. If any gilding is to be done it is done at this stage, after the slab comes out of the kiln for the third time. The next stage consists in rubbing with very fine pumice stone and a felt bock, after which it is baked for the last time. Rubbing with rotten stone follows, and the final polish is put on by rubbing with the palm of the hand.

SLATE PRODUCT AND ITS VALUE, BY STATES.

The following table of production for the year 1894 shows the number of squares of roofing slate, its value, the value of milled stock, and the total value of slate for all purposes:

Value of slate production in 1894, by States.

States.	Roofing.		Other purposes, value.	Total value.
	Squares.	Value.		
California	900	$5, 850	....	$5, 850
Georgia	5, 000	22, 500	....	22, 500
Maine	24, 690	123, 937	$22, 901	146, 838
Maryland	39, 460	150, 568	2, 500	153, 068
New Jersey	375	1, 050	....	1, 050
New York	7, 955	42, 092	2, 450	44, 542
Pennsylvania	411, 550	1, 380, 430	239, 728	1, 620, 158
Vermont	214, 337	455, 860	202, 307	658, 167
Virginia	33, 955	118, 851	19, 300	138, 151
Total	738, 222	2, 301, 138	489, 186	2, 790, 324

The following table shows the value of the production of slate, by States, during the years 1890 to 1894, inclusive:

Value of slate, by States, from 1890 to 1894.

States.	1890.				1891.			
	Roofing.	Value.	Other purposes than roofing, value.	Total value.	Roofing slate.	Value.	Other purposes than roofing, value.	Total value.
	Squares.				*Squares.*			
Arkansas	....	....	....	....	120	$480	....	$480
California	3, 104	$18, 089	....	$18, 089	4, 000	24, 000	....	24, 000
Georgia	3, 050	14, 850	$480	15, 330	3, 000	13, 500	....	13, 500
Maine	41, 000	201, 500	18, 000	219, 500	50, 000	250, 000	....	250, 000
Maryland	23, 099	105, 745	4, 263	110, 008	25, 166	123, 425	$2, 000	125, 000
New Jersey	2, 700	9, 675	1, 250	10, 925	2, 500	10, 000	....	10, 000
New York	16, 767	81, 726	44, 877	126, 603	17, 000	136, 000	40, 000	176, 000
Pennsylvania	476, 038	1, 641, 003	370, 723	2, 011, 726	507, 824	1, 741, 836	401, 000	2, 142, 905
Utah	....	....	....	....	....	....	....	....
Vermont	236, 350	596, 997	245, 016	842, 013	247, 643	698, 350	257, 267	955, 617
Virginia	30, 457	113, 079	....	113, 079	36, 059	127, 819	....	127, 819
Other States (a)	3, 060	15, 240	....	15, 240	....	....	....	....
Total	835, 625	2, 797, 904	684, 609	3, 482, 513	893, 312	3, 120, 410	700, 336	3, 825, 746

Value of slate, by States, from 1890 to 1894—Continued.

States.	1892. Roofing slate.	1892. Value.	1892. Other purposes than roofing, value.	1892. Total value.	1893. Roofing slate.	1893. Value.	1893. Other purposes than roofing, value.	1893. Total value.
	Squares.				*Squares.*			
Arkansas	....	....						
California	3,500	$21,000	....	$21,000	....	....	....	....
Georgia	2,500	10,625	....	10,625	2,500	$11,250	....	$11,250
Maine	50,000	250,000	....	250,000	18,184	124,200	$15,000	139,200
Maryland	24,000	114,000	$2,500	116,500	7,422	37,884	....	37,884
New Jersey	3,000	12,000	....	12,000	900	3,653	....	3,653
New York	20,000	160,000	50,000	210,000	69,640	204,776	206	204,982
Pennsylvania	550,000	1,925,000	408,000	2,333,000	364,051	1,314,451	157,824	1,472,275
Utah	....	....	....	....	75	450	400	850
Vermont	260,000	754,000	260,000	1,014,000	132,061	407,538	128,194	535,732
Virginia	40,000	150,000	....	150,000	27,106	104,847	12,500	117,347
Total	953,000	3,396,625	720,500	4,117,125	621,939	2,209,049	314,124	2,523,173

States.	1894. Roofing slate.	1894. Value.	1894. Other purposes than roofing, value.	1894. Total value.
	Squares.			
Arkansas	....	....	....	....
California	900	$5,850	....	$5,850
Georgia	5,000	22,500	....	22,500
Maine	24,690	123,937	$22,901	146,838
Maryland	39,460	150,568	2,500	153,068
New Jersey	375	1,050	....	1,050
New York	7,955	42,092	2,450	44,542
Pennsylvania	411,550	1,380,430	239,728	1,620,158
Utah	....	....	....	....
Vermont	214,337	455,860	202,307	658,167
Virginia	33,955	118,851	19,300	138,151
Total	738,222	2,301,138	489,186	2,790,324

(*a*) Includes Arkansas, Michigan, and Utah.

An inspection of this table shows that during the past year slate has been produced in nine States. During the census year 1890 twelve States yielded slate. The financial depression has had the effect of shutting down operations in a number of States in which the industry had not yet secured a firm foothold.

SLATE INDUSTRY IN THE VARIOUS STATES.

California.—As is the case with other kinds of stone, quarrying of slate in this State has not enjoyed great prosperity during the past year. The entire output comes from Eldorado County and was entirely devoted to roofing.

Georgia.—The slate industry in Georgia undoubtedly has a future, although operations have not been very extensive in the past. Demand for slate as a roofing material in the South has not been a keen one, but it is difficult to understand why it should not become so in view of the extending use of slate for roofing in other portions of the country.

Although slate is known to occur at a number of localities in the South, the quarries at Rock Mart are the only ones at present equipped to supply any considerable demand.

Maine.—Slate production in Maine increased from a total valuation of $139,200 in 1893 to $146,838 in 1894. Of the total value in the latter year, $123,937 represents the value of 24,690 squares of roofing slate, while the remainder, $22,901, is the value of milled stock, the production of which is on the increase. The entire output comes from quarries in Piscataquis County.

Maryland.—The slate region of this State is a continuation of the York County slate belt. The Maryland quarries are all in the northern part of Harford County, near the State line. The quarries of these two counties constitute what is known as the Peach Bottom slate region. This region is discussed more fully in connection with Pennsylvania slate statistics. The Maryland product is almost entirely used for roofing purposes, 7,422 squares having been produced in 1893 and 39,460 in 1894. These products were valued at $37,884 and $150,568, respectively.

New Jersey.—The slate quarries of this State are an extension of the Pennsylvania slate belt, and only a little quarrying is annually done. The quarries are in Sussex and Warren counties.

New York.—The slate quarries of this State are all in Washington County, near the line separating New York and Vermont. The New York quarries produce slate of a cherry-red color, which is the only slate of its kind in the world. The price for this slate is much higher than for any other slate in the country. No red slate is quarried on the Vermont side of the line. In 1894 the product amounted to 7,955 squares, valued at $42,092. Many of the quarrymen operating in Vermont reside in New York State.

In the report for 1893 the value of the output of slate in New York was placed at too high a figure, on account of an error arising from the difficulty in identifying quarries near the State line as belonging to one State or the other. The figures for 1894 are exact, having been verified by Mr. George W. Harris, formerly a resident of Fair Haven, Vt., who is familiar with the Vermont and New York slate region.

Pennsylvania.—As is evident from the table of production, this State produces more than half of the entire slate output of the country. The product of 1894 was valued at $1,620,158. Of this amount $1,380,430 is the value of 411,550 squares of roofing slate, while the remainder is the value of milled stock.

The following description of the State quarrying regions of Pennsylvania is taken from the writer's report in Mineral Resources for 1889–90:

While there is a great variety in the colors of the slate produced in Vermont, a similar statement does not apply to Pennsylvania, the product of which is entirely black, although a very fine distinction is locally made between black and a sort of bluish-black.

The actively quarried slate belt of Pennsylvania really begins in Sussex County, in the northeastern part of New Jersey, where, at Lafayette and Newton, there are slate quarries in operation, and also in Warren County, at Polkville. The Pennsylvania portion of this slate belt begins at the Delaware Water Gap, in the northeastern part of Northampton County, and extends through Northampton, Lehigh, and Berks counties in a southwesterly direction. There is then a break filled up by Lebanon and Lancaster counties to the southwest, but in the southern part of York County operations in what is known as the Peach Bottom region reappear. Passing from the Delaware Water Gap in a southwesterly direction, the most important producing localities are as follows: Slateford, Mount Bethel, East Bangor, Pen Argyl, Wind Gap, Belfast, Edelman, Chapman Quarries, Treichlers, Danielsville, Walnutport, Slatington, Tripoli, Lynnport, Steinsville, and finally, in York County, a portion of what is known as the Peach Bottom region, which is for the most part in the northern part of Harford County, Md. The most important localities in York County are West Bangor and Delta, which may be regarded as the principal points for the entire Peach Bottom region. The slate of Pennsylvania is frequently divided, more for commercial reasons than anything else, into the following regions: The Bangor region, the Lehigh, the Northampton Hard Vein, the Pen Argyl, and the Peach Bottom regions. The Bangor region is entirely within Northampton County, and is the most important. It includes quarries at Bangor, East Bangor, Mount Bethel, and Slateford; the Lehigh region includes Lehigh County entire, also a few quarries in Berks and Carbon counties, and also a small number of quarries in Northampton County, on the side of the Lehigh River, opposite Slatington; the Pen Argyl region embraces quarries at Pen Argyl and Wind Gap, in Northampton County. The Northampton Hard Vein region is especially distinguished on account of the extreme hardness of the slate as compared with that produced in other regions of the State. It includes the following localities: Chapman Quarries, Belfast, Edelman, Seemsville, and Treichlers, all in Northampton County. The Peach Bottom region includes four quarries in York County, Pa., and five in Harford County, Md.

One of the chief difficulties met with in quarrying the so-called "soft" slate of Pennsylvania is the occurrence of what are known as "ribbons." These ribbons are composed of foreign material and are exceedingly hard and interfere not a little with the smooth and economical quarrying of the slate. These ribbons are entirely wanting in the Peach Bottom slate, and this makes a great difference in the ease of quarrying in favor of the product of the Peach Bottom region. The slate produced at Chapman Quarries and other localities quarrying the same kind of slate that is produced at this locality is so extremely hard that although it can be split with about the same readiness as the soft slate, it has to be sawed with diamond saws. This hardness is naturally an advantage to the slate, rendering it durable and nonabsorptive. For flagging purposes it is extremely well adapted, chiefly on account of its hardness. The most important product into which this hard vein slate is made is roofing slate, although it finds considerable application for billiard tables, imposing stones, blackboards, cisterns, lintels, window sills, copings, ridgepoles, stairsteps, and floor tiles. For paving purposes it has given great satisfaction.

The largest quarry in the State, and probably in the country, is the old Bangor quarry at Bangor. The dimensions of this quarry are 1,100 feet long, 350 feet wide, with an average depth of 175 feet. Operations are conducted on a very large scale here in every respect, two locomotive engines and a large number of cars being kept during a part of the year almost constantly employed in stripping and transporting the surface material to the dump.

Slate quarrying not only in Pennsylvania, but in all other States producing slate, is carried on almost entirely by the Welsh, in so far as skilled labor is concerned. This is of course due to the fact that operations of quarrying slate have been better studied in the enormous slate quarries of Wales than in any other part of the world, and naturally labor skilled in slate quarrying comes from that country. For ordinary labor, such as stripping, Italians supply most of the demand. A large school-slate factory is in active operation at Bangor. In this factory the operations are carried on almost entirely by machinery, which is so perfect in its working that the manual labor required in attending to it is largely monopolized by children of both sexes. Similar statements may be made of large and prosperous school-slate factories in operation in Slatington and Walnutport. In the manufacture of roofing slate, boys are quite freely employed in the work of trimming the slates after they have been split to the proper thickness and approximate size. This practice enables the Welsh to keep the skilled work largely in their own hands, as they bring up their sons to learn the business after them, beginning with the light work of trimming, and as they grow older and stronger extending their work to the heavier operations.

Vermont.—The slate output of this State comes entirely from quarries in Rutland County. The industry has suffered quite noticeably from the financial depression which has characterized the years 1893 and 1894. The total value of the output of 1893 was placed at $535,732. As explained in connection with the consideration of slate statistics in New York State, the above figures for 1893 in Vermont are somewhat too low, as returns from some Vermont quarries operated by residents of New York State were erroneously returned as belonging to the latter. The value of the product in 1894 for Vermont has been very exactly ascertained to be $658,167. Of this amount, $455,860 represents the value of 214,337 squares of roofing slate, while the remainder is the value of milled stock.

The area in which slate is actually produced at present is confined to a narrow strip in Washington County, N. Y., and a somewhat wider one lying next to it in Rutland County, Vt. It extends from Castleton, Vt., on the north, to Salem, N. Y., on the south, a distance of 35 or 40 miles, and has a maximum width of 6 miles, but the average is not more than a mile and a half. Scattered over this territory there are about forty-nine quarries in Vermont, and abandoned quarries, or those which for one cause or another are at present idle, number many more. The first commercial use to be made of the slate of this region was between thirty and forty years ago, when Messrs. Alanson and Ira Allen began on a small scale the manufacture of school slates from the stone obtained at Scotch Hills, 2 miles north of the village of Fair Haven. This quarry is still in operation. The industry has now reached large proportions, the number of quarries keeping pace with the demand for the stone, and this is steadily increasing as new purposes are found for its application.

According to Mr. George W. Harris an outcropping of black slate has been observed near Benson, Rutland County. No actual developments have been made, but tested samples give promising indications both as to texture and color.

The slate differs somewhat in its physical properties, such as hard, ness, homogeneity, and cleavage, but the greatest variation is to be found in its color, no other place in the world showing so many colors in an area of equal size. Most of the commercial names under which the slate is sold are descriptive of the color of each kind, and are as follows: Sea green, unfading green, uniform green, bright green, red-bright red, cherry red, purple, purple variegated, variegated, and mottled.

The line dividing Vermont and New York also marks the division of two important varieties of slate. The true sea-green is found only in the former State, while the red is entirely confined to the latter, some of the quarries producing the respective kinds being, however, but a few hundred yards apart. The sea-green slate is manufactured almost entirely into roofing slates, more than three times as many squares being made from it as from all other varieties combined. It is quarried very extensively in the villages of Pawlet and Poultney. The selling price per square is lower than for any other prominent kind quarried in the region, and the greater output results both from its predominance in the localities mentioned and from the ease with which it is worked, the split being remarkably pronounced. When first quarried its color is a pleasant grayish-green, but after being exposed to the weather it gradually fades and changes in a very unequal manner, certain sheets turning brown, others light gray, while some remain practically unchanged. A roof covered with it presents, after a year or two, a peculiar spotted appearance. It is, however, a good wearing slate, and the objection to its color is the principal one against it.

As already stated, no red slate is produced in Vermont, while the red-slate quarries of New York, just across the dividing line, are the only ones in the world producing red slate.

Virginia.—The slate industry of Virginia is developing in a satisfactory manner, and although the general business depression has affected the industry during the past two years, progress has been made both in an increase of output in 1894 as compared with 1893, and in the further perfection of mills for the manufacture of products other than roofing slate. The value of the output in 1893 was $117,347, representing the value of 27,106 squares of roofing slate and $12,500 worth of milled stock. In 1894 the total value of the output was $138,151, of which $19,300 represented the value of milled stock and the remainder that of 33,955 squares of roofing slate. Most of the product comes from Buckingham County, while the rest is quarried in Amherst and Albemarle counties.

HISTORICAL DATA.

According to Mr. George W. Harris, of Fair Haven, Vt., the quarrying of slate began with the operations at the Cilgwyn quarries in Wales. From these was taken the slate used in roofing some of the oldest castles in that country. Some of these structures are said to have been in existence prior to the Norman conquest. Excavations made in one of the ancient churchyards of Wales revealed a headstone erected over the grave of Sir William Brereton, who, according to the inscription, died in the year 1651. A headstone in a graveyard at Plymouth, Mass., bears the date February 23, 1672. This slab and others were brought to this country as ballast in ships from the earliest Welsh quarries.

The first use to which Vermont slate appears to have been put was the manufacture of school slates by Deacon Ranney and Colonel Allen, of Fair Haven, Vt. In 1847 the production of roofing slate began, only 200 squares being manufactured the first year. In 1855 the same locality yielded 45,000 squares of roofing slate.

THE SANDSTONE INDUSTRY.

NATURE AND VARIETIES OF SANDSTONE.

The constituent granules of sandstone have resulted from the disintegration of the older rocks under the influences of dynamic action, erosion, and weathering. The sedimentary deposition of these granules from suspension in water, supplemented by the cementing effect of other substances, aided by pressure, has given rise to what is known as sandstone. The hardest essential component of the older rocks is quartz, which is naturally therefore the most abundant granule-forming material, and while other minerals are to be found in sandstone most of the sandstones are almost entirely made up of quartz. Feldspar and mica are to be found in some sandstones, but the constitution of this rock on the whole is much simpler and more uniform than is the case with granitic and volcanic rocks.

The size of the constituent granules in sandstone is quite variable, and thus it is customary to distinguish between fine and coarse grained stone.

The nature of the material which binds the granules together is an important consideration, since it determines largely the strength, durability, and beauty of the stone, and consequently its commercial value. It is scarcely necessary to observe that no matter how hard the granules of a sandstone may be, if they are not firmly bound together the rock as a whole may be easily crushed and disintegrated. The commonly occurring cementing materials are oxides of iron, argillaceous material, calcium carbonate, and silica, the latter in a different physical condition from that which constitutes the quartz granules themselves.

Argillaceous sandstone is that in which the cementing material is clay; such stone is apt to be weak and easily crushed, unless it happens that the original clay has been changed and hardened by metamorphic action.

The cementing material of calcareous sandstone is calcium carbonate, which, owing to its susceptibility to decomposition under the influence of an acid atmosphere, is not so desirable as some other materials.

Ferruginous sandstone is that in which the cement consists of one or another of the oxides of iron, or mixtures of them. These oxides of iron are to be found in many of the best sandstones. In addition to their cementing qualities they are also responsible for the color of the stone when this is pink, red, brown, or some shade intermediate between them. Sandstones in which but little or no ferric oxide is present usually show a light color, due to the absence of iron compounds altogether or to their presence only in the ferrous or unoxidized condition. Light-colored stone frequently becomes darker in color upon exposure to the air, on account of the oxidation of ferrous compounds (oxide or carbonate) or iron pyrites to ferric oxide.

When the cementing material is silica, which is chemically the same thing as quartz, the stone consists entirely of silica. Such stone is extremely hard and durable, but difficult to work. It is not subject to change in color, which is light gray or bluish gray. When such stone occurs in thin layers it is easily quarried in sheets or slabs, in which form it is used extensively for curbing and flagging in our largest cities, and is known commercially as bluestone. Siliceous sandstone grades into what is known as quartzite, which has been hardened by heat and pressure.

COMPOSITION OF SANDSTONE AS SHOWN BY ANALYSES OF SAMPLES FROM VARIOUS LOCALITIES.

The following table of analyses of sandstone from a number of localities will serve to indicate its general composition:

Analyses of sandstone.

No.	Kinds of stone.	Locality.	Silica.	Alumina.	Iron oxides.	Manganese oxide.	Lime.	Magnesia.	Potash.	Soda.	Carbonic acid, water, and loss.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	Manyard	East Longmeadow, Mass.	79.38	8.75	2.43	......	2.57	......	4.08		2.79
2	Worcester	....do	88.89	5.95	1.79	.41	.27	......	.86		1.83
3	Kibbie quartz	....do	81.38	9.44	3.54	.11	.76	.28	......	......	4.49
4	Brownstone	Portland, Conn.	69.94	13.15	2.48	.70	3.09	Trace	3.30	5.43	1.01
5	Sandstone	Stony Point, Mich.	84.57	5.90	6.48	......	......	.68	Undetermined.		1.92
6	Quartzite	Pipestone, Minn	84.52	12.33	2.12	......	.31	Trace	.11	.34	2.31
7	Buff	Amherst, Ohio	97.00	......	1.00	......	1.15	......	.64		.21
8	Berea	Berea, Ohio	96.90	......	1.68	......	.55	......	.55		.32
9	Euclid bluestone.	Euclid County, Ohio.	95.00	2.50	1.00	......	......	......	......	......	1.50
10	Columbia	Columbia, Ohio	96.50	......	......	......	1.00	......	.50		2.00
11	Red	Laurel Run, Pa.	94.00	Trace	1.90	......	1.10	1.00	......	......	1.92
12	Elyria	Grafton, Ohio	87.66	1.72	3.52	......	.17	.20	......	......	2.03
13	Sandstone	Fond du Lac, Minn.	78.24	10.88	3.83	......	.95	1.60	1.67	.06	......

AUTHORITIES FOR ANALYSES.—Nos. 1 and 2, Leonard P. Kinnicutt, Ph. D.; No. 3, C. F. Chambers, Ph. D.; No. 4, F. W. Taylor; No. 5, F. W. Clarke, United States Geological Survey, Bulletin No. 27; No. 6, Geology of Minnesota, vol. 1; No. 7, J. H. Salesbury; No. 8, John Eisenmann; No. 11, A. A. Breniman; No. 12, F. F. Jewett; No. 13, N. H. Winchell, Geology of Minnesota, vol. 1.

USES TO WHICH SANDSTONE IS PUT.

The following is a list showing the various uses to which the sandstone of the country is put:

FOUNDATIONS, SUPERSTRUCTURES, AND TRIMMINGS.

Solid fronts.	Buttresses.	Capping.	Ashlar.
Foundations.	Window sills.	Belting or belt courses.	Forts.
Cellar walls.	Lintels.	Rubble.	Dimensions.
Underpinning.	Kiln stone.		Sills.
Steps.			

STREET WORK.

Paving blocks.	Basin heads or catch-basin covers.	Road making: Macadam.	Sledged stone.
Curbing.	Stepping stones.	Road making: Telford.	Crushed stone.
Flagging.		Road making: Concrete.	

ABRASIVE PURPOSES.

Grindstones.	Whetstones.	Shoe rubbers.	Oilstones.

BRIDGE, DAM, AND RAILROAD WORK.

Bridges.	Breakwater.	Rails.	Bank stone.
Culverts.	Jetties.	Ballast.	Parapets.
Aqueducts.	Piers.	Approaches.	Docks.
Dams.	Buttresses.	Towers.	Bridge covering.
Wharf stone.	Capstone.		

MISCELLANEOUS.

Grout.	Lining for blast furnaces.	Watering troughs.	Glass furnaces.
Hitching posts.	Rolling-mill furnaces.	Fluxing.	Core sand for foundries.
Fence wall.	Adamantine plaster.	Ganister.	Random stock.
Sand for glass.	Millstones.	Fire brick, silica brick.	
Sand for plaster and cement.	Cemetery work.	Lining for steel converters.	
Furnace hearths.			

VALUE OF THE SANDSTONE PRODUCT, BY STATES.

The following table shows, by States, the value of the sandstone produced during the calendar year 1894:

Value of sandstone production in 1894, by States.

States.	Value.	States.	Value.
Alabama	$18,100	Missouri	$131,687
Arkansas	2,365	Montana	16,500
California	10,087	New Jersey	217,941
Colorado	69,105	New Mexico	300
Connecticut	322,934	New York	450,992
Georgia	11,300	Ohio	1,777,034
Idaho	10,529	Pennsylvania	349,787
Illinois	10,732	South Dakota	9,000
Indiana	22,120	Texas	62,350
Iowa	11,639	Utah	15,428
Kansas	30,265	Virginia	2,258
Kentucky	27,868	Washington	6,611
Maryland	3,450	West Virginia	63,865
Massachusetts	150,231	Wisconsin	94,888
Michigan	34,066	Wyoming	4,000
Minnesota	8,415		
		Total	3,945,847

Inspection of the foregoing table, which reveals a total value of $3,945,847, and a comparison with the total for the year 1893, shows a falling off in production of $1,249,304. This decrease is greater than for any other kind of stone. This is what would naturally be expected, in view of the fact that sandstone is more exclusively used for building purposes than any other variety of stone. Thus, granite is quite largely employed as paving material in the form of Belgian blocks, and for monumental and cemetery purposes; limestone, also, besides its use as building material, is used for road making, burning into lime, and for blast-furnace flux purposes, requiring large quantities of stone. In the census year 1889, 23 per cent of the limestone, 43 per cent of the granite, and 65 per cent of the sandstone were the proportions of each used for building purposes. Hence it is, that building operations being restricted on account of hard times, the sandstone industry suffered more than the others. A surprisingly large number of sandstone quarries shut down operations entirely on account of the lack of demand, while, without any exception, the largest producers report a serious falling off in output, sometimes amounting to 50 per cent of the value of the output in 1893.

The following table shows the production of sandstone, by States, for the years 1890 to 1894:

Value of sandstone, by States, from 1890 to 1894.

States.	1890.	1891.	1892.	1893.	1894.
Alabama	$43, 965	$30, 000	$32, 000	$5, 400	$18, 100
Arizona	9, 146	1, 000	35, 000	46, 400	....
Arkansas	25, 074	20, 000	18, 000	3, 292	2, 365
California	175, 598	100, 000	50, 000	26, 314	10, 087
Colorado	1, 224, 098	750, 000	550, 000	126, 077	69, 105
Connecticut	920, 061	750, 000	650, 000	570, 346	322, 934
Florida	(*a*)				
Georgia	(*a*)	....	2, 000	....	11, 300
Idaho	2, 490	....	3, 000	2, 005	10, 529
Illinois	17, 896	10, 000	7, 500	16, 859	10, 732
Indiana	43, 983	90, 000	80, 000	20, 000	22, 120
Iowa	80, 251	50, 000	25, 000	18, 347	11, 639
Kansas	149, 289	80, 000	70, 000	24, 761	30, 265
Kentucky	117, 940	80, 000	65, 000	18, 000	27, 868
Maryland	10, 605	10, 000	5, 000	360	3, 450
Massachusetts	649, 097	400, 000	400, 000	223, 348	150, 231
Michigan	246, 570	275, 000	500, 000	75, 547	34, 066
Minnesota	131, 979	290, 000	175, 000	80, 296	8, 415
Missouri	155, 557	100, 000	125, 000	75, 701	131, 687
Montana	31, 648	35, 000	35, 000	42, 300	16, 500
Nevada	(*a*)	....	....	....	....
New Hampshire	3, 750	....	....	....	....
New Jersey	597, 309	400, 000	350, 000	267, 514	217, 941
New Mexico	186, 804	50, 000	20, 000	4, 922	300
New York	702, 419	500, 000	450, 000	415, 318	450, 992
North Carolina	12, 000	15, 000	....	....	....
Ohio	3, 046, 656	3, 200, 000	3, 300, 000	2, 201, 932	1, 777, 034
Oregon	8, 424	....	35, 000	....	....
Pennsylvania	1, 609, 159	750, 000	650, 000	622, 552	349, 787
Rhode Island	(*a*)	....	....	....	....
South Dakota	93, 570	25, 000	20, 000	36, 165	9, 000
Tennessee	2, 722	....	....	....	....
Texas	14, 651	6, 000	48, 000	77, 675	62, 350
Utah	48, 306	36, 000	40, 000	136, 462	15, 428
Vermont	(*a*)	....	....	....	....
Virginia	11, 500	40, 000	....	3, 830	2, 258
Washington	75, 936	75, 000	75, 000	15, 000	6, 611
West Virginia	140, 687	90, 000	85, 000	46, 135	63, 865
Wisconsin	183, 958	417, 000	400, 000	92, 193	94, 888
Wyoming	16, 760	25, 000	15, 000	100	4, 000
Total	14, 464, 095	8, 700, 000	8, 265, 500	5, 195, 151	3, 945, 847

a Sandstone valued at $26,199 was produced by Rhode Island, Nevada, Vermont, Florida, and Georgia together, and this sum is included in the total.

SANDSTONE INDUSTRY IN THE VARIOUS STATES.

Alabama.—Sandstone has been produced from quarries in Jefferson, Colbert, and St. Clair counties. Production in 1894 has been much restricted, but indications for improvement in 1895 are well defined and unmistakable.

Arkansas.—But very little sandstone is quarried in Arkansas, although it has been produced on a limited scale in four different counties, namely, Johnson, Sebastian, Conway, and Miller.

California.—In sandstone production, as in that of all other kinds of stone, the year 1894 has been an exceedingly dull one in this State. Production in 1894 was so limited as to be hardly worth noting. In former years sandstone has been produced in the following counties, named in order of importance: Santa Clara, Amador, Ventura, San Bernardino, Yolo, Solano, and Napa.

Colorado.—Production of sandstone in Colorado a few years ago had assumed quite large proportions, and in 1889 the value of the output was found to be $1,224,098. During 1894 the industry almost came to a standstill, many operators quitting the business entirely, while others barely existed in their struggles with slack demand, low prices, and slow collections. The counties which have yielded sandstone are, in order of importance: Boulder, El Paso, Larimer, Eagle, Jefferson, Las Animas, Fremont, Park, Huerfano, and Montezuma.

Connecticut.—Practically the entire output of sandstone in this State comes from the well-known quarries at Portland, Middletown, and Cromwell, in Middlesex County. The product of these localities has long been in favor in the most important cities of the East. While production is in amount well below that of a few years since, the industry is in a stable condition, with promise of decidedly better results in 1895.

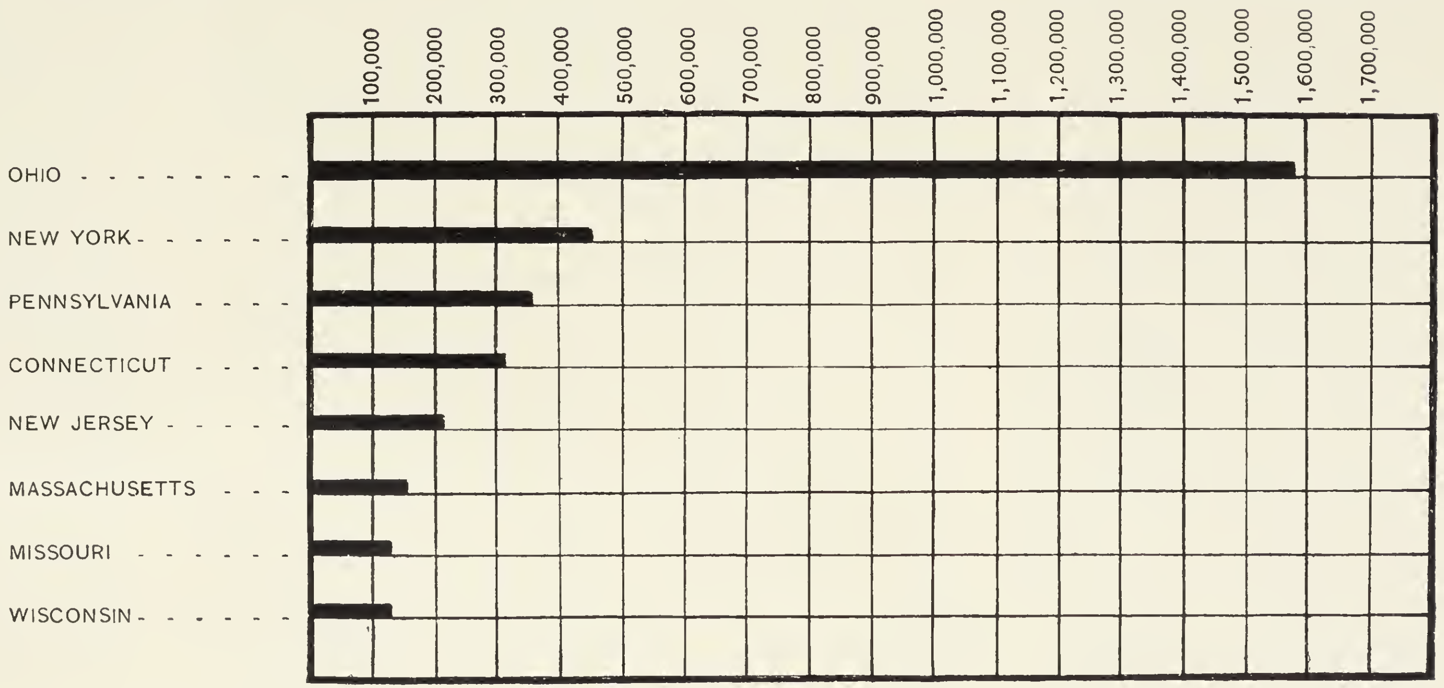
Georgia.—While a small quantity of sandstone was produced in 1894, this branch of the stone industry in Georgia has never amounted to a great deal. Much more enterprise has been shown in the development of its valuable resources in granite, marble, and slate.

Idaho.—The output of sandstone in Idaho exceeded that of the census year, but the industry does not yet cut much of a figure. The product is confined to Ada County.

Illinois.—This State, while very prominent for its limestone output, has not as yet done much in the way of quarrying sandstone, although operations have been carried on in Henry, Fulton, Whiteside, Union, Knox, Lee, and Clay counties.

Indiana.—Indiana is widely known for oolitic limestone rather than for other varieties. Sandstone is produced to a limited extent in the following counties: Warren, Fountain, Orange, and Putnam.

The sandstone of Orange County deserves especial mention on account of its value for abrasive purposes. This stone is said to need no oil to soften it, but is used with water alone, and it appears to be very



VALUE OF SANDSTONE PRODUCED IN THE VARIOUS STATES DURING THE YEAR 1894.

popular for the purpose of sharpening tools. It has been very highly recommended for razor hones and for sharpening axes and knives. It is found chiefly in the western part of Orange County, and appears to be produced in no other county of the State. Much of it is shipped in the rough to various points in New York to be sawed.

Iowa.—Sandstone production has been at quite a low ebb in 1894, although it has never been of much importance to the State. Marion and Hardin counties have been the most important, though small amounts have been quarried in Cerro Gordo, Clayton, Lee, Jasper, Washington, and Scott counties.

Kansas.—Sandstone is found in all parts of this State, but the most productive portions are in the southern and southeastern counties. Bourbon, Phillips, and Rawlins counties are the most productive, although quarries have been operated in Crawford, Woodson, Clark, Wilson, Kingman, Harper, and Comanche counties.

But little was done in 1894.

Kentucky.—Although sandstone has been quarried in seven counties of the State, almost nothing was done in 1894. Productive counties are Rowan, Muhlenberg, Lewis, Bell, Crittenden, Rockcastle, and Ohio.

Maryland.—The annual production of sandstone in this State has never been large, although some of the stone is fine in quality. This statement applies particularly to stone quarried in Montgomery County, on the Potomac River, 20 miles from Washington. It was known originally as Seneca red sandstone. It has been used in quite a large number of buildings in the city of Washington, notably the Smithsonian Institution. From all the evidence which has been submitted it appears to be one of the best red sandstones in the country. Many of the strong and unqualified indorsements of this stone appear as the favorable result of an investigation of a committee of Congress appointed to investigate the use of this stone in the construction of the State, War, and Navy Department building in Washington.

Massachusetts.—While the granite interests of Massachusetts have held their own during the financial depression, sandstone production has fallen off decidedly. The productive counties are Hampden, Suffolk, Norfolk, and Hampshire. The first named yields most of the product.

Michigan.—This State has produced some fine grades of sandstone, which are favorably received by builders over quite a wide area of the country. Leading producers report poor business for the past year, but there is no doubt that indications for 1895 are much more favorable. Productive counties are chiefly Houghton and Marquette.

Minnesota.—Production fell off markedly in 1894. Productive counties are Pine, Pipestone, St. Louis, Houston, Rock, and Scott.

The developments which have been made in Pipestone County in what is commercially known as "Pipestone red jasper" are of particular interest. This is a metamorphic quartzite rock of intense hardness, varying in color from cherry to lavender or violet. Its extreme hardness is another important characteristic. The following analysis was made by Dr. C. T. Jackson:

Analysis of red pipestone from Pipestone County, Minn.

	Per cent.
Water	8.4
Silica	48.2
Alumina	28.2
Magnesia	6
Peroxide of iron	5
Oxide of manganese	.6
Carbonate of lime	2.6
Loss	1
Total	100.0

The following tests of this stone have been made:

Tests of Minnesota red pipestone.

Crushing strength	lbs. per sq. in.	23,000
Specific gravity		2.8
Weight per cubic foot	lbs.	170.6

On account of its color and desirable properties which tend to make the stone durable, it is quite popular as a building material, and has already been used in the construction of a large number of important buildings.

Missouri.—Sandstone quarrying was very much depressed throughout the year. In spite of hard times, however, the falling off was not nearly so pronounced as in many other States. The value of the product in 1889 was $155,557, and in 1894, $131,687. The most important counties are Johnson, St. Clair, and Cape Girardeau; others less productive are Carroll, Barton, Saline, Franklin, Vernon, Holt, Lewis, Buchanan, and Henry.

Montana.—A small amount of sandstone was quarried during the year. The productive counties are Deer Lodge, Cascade, Custer, and Yellowstone.

New Jersey.—The sandstone industry of New Jersey is one of considerable magnitude, having amounted in 1889 to a valuation of $597,309. The decrease to $217,941 in 1894 appears to be entirely attributable to the general low condition of trade.

New York.—The sandstones of this State are quite various in color and in fineness of texture; some of them have won lasting reputations for adaptability to building purposes. Production languished in 1894, amounting in value to $450,992, while in 1889, the corresponding figure was $702,419.

The best known sandstone is the Potsdam red sandstone. It has an enviable reputation for durability and for ability to withstand the effects of sudden heating and cooling.

The leading countries producing sandstone are Orleans and St. Lawrence; others are Niagara, Oswego, Oneida, Jefferson, Chenango, Monroe, Allegany, Greene, Rockland, Washington, Tioga, Steuben, Schuyler, Franklin, Wyoming, Essex, Chautauqua, Otsego, and Cattaraugus.

In addition to the production of sandstone in New York, a large quantity of what is commercially known as "bluestone" is quarried. Bluestone is the name given to the variety of sandstone which consists almost entirely of granules of silica cemented together by silica. The identity of this stone with sandstone is not generally recognized among the bluestone producers; in fact, many of them seem almost indignant if it is called sandstone. The bluestone industry is entirely distinct from what is herein given as the sandstone industry. Owing to the hardness and durability of bluestone, as well as the manner in which it occurs in the earth, it is well adapted to purposes of street paving, such as flagging and curbing, and most of it is devoted to these uses. A certain amount of the stone is quarried from regularly organized quarries, with a definitely invested capital and plant and good facilities for quarrying, but a large amount is produced irregularly and spasmodically by men who invest no capital and have no definite organization as producers of stone. Their operations are conducted as follows: Provided with a very simple equipment of the most ordinary quarry tools, they dislodge the stone found on land belonging to other persons and transport it to a number of shipping points, selling it there to dealers who make a business of collecting the stone in this manner and shipping it to places where it is used. The dealers pay the individuals who quarry the stone an amount which simply compensates them for their time and labor, while the owner of the property receives a certain definite percentage from the dealer for the amount of stone thus taken from his land. During the year 1889, and a number of years previous, some of the dealers at various points in New York State constituted the members of the Union Bluestone Company, with headquarters in New York City. Each member of this company was entitled to furnish a certain percentage of the total amount sold by this company in a given year. The dealers may, therefore, be regarded in a certain sense as producers. The land on which this stone is quarried is, generally speaking, of little value for anything but the bluestone contained n it. Originally the stone was quarried for flagging only, but more recently it has been applied to quite a long list of purposes, such as rubble masonry, retaining walls, and bridge stone, curbing, gutters, step stones flooring, vault covers, bases of tombstones, porch and hitching posts, house trimmings, such as platforms, steps, door and window sills, lintels, and caps.

The stone is known commercially by a number of names, which designate approximately the region from which it is taken. Among the names in common use may be mentioned the following: Hudson River bluestone, Hudson River flagging, North River bluestone, North

River flagging, Pennsylvania bluestone, Wyoming Valley bluestone, Delaware River bluestone, Delaware flags, bluestone flagging, and bluestone.

The value of the bluestone produced in New York in 1889 was $1,303,321. This product came from 142 quarries, in addition to numerous minor quarries or holes from which the product was taken by laborers, as has already been described. The productive counties are seen in the following list: Ulster, $662,324; Delaware, $150,866; Chenango, $93,100; Sullivan, $87,930; Wyoming, $50,260; Schenectady, $47,906; Orange, 33,405; Albany, $23,285, and smaller amounts from Otsego, Jefferson, Tompkins, Schoharie, Steuben, Seneca, Greene, Chemung, Broome, Saratoga, Oneida, Rockland, Franklin, Washington, and Yates. The Union Bluestone Company, as organized in 1889, has dissolved.

No canvass of the bluestone producers has been made since 1889, when the census figures, which were collected with great care by personal visitation of all producing localities, gave the values and distribution above stated. It is safe, however, to estimate the output for 1894 at $900,000, as production has fallen off in value since 1889.

The following article, originally published in "Stone" for July, 1893, is of interest as showing the peculiarities of bluestone quarrying:

The quarrying of bluestone probably requires as much skill, if not more, than any other kind of stone, a fact often overlooked, and a potent factor in the success or failure of a quarryman. It seems to be the general impression among a great many users, and perhaps a few of the producers, of this most useful and durable stone that a man need only find a deposit of salable quality of bluestone, with no more than the usual proportion of top to bed, and with the usual shipping facilities, and success is assured, but for any one who has been closely connected with this especially interesting business it is easy to find the reason why a quarry has not paid. The causes are usually radical, and one of the first flaws, after ascertaining that the quarry contains stone in fair quantity, will be found by looking into the system of quarrying, wherein usually inheres the drawback to the prosperity of the quarry.

The peculiar formation of bluestone, and the fact that it is found in comparatively small deposits, make the use of machinery impracticable, a quarry in Chenango County, N. Y., probably being the only one which uses any of the modern machinery or blasting devices in quarrying, such as the Knox system in use at this place. Some few of the other large quarries, perhaps, are using the Knox system in blasting their top rock, and quite a number are equipped with steam drills, but it is safe to say that 90 per cent of all the bluestone is quarried by hand wedges and sledges. Flagging is a large percentage of the kind produced, and runs from one-fourth inch thick up. The beds usually produce the thinner stone on top, running heavier as the bed is worked down. Nearly every quarry has its own peculiar formation. Quarries within 400 or 500 yards of each other frequently differ greatly as to quality and formation. As a rule the best quarrymen have worked in the quarries from the time they have been able to do anything, and as that is usually pretty early in life, many of them have gained such knowledge of the work that they know to a certainty how the stone will work as soon as they see the bed, without raising a lift. It is only after long work at quarrying that a man becomes expert. In raising the flag it is very necessary that they come up in as large pieces as possible, that the cutters may get the larger-sized stone most in demand and for which the best prices are obtained. A good quarryman will handle a lift with utmost skill, driving the wedges just enough to give it the proper strain to free itself from the bed of stone, and yet not so to strain it that it will break under the stonecutter's tool, or perhaps before it is raised. There are no general rules or directions to follow; only knowledge and skill obtained by long and close attention to the work are of any service.

Ohio.—This State stands in first place among all the States of the Union for its output of sandstone. The value of the product in 1894 is $1,777,034. The financial depression during the past two years has been severely felt by the sandstone producers of the State. In 1890 the total value amounted to $3,046,656. The productive counties, in order of importance, are as follows: Cuyahoga, Lorain, Stark, Scioto, Washington, Huron, Fairfield, Summit, Trumbull, Morrow, Wayne, Muskingum; and smaller amounts from Crawford, Richland, Holmes, Harrison, Tuscarawas, Belmont, Jefferson, Mahoning, Erie, Delaware, Franklin, Lucas, Meigs, Montgomery, Ross, Licking, Guernsey, Columbiana, Perry, Portage, Wood, Ashland, Pike, and Lawrence. By far the most of the stone comes from Cuyahoga and Lorain counties, in the northern part of the State.

Some of the sandstone quarries of Cuyahoga and Lorain counties are operated in a most thorough, complete, and economical manner; the latest appliances are in use, and for smoothness of working very few quarries in the country can compare with them. The use of the Knox system of blasting in the quarries of this State is attended with great success. The stone is of such a thoroughly homogeneous character that the result of a blast by the Knox system is simply to move, slightly, large masses of stone without spalling or weakening them in any manner. One could almost stand upon the mass of rock while being blasted out without danger of personal injury.

The uses to which Ohio sandstone is put are as follows: About one-sixth is consumed for abrasive purposes, for which the stone has a very high reputation. It supplies most of the demand in the United States for grindstones, etc. Somewhat more than one-half is used for building. About one-seventh is devoted to street work; while the remainder is consumed in bridge, dam, and railroad construction.

Pennsylvania.—The value of the product in 1894 was $349,787. A great many quarries ceased operations entirely during the past year, demand being very light and prices lower than heretofore. The following are the productive counties, in order of importance: Beaver, Dauphin, Lawrence, Allegheny, Westmoreland, Montgomery, Lackawanna, Fayette, Luzerne, and Somerset; and smaller amounts from Huntingdon, Bucks, Chester, Tioga, Philadelphia, Lancaster, Indiana, Berks, Blair, Lehigh, Erie, Lebanon, Clearfield, Lycoming, Venango, Jefferson, Cambria, Warren, Elk, Crawford, Armstrong, Clarion, McKean, Delaware, Greene, and Susquehanna.

South Dakota.—The total output reached a valuation of only $9,000. The industry is a new one in this State, but there is reason to believe that it will develop considerably in the course of the next decade.

Texas.—The value of the output was $62,350, which is quite an increase over the product of a few years ago. The output comes from quarries in Washington, Parker, Grimes, Llano, Brown, Collin, and Wise counties.

Utah.—The value of the output of 1894 was $15,428. The productive counties are Utah, Summit, Emery, and Boxelder.

Virginia.—The production of sandstone in Virginia has thus far been very limited. Campbell and Prince William counties have yielded most of the product.

Washington.—Although very fine sandstone is known to occur on the shores of Lake Whatcom, but very little has yet been done in the way of development. The product of 1894 is valued at $6,611.

West Virginia.—In this State there are large quantities of sandstone admirably adapted for use in heavy foundation work, and particularly bridge work. Productive counties are Kanawha, Wood, Summers, Ohio, Marion, Lewis, Preston, Ritchie, Harrison, McDowell, and Taylor. The value of the output in 1894 was $63,865.

Wisconsin.—This State produced $94,888 worth of sandstone in 1894. This amount differs but little from that of 1893. Productive counties are Bayfield, Pierce, Douglas, Ashland, Dunn; small amounts have been taken from the following: Sauk, Lafayette, Monroe, Portage, Jackson, La Crosse, Trempealeau, Dane, and Grant.

Wyoming.—Quarrying in this State is in its infancy, although there appear to be many possibilities well worth investigation when the demand for sandstone is such as to justify it. Stone has been produced in Laramie, Albany, Converse, Carbon, and Sweetwater counties.

THE LIMESTONE INDUSTRY.

NATURE, ORIGIN, AND USES OF LIMESTONE.

The name "limestone" implies stone from which lime is made. Strictly speaking, therefore, it should apply only to the carbonate of calcium, which, by ignition, is converted into lime. In practice, however, the name covers quite a variety of materials which contain carbonate of calcium, but in very different degrees. When limestone presents itself in crystalline condition, so as to be susceptible of fine polish and delicate ornamentation, it is known as marble. Marble is specially treated in an earlier portion of this report, inasmuch as its beauty of texture and fine crystalline condition make it applicable to uses for which the noncrystalline variety of limestone can not serve.

Calcium carbonate is frequently associated with magnesium carbonate in varying proportions. When the proportion of the latter is small the stone is called magnesian limestone, but when the proportion becomes 54.35 parts of calcium carbonate to 45.65 parts of magnesium carbonate it receives the name of "dolomite," which, if crystalline, may constitute a marble, but if noncrystalline is classed with the ordinary limestones. The term "ordinary limestone" is commonly used to include all the grades and degrees of limestone except marble, and it is of "ordinary limestone" with this meaning that this report treats.

The limestones are mainly, though probably not entirely, of organic origin, resulting from the deposition and aggregation of shells, corals, etc.; but at the time of deposition other materials, such as clay, sand, iron oxides, iron pyrites, mica, etc., may have been included, thus producing a large number of grades, which are frequently distinguished by names which imply the presence of the most characteristic impurity. Siliceous, argillaceous, and micaceous limestones are names in common use. Usually the presence of these impurities is an objection to the stone for almost all the great variety of uses to which limestone is applied.

The detailed uses to which ordinary limestone is put are numerous, and some of them are of vast importance, because they can not be met by any other kind of stone. Some of the uses to which limestone is put bring it into competition with the granites and sandstone, such as building of all kinds, road making, and structural purposes generally. In its application to lime burning and blast-furnace flux, limestone stands alone, and, as will be seen from the table of production, large quantities are devoted to these purposes.

VALUE OF LIMESTONE PRODUCT, BY STATES.

Owing to the widespread distribution of limestone throughout the United States and the number and varied character of the uses to which it is put, the collection of accurate statistics becomes a much more difficult problem than is encountered in the same undertaking with any other kind of stone. In view of the difficulties which present themselves in connection with statistics of limestone, an entire revision of the directory was made, and as a result the original list of names of producers was decidedly lengthened. While the original list contained the names of all important operators, a great many additional names of less important producers were secured. The method which was found most effective in obtaining knowledge of new names consisted in addressing to postmasters of all offices located in limestone producing counties of the country a double postal card, which enabled them to return to this Bureau names of all persons in their vicinity who quarry limestone for any purpose whatsoever. The results which followed our subsequent request for information addressed to limestone producers are most gratifying, since there was every reason to believe that the returns relating to value of output were so full and complete as to amount to an actual census.

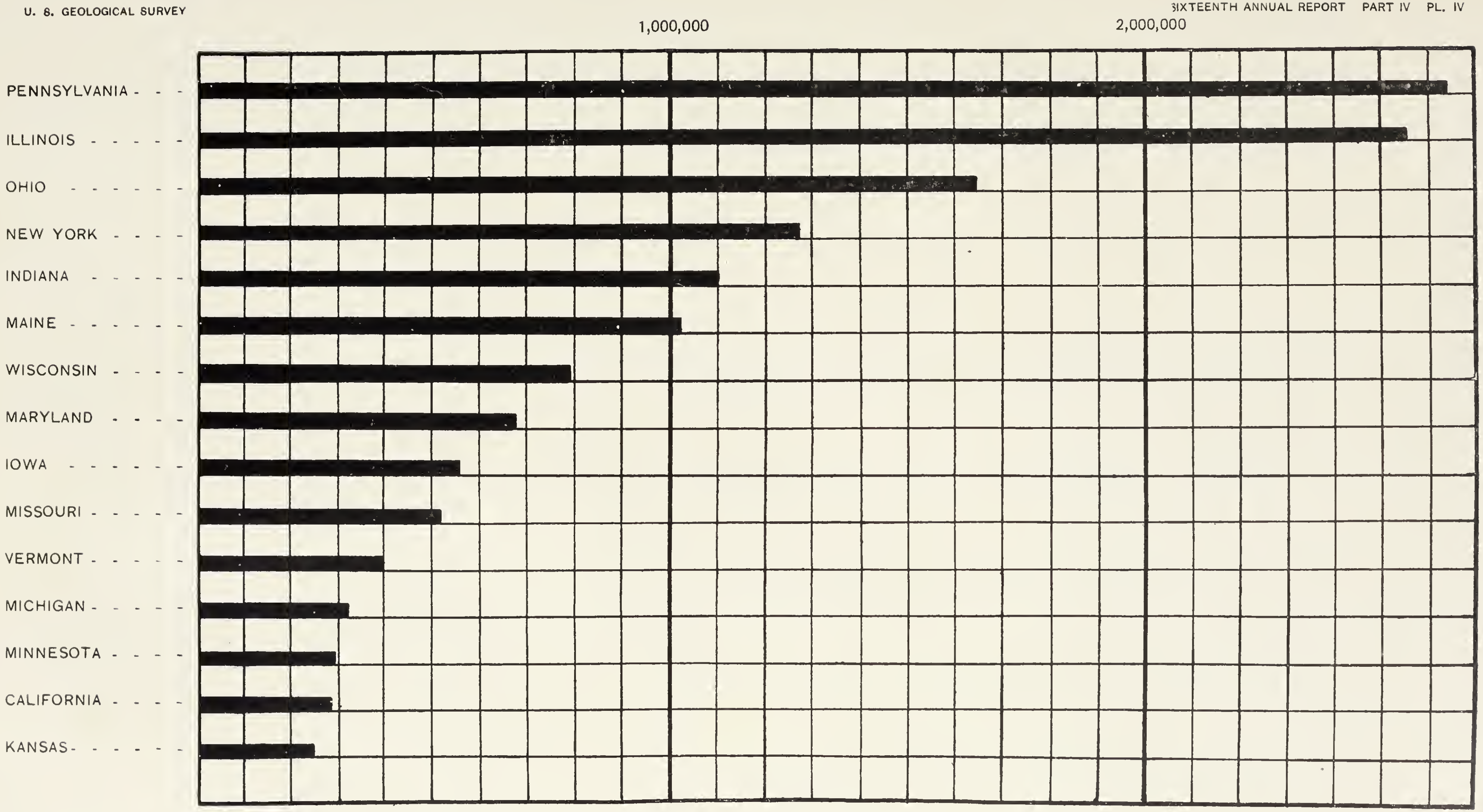
The following table shows the value of lime made, the value of stone used for building and road making, the value of stone used for blast-furnace flux, and the total value for all purposes together:

Value of limestone production in 1894, with uses to which the stone was applied.

States.	Lime.	Building and road making.	Flux.	Total.
Alabama	$171,344	$30,925	$8,000	$210,269
Arizona	15,710	44,100		19,810
Arkansas	34,360	3,868		38,228
California	273,250	15,650		288,900
Colorado	24,413	35,077	72,680	132,170
Connecticut	204,414			204,414
Florida	16,419	14,220		30,639
Georgia	32,000			32,000
Idaho	5,315			5,315
Illinois	387,973	2,167,979		2,555,952
Indiana	307,545	895,563		1,203,108
Iowa	237,066	379,564		616,630
Kansas	12,065	228,974		241,039
Kentucky	17,815	96,119		113,934
Maine	810,089			810,089
Maryland	628,979	43,807		672,786
Massachusetts	173,065	22,917		195,982
Michigan	44,656	291,631		336,287
Minnesota	78,499	212,764		291,263
Missouri	167,133	411,669		578,802
Montana	42,850	36,165	13,955	92,970
Nebraska	700	7,528		8,228
New Jersey	177,197	8,190	8,136	193,523
New Mexico	690	4,220		4,910
New York	660,503	709,962	8,386	1,378,851
Ohio	930,705	752,772	50,000	1,733,477
Pennsylvania	1,743,947	547,990	333,625	2,625,562
Rhode Island	20,433			20,433
South Carolina	25,000	100		25,100
South Dakota	2,013	1,650		3,663
Tennessee	102,921	85,743		188,664
Texas	13,308	28,218		41,526
Utah	11,665	10,031	2,000	23,696
Vermont	407,730	1,080		408,810
Virginia	151,915	109,172	23,460	284,547
Washington	57,148	2,000		59,148
West Virginia	34,801	8,972		43,773
Wisconsin	584,971	213,435		798,406
Total	8,610,607	7,382,055	520,242	16,512,904

It is evident from an inspection of the totals that the value of the lime output for the entire country is $8,610,607, or somewhat more than one-half the total value of the total output of limestone for all purposes. Somewhat less than half has been devoted to building and road making, while the remainder has been used for fluxing purposes. For the last-named uses the amount consumed has in the last year been smaller than usual on account of the depression which has existed in the manufacture of iron.

A comparison of the figures for 1894 with those of the census year 1890 shows a decline from $19,095,179 to $16,512,904. This, however, is not surprising in view of the exceptional financial depression.



VALUE OF LIMESTONE PRODUCED IN THE UNITED STATES DURING THE YEAR 1894.

(In millions of dollars.)

The following table shows the value of the limestone output by States for the years 1890 to 1894, inclusive:

Value of limestone, by States, from 1890 to 1894.

States.	1890.	1891.	1892.	1893.	1894.
Alabama	$324, 814	$300, 000	$325, 000	$205, 000	$210, 269
Arizona	(a)	....	....	15, 000	19, 810
Arkansas	18, 360	20, 000	18, 000	7, 611	38, 228
California	516, 780	400, 000	400, 000	288, 626	288, 900
Colorado	138, 091	90, 000	100, 000	60, 000	132, 170
Connecticut	131, 697	100, 000	95, 000	155, 000	204, 414
Florida	(a)	....	....	35, 000	30, 639
Georgia	(a)	....	....	34, 500	32, 000
Idaho	28, 545	....	5, 000	1, 000	5, 315
Illinois	2, 190, 607	2, 030, 000	3, 185, 000	2, 305, 000	2, 555, 952
Indiana	1, 889, 336	2, 100, 000	1, 800, 000	1, 474, 695	1, 203, 108
Iowa	530, 863	400, 000	705, 000	547, 000	616, 630
Kansas	478, 822	300, 000	310, 000	175, 173	241, 039
Kentucky	303, 314	250, 000	275, 000	203, 000	113, 934
Maine	1, 523, 499	1, 200, 000	1, 600, 000	1, 175, 000	810, 089
Maryland	164, 860	150, 000	200, 000	....	672, 786
Massachusetts	119, 978	100, 000	200, 000	156, 528	195, 982
Michigan	85, 952	75, 000	95, 000	53, 282	336, 287
Minnesota	613, 247	600, 000	600, 000	208, 088	291, 263
Missouri	1, 859, 960	1, 400, 000	1, 400, 000	861, 563	578, 802
Montana	24, 964	....	6, 000	4, 100	92, 970
Nebraska	207, 019	175, 000	180, 000	158, 927	8, 228
New Jersey	129, 662	100, 000	180, 000	149, 416	193, 523
New Mexico	3, 862	2, 000	5, 000	....	4, 910
New York	1, 708, 830	1, 200, 000	1, 200, 000	1, 103, 529	1, 378, 851
Ohio	1, 514, 934	1, 250, 000	2, 025, 000	1, 848, 063	1, 733, 477
Oregon	(a)	....	....	15, 100	....
Pennsylvania	2, 655, 477	2, 100, 000	1, 900, 000	1, 552, 336	2, 625, 562
Rhode Island	27, 625	25, 000	30, 000	24, 800	20, 433
South Carolina	14, 520	50, 000	50, 000	22, 070	25, 100
South Dakota	(a)	....	....	100	3, 663
Tennessee	73, 028	70, 000	20, 000	126, 089	188, 664
Texas	217, 835	175, 000	180, 000	28, 100	41, 526
Utah	27, 568	....	8, 000	17, 446	23, 696
Vermont	195, 066	175, 000	200, 000	151, 067	408, 810
Virginia	159, 023	170, 000	185, 000	82, 685	284, 547
Washington	231, 287	25, 000	100, 000	139, 862	59, 148
West Virginia	93, 856	85, 000	85, 000	19, 184	43, 773
Wisconsin	813, 963	675, 000	675, 000	543, 283	798, 406
Wyoming	(a)	....	....	....	....
Total	19, 095, 179	8, 700, 000	18, 392, 000	13, 920, 223	16, 512, 904

a Limestone, valued at $77,935, was produced in Oregon, Georgia, Florida, Arizona, South Dakota, and Wyoming. This value is included in the total.

LIMESTONE INDUSTRY IN THE VARIOUS STATES.

Alabama.—The total value of the output in 1894 is $210,269, including the value of lime, amounting to $171,344. The product comes from the following counties: Shelby, Colbert, Lee, Blount, Franklin, Dekalb, Etowah, and Jefferson.

Arizona.—The production of limestone in this State is a comparatively new development and the product amounts to but little as yet, namely, for 1894, $19,810, of which $15,710 is the value of lime made. The producing counties are Yavapai and Maricopa.

Arkansas.—The total value of the output in 1894 was $38,228, of which the value of lime made was $34,360. The productive counties are Washington, Independence, Carroll, and Benton. The State has never produced a large quantity of lime or limestone.

In northern Arkansas, according to the geological survey made under the direction of Mr. John C. Branner, State geologist, there are six distinct beds of limestone. Each of these six beds will furnish good building material. The upper bed in places will furnish marble, although the greater part of it has little commercial value. The third bed in the series furnishes an excellent building stone at almost every outcrop, and it is found throughout nearly all the northern counties. It corresponds quite closely with the Indiana oolitic limestone, being in the same geological horizon, and resembling it in structure, except that it is more crystalline and takes a finer polish than the Bedford (Indiana) stone. It is more crystalline, less oolitic, and more fossiliferous in the western than in the eastern part of the bed. It has been quarried at Batesville, Independence County, for building stone and burning into lime. The fourth bed in the series, belonging to the Trenton period, occupies the same geological position as the Tennessee marble, which it resembles in structure and appearance. It has been traced and carefully mapped through Independence, Izard, Stone, Searcy, Marion, and parts of Newton and Boone counties. It is known to exist also in Madison and Carroll counties, and possibly extends as far west as the State line or beyond. Only small quantities have been quarried, for local use in monuments and mantels. It varies in color through light gray, pink, red, variegated, and mottled. The fifth bed is found in great quantities in Independence, Izard, Stone, and Searcy counties. It is a fair building material, and produces good lime. Some lithographic stone has been obtained from it.

California.—The value of the limestone output, $288,900, in 1894 is largely the value of lime produced; i. e., $273,250. The productive counties, in order of importance, are Santa Cruz, San Bernardino, Kern, Riverside, and San Benito; small amounts have been quarried also in Eldorado, Santa Clara, San Diego, and Placer counties.

Colorado.—The total value of the output in 1894 was $132,170. Of this value $72,680 represents the quantity used for fluxing purposes, while the remainder was about evenly divided between building and lime making. Productive counties are Pitkin, Jefferson, La Plata, Boulder, Fremont, Pueblo, Larimer, and Chaffee.

Connecticut.—The total value of the output in 1894 was $204,414. The entire output is converted into lime. In spite of considerable complaint about hard times, business was better in 1894 than in 1893, as shown by a gain of $49,414. The product comes entirely from Litchfield and Fairfield counties.

Florida.—Production of stone of any kind in this State is limited to the past few years. The value of the limestone output in 1894 was $30,639, and its use was divided about equally between the building of jetties and burning into lime.

Georgia.—Catoosa County yielded lime valued at $32,000. Ordinarily, quite a considerable amount is used for fluxing in blast furnaces, but much less was used for this purpose in 1894 than formerly.

Idaho.—A little limestone was converted into $5,315 worth of lime in Kootenai, Bingham, Alturas, and Fremont counties.

Illinois.—The limestone interests of this State are very large and important. The total value of the output in 1894 was $2,555,952. Of this amount $2,167,979 worth was used for building purposes. More than half of the product comes from Cook and Will counties, while the rest is distributed among the following counties: Adams, Jersey, Madison, Hardin, Kane, Pike, Kankakee, Hancock, St. Clair, Winnebago, Rock Island, Henderson, Dupage, Randolph, Union, Whiteside, Monroe, Ogle, Stephenson, Kendall, Jo Daviess, McHenry, Greene, and Lasalle.

The following description of the Lemont and Joliet stone is taken from the writer's report in Mineral Resources for 1889–90:

The operations in Cook and Will counties, on account of their magnitude, the general excellence of the stone produced, and the ease of quarrying and working out, deserve special mention. The region embraced by these two counties is known generally as the Joliet region. It includes territory from about 5 miles south of the city of Joliet to about 10 to 12 miles north, taking in the towns of Lockport and Lemont and running along the valley of the Illinois River. Most of the quarries are situated on the banks of either the river or the canal. The stone exists in layers at the surface, varying from 1 inch to 3 inches in thickness. and growing in thickness with the increasing depth, until at about 25 feet it is found of a thickness varying from 15 to 20 inches. It is, however, rarely quarried below the 25-foot level, owing to the expense of getting it out and dressing it, since at that depth it is much harder, although the quality of the stone is superior to that in the upper levels. At the depth of 25 feet the inflow of water materially adds to the expense of quarrying. The stone found at or near the surface is almost valueless and is almost entirely thrown away in stripping the quarry. The next two-fifths furnish stone of sufficiently good quality to be used for riprap, rubble, sidewalks, and curbing. The last two-fifths contain the best stone, namely, that used for building. It is generally of a bluish-gray color. The exposed stone is of a yellowish color, from the effects of the exposure to the atmosphere. It is also true that most of the Joliet stone turns more or less yellow upon exposure. The beds are divided vertically by seams occurring at somewhat irregular intervals of from 12 to 50 feet, and continue with quite smooth faces for long distances, and also by a second set of seams running nearly at right angles with the first, but continuous only between main joints, and occurring at very irregular intervals. This structure renders the rock very easily quarried and obtainable in blocks of almost any required lateral dimensions. The stone is easily worked into required shapes, and takes a fine, smooth finish, and is susceptible of being readily planed. This forms a very rapid and cheap method of finishing flagging stones and preparing such as are to receive a smooth finish on the polishing bed. Enormous quantities of flagging stone are taken out, most of which goes into Chicago; but business with other cities is decidedly on the increase. The finest varieties are readily produced in forms which are capable of being turned out by lathes.

The following is an analysis of Cook County limestone:

Analysis of Cook County, Ill., limestone.

	Per cent.
Silica	26.08
Alumina and oxide of iron	6.57
Carbonate of lime	46.90
Carbonate of magnesia	14.19
Water	6.26
Total	100.00

The crushing strength of this stone is 16,017 pounds to the square inch; specific gravity, 2.512. The stone obtained in the vicinity of the towns of Sterling, Morrison, Fulton, Cordova, and Port Huron is largely burned into lime. This is true of much of the stone all along the Mississippi River. The best grades of Alton stone become whiter upon exposure to the air, and some of it that has stood in buildings for twenty to twenty-five years has become almost perfectly white. The quarry at the Chester (Illinois) State prison is an immense bluff about 200 feet in height. It has been worked for only the past two or three years and is now turning out fine stone. All work is done by the convicts.

Indiana.—Owing to the production of what is known as Bedford oolitic limestone, this State is widely known as the most important in the Union in its output of limestone for fine building and ornamental purposes. The total value of the output of limestone of all kinds for the year 1894 is $1,203,108. Three-fourths of this amount is the value of stone used for building, while the remainder represents the value of lime made. The productive counties are as follows, in order of their relative magnitude: Lawrence, Huntington, Monroe, Decatur, Washington, Ripley, Owen, Clark, Franklin, Putnam, Wabash, and smaller amounts from Shelby, Grant, Carroll, Cass, Delaware, Howard, Blackford, Madison, Harrison, Jennings, Adams, Floyd, Wells, Crawford, Jay, Fayette, Miami, Randolph, Vanderburg, Wayne, and White.

The most productive portions of the State are the southern and southeastern. The limestone of the State may, for convenience, be divided into three general classes: First, the oolitic limestone, otherwise known as cave limestone, from the numerous caverns which are to be found scattered through it; second, the harder and much more crystalline variety; and third, the rock which occurs in thin strata and which is well adapted for purposes of flagging, etc. The oolitic limestone extends in a southeastern direction from Greencastle, in Putnam County. This stone is commonly known in trade as Indiana stone, or Bedford stone. It is well known over a wide area in the United States, and is an exceedingly popular building stone not only in cities of the West, but in Eastern cities as well. It has been most extensively quarried at Stinesville, Ellettsville, and Bloomington, Monroe County, and at Bedford, in Lawrence County; but owing to the increased demand for this stone, new quarries are being opened and extensively worked at frequent intervals along the line of the Louisville, New Albany, and Chicago Railroad from Gosport to Bedford, and these give promise of rich and practically inexhaustible supplies. This stone is almost exclusively used for building purposes, and it is the great production of this stone which enables Indiana to take second place among the States producing limestone for building purposes, Illinois standing in the first place. The stone is characterized by its oolitic character, and is comparatively soft when first removed from the quarry, but hardens on exposure to air. The deposit varies from a few feet to a great many in thickness, and it is practically free from fissures. Solid walls 40 to 50 feet in depth, without a seam or fault of any kind from top to bottom, have already been revealed. It is easily quarried in blocks of any size required, being cut from the solid mass by means of channelers. It is soft enough to be readily sawed, ordinary steel blades, with sand as the abrasive material, being used for sawing. Occasionally diamond saws are used with fine results. For most part the stone is fine-grained, but contains also layers of coarser material in which shells are easily recognized with the unaided eye. Operations in all quarries producing this kind of stone are conducted on the largest scale and the machinery employed is usually of the very best.

The harder, more crystalline stone is found in the eastern and southeastern parts of the State, principally in Decatur County, in the southeastern part. The quarries in general are rather small, there being twenty of them in Decatur County alone. Some of the quarries are operated on a large scale. On account of its hardness this stone can not be sawed. It is used quite largely for building purposes. In the northern and northeastern portions of the State the stone is used somewhat for building and street purposes, and in Huntington County it is largely burned into lime. The great center of the lime industry is at Huntington. The most important concern producing lime at this point is the Western Lime Company. The product has a widespread reputation for use in building. On account of the flagging nature of the stone in the more northern portions of the State, it is often quarried simply by aid of a pick and bar. This is more especially true in regard to the northeastern sections of the State. In the northern, northeastern, and eastern portions of Indiana are a great many small quarries. A number of them seem to be capable of more extended operations, but the lack of railroad facilities from the quarries to the main lines of travel exerts a retarding influence. The stone quarried at Greensburg, in Decatur County, is decidedly crystalline, and is susceptible of a high polish. The thin-bedded stone in the upper portions of these quarries is used to some extent for flagging.

The development of the oolitic or Bedford stone is largely the result of operations conducted within a comparatively few years. In a small way it has been quarried and used for twenty-five years or more, but it is within the last twelve years that the stone has been recognized and appreciated by the larger cities of the East and West. It occupies at present a very prominent position among the best building stones of the country.

Iowa.—The total value of the limestone output in 1894 was $616,630. As is evident from the following list of productive counties, the stone is widely distributed. There are as yet few large operators, but a large number of firms producing in each case upon a comparatively limited scale. The counties yielding the product are Jackson, Dubuque, Cedar, Marshall, Jones, Scott, Lee, Clinton, and smaller amounts from Des Moines, Madison, Decatur, Cerro Gordo, Dallas, Wapello, Linn, Muscatine, Blackhawk, Mahaska, Washington, Benton, Clayton, Pocahontas, Montgomery, Tama, Floyd, Adams, Mitchell, Humboldt, Johnson, Jefferson, Clarke, Van Buren, Howard, Taylor, Keokuk, Pottawattamie, Louisa, Webster, Allamakee, Story, and Buchanan.

The following notes on Iowa building stones, by Mr. H. Foster Bain, of the Iowa State Geological Survey, are of much interest, particularly as indicating future possibilities in the stone industry of the State. Although these notes are not entirely confined to the consideration of limestone, so much of the matter relates to it that it has been thought best to insert them in the space devoted to Iowa limestone rather than in any other connection.

NOTES ON IOWA BUILDING STONES.

By H. Foster Bain.

The work of the present Geological Survey of Iowa has not as yet extended over the main stone-producing counties of the State, so that only very fragmentary notes on the stone industry are at present possible. The stone marketed from this State is almost exclusively limestone. The Sioux quartzite, occurring in Lyon County, has never been worked, except to furnish a few display and test blocks. Excellent quarry sites, however, occur over a number of square miles, and there is an ample supply of quartzite within the State for the support of a large industry. The sandstones occurring are in the main too incoherent to be of much value. Important exceptions, however, occur, among which may be mentioned the Red Rock sandstone of the coal measures occurring in Marion County. The quarries here have been idle for a few years, but it is expected that work will be resumed shortly. Similar beds occurring near Monroe, in Jasper County, have also been opened up, and it is expected that the active work of development will begin this spring.

Within the year considerable attention has been attracted to the "marble" beds along the Cedar and Iowa rivers. Extensive exposures near Iowa Falls are reported, and arrangements are being made to open them up. The Charles City beds, which are the only ones at present supplying stone to the market, belong to the Devonian, and represent the portion which has usually been called the Hamilton. The rock is a coralline limestone, and occurs in layers 8 to 30 inches thick, with a total thickness, so far as known, of about 20 feet. It is a trifle harder than Italian marble, and is reasonably free from the checks and seams so common in colored marbles. There is a great variety of colors displayed, the groundwork being mostly buff, gray, blue, or drab. Inlaid in this are masses of coral, from 1 to 20 inches in diameter, exhibiting very delicate coloring and tracing. A mantel made of this material received honorable mention at the Columbian Exposition. The stone has been on the market for several years. The quarries and mills have recently passed into other hands, and the business will be enlarged. Samples of the stone found near Iowa Falls show it to be similar to that at Charles City.

Linn County.—The chief quarries in this county are in the Upper Silurian limestones near Stone City, Waukee, and Mount Vernon. The stone is exceedingly uniform and is in color a warm-gray or pleasing cream tint. It is so homogeneous as to be readily carved and easily worked, being quite soft when first taken from the quarry. The bedding planes are so constant, smooth, and parallel as to require very little dressing. It is dolomitic, and contains very little impurity. These facts, together with the fineness and evenness of grain, presenting uneven expansion, make it one of the most durable of the limestones. In the Mount Vernon Cemetery, tombstones bearing dates as early as 1845 show little decay, though various marbles in the same cemetery show the usual loss of polish, checking, and cracks, indicating the progress of disintegration.

In the Crescent quarry near Stone City there is a total face of 60 feet of available stone, the courses running from 1 foot to 8 feet 4 inches in thickness, and including layers available for dimension, bridge, and rubble work. At Mount Vernon a switch has recently been built to the quarries and an expensive quarry plant, including steel derricks, channelers, and planers, has been put in. Borings here show a thickness of at least 50 feet of available stone below the base of the present quarry.

In addition to the larger quarries operated in the Mount Vernon beds, which are the western continuation of the well-known Anamosa limestone, there are a number of smaller openings in the various other formations exposed in the county. The Devonian does not in this county afford such good stone as elsewhere, and can hardly compete as a building stone with the Silurian stone just described. The Otis beds, however, yield abundant supplies of macadam, and are quarried for that purpose at Cedar Rapids. The Coggan beds (of the Silurian) have been used with good results in bridge work.

Van Buren County.—The rocks exposed in this county belong entirely to the Carboniferous, both the Coal Measures and the Mississippian being present. The quarry rock is taken from the latter. Both limestone and sandstone are obtained; the former from both the Keokuk and St. Louis stages, and the latter from the lower portion of the St. Louis. About 8 years ago a considerable quantity of stone was quarried from the Keokuk beds near Bentonsport and used for bridge work and riprap. In the winter of 1893 and 1894 about 1,000 yards were taken out and used to protect the piers of the bridge at that point. Magnesian limestone from the St. Louis has been quarried and used for dam work along the Des Moines River, and was used to some extent at the time the State capitol was built. There are, however, no quarries which support more than a local trade. In the upper divisions of the St. Louis, white limestone of good quality, running in courses of 12 to 15 inches in thickness, is obtained at a number of points. The "Chequest marble," a compact, dove-colored, fossiliferous limestone, susceptible of a good degree of polish, and which has been used to some extent for ornamental work, is found near Keosauqua. A block of this stone may be seen in the Washington Monument at Washington.

Mahaska County.—The quarry industry of this county is not great, a fact due in part to the poor quality of the stone exposed, and in part to the great amount of capital absorbed by the coal interests, together with the active competition of the clay interests. At present only a few quarries are open, they being worked for local trade. The limestone of the St. Louis stage is exposed along the major streams, and is opened up near New Sharon, Union Mills, Fremont, Peoria, Given, and on Spring Creek, northeast of Oskaloosa. It yields a fine-grained, ash-gray to buff stone, breaking with a sharp conchoidal fracture and running in courses of from 6 to 24 inches. This stone is used for foundations, well curbing, and similar purposes, bringing from $2 to $3 per perch. Only about 900 to 1,000 perch are quarried each year. The Coal Measures contain several heavy standstones which are not as yet used. At Raven Cliff, on the Des Moines River, there is an excellent face of this stone extending along an old arm of this river nearly 2 miles. The bed is over 90 feet thick, and shows single precipitous faces of more than 50 feet. The stone is clear and homogeneous, of pleasing color, and apparently of good strength. There is a railway within about two miles.

Keokuk County.—All the formations exposed within this county yield more or less quarry rock. By far the greater portion, however, comes from the St. Louis limestone. The Coal Measures here, as in the neighboring regions, contain more or less sandstone, but with the exception of the heavy beds south of Delta, which have been used a little for the construction of a dam and as foundation stone, this formation is not productive. The St. Louis contains the usual thin-bedded, fine-grained, ash-gray limestones, and has been quarried for local purposes at a number of points near What Cheer, Delta, Sigourney, Hedrick, and Richland. Near Atwood the

Chicago, Rock Island and Pacific Railway operated a quarry for some time, mainly for ballast. The greater portion of the rock is too irregular to admit of quarrying on a large scale. The lower magnesian portion of the St. Louis occurs, and yields some stone of good quality. By far the best rock in the county occurs below the St. Louis in the Augusta beds. This is a coarse, subcrystalline stone, in buff, blue, and white ledges. It is encrinital, and takes a fair degree of polish. It is readily accessible along Rock Creek near Ollie, where a switch from the Iowa Central Railway leads to the quarries. The stone is not now shipped, but arrangements are being made to reopen the property.

Washington County.—This county yields stone from all three of the major members of the Mississippian series. The principal quarries are located near Brighton, and supply stone from the St. Louis. The ledges quarried belong to the upper beds of this stage, and run in courses from 8 inches to 7 feet. The heavier and lower ledges are not now taken out, as they are badly water-coursed. The stone marketed is used for bridge and rubble stone, as well as paving flags. It is of excellent quality, but the number of ledges which are suitable for quarrying is limited. Northwest of Washington is a small group of quarries on Crooked Creek. The stone belongs to the Augusta formation. It is a coarse encrinital limestone, of great durability and of very pleasing tints. Quite an important local trade is sustained. Stone from equivalent ledges is quarried a little in the northern part of the county, near Dayton and south of Riverside. An impure magnesian limestone belonging to the Kinderhook occurs along English River and its branches, and is quarried locally. It is apparently very soft and worthless, but is really much more durable than might be supposed from its appearance.

Lee County.—The limestone of the Lower Carboniferous and the sandstones of the Coal Measures are exposed throughout Lee County, and are quarried at many points. The Burlington, Keokuk, and St. Louis beds yield the greater amount of stone. The Coal Measures yield at several points a soft, more or less ferruginous, coarse-grained sandstone, which is used but little. The Burlington beds are made up largely of a coarse encrinital lime rock, varying in color from brown to white. It is very durable, easily quarried, and readily dressed. The Keokuk limestone is, as a rule, a compact, rather hard, often subcrystalline rock, of an ashen or bluish color. Its fracture is even, approaching conchoidal. The quarry rock of the upper part of the Keokuk, sometimes called the Warsaw, is chiefly a magnesian limestone containing some sand and pebbles. It is quarried at Sonora on the east side of the Mississippi, and is known locally as the Sonora sandstone. It occurs in a massive layer 6 to 12 feet in thickness, is bluish or brownish when first taken out, but after exposure turns to buff or light brown. It has been quite extensively used at Keokuk, and has proven very durable. The St. Louis limestone is a fine-grained, compact limestone, of blue to gray color, breaking with a marked conchoidal fracture, and resembling lithographic stone in appearance.

The principal quarry industry of the county is centered around Keokuk, where there are a number of large and well-worked openings, mainly in the Keokuk beds. Quarries are found along the Mississippi, from Keokuk to Montrose, and along the Des Moines, from Croton to Sand Prairie. A number of smaller openings are located on Sugar Creek near Pilot Grove and Franklin.

Des Moines County.—This county affords quarry rock from the same beds as Lee County, and in addition a certain amount of stone is taken from the Kinderhook. The latter contains a thin bed of oolite, which is readily accessible and easily worked. It will not, however, stand well in exposed positions, and is of small value. By far the larger number of quarries in the county draw their supply from the Upper Burlington beds. These beds underlie about one-fourth of the county, and stretch out in a broad belt parallel to the Mississippi River. The rock is massive and compact, and varies in color from a pure white to shades of gray and buff. It is of excellent quality.

The quarries are located near Burlington, on Flint River and Knotty Creek, along the Mississippi, at Cascade and Patterson, and near Augusta, on Long Creek and Skunk River. A considerable expansion in the quarry industry of the county may be expected.

Allamakee County.—This county is one of the few counties of Iowa which are not covered by heavy drift deposits. There are accordingly a large number of exposures and excellent quarry sites, though the rough topography of the county has made railroad building expensive, and transportation facilities are accordingly limited. The beds exposed represent the St. Croix stage of the Cambrian, and the Oneota, St. Peter, Trenton, and Galena stages of the Ordivican. They all yield more or less good quarry stone. The St. Croix beds are quarried a little at Lansing, at a level about 100 to 125 feet above the river. The rock taken out here comes from immediately below the calcareous shale layers, which, in Minnesota, have been called the St. Lawrence limestone. It is a sandstone in which the grains of silica are cemented with calcium carbonate. The beds are exposed at numerous points along the Oneota Valley, but the St. Croix yields comparatively little stone. The Oneota limestone yields quarry rock from several horizons. At New Albin, Lansing, Harpers Ferry, and other points along the Mississippi, a fine-grained, even, and regularly bedded dolomite, in layers varying from 3 to 36 inches, is quarried. The workable beds have an aggregate thickness of about 30 feet. In the northwestern part of the county the beds are finer grained, more compact, and furnish a stone which for fine masonry is not excelled by any stone in the Mississippi Valley. Smooth-surfaced slabs, 10 or 15 feet in length and almost equal width, may be seen at numerous points. The stone stands weathering influences excellently. The beds of the Oneota above this horizon, while yielding some good stone, rarely afford the opportunity for extensive development.

The St. Peter sandstone is usually a bed of unconsolidated sand. At a few points only the particles have been cemented by siliceous or ferruginous cement, so as to be available for building stone. The Trenton limestone, while in part of excellent character, is not in this county sufficiently regular in character to supply more than local demands. A thick-bedded, yellowish limestone, resembling dolomite in appearance, and belonging to this formation, is quarried in the head of Paint Creek, near Waukon. About 75 feet above the base of the beds a thin-bedded, fine-grained, dark-gray to slate-colored stone has been quarried in the same vicinity. It does not, however, stand the weather so well as other stone in the county, and requires the handling of considerable rubbish. The Galena limestone is not quarried in Allamakee County, though it supplies a good quality of stone in the neighboring portion of Clayton County.

Rock taking a high polish and affording suitable material for ornamental purposes is taken from the Trenton. It is a compact limestone, made up of fragments of brachiopods and bryozoans, cemented with what was originally a fine calcareous mud. All the pores and interstices of the original rock and of the fossils have become filled with calcite, and very good effects may be obtained by its use.

Kansas.—The value of the product in 1894 was $241,039. Most of this was used in building and road making. The following are the productive counties: Cowley, Leavenworth, Marshall, Chase, Ripley, Butler, Lyon, Wyandotte, and smaller amounts from Marion, Atchison, Wabaunsee, Shawnee, Washington, Johnson, Russell, Dickinson, Franklin, Morris, Elk, Brown, Douglas, Republic, Pottawatomie, Coffey, Anderson, Jefferson, Ness, Montgomery, Jackson, Harper, Sumner, Ellsworth, and Osage. The stone is pretty well distributed over the eastern portion of the State. Most of it, however, comes from the vicinity of Atchison, Leavenworth, Topeka, and Fort Scott.

Tests and analyses of Kansas building stones.

LIMESTONE.

Counties.	Formations.	Crushing strength.	Weight per cubic foot.	Specific gravity.	Ratio of absorption.	Analyses. Insoluble matter.	Analyses. Oxides of iron and alumina.	Analyses. Calcium carbonate.	Analyses. Magnesium carbonate.	Analyses. Sulphates.	Analyses. Moisture.	Remarks.
		Pounds.	*Pounds.*			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Johnson		19,279	165.4	2.65	.01	8	1.35	90	.12	.02		From Ottawa; average from 3 blocks
Allen						1.53	1.75	94.12	2.72			From Humboldt.
Leavenworth		7,862	168.5	2.70	.02	5.91	2.47	89.88	1.11	.38		From Lansing; average from 5 blocks.
Do		15,961	169.1	2.71	.004	6.20	3.31	88.17	1.88	.28	.04	From Lansing.
Cowley	Permian		165.4	2.65	.045	13.60	2.55	76.16	7.63			From Arkansas City; fine-grained and homogeneous; no appearance of fossils.
Do	do	4,555	157.3	2.52	.07	4.25	.85	94.06	.62			From Winfield.
Marion	do		167	2.67	.07	5.13	3.15	53.16	38.33			From Marion; this stone appears to have nearly the composition of dolomite. It is fine-grained, takes a smooth surface, and is gray in color.
Do	Carboniferous	5,824	169.8	2.72	.01	6.85	1.91	59.21	30.09	.95	.90	From Marion.
Do	Permian	8,136	167.6	2.68	.05	13.51	1.65	61.64	22.72			From Marion; produced by I. Kuhn & Co.; dark gray; not perfectly homogeneous, occasional spots.
Do	do	13,711	170.7	2.73	.04	6.75	1.59	51.05	40.51			Produced by I. Kuhn & Co.; average from 4 blocks, 5 miles northeast of Marion.
Do	do	12,364	168.2	2.69	.03	5.51	1.24	91.50	1.62			
Clay	do	10,291	170.4	2.73	.05	9.50	6.40	60.04	24.72			From Clay Center; average from 3 blocks.
Butler	do	2,727	162.9	2.61	.01	5.04	.96	93.32	1.06			From Eldorado.
Douglas	Carboniferous	11,630	167.6	2.68	.007	3.53	1.07	94.18	1.16			Crushing strength is the average from 5 blocks; from Lawrence.
Franklin		2,940	162	2.59	.03	1.18	3.09	92.71	2.64			From Greeley.
Leavenworth		8,223	170.4	2.73	.01	12.97	3.06	78.46	1.16	2.32		From Lansing.
Marshall		4,216	158.8	2.54	.06	13.89	4.29	80.10	1	.39		From Beattie; average from 5 blocks.
Do		9,810	163.2	2.61	.03	8.75	2.37	84.80	2.80	.78	.25	Do.
Do	Carboniferous	6,543	163.5	2.62	.05	14.01	1.34	80.31	3.87			From Beattie; average from 4 blocks.
Riley	Permian	3,272	159.1	2.55	.07							From Monterey; quarried by Ulrich Bros.
Wabaunsee			166.3	2.67	.01	6.22	1.74	89.68	1.99			From Alma.
Do	Carboniferous	7,646	161.3	2.58	.05	9.12	.70	88.55	1.25			From Alma; quarried by A. Zechser.
Do		2,891	154.4	2.49	.06	10.37	2.49	84.53	2.35			Crushing strength is the average from 5 blocks.
Chase	Carboniferous	7,907	162.9	2.61	.04	7.30	1.05	90	1.60	.03		From Strong City; average from 6 blocks.
Do		6,800	161.6	2.59	.04	8.57	3.62	84.72	1.75	.90		From Cottonwood Falls; quarried by Bittiger Bros.; crushing strength, average from 4 blocks.

Cowley		12,567	164.5	2.63	.01	3.34	1.69	93.98	.94			From Cambridge; quarried by H. Heddeman; average from 5 blocks.
Do	Carboniferous	3,649	153.5	2.46	.08							From Cambridge; average from 5 blocks.
Lincoln	Benton Cretaceous											No data; known as Lincoln marble, but is hardly a marble, not being sufficiently crystalline.
Hodgeman						5.06	2.08	91.30	.87	(*b*)	.44	From Jetmore.
Hamilton	Benton Cretaceous					4.81	3.07	90.63	.84	do	.08	From Coolidge.
Norton	Loup Fork Tertiary	4,277	156.3	2.51	.06	8.29	*a*.90	89	2			From Norton; crushing strength, average from 4 blocks.
Cherokee	Subcarboniferous	9,520	166	2.66	.003	8	.69	97.32	.80			From Galena.
Allen			167.3	2.68	.02	2.75	5.91	91.02	.14			Iola Marble Company.
Do		7,683	166	2.66	.02	2.63	1.76	94.10	1.54			Average crushing strength from 5 blocks.
Montgomery		7,731	169.8	2.72	.006	16.15	1.91	79.25	1.80			From Independence.
Barber		10,349	163.5	2.62	.01	1.85	1.95	94.62	1.40			Average from 6 blocks.
Franklin		12,809	167.3	2.68	.008	1.18	2.38	94.77	1.07			From Lane; quarried by Hanway.
Do		14,415 / 16,609	169.8	2.72	.005	3.82	*a*.77	94.21	1.30			Do.
Do		10,469	167.9	2.69	.009	3.94	1.20	93.61	1.20			Do.
Do		12,354	167.9	2.69	.006	4.79	1.18	93.30	1.26			Do.
Anderson	Carboniferous	14,647	168.2	2.69	.004	4.30	.81	92.76	.95	.23	.43	From Garnett.
Do		4,399	154.2	2.47	.04	.61	*a*1.51	97.32	.32	.43		Do.
Jackson		11,005	163.5	2.62	.02	10.93	2.02	83.99	2.66	.14		Quarried by A. W. Charles.
Woodson		14,145	168.2	2.69	.007	6.80	2.60	88.03	2.04	.21		From Yates Center.
Elk		10,162	166.2	2.66	.008	.66	2.13	93.49	3.04	.36		From Moline.
Leavenworth		5,515	160.4	2.57	.02	17.49	4.09	69.07	3.06	.37		From Soldiers' Home.
Wabaunsee		5,273	156.3	2.50	.06	3.27	2.61	92.50	1.62			From McFarland; average from 5 blocks.
Micami		2,036	128.2	2.50	.06	1.50	.95	96.50	.74			From Fontana.
Do		13,802	165.4	2.65	.004	1.35	1.32	96.09	1			From Fontana; crushing strength, average from 4 blocks.
Do		4,625	145.4	2.33	.04	2.44	.82	95.57	.80			From Fontana; crushing strength, average from 5 blocks.
Jefferson		8,767	169.8	2.72	.005	6.98	1.04	90.01	1.66			From Winchester.
Nemaha		6,757	161.6	2.59	.05	11.97	3.59	81.98	1.20	.55	.29	From Sabetha.
Leavenworth		12,266	161.1	2.71	.01							From Lansing; crushing strength, average from 5 blocks.
Brown		4,721	164.5	2.63	.06	11.83	5.53	81.91	1.56	.05		From Horton; owners, Frey Bros.; crushing strength, average from 5 blocks.
Douglas		10,339	166.6	2.67	.01	2.29	1.79	95.02	.79			From Lawrence; crushing strength average from 5 blocks.
Do		11,038	166.6	2.67	.01	8.02	2.05	88.54	1.29			From Lawrence.
Allen		17,160	168.8	2.70	.008	1.99	1.21	95.20	1.10			From Humboldt; crushing strength, average from 3 blocks.
Do		11,267	166	2.66	.02	3.79	1.07	93.20	1.01	.20		From Humboldt; crushing strength, average from 5 blocks.

a Iron in ferrous state. *b* Not determined.

All of these limestones are fossiliferous in appearance. The surface appears to polish very well. Fossil outlines are very distinct in most of them. The prevailing color of the samples is a sort of gray, occasionally brownish. The polished surface of certain bluish-gray specimens is quite dark. The polish of some of these stones is very good indeed.

The foregoing table is made from the collection of limestone specimens at the World's Columbian Exposition; the determinations having been made by Dr. S. W. Williston, of Lawrence, Kans.

Kentucky.—Limestone to the value of $113,934 was quarried in Kentucky in 1894. The productive counties are Warren, Jefferson, Kenton, Fayette, Pendleton, Lyon, Jessamine, Menifee, Logan, Montgomery, Caldwell, Crittenden, Boyd, Marion, Hardin, Washington, Carter, and Trigg.

The product of Warren is deserving of special notice because of its peculiarities and its value as a building stone. This stone is known commercially as Bowling Green oolite. It is quite different from the oolitic stone of Indiana, inasmuch as it belongs to another limestone group, the constituent globules being large and distinct, whereas in most of the Indiana stone they are minute. It is quite similar to the Portland oolite of Ireland. The following analyses of Bowling Green and Portland oolite show the similarity between the two:

Composition of Bowling Green, Ky., limestone compared with Portland, Ireland, limestone.

	Bowling Green.	Portland.
	Per cent.	*Per cent.*
Carbonate of lime	95.31	95.16
Carbonate of magnesia	1.12	1.20
Silica	1.42	1.20
Water and loss	1.76	1.94
Iron and alumina	.39	.50
Total	100.00	100.00

The quarries are of large extent and are well equipped with channeling machines, derricks, etc. A mill with twelve gangs of saws finishes the stone. Blocks of almost any size can be furnished. These quarries were first opened in 1833, but until recently they were operated in the most primitive manner, and while the product has been used chiefly in the South, efforts are now being made to introduce the stone to the building trade of the Northern States. Among the cities in which it has been most used are Louisville, Memphis, Nashville, and Bowling Green; to some extent also in Chicago. The stone is soft and easily worked, and, like the Indiana stone, hardens on exposure to the atmosphere. Carvings made upon the stone stand exposure to the air very well. Its color, under the influence of sunlight, tends to become continually lighter. Its crushing strength is such as to enable it to resist a pressure of 3,000 pounds to the square inch. When heated to redness on the surface and plunged into cold water it revealed no crack, even upon examination with a magnifying glass, and in some cases on being reheated for a second and third time and plunged into water, still failed to present indications of cracking. According to present indications the extended application of the stone in the northern and eastern portions of the country seems highly probable.

Maine.—All of the limestone quarried in Maine is converted into lime. The value of the lime output in 1894 was $810, 089. This figure is lower than it has been for several years previous. Many complaints relative to business depression were made by the lime producers. The product comes mainly from Knox County, but smaller quantities are produced in Waldo and Penobscot counties.

The stone is almost inexhaustible in quantity and is admirably adapted to the purpose for which it is used. Operations of quarrying consist simply in blasting by means of dynamite, which breaks the stone up at once into sizes suitable for use in the kilns. It is then hoisted out by means of improved cables and machinery and sent directly to the limekilns, which are favorably situated for transportation by water. The stone is partially crystalline, but very coarse-grained. Fine crystals of calcite are very numerous, and gypsum also occurs. The operations at the quarries near Rockland are all below the surface of the ground. The fuel used in the kilns is entirely wood, which is imported from Canada. The stone produced for burning into lime is not measured as such, but is measured only by the quantity of lime produced from it, so that in speaking of the amount of stone quarried the producers name the amount of lime obtained from it, and the unit of measurement is a bushel or barrel of lime. The lime produced at Rockland is of fine character and is the standard lime of New York City, to which it is shipped in enormous quantities. Boston also forms an important market for the product.

Maryland.—The result of an exceptionally complete canvass of the limestone-producing sections of this State have revealed a much greater activity in limestone and lime production than has heretofore been supposed to exist. Frederick County yields two-thirds of the entire output; the rest comes from Baltimore, Allegany, Washington, Carroll, and Howard counties. The value of the product in 1894 was $672,786, almost all of which is the value of lime made.

Massachusetts.—The value of the product in 1894 was $195,982. Most of the stone is converted into lime. The output comes from Berkshire County.

Michigan.—The value of the output in 1894 was $336,287. The productive counties are Monroe, Huron, Wayne, Charlevoix, and Alpena. Most of the product was used for building and road making. The industry has grown quite markedly since 1889.

Minnesota.—The great bulk of the limestone output of Minnesota comes from quarries in the southeastern part of the State, where the cities of St. Paul and Minneapolis form important outlets. The value of the product in 1894 was $291,263. The productive counties are Lesueur, Hennepin, Blue Earth, Ramsey, Goodhue, Winona, Wabasha, Rice, Dodge, Houston, Brown, Fillmore, Olmsted, and Scott. The product is used largely for building and street work.

Missouri.—The value of the limestone and lime output in 1894 was $578,802. The corresponding figure for 1890 was $1,859,960. There has thus been a very decided falling off in production. The productive counties are St. Louis, Jackson, Marion, Greene, Buchanan, Dade, Pike, Jasper, Perry, Clark, Mercer, Lawrence, Callaway, and smaller amounts in Jefferson, Lewis, Wright, Cape Girardeau, Livingston, Andrew, St. Charles, Macon, Clay, Pettis, Cole, Linn, Caldwell, Sullivan, Randolph, Ray, Harrison, Monroe, Saline, Boone, Henry, Dekalb, Webster, and Nodaway. By far the most important county producing limestone is St. Louis County. Many quarries in and around the city of St. Louis are operated. The stone is used for purposes of heavy construction, such as bridge and railroad masonry, building, paving, macadam, riprap, and the manufacture of lime. It is of excellent quality and shows great strength. In some of the quarries steam drills are in use, but in most of them the old methods are adhered to. The manufacture of a superior quality of lime in St. Louis has grown to be a large industry. Most of the kilns are located just outside of the city limits. They are well equipped and numerous. The product is almost entirely used in St. Louis.

Analysis of Marion County, Mo., limestone.

[By Regis Chauvenet & Bro.]

	Per cent.
Silica	.08
Alumina and oxide of iron	.40
Magnesia	.02
Carbonate of lime	98.80
Total	99.30

These chemists state that this is the purest sample of limestone they have ever analyzed, leaving nothing to be desired for whiteness and purity.

Montana.—The value of the product in 1894 was $92,970, about equally divided between building and lime burning. The product comes from Jefferson, Cascade, Deerlodge, and Park counties.

Nebraska.—The limestone industry in this State was at a very low ebb in 1894, the product being valued at only $8,228.

New Jersey.—The value of the total output in 1894 was $193,523. Most of this amount represents the value of lime made. The productive counties are, in order of importance, Sussex, Hunterdon, Warren, Morris, and Somerset.

New Mexico.—The output in this Territory is so small as to call for no special comment.

New York.—The total value of the limestone output for 1894 was $1,378,851, divided equally between building and road making and lime. The productive counties are Onondaga, Westchester, Warren, Rockland, Washington, Madison, Schoharie, Ulster, Herkimer, Erie, Dutchess, Clinton, Albany, Fulton, Monroe, Columbia, Genesee, Niagara, Orange, Saratoga, St. Lawrence, Wayne, Rensselaer, Cayuga, Lewis, Montgomery, Orleans, Jefferson, Oneida, Seneca, Yates, Essex, and Greene.

Ohio.—The total value of the limestone product for 1894 was $1,733,477, about equally divided between lime and building and road making. The industry has long been an important one to the State, and the quarries are distributed over a large area embraced by the following counties: Ottawa, Sandusky, Stark, Erie, Clark, Miami, Montgomery, Wood, Franklin, Seneca, Lucas, Preble, Hamilton, Allen, Hancock, Highland, Greene, Hardin, Lawrence, Wyandot, Butler, Delaware, Muskingum, Scioto, Shelby, Van Wert, Logan, Guernsey, Jackson, Putnam, Clermont, Crawford, and Clinton.

Pennsylvania.—Production of limestone in this State is active; in fact, the value of the output for 1894 exceeds that of any other State in the Union. Four important uses, namely, building, lime, road making, and blast-furnace flux, unite in placing this State at the head of the list in consumption of limestone. The total value for all purposes in 1894 was $2,625,562. The value of the lime produced was $1,743,947; stone used for building and road making, $547,990; flux, $333,625. In addition to some very large producers, there is a large number of small producers of lime, whose output in toto amounts to a very considerable figure. The productive counties are Chester, Montgomery, Lawrence, Northampton, Bedford, Lancaster, Berks, Lehigh, Union, Blair, Dauphin, Lebanon, Northumberland, Lycoming, York, Westmoreland, Adams, Franklin, Bucks, Somerset, Mifflin, Butler, Armstrong, Huntingdon, Columbia, Cumberland, Monroe, Montour, Warren, Schuylkill, Beaver, Mercer, Washington, Allegheny, and Clarion.

Rhode Island.—The limestone production in this State amounted to $20,433, all of which was the value of lime produced in Providence County.

South Carolina.—Lime to the value of $25,000 was produced from limestone in Spartanburg County during the year 1894.

South Dakota.—The limestone industry in this State does not as yet amount to a great deal. A small quantity was produced in Custer County during the year 1894.

Tennessee.—The limestone industry in Tennessee has increased quite notably since the year 1889, when the output was valued at $73,028. In 1894 the total output reached a value of $188,664. Somewhat more than one-half of this represents the value of lime made; the remainder was devcted to building and road making. The productive counties, in order of their importance, are Davidson, Houston, Dickson, Franklin, Colbert, Hamilton, James, Montgomery, Maury, and Hickman.

Texas.—There appears to have been quite a falling off in the limestone industry of Texas. The total value of the output was only $41,526.

Most of this went for building and road making. The productive counties are Coryell, El Paso, Bell, Williamson, Travis, Hood, Grayson, Hamilton, Lampasas, and Mills.

Utah.—In Salt Lake and Sanpete counties $23,696 worth of limestone was produced in 1894. This was equally divided between lime and building purposes.

Vermont.—The value of the total output in 1894 was $408,810. This was almost entirely converted into lime, which was valued at $407,730. The product was taken from quarries in Addison, Franklin, Windham, Chittenden, and Windsor counties.

Virginia.—The production of limestone in this State has increased quite noticeably in the last few years. The value of the output in 1894 was $284,547. A comparatively small quantity was used for blast-furnace flux, while the remainder was equally divided between lime and building and road making. The most important counties are Botetourt, Warren, Alleghany, and Shenandoah. Very much smaller quantities were produced in Loudoun, Roanoke, Montgomery, Washington, Augusta, Frederick, Pulaski, Giles, Rockingham, and Tazewell counties.

Washington.—Three counties in this State yielded, in 1894, an output valued at $59,148. This was almost entirely converted into lime. The productive counties were San Juan, Stevens, and Whitman.

West Virginia.—From Berkeley, Jefferson, Greenbrier, Monroe, and Tucker counties, a product valued at $43,773 was quarried. Most of it was converted into lime.

Wisconsin.—The limestone industry in Wisconsin has become one of considerable importance. The output in 1894 was valued at a total of $798,406. Of this amount $584,971 represents the value of lime made. The remainder was consumed for building and road making. The productive counties are as follows: Calumet, Fond du Lac, Manitowoc, Dodge, Jefferson, Milwaukee, Ozaukee, Brown, Iowa, Door, Monroe, Outagamie, Racine, La Crosse, Dane, Grant, Green, Kewaunee, Columbia, Buffalo, Oconto, Waukesha, Washington, Rock, Sheboygan, Walworth, Trempealeau, St. Croix, Shawano, and Waupaca.

SOAPSTONE.

By Edward W. Parker.

OCCURRENCE.

Soapstone or talc is found in nearly every State along the Atlantic Slope, the principal deposits being in New York and North Carolina, though it is also quarried in New Hampshire, Vermont, Massachusetts, New York, New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, and Georgia. It has also been reported in some of the Western States, particularly in California, Arizona, South Dakota, and Texas, but no commercial product has been obtained west of the Mississippi River. Pure soapstone is a massive amorphous mineral, usually white, light green, or gray in color. In some cases, notably at Gouverneur, St. Lawrence County, N. Y., it occurs in a foliated or fibrous form, very valuable as a filler or makeweight in the manufacture of paper. This latter variety, known as fibrous talc or mineral pulp, is considered separately in these reports.

USES.

The aboriginal inhabitants of North America recognized soapstone as a valuable mineral. Its resistance to heat and the ease with which it could be worked into desirable shapes, even with the crude implements at their command, made the manufacture of cooking utensils from soapstone one of their few industrial occupations. Tobacco pipes and articles used in their religious ceremonies were also made of soapstone, and traces of their handiwork are still found in the vicinity of soapstone deposits. The uses to which soapstone is applied to-day are very numerous, though in the light of present knowledge the development of the industry seems to have been exceedingly slow. It makes a more durable and satisfactory lining for cooking stoves, heaters, and furnaces than ordinary fire brick. Soapstone does not absorb grease or acids, and is not affected by the ordinary chemical agents, and is as impervious to extreme cold as to heat, making it especially valuable for sinks, etc., in chemical laboratories. Laundry tubs, hearths, mantels, and stove griddles are produced from soapstone, and the readiness with which all dirt and impurities are removed make it popular with housekeepers. The manufacture of slate pencils from soapstone is an industry as old as the manufacture of slates. Ground soapstone is used chiefly as a makeweight in paper manufacture, but it is also used as a base for pigments and cosmetics, as an adulterant in soap and rubber, for dressing skins and leather, and for lubricating.

PRODUCTION.

The amount of soapstone produced in the United States in 1894 was 23,144 short tons, valued at $401,325, against 21,071 short tons, worth $255,067, in 1893. The increase in production was in the amounts sawed into slabs, and ground. The production of manufactured articles decreased slightly, but the value of the products shows a gain of over $110,000, or over 40 per cent.

Following is a statement of the production of soapstone (exclusive of fibrous talc and soapstone ground for paint) in 1893 and 1894, showing the amount and value of the different conditions in which it was marketed:

Production of soapstone in 1893 and 1894.

Condition in which marketed.	1893.		1894.	
	Short tons.	Value.	Short tons.	Value.
Rough	5,760	$51,600	5,620	$50,780
Sawed into slabs	104	4,400	1,303	19,500
Manufactured articles (*a*)	7,070	123,600	6,425	244,000
Ground (*b*)	8,137	75,467	9,796	87,045
Total (*c*)	21,071	255,067	23,144	401,325

a Includes bath and laundry tubs; fire brick for stoves, heaters, etc.; hearthstones, mantles, sinks, griddles, slate pencils, and numerous other articles of everyday use.
b For foundry facings, paper making, lubricators, dressing skins and leather, etc.
c Exclusive of the amount used for pigment, which is included among mineral paints.

In the following table is shown the amount and value of soapstone produced in the United States since 1880:

Annual product of soapstone since 1880.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	8,441	$66,665	1888	15,000	$250,000
1881	7,000	75,000	1889	12,715	231,708
1882	6,000	90,000	1890	13,670	252,309
1883	8,000	150,000	1891	16,514	243,981
1884	10,000	200,000	1892	23,208	423,449
1885	10,000	200,000	1893	21,070	255,067
1886	12,000	225,000	1894	23,144	401,325
1887	12,000	225,000			

FIBROUS TALC.

The supply of this variety of soapstone is obtained only at Gouverneur, St. Lawrence County, N. Y. The entire output is ground and used almost exclusively as a filler in the manufacture of the medium grades of paper. The product in 1894 was 39,906 short tons, valued at $435,060, an increase, as compared with 1893, of 4,045 short tons in quantity and $31,624 in value. The largest output was in 1891, when the product was 53,054 short tons, valued at $493,068. The annual production since 1880 has been as follows:

Annual production of fibrous talc since 1880.

Years.	Quantity.	Value.	Years.	Quantity	Value.
	Short tons.			*Short tons.*	
1880	4,210	$54,730	1888	*a* 20,000	$210,000
1881	*a* 7,000	60,000	1889	23,746	244,170
1882	*a* 6,000	75,000	1890	41,354	389,196
1883	*a* 6,000	75,000	1891	53,054	493,068
1884	*a* 10,000	110,000	1892	41,925	472,485
1885	*a* 10,000	110,000	1893	35,861	403,436
1886	*a* 12,000	125,000	1894	39,906	435,060
1887	*a* 15,000	160,000			

a Estimated.

Talc imported into the United States from 1880 to 1894, inclusive.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880		$22,807	1888	24,165	$22,446
1881		7,331	1889	19,229	30,993
1882		25,641	1890	1,044	1,560
1883		14,607	1891	81	1,121
1884		41,165	1892	531	5,546
1885		24,356	1893	1,360	12,825
1886		24,514	1894	622	6,815
1887	(*a*)	49,250			

a Quantity not reported previous to 1888.

MAGNESITE.

OCCURRENCE.

Magnesite (carbonate of magnesia) occurs in several of the United States, but is mined commercially only in California. Some years ago a small quantity was taken from magnesite quarries at Goat Hill, Chester County, Pa., but the work was continued only a short time. In that State it also occurs at Low's chrome mine in Lancaster County, at Scott's mine in Chester County, and in Delaware and Lancaster counties in small masses. The other localities in the United States where the mineral occurs but is not mined are as follows: North Carolina—Webster, Jackson County; Hampton, Yancy County, and McMakins, Cabarras County; New York—New Rochelle and Rye, Westchester County; Warwick, Orange County; Stoney Point, Rockland County, and Serpentine Hills, Staten Island. In all these localities it occurs in thin veins and seams. New Jersey at Hoboken (with serpentine). In Arizona the mineral is abundant, but is not utilized.

The localities where the mineral occurs in California are numerous, but it has never been mined except at two places, one in Alameda and the other in Napa County. In Santa Clara County there are several known deposits. One is on Coyote Creek, about 2 miles from Madrone Station, on the Southern Pacific Railroad. It occurs in the shape of small nodules in and near serpentine. In the report of the California State mineralogist it is stated that a close examination of the magnesite, particularly the poorer quality, reveals traces of the surrounding country rock, greenstones and shales. There are several deposits in the immediate neighborhood. Another locality in this county is the Red Mountain district, where on the Jarvis and Ryan claim, large, irregular masses of magnesite crop out and in some places more than 10 feet are exposed. On the Favill and Martin, or Mammoth claim, there is a large quantity exposed. These Red Mountain claims are 20 miles from a railroad, too far to be useful at present.

In Alameda County, on the shore of San Francisco Bay, the mineral occurs at Cedar Mountain, and a few tons were shipped from there in 1886, but the experiment was evidently not a success, as work has not been carried on since. The mineral has also been found in the hills near Livermore Valley.

In Mariposa County a heavy bed of magnesian rock, chiefly magnesite[1] charged with crystals of iron pyrites, accompanies the chief gold-bearing vein of the county. The rock is associated with mariposite, a green micaceous mineral containing chromium.

In Fresno County, in section 5, T. 13 S., R. 24 E., is a large vein or deposit of magnesite, which crops to the surface. At Arroyo Seco, Monterey County, a vein has been found 2 feet wide; and the substance has also been found at Mansfield, near the gold mines. About 40 miles east of Visalia, Tulare County, a large deposit has been found near Mineral King district. In the same county, near Visalia, below Four Creeks and Moores Creek, it occurs in solid beds of pure white mineral, hard and fine grained, like unglazed porcelain. The beds are from 1 to 6 feet thick, interstratified with serpentine and talcose slates. In this same county it is also found on the south side of Tule River, 10 miles from Porterville. In Placer County magnesite occurs in quantities at Gold Run, Iowa Hill, and Damascus, in the same region as the large hydraulic and drift gold mines. In San Luis Obispo County it has been discovered near Port Harford.

The mineral is also known to occur near Los Alamos, Santa Barbara County; at several places in Humboldt and Napa counties, and in San Mateo, Lake, Tuolumne, Sonoma, Solano, Contra Costa, San Bernardino, and Calaveras counties in isolated instances. In none of these places mentioned, however, is the mineral now mined.

In 1886 work was commenced on the deposit at Cedar Mountain, Alameda County, and several carloads were shipped, but work has been stopped for some years, the experiment not proving a financial success. The mineral occurs here in a decomposed serpentine rock and in a yellow clay in which are embedded large bowlders. It lies in pockets and small veins, the latter running in every direction. The richest spots were found under the bowlders, where the mineral is quite pure. At this place every piece of mineral had to be cleaned by hand, and the whole was carefully sorted according to purity, being divided into three classes. It was then packed on animals down the mountain.

PRODUCTION.

The only deposit in California which has been utilized to any extent on a commercial basis is that in Childs Valley, Napa County, 10 miles from Rutherford and 65 miles from San Francisco. Here the mineral occurs in a lode 5 to 7 feet thick, standing at an angle of 70° and having regular walls. Most of the deposits found elsewhere occur in beds from 2 to 6 feet in thickness. This lode consists of a white carbonate of magnesia, the mineral being broken out in slabs several inches thick and from 2 to 6 feet in width. The output from this mine is employed in the manufactures and the arts to some extent, and experiments are

[1]According to Professor Silliman (Proc. Cal. Acad. Sci., Vol. III, p. 380) the magnesian mineral accompanying the great quartz vein of Mariposa County is chiefly ankerite, a carbonate of calcium, magnesium, and iron.—H. W. T.

being made for its larger utilization in new branches. The main uses to which it is put at present are for furnace linings at rolling mills and for paper manufacture. Small lots are used in experimental work in the manufacture of artificial stone, paint, epsom salts, flocculent magnesia, and other chemical processes.

The product of this mine for the past four years has been as follows:

Condition in which sold.	1891.	1892.	1893.	1894.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Raw ore	234,440	1,215,155	526,685	2,880,000
Calcined ore	643,748	794,085	880,613	

In these figures only the raw ore is named which was sold as such, the rest of the output having been calcined. It takes nearly 2 tons of raw ore to make one of the calcined. Of the last season's output all but 15 tons of the calcined material was used by the Willamette Pulp and Paper Company, Oregon. About 100 tons of the raw ore was used by the Pacific Rolling Mills, of San Francisco, for furnace lining.

The mill and furnaces at the mine can readily be enlarged should demand for the calcined ore warrant. At present Chicago and Pittsburg obtain their supplies from New York and other Atlantic seaports, into which it is imported from Europe. In Pittsburg and other large manufacturing centers dolomitic limestone is employed in making basic steel. For this stone magnesite would be substituted if it could be obtained at prices somewhat lower than now has to be paid for the imported calcined material, on which there is imposed a duty of 20 per cent, the raw coming in free. There is an abundance of this ore in California, as may be seen from the number of localities noted, but distance from large manufacturing centers prevents shipment under present conditions.

CLAY.

STATISTICS OF THE CLAY-WORKING INDUSTRIES OF THE UNITED STATES IN 1894.

By Jefferson Middleton.

In the previous reports on clays and their products in this series, statements have been made of the amounts and values of such varieties of clay as are consumed in pottery manufacture; and in the earlier reports several valuable statements have been published as to the condition of brick manufacture at prominent centers for this industry. But the many difficulties have baffled several attempts at a census of the brick product; chief among the obstacles is the irregular way in which brickyards are established and again quickly abandoned in obedience to the demands of trade.

The labor involved in this compilation was greatly increased by the inexperience of the producers in filling out schedules, involving the writing of at least 1,000 individual letters. I wish, however, to thank the operators for the patience displayed in answering inquiries, and also for their cooperation, without which this report would be impossible, and to express the hope that they will see the advantage of having statistics in regard to an industry in which they have so much interest and that next year they will respond with even greater promptness.

Production.—As shown in the following table, the total value of the clay products of the United States in 1894, excluding pottery, was $65,389,784. The only figures with which comparison can be made are those published by the Eleventh Census (1890), when the value of the same classes of products was $67,770,695. This decline of $2,380,911 is due, no doubt, to the general financial depression. The great strikes of the year also had the effect of lessening the product to an appreciable degree in the great clay-producing region, the Mississippi and Ohio valleys, this region being the center of these strikes. As would be supposed, the product of greatest value is the building brick, this alone making over 53 per cent of the total, the number aggregating 6,152,420,000 brick. To give a more striking idea of the number of common and pressed brick made last year of which we have record, they would make a walk over 10 feet wide around the entire globe, or cover an area of 49 square miles, assuming the average size of the brick to be 8 by 4 inches. If to this the paving brick were added, 457,021,000, the walk would be over 11 feet in width.

Clay products of United States in 1894.

States.	Number of firms reporting.	Common and pressed brick.		Average price per thousand.	Fancy or ornamental brick.	Fire brick.	Vitrified paving brick.		Average price per thousand.
		Quantity.	Value.				Quantity.	Value.	
		Thousands.					*Thousands.*		
Alabama	53	34, 194	$205, 531	$6. 01	$1, 000	$57, 414	150	$1, 500	$10. 00
Arizona	14	2, 092	16, 031	7. 66		2, 050			
Arkansas	53	24, 604	162, 041	6. 59	80	1, 860	705	7, 050	10. 00
California	70	94, 561	627, 235	6. 63	14, 350	2, 575	110	2, 150	19. 55
Colorado	78	33, 998	228, 344	6. 72	2, 680	113, 393	2, 188	21, 880	10. 00
Connecticut	44	100, 300	549, 650	5. 48	5, 000	57, 500	10	250	25. 00
Delaware	13	6, 080	43, 528	7. 16					
District of Columbia	23	56, 348	317, 565	5. 64	815		250	2, 000	8. 00
Florida	23	13, 402	82, 387	6. 15					
Georgia	64	110, 218	585, 693	5. 31	14, 048	17, 650			
Idaho	19	3, 184	26, 768	8. 41					
Illinois	697	825, 845	4, 495, 613	5. 44	72, 920	116, 904	109, 700	843, 217	7. 69
Indiana	663	335, 868	1, 720, 017	5. 12	6, 650	22, 720	23, 936	224, 473	9. 38
Iowa	437	208, 195	1, 317, 473	6. 33	2, 950	36, 525	45, 488	376, 951	8. 29
Kansas	67	24, 518	141, 042	5. 75	4, 000	2, 350	7, 948	57, 310	7. 21
Kentucky	87	84, 498	418, 886	4. 96	50, 700	87, 800	6, 256	51, 389	8. 21
Louisiana	50	78, 996	442, 862	5. 61	52, 500		1, 200	9, 400	7. 83
Maine	109	72, 302	401, 982	5. 56	200	20, 000	1, 650	11, 200	6. 79
Maryland	67	141, 055	974, 669	6. 91	1, 100	164, 848	50	470	9. 40
Massachusetts	114	263, 732	1, 648, 065	6. 25	139, 100	93, 825	1, 854	14, 536	7. 84
Michigan	196	174, 881	924, 872	5. 29	54, 750	401, 880	145	1, 560	10. 76
Minnesota	122	98, 957	473, 904	4. 79	1, 340	3, 950			
Mississippi	31	22, 897	134, 930	5. 89	1, 500	4, 500	110	770	7. 00
Missouri	242	258, 922	1, 541, 553	5. 95	47, 933	202, 722	23, 189	190, 220	8. 20
Montana	17	10, 316	80, 629	7. 82		545, 700			
Nebraska	104	58. 289	411, 409	7. 06	29, 375		5, 700	52, 800	9. 26
New Hampshire	56	89, 152	482, 330	5. 41	1, 075	15, 000	700	4, 900	7. 00
New Jersey	129	317, 260	1, 601, 096	5. 05	257, 300	502, 430	400	6, 000	15. 00
New Mexico	5	2, 280	17, 125	7. 51		1, 200			
New York	302	821, 286	3, 945, 022	4. 80	52, 500	298, 578	9, 304	136, 697	14. 69
North Carolina	78	43, 525	226, 882	5. 21		1, 100	125	888	7. 10
North Dakota	8	8, 600	52, 400	6. 09					
Ohio	968	386, 712	2, 136, 691	5. 53	92, 683	742, 304	113, 329	928, 948	8. 20
Oklahoma (*a*)	18	6, 404	37, 338	5. 83			100	1, 000	10. 00
Oregon	69	14, 770	95, 820	6. 49	3, 320	630	1, 550	21, 000	13. 55
Pennsylvania	508	642, 326	4, 173, 274	6. 50	75, 281	1, 568, 545	74, 029	521, 359	7. 04
Rhode Island	1	30, 000	240, 000	8. 00	10, 000	3, 000	3, 000	33, 600	11. 20
South Carolina	47	48, 534	229, 877	4. 74		3, 300			
South Dakota	8	3, 312	24, 902	7. 52		1, 600			
Tennessee	76	70, 519	417, 616	5. 92	2, 971	30, 873	7, 687	39, 384	5. 12
Texas	124	134, 963	895, 359	6. 63	16, 989	87, 360	100	1, 000	10. 00
Utah	50	21, 606	156, 047	7. 22		4, 440	1, 575	12, 863	8. 17
Vermont	17	16, 950	92, 552	5. 46	1, 500				
Virginia	104	112, 488	779, 285	6. 93	76, 474	4, 794	5, 400	52, 750	9. 77
Washington	59	22, 625	153, 259	6. 77	15, 200	24, 400	1, 024	17, 600	17. 19
West Virginia	36	38, 719	227, 032	5. 86	1, 000	500	8, 059	63, 964	7. 94
Wisconsin	140	181, 287	1, 099, 102	6. 06	19, 324	6, 200			
Wyoming	4	850	6, 850	8. 06					
United States	6, 264	6, 152, 420	35,062,538	5. 70	1,128,608	5, 252, 420	457, 021	3,711,073	8. 12
Per cent of total			53. 62		1. 73	8. 03		5. 68	

(*a*) Includes Indian Territory.

Clay products of United States in 1894—Continued.

States.	Drain tile.	Sewer pipe.	Ornamental terra cotta work.	Terra cotta lumber.	Tile (not drain), including hollow building tile or blocks, roofing tile, floor tile, encaustic and art tile, and enameled brick	Miscellaneous. (*b*)	Total value.
Alabama	$600						$266,045
Arizona							18,081
Arkansas	2,055	$10			$2,000	$37,000	212,096
California	15,850	102,950	$23,085			53,300	841,495
Colorado	1,540	50,000			7,500	52,740	478,077
Connecticut	500	15,000	60,100		5,000	24,000	717,000
Delaware	2,500						46,028
District of Columbia	2,800	61,100				6,392	390,672
Florida						1,200	83,587
Georgia	2,000	47,300	11,000			22,196	699,887
Idaho	3,500						30,268
Illinois	1,418,572	308,963	430,000	$81,288	44,144	662,739	8,474,360
Indiana	954,264	1,000	50,000	50,000	101,855	4,590	3,135,569
Iowa	557,312	58,000	50	500	8,545	21,200	2,379,506
Kansas	8,048		100		375	5,350	218,575
Kentucky	31,400	15,000			60,000	44,500	759,675
Louisiana	12,500						517,262
Maine	8,400	390,000					831,782
Maryland	3,050	20	50		23,500	177,158	1,344,865
Massachusetts			48,000	50,000	46,983	299,431	2,339,934
Michigan	741,327	99,040			4,300	26,600	2,254,329
Minnesota	77,300	543,065		34,500		111,250	1,245,309
Mississippi	1,000						142,700
Missouri	172,220	150,000	225		24,679	286,026	2,615,578
Montana		7.200			7,500	3,000	644,029
Nebraska	14,000				11,200	1,000	519,784
New Hampshire						200	503,505
New Jersey	8,600	137,977	88,000	206,471	701,955	466,726	3,976,555
New Mexico							18,325
New York	62,955	10,000	508,000	828	64,704	84,738	5,164,022
North Carolina	1,810	21,000				35,000	286,680
North Dakota							52,400
Ohio	1,465,586	3,311,895	19,000		476,118	1,495,273	10,668,498
Oklahoma (*a*)							38,338
Oregon	29,093		1,575	750	7,800	2,000	161,988
Pennsylvania	61,952	347,202	61,000	75,000	67,300	477,135	7,428,048
Rhode Island					8,000		294,600
South Carolina	3,500				20		236,697
South Dakota					500		27,002
Tennessee	25,900	75,000		15,300		27,300	634,344
Texas	10,049	2,000				16,096	1,028,853
Utah	20	2,000				1,530	176,900
Vermont	4,000						98,052
Virginia	10,705				6,696	6,889	937,593
Washington	2,750	209,000	86,000		6,750	700	515,659
West Virginia	360	350,000	10,000			20,150	673,006
Wisconsin	85,150				1,300	44,300	1,255,376
Wyoming							6,850
United States	5,803,168	6,314,722	1,396,185	514,637	1,688,724	4,517,709	65,389,784
Per cent of total	8.87	9.66	2.13	.79	2.58	6.91	100.00

a Includes Indian Territory.
b Including clay ballast (burned), clay pipes, clay retorts, railroad fire-clay tile, stove linings, wall copings, earthenware, cooking utensils, cuspidors, pitchers, vases, flower pots, chemical and cylinder brick, stoneware, stone pumps, well brick and staves, tile posts, furnace and flue linings, terra cotta chimney pipe tops, terra cotta grave and lot markers, fence-posts, fence-post stubs, electrical porcelain specialties, statuary, relief signs, melting pots, etc.

The average value of the common and pressed brick throughout the United States was $5.70 per thousand. The average value in the various States ranged from $4.74 in South Carolina to $8.41 in Idaho. The average value of the vitrified paving brick was $8.12 per thousand, ranging from $5.12 in Tennessee to $25 in Connecticut.

The following tables show the average value of the common and pressed and vitrified paving brick, arranged in the order of the value per thousand, in the several States:

Average price of brick in 1894, by States and Territories.

COMMON AND PRESSED.

States.	Price per thousand.	States.	Price per thousand.
Idaho	$8.41	Missouri	$5.95
Wyoming	8.06	Tennessee	5.92
Rhode Island	8.00	Mississippi	5.89
Montana	7.82	West Virginia	5.86
Arizona	7.66	Oklahoma Territory	5.83
South Dakota	7.52	Kansas	5.75
New Mexico	7.51	District of Columbia	5.64
Utah	7.22	Louisiana	5.61
Delaware	7.16	Maine	5.56
Nebraska	7.06	Ohio	5.53
Virginia	6.93	Connecticut	5.48
Maryland	6.91	Vermont	5.46
Washington	6.77	Illinois	5.44
Colorado	6.72	New Hampshire	5.41
California	6.63	Georgia	5.31
Texas	6.63	Michigan	5.29
Arkansas	6.59	North Carolina	5.21
Pennsylvania	6.50	Indiana	5.13
Oregon	6.49	New Jersey	5.05
Iowa	6.33	Kentucky	4.96
Massachusetts	6.25	New York	4.80
Florida	6.15	Minnesota	4.79
North Dakota	6.09	South Carolina	4.74
Wisconsin	6.06		
Alabama	6.01	Average for United States	5.70

VITRIFIED PAVING.

States.	Price per thousand.	States.	Price per thousand.
Connecticut	$25.00	Kentucky	$8.21
California	19.55	Missouri	8.20
Washington	17.19	Ohio	8.20
New Jersey	15.00	Utah	8.17
New York	14.69	District of Columbia	8.00
Oregon	13.55	West Virginia	7.94
Rhode Island	11.20	Massachusetts	7.84
Michigan	10.76	Louisiana	7.83
Alabama	10.00	Illinois	7.69
Arkansas	10.00	Kansas	7.21
Colorado	10.00	North Carolina	7.10
Oklahoma	10.00	Pennsylvania	7.04
Texas	10.00	Mississippi	7.00
Virginia	9.77	New Hampshire	7.00
Maryland	9.40	Maine	6.79
Indiana	9.38	Tennessee	5.12
Nebraska	9.26		
Iowa	8.29	Average for United States	8.12

In the following table is given the rank of the States making clay products in the United States in 1894, together with a statement of the percentage of the total product of each.

Clay products.

Rank.	States.	Value.	Per cent of total product.	Rank.	States.	Value.	Per cent of total product.
1	Ohio	$10, 668, 498	16. 32	26	Washington	$515, 659	0. 79
2	Illinois	8, 474, 360	12. 96	27	New Hampshire	503, 505	. 77
3	Pennsylvania	7, 428, 048	11. 36	28	Colorado	478, 077	. 73
4	New York	5, 164, 022	7. 90	29	Dist. of Columbia.	390, 672	. 60
5	New Jersey	3, 976, 555	6. 08	30	Rhode Island	294, 600	. 45
6	Indiana	3, 135, 569	4. 79	31	North Carolina	286, 680	. 44
7	Missouri	2, 615, 578	4. 00	32	Alabama	266, 045	. 41
8	Iowa	2, 379, 506	3. 64	33	South Carolina	236, 697	. 36
9	Massachusetts	2, 339, 934	3. 58	34	Kansas	218, 575	. 33
10	Michigan	2, 254, 329	3. 45	35	Arkansas	212, 096	. 32
11	Maryland	1, 344, 865	2. 06	36	Utah	176, 900	. 27
12	Wisconsin	1, 255, 376	1. 92	37	Oregon	161, 988	. 25
13	Minnesota	1, 245, 309	1. 90	38	Mississippi	142, 700	. 22
14	Texas	1, 028, 853	1. 57	39	Vermont	98, 052	. 15
15	Virginia	937, 593	1. 43	40	Florida	83, 587	. 13
16	California	841, 495	1. 29	41	North Dakota	52, 400	. 08
17	Maine	831, 782	1. 27	42	Delaware	46, 028	. 07
18	Kentucky	759, 675	1. 16	43	Oklahoma	*a* 38, 338	. 06
19	Connecticut	717, 000	1. 10	44	Idaho	30, 268	. 05
20	Georgia	699, 887	1. 07	45	South Dakota	27, 002	. 04
21	West Virginia	673, 006	1. 03	46	New Mexico	18, 325	. 03
22	Montana	644, 029	. 98	47	Arizona	18, 081	. 03
23	Tennessee	634, 344	. 97	48	Wyoming	6, 850	. 01
24	Nebraska	519, 784	. 79				
25	Louisiana	517, 262	. 79		United States.	65, 389, 784	100. 00

a Includes Indian Territory.

An inspection of this table shows some interesting facts. It will be noted that forty-nine States and Territories contributed to this total, all participating except Alaska and Nevada, the product ranging in value from $6,850 in Wyoming to $10,668,498 in Ohio. In Nevada no trace of a clay worker could be found, and no attempt was made to get returns from Alaska.

The first eight States, embracing the great clay-producing region between the Ohio and Missouri rivers, together with Pennsylvania, New York, and New Jersey, produced over two-thirds of the entire product—67.05 per cent—while Ohio, Illinois, Indiana, and Iowa produced nearly 38 per cent of the total.

The following table shows the amount and value of the potters' materials produced in the United States from 1887 to 1894:

Amount and value of potters' materials from 1887 to 1894.

	1887.		1888.		*a* 1889.		1890.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*		*Tons.*		*Tons.*	
Kaolin and china clay	22, 000	$231, 000	18, 000	$189, 000	} 294, 344	} $635, 578	} 350, 000	} $756, 000
Ball clay	6, 000	36, 000	5, 250	31, 500				
Fire clay	15, 000	45, 000	13, 500	40, 500				
Ground flint	19, 800	168, 000	16, 250	138, 125	11, 113	49, 137	13, 000	57, 400
Ground feldspar	10, 200	112, 200	8, 700	95, 700	6, 970	39, 370	8, 000	45, 200

	1891.		1892.		1893.		1894.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*		*Tons.*		*Tons.*	
Kaolin and china clay, Ball clay, Fire clay	400, 000	$900, 000	420, 000	$1, 000, 000	400, 000	$900, 000	360, 000	$800, 000
Ground flint	15, 000	60, 000	20, 000	80, 000	29, 671	63, 792	38, 000	319, 200
Ground feldspar	10, 000	50, 000	15, 000	75, 000	18, 391	68, 037	17, 200	167, 700

a From 1889 all clays burned in kilns are considered.

IMPORTS.

Classified imports of clay during the calendar years ending December 31, from 1885 to 1894.

Kinds.	1885.		1886.		1887.	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
China clay or kaolin	10,626	$83,722	16,590	$123,093	23,486	$141,360
All others:						
Unwrought	9,736	76,899	13,740	113,875	17,645	139,405
Wrought	3,554	29,839	1,654	20,730	2,187	22,287
Total	23,916	190,460	31,984	257,698	43,318	303,052

Kinds.	1888.		1889.		1890.	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
China clay or kaolin	18,150	$102,050	19,843	$113,538	29,923	$270,141
All others:						
Unwrought	20,604	152,694	19,237	145,983	21,049	155,486
Wrought	6,832	53,245	8,142	64,971	2,978	29,143
Total	45,586	307.989	47,222	324,492	53,950	454,770

Kinds.	1891.		1892.		1893.		1894.	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
China clay or kaolin	39,901	$294,458	49,468	$375,175	49,713	$374,460	62,715	$465,501
All others:								
Unwrought	16,094	118,689	20,132	155,047	14,949	113,029	13,146	98,776
Wrought	6,297	56,482	4,551	64,818	6,090	67,280	4,768	60,786
Total	62,292	469,629	74,151	a595,040	b70,752	554,769	c80,629	625,063

a In addition, 5,172 long tons of common blue clay, worth $59,971, were imported.
b In addition, 4,304 long tons of common blue clay, worth $51,889, were imported.
c In addition, 2,528 long tons of common blue clay, worth $28,886, were imported.

Earthenware and china imported and entered for consumption in the United States, 1867 to 1894, inclusive.

Years ending—	Brown earthen and common stoneware.	China and porcelain not decorated.	China and decorated porcelain.	Other earthen, stone, or crockery, ware, etc.	Total.
June 30, 1867	$48,618	$418,493	$439,824	$4,280,924	$5,187,859
1868	47,208	309,960	403,555	3,244,958	4,005,712
1869	34,260	400,894	555,425	3,468,970	4,459,549
1870	47,457	420,442	530,805	3,461,524	4,460,228
1871	96,695	391,374	571,032	3,573,254	4,632,355
1872	127,346	470,749	814,134	3,896,664	5,308,893
1873	115,253	479,617	867,206	4,289,868	5,751,944
1874	70,544	397,730	676,656	3,686,794	4,831,724
1875	68,501	436,883	654,965	3,280,867	4,441,216
1876	36,744	409,539	718,156	2,948,517	4,112,956
1877	30,403	326,956	668,514	2,746,186	3,772,059
1878	18,714	289,133	657,485	3,031,393	3,996,725
1879	19,868	296,591	813,850	2,914,567	4,044,876
1880	31,504	334,371	1,188,847	3,945,666	5,500,388
1881	27,586	321,259	1,621,112	4,413,369	6,383,326
1882	36,023	316,811	2,075,708	4,438,237	6,866,779
1883	43,864	368,943	2,587,545	5,685,709	8,686,061
1884	50,172	982,499	2,664,231	666,595	4,363,497
1885	44,701	823,334	2,834,718	963,422	4,666,175
Dec. 31, 1886	37,820	865,446	3,350,145	951,293	5,204,704
1887	43,079	967,694	3,888,509	1,008,360	5,907,642
1888	55,558	1,054,854	4,207,598	886,314	6,204,324
1889	48,824	1,148,026	4,580,321	788,391	6,565,562
1890	56,730	974,627	3,562,851	563,568	5,157,776
1891	99,983	1,921,643	6,288,088	353,736	8,663,450
1892	63,003	2,022,814	6,555,172	380,520	9,021,509
1893	57,017	1,732,481	6,248,255	338,143	8,375,896
1894	47,114	1,550,950	5,392,648	176,391	6,990,712

TECHNOLOGY OF THE CLAY INDUSTRY.

By Heinrich Ries.

INTRODUCTION.

In spite of the financial depression the past year has been one of importance and progress to the clay-working industry. The establishment of a school for the training of clay workers in connection with the Ohio State University is a step toward giving proper and deserving recognition to the clay-working industries of the United States. Such schools are by no means new abroad, and have done much toward the progress and development of the ceramic art in their respective countries.

Before taking up and describing the technology of the clay industry, there are several points that have come up during the past year and deserve special mention.

TESTING OF BRICKS.

Engineers have heretofore held, and do so still to some extent, that a paving brick whose crushing resistance is less than 10,000 pounds per square inch should be rejected, and some have even set the limit at 12,000 pounds. It was furthermore thought by many that this was the most important test to which the brick could be subjected; opinion is, however, changing, for it is beginning to be understood that in actual usage the brick is seldom, if ever, subjected to such pressure. For paving brick the absorption and abrasion tests are more important. On the other hand too much leniency exists with regard to common building brick. Strength is an important item in their constructure, and should be carefully looked after.

SIZES OF BRICK.

The recent experiments of Mr. E. S. Fickes, which were published in the Engineering News of December 13, 1894, bring out very clearly the great variation which exists in the sizes of brick, and the small dimensions of some of them. There is a common tendency on the part of the manufacturer to decrease the size of his brick in order to gain greater profits or to keep the existing ones from becoming smaller.

This total lack of uniformity is a matter which should be remedied, and one which seems of a sufficient importance to be regulated by legislation.

CONTINUOUS KILNS.

The general practice among American brick manufacturers is to use the ordinary updraft skove kiln for burning common brick, and down-draft kilns for better and for more refractory ware. Continuous kilns are a comparatively recent introduction in the American clay-working industry. Nearly all of those used in this country are modifications of the Hoffmann kiln which has been successfully used abroad for some years. They consist essentially of an endless tunnel, divided into compartments by easily removable partitions. The heat from the burning bricks in one compartment is used to dry out those in another chamber not yet burned. The continuous kiln has not proven a success thus far in this country. The cost of erection is high, the kiln requires considerable skill to operate, and is hard to control. It has been tried for burning paving brick, but its action is too quick to permit annealing of the ware. It has not shown itself adapted to ornamental brick on account of the great difficulty to control the color. Its chief use is for burning refractory ware, which needs much fuel, and where color is unimportant. These kilns require little labor, but need a good quality of fuel.

I am informed by Mr. H. A. Wheeler that continuous kilns are used at St. Louis and Fulton, Mo., for burning fire brick. At Galesburg, Ill., attempts were made to burn paving brick in continuous kilns, but they were unsuccessful. They are somewhat used in Ohio, and at one locality in California for burning brick. Continuous kilns are also in successful operation at Golden, Col.

FUSIBILITY OF CLAYS.

It is well known that iron, lime, magnesia, and the alkalies lower the fusibility of clay, often to a great extent. This fact was expressed by Bischoff in the following equation:

$$\text{Fusibility quotient} = \frac{\text{Alumina} \times \text{alumina}}{\text{Silica} \times \text{fluxes.}}$$

According to the above, the more refractory a clay, the more alumina it must contain.

Recent experiments by Wheeler on Missouri clays[1] show that the alumina may be replaced by sand without affecting the fusibility of the clay, whereas detrimental impurities, especially alkalies, greatly increase the fusibility, and furthermore the fineness of grain has an important influence on its refractoriness. Therefore Bischoff's formula is unreliable. When clays are similar in density and fineness, the refractoriness will be inversely as the detrimental impurities, when the latter are equated as to their proper fluxing values, and if this

[1] Eng. and Min. Jour., Mar. 10, 1894.

is called the "fusibility factor," it may be expressed by the formula $F.\ F. = \frac{N}{D+D^1}$, in which N represents the sum of the nondetrimentals or total silica, alumina, titanic acid, water, moisture, and carbonic acid; D represents the sum of the detrimental impurities, or the iron (Fe_2O_3), lime, magnesia, alkalies, sulphuric acid, sulphur, etc.; D^1 represents the sum of the alkalies, which have been found to have about double the fluxing value of the other fluxes. This formula gives a good comparative value for clays not differing more than 0.2 in density. When clays to be compared differ in density or fineness, then the formula has to be modified by the constant C, and the formula becomes $F.\ F. = \frac{N}{D+D^1+C.}$ C=1, when the clay is coarse grained and the specific gravity exceeds 2.25; C=2, when clay is coarse grained and specific gravity ranges from 2 to 2.25; C=3, when it ranges from 1.75 to 2; C=2, when clay is fine grained and specific gravity above 2.25; C=3, when it ranges from 2 to 2.25; C=4, when it is from 1.75 to 2. These values of C are approximate.

Another series of experiments has been made by H. O. Hofman and C. D. Demond to determine the refractory values of clay by indirect methods.[1] The method consisted in mixing fire clays with varying proportions of calcium carbonate and calcium carbonate and silica to render them fusible at temperatures below the melting point of platinum. Common brick clays were mixed with alumina and silica to decrease their fusibility. The object was to obtain a standard temperature at which both fire clays and common brick clays could be tested; the amount of ingredients required by each clay for fusion was the measure of its refractoriness.

"The behavior of the samples in the fire gave such a satisfactory series, both in the descending scale with fire clay and the ascending scale with common brick clay, that it seemed an easy matter to assume a standard temperature 1,500° C. and to add fluxing or refractory substances to the clays until they melted at this temperature. This was found, however, to be very difficult."

CLAY BALLAST.

The use of burned clay for ballasting railroads in the Western States has been already mentioned in the Mineral Resources, 1892. The clay used is such as is found in the bottom lands.[2] A side track is run from the main line to the point where the kiln is built. "The kiln is started on a triangular core of old ties and kindlings piled about 3 feet high and the entire length of the kiln, which is from 2,000 to 4,000 feet. This core is filled with coal and covered about a foot deep with

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[1] Trans. Amer. Inst. Min. Eng., Vol. XXIV, p. 42.

[2] Sci. Amer. Sup. No. 940, p. 15022, Jan. 6, 1894.

clay, and the fires lighted. After this has burned down somewhat the kiln is covered with several layers of coal and clay each 6 to 9 inches deep." A car with plow for digging the clay and a conveyor for distributing it runs along the side track and digs the clay from the space between kiln and track. The conveyor distributes it over the kiln. The coal is distributed from another car. When the clay has been dug to sufficient depth the track is shifted to another spot. Ordinary slack coal is used for fuel, and about 560 pounds of coal will burn a cubic yard of ballast. About 1,000 cubic yards per day can be burned in a kiln 4,000 feet long, and about 50 men are required to operate such a kiln. The cost of ballast is about $1.05 per cubic yard, and it weighs 40 to 50 pounds per cubic foot. It lasts six to eight years, and the chief objection is its low crushing strength, but it is clean and easy on rolling stock.

BRICK-DUST MORTAR.[1]

The use of brick-dust mortar as a substitute for hydraulic cement when the latter can not be obtained is now often recommended. Mixtures of brick dust and quicklime showed that blocks one-half inch thick, after immersion in water four months, bore without crumbling or splitting a pressure of 1,500 pounds per square inch. The addition of 10 per cent brick dust as sand to common mortar is said to prevent disintegration.

MINING OF CLAY AND SHALE.

As the larger portion of the clay deposits which are being worked are surface beds of soft material, the methods of mining followed are extremely simple, and it is only the larger concerns that use more elaborate ones.

(1) *Pick and shovel attack.*—Plastic clay is commonly dug with a pick and shovel and thrown into cars or carts. The shovel is often of peculiar form, being flat and narrow.

(2) *Bench working.*—The clay is worked in benches in order to provide greater length of working surface. Cars or carts are run up to and along the several benches.

(3) *Plows and scrapers* are sometimes employed to loosen the clay and bring it down to foot of the bank. The clay thus becomes mixed from top to bottom of the deposit.

(4) *Undermining* is often resorted to when the clay is tough, the falling of a mass of clay breaking it up quite completely.

(5) *Steam shovels* are found economical for large works and provided the material does not slide easily, as a steam shovel usually leaves a vertical face. This method is applicable to clay and soft shale.

(6) *Shafts, drifts, and slopes.*—Much of the fire clay occurs as interbedded deposits, often some distance below the surface, therefore underground mining is necessary, as the cost of stuffing prohibits open workings.

[1] Scient. Amer., Dec. 29, 1894, p. 403.

(7) *Dredging* is used in rare instances when the clay bed underlies a river or lake, as at Croton Landing, New York.

HAULAGE.

Most factories are located near the clay or shale bank, and when the distance is short carts drawn by horses are used to haul the clay. For longer distances, generally above 500 feet, it pays to lay tracks and use cars. These are made into trains of three or four and drawn by horses. Locomotive haulage is economical if the scale of operations warrants it, and has been profitably used for a 600-foot lead. Very often the loaded cars can be run from the bank to the works by gravity; at other times, when the lead is straight, wire rope haulage is used, or even a gravity plane.

USES OF CLAY.

A classified list of the uses to which clay was put has been given in the Mineral Resources, 1891, and need not be repeated here.[1]

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PAVING BRICK.

The paving-brick industry and market are confined largely to the cities of the Central States, Philadelphia being the only large Eastern city which has adopted brick pavements to any extent. One reason for

[1] For a commercial classification of clays and their origin, see Mineral Resources, 1891, p. 480.

this may be that the cost of transportation prevents competition with asphalt; another is that engineers are cautious about introducing them in large cities where traffic is very heavy. Over one-half the cities now using brick for paving are in Ohio, Indiana, Illinois, and Iowa, these States being the center of manufacture.[1]

CLAY REQUIRED.

This must be one which will produce a "vitrified" product. This term, which is misleading, simply means that the clay in burning is brought to incipient fusion, and thereby forms a tough homogeneous mass. The clay while attaining this condition should be able to keep its shape.

Vitrification begins at a red heat in most clays, and it is often found that a mixture of two clays—one possessing refractoriness and the other fusibility—gives the best results. A sufficient amount of iron is also necessary to give the brick a red color in accordance with popular demand. Silicate of iron is apt to form blotches on the surface. Mr. Mead[2] claims that in order to vitrify a clay should contain at least 3 per cent potash, 3½ per cent soda, or 5 per cent lime or magnesia, or 8 per cent iron, or a combined proportion of any or all of these fluxes equal to these amounts.

The classes of materials used are Silurian, Devonian, and Carboniferous shales, impure fire clays, and less often surface deposits of Quaternary clay. The latter are apt to be too fusible.

The heat required to vitrify a clay varies, and some of the fire clays used can not be said to do so. In the Ohio clays[3] it was found that the heat required to vitrify the clay or shale was about 1860° F. The fusibility seemed to be due partly to the alkaline earths and alkalies present. The iron did not seem to aid much in the fusion, as vitrification began while the iron was still in the form of sesquioxide, and that a subsequent elevation of the temperature breaks it up, as is shown by the darker color of the brick.

PREPARATION OF CLAY.

When clay of a shaly nature is used it has to be first ground to powder in a dry pan. This consists essentially of a circular iron pan with a perforated bottom. In the pan are two iron wheels 6 to 14 inches wide and weighing 2,000 to 6,000 pounds, and which revolve by the tangential friction of the pan floor. Scrapers attached to the axle carrying the wheels throw the clay under the latter, and when fine enough it falls through the perforated bottom. The capacity of a dry pan varies with the size of the screen plates of the bottom and character of the clay. The maximum record is 200 tons of shale fire clay in ten hours through

[1] For map showing cities where factories are located and brick pavements laid, see D. W. Mead, Paving and Munic. Eng., January, 1894.

[2] D. W. Mead, loc. cit.

[3] Geol. Surv., Ohio, VII, p. 138.

a one-eighth and three-sixteenth inch mesh bottom,[1] but the average capacity of one pan with one-eighth-inch mesh bottom is 100 tons for the same time.

SCREENING.

The ground clay passes from the dry pan to the screen by means of a bucket elevator. All manufacturers do not screen their clay, trusting to the dry pan to reduce it to sufficient fineness. Three general types of screen are used:

1. *Inclined screens*, 10 to 14 feet long, with wire cloth or perforated metal bottom. This is the simplest and cheapest form, but has small capacity.

2. *Rotary screens* of cylindrical or octagonal form, often provided with automatic devices to make the clay pass through them more quickly.

3. *Shaking screens*, fixed at one end and driven by a crank and piston or eccentric. They have a perforated metal bottom, and are cheap and simple in operation.

TEMPERING.

This is done in wet pans or pug mills.

Wet pans.—These are like dry pans, but have a solid instead of perforated bottom. The clay is charged in lots of 600 to 1,200 pounds, and water added to it. The tougher and more refractory the clay the finer it must be ground, while if easily vitrified it need not be so fine. The action of the wet pan is very rapid, a charge for bricks being tempered in two to three minutes and for sewer pipe in four to five minutes, and it is the most thorough tempering machine. When sufficiently tempered the clay is removed through a trapdoor in the bottom of the pan or else by means of a specially constructed shovel. Wet pans have a greater capacity and are more efficient than pug mills, but they consume more power.

Pug mills.—These consist of a horizontal trough in which there revolves a shaft bearing knives. The material is charged at one end, together with water, and becomes thoroughly mixed as it passes forward, the speed being controllable by the angles which the knives make with the shaft. Pug mills occupy less space than dry pans and require less power, but are less effective.

MOLDING.

Nearly all paving brick manufacturers use stiff-mud machinery In stiff-mud machines the clay is tempered quite stiff and is forced from the machine in the form of a bar, which is then cut up into brick. Two types of stiff-mud machines exist—the auger and the plunger.

Plunger machines.—In these the clay is charged into an upright iron cylinder, and issues from it through a die and under great pressure.

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[1] Geol. Surv., Ohio, VII, p. 142.

This bar of clay is received on the cutting table, and when it has issued to a certain distance, a frame bearing a number of parallel wires is drawn over and cuts the bar into a number of pieces, each equal in size to a brick.

Auger machines consist of a horizontal tapering cylinder, in which there revolves a shaft bearing knives and, at the smaller end of the cylinder, a screw. The clay is charged at the wide end and becomes compressed as it moves forward toward the die, through which the screw forces it onto the cutting table. The auger machine is often provided with an automatic device for cutting up the bar of clay, which insures continuous action; it is also called end cut or side cut, according as the section of the bar of clay has the same area as the end or side of a brick. To increase the capacity of an auger machine several bars of clay may be forced from it at once. Auger machines consume more power than plunger machines, but with their continuous action have a much greater capacity. The continuous automatic cutting device has thus far only proved applicable to end-cut brick.

Stiff-mud machines are among the cheapest used, but one objection to them is the laminated character which they impart to the brick. This fault arises partly from the flow of the clay through a die and also from the effect of the screw of the auger machine. It has been found that rich, fat clays laminate most. If in burning the brick is vitrified the effect of the lamination is partly lessened. The average capacity of a stiff-mud machine is 30,000 per day, but some machines using the automatic cut-off have produced 75,000 in ten hours.

A combination machine is described by Prof. E. Orton, jr.,[1] which consists of "a vertical pug mill to force the clay downward and a large mud wing or revolving arm to give the final propulsion to the clay. This mud wing forces the clay down into a set of molds arranged around the periphery of a horizontal table. Each mold box is filled with clay, and when full comes under a pair of plungers acting vertically, one working under the clay and the other down on it. The clay is thus compressed into a solid block, which is subsequently removed when the movable bottom of the box is elevated to the surface of the table." The advantage of this machine is that the brick has no structure, and a very plastic clay can be worked. The daily capacity is about 20,000 brick.

Dry-press process.—This method has been tried for making paving brick, but thus far has met with little success. Its most important application is for the manufacture of pressed brick, under which head it is described.

REPRESSING.

Most paving brick receive no further treatment to alter their shape, but some manufacturers repress the green brick, the advantage claimed being production of a better and smoother shape, as well as a denser

[1] Ohio Geol. Surv., VII, 1893.

product. The Ohio geological survey made a number of rattling tests of plain and repressed brick from several factories, and the results are somewhat in favor of the repressed material, but are not conclusive.[1]

DRYING.

Excluding open-air drying, which is rarely used for paving brick, the methods employed are:

Drying floors.—These are brick floors with flues underneath to conduct the heat from the fireplace situated at one end. They are generally large enough to hold a day's output. The advantage is cheapness, but the objections are great inequality of heat at the two ends of the floor and the amount of handling, as the bricks have to be spread and removed by hand. The chief application of drying floors is in the manufacture of fire brick.

Sewer-pipe floors.—The floors of the building where the drying is done are slatted instead of solid, and the heat is provided by steam pipes arranged around the sides of the building. This method is cheap and very safe, but slow. It requires about the same amount of labor as the first method, but the original cost of plant is considerable.

Chambers dryers.—These are essentially tunnels made of brick and arranged side by side. The green brick are piled on cars, which are run on tracks into the tunnels. They are heated by flues under the track, and coal, coke, wood, oil, or gaseous fuel are used. Their theoretical action is good, but they are not found to be so in practice. Two objections are, danger of cracking, due to sudden drying, and large amount of labor required.

Progressive dryers.—These are very similar to the preceding, but the green ware is run in at one end and the dried material is removed at the opposite end. Air and heat enter at the end where the bricks are removed, and the draft is produced by stacks or fans, preferably the latter. The air is heated by passage over steam pipes or through fireplaces. This method is, perhaps, the best and safest means of drying brick. Drying has also been done in the kiln by drawing the hot air from a cooling kiln to one not yet burned.

BURNING.

This is usually done in round or rectangular down-draft kilns. Each type of kiln has several fireplaces, and the products of combustion are conducted to the top of the kiln by "pockets" on the inside walls, and then pass down through the brick and out through flues under the floor of the kiln. The rectangular kilns have several stacks to insure an equal amount of draft to all portions of the kiln, while the round forms generally have one stack. The latter have a capacity for about 30,000 brick.

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[1] Ohio Geol. Surv., VII.

In burning the temperature is gradually raised to the point of vitrification and held at this temperature for several days. It is then cooled very slowly to anneal the brick and give a hard, tough product. Quick cooling makes a brittle brick. The following measurements have been made by Professor Orton in Ohio,[1] and give an idea of the temperature reached in paving-brick kilns. Unfortunately the measurements were made with a lunette pyrometer, which is apt to give an error of 50°:

Temperatures reached in paving-brickkilns as determined by the Ohio geological survey.

Material.	Portion of kiln.	Temperature, Fahrenheit.
		Degrees.
Fire clay	Kiln at best heat	1, 862
Shales	do	1, 800
Fire-clay mixture	Kiln past best heat	1, 702
Fire clay	Kiln at highest heat	1, 920
Shales	do	1, 800
Do	do	1, 840
Fire clay	Kiln at best heat	1, 920
Do	Kiln at about best heat	1, 830

TESTING.

Three tests are usually applied: Absorption, abrasion, and crushing.

Absorption.—A thoroughly vitrified brick must of necessity be dense, and absorption will therefore be a measure of the porosity. The absorption is determined by weighing the thoroughly dry samples, immersing in clean water from 48 to 72 hours, then wiping dry and weighing again. Vitrified bricks should not show a gain in weight of over 2 per cent. There are cases where bricks of apparently good quality show a greater absorption than this, but they have great toughness and refractory qualities. Bricks made from fire clays which will not vitrify so easily will naturally show higher absorption. This absorption test is of great importance in our severe northern climate.

Abrasion.—This test approximates closely the conditions under which the brick is used, and is therefore an important one. The usual method of conducting this test is to put the bricks in an ordinary foundry rattler, filling it about one-third full. It is then set in rotation at the rate of about 30 revolutions per minute, and about 1,000 turns are sufficient. The bricks are weighed before and after to determine loss by abrasion. A more recent modification is to line the rattler with the bricks to be tested and then put in loose scrap iron. This is claimed to give more accurate results and avoids loss by chipping due to the bricks knocking against each other, as in the previous method, although even this was obviated somewhat by Professor Orton, jr., by the introduction of a few billets of wood into the rattler. The abrasion test may also be made by putting the weighed bricks on a grinding

[1] Ohio Geol. Surv., VII, p. 138.

table covered with sand and water, and noting the weight before and after grinding.

Crushing.—The amount of pressure which a paving brick shall be able to withstand is an unsettled matter. There are bricks in use which crush at 5,000 pounds per square inch, while others will stand 15,000 pounds. Some engineers refuse to accept a brick which will not stand 12,000 pounds per square inch, but this limit is undoubtedly too high, for when laid in pavements it is abrasion and not so much pressure which the bricks are subjected to. Furthermore, experiments show that a brick of high crushing power may have great absorption and little vitrification.

From a large series of tests recently made by Mr. Fickes and published in the Engineering News, December 13, 1894, the following facts were developed:

1. A brick which stands rattling well has ample crushing strength and rarely chips under less than 5,000 pounds per square inch, or crushes under less than 10,000 pounds. The crushing strength tends to vary with the resistance to abrasion, however, but more slowly and irregularly.

2. The transverse strength also tends to vary with the resistance to abrasion, but more slowly and irregularly.

3. The toughest brick usually absorb the least water, but exceptions occur.

Some valuable and interesting tests were recently made by the Ohio geological survey to determine the relative merits of fire clays and shales for the manufacture of paving brick, as well as the influence, if any, of the method of manufacture used. Twenty-three varieties of shale brick, or bricks whose largest constituent is shale, were grouped together; fifteen varieties of fire-clay brick; four varieties composed of shale and fire clay mixed in equal proportion; three varieties made of Ohio River sedimentary clays. The average of these four classes of results were as follows:

Results of tests of fire clays and shales for the manufacture of paving brick, by the Ohio geological survey.

Kind.	Absorption.	Rattling.	Crushing.	
			Square inches.	*Cubic inches.*
Shales	1.17	17.61	7,307	1,764
Fire clay	1.62	17.32	6,876	1,678
Mixture	1.44	18.72	5,788	1,400
River clay	1.36	19.02	4,605	1,176

Taking nine samples of brick made on end-cut machinery, whether auger or plunger, and comparing them with twelve side-cut, re-pressed brick, the following figures were obtained:

Comparative tests of side-cut paving brick with end-cut brick.

Kind.	Absorption.	Rattling.	Crushing.	
			Square inches.	*Cubic inches.*
Side cut	0.72	17.78	6.925	1,649
End cut	.92	17.49	5,418	1,354

This showed a distinct advantage in general for the side-cut material; but the end-cut material in this test was made in many different kinds of machinery and of very different clay. Separating the various kinds more closely, the following figures were obtained:

Test of paving brick.

Machine used.	Absorption.	Rattling.	Crushing.	
			Square inches.	*Cubic inches.*
Sewer-pipe press (re-pressed)	1.18	11.13	5,903	1,480
Penfield machine (re-pressed)	1.08	32.77	4,465	1,138
Average for plunger machines	1.15	16.54	5,544	1,385

Five samples made on the Penfield automatic cut-off, end-cut auger machine and then re-pressed.

	Absorption.	Rattling.	Crushing.	
			Square inches.	*Cubic inches.*
End-cut auger brick	0.73	18.25	5,318	1,322
Side-cut auger brick	.72	17.78	6,925	1,649

By still further eliminating the causes of variation in these samples aside from the effect of the mode of manufacture, the following figures are deduced of four samples of end-cut re-pressed auger brick made from shale clays, against eight samples of side-cut re-pressed auger brick, also made of shales:

	Absorption.	Rattling.	Crushing.	
			Square inches.	*Cubic inches.*
End-cut shale	0.58	18.94	5,326	1,338
Side-cut shale	.74	15.64	7,690	1,187

In this last comparison the sources of variation have been eliminated largely and the results are therefore much more valuable. They point strictly to the general superiority of side cut over end cut. Further experiments show that comparing plain and repressed bricks, the former stand greater pressure, while the latter absorb less water. Large bricks stood the rattling test better than small ones, but the latter showed greater crushing strength.

The following list gives the results of Mr. Fickes's experiments, showing the absorption, abrasion, and crushing strength of paving bricks from different localities in the United States:

Absorption, abrasion, and crushing tests of paving brick from various localities.

Locality.	Absorption.	Weight lost in rattling.	Crushing strength per square inch.	Material used.	Process of manufacture.
	Per cent	*Per cent.*			
Logan, Ohio	0.7	7.5	a 7,490	Semi fire clay	Machine-made salt-glazed.
Corning, N. Y	1.8	....	b 9,320	Blue shale	Auger machine side cut, repressed.
Galesburg, Ill	.7	11.8	a 10,100	Shale	Auger machine end cut.
Clearfield, Pa	2.9	13	a 8,564	Semi fire clay	Auger machine side cut.
Syracuse, N. Y	.7	13.7	b 9,810	Shale	Auger machine.
Franklin, Pa	.9	9.6	b 9,030	....do	Auger machine side cut.
Pittsburg, Pa	2.7	....	b 8,450	Semi fire clay	Do.
Barrington, R. I	.6	8.6	b 10,860	Clay	Do.
Canton, Ohio	1.2	7.9	b 8,520	Shale	Do.
Do	.1	6.6	b 9,070	....do	Auger machine end cut.
New Cumberland, W. Va	3.1	6.9	b 8,800	Semi fire clay	Auger machine side cut, repressed.
New Brighton, Pa	1.6	3.8	b 11,170	....	

a Are such as only some of the bricks, which are averaged, did not crush or fail as the case may be, under the maximum pressure.

b Those which did not crush or fail, as the case may be, under the maximum of 150,000 pounds pressure.

Paving brick are sometimes salt-glazed, the advantage being a lowering of the absorption and protection to the surface of the brick. When put into pavements the brick are laid on edge with a foundation of sand, gravel, stone, or concrete, according to the amount of traffic. The average cost per square yard of pavement varies from $1.50 to $2.50, but may be both above or below these limits. Paving brick sell for $10 to $23 per thousand, depending on quality, transportation, etc.[1]

The advantages of a brick pavement are smoothness without being slippery, reasonable cost, and good sanitary qualities. The color of a paving brick is no guide to its quality, except when bricks from the same factory are compared.

[1] An excellent article on brick pavements by T. W. Gibson, appeared in Report of Bureau of Mines, Ontario, 1893, and reprinted in School of Mines Quarterly, January, 1895.

STRUCTURAL MATERIALS.

This includes common brick, pressed brick, enameled brick, terra cotta, hollow goods, chimney and flue linings, building and foundation blocks, roofing tiles, glazed and encaustic tiles.

COMMON BRICK.

Building brick were among the earliest of the clay products of the United States, and at the present day the manufacture of low grade brick is one of great importance. The methods of brickmaking have made enormous progress in the last twenty years, and manufacturers have exerted all their efforts to perfect the better grades, but the same can not be said of common brick. Unfortunately the contractor, whose business it is to see that the brick are up to a standard of good quality, accepts almost anything so long as it is fairly hard.

PREPARATION OF CLAY.

Common brick are with few exceptions made from surface deposits of clay which requires little or no preparation. If shale is used it has to be crushed in a dry pan or between rolls. The occurrence of lime pebbles in many surface clays causes additional labor, and their elimination is effected either by permitting the clay to dry and then passing it through a barrel screen or else feeding the fresh clay directly to a pair of rolls which crush the pebbles and while not removing them render the lime less harmful.

Tempering.—Many brick clays require the addition of a certain amount of sand, generally 25 per cent, to prevent the brick from shrinking too much and warping. The simplest method of mixing these two is to shovel them into a square pit, or "soak pit," add water and let the mass soak over night. About one bushel of coal dust per 1,000 brick is added, to help in the burning. Ring pits are a step farther advanced, and consist of a shallow, circular pit in which there revolves an iron wheel. As the wheel travels around the pit the sand and clay become thoroughly mixed. This is far more effective than the soak pit. Sufficient clay for 20,000 to 30,000 brick is tempered in six hours by this process.

Pug mills and wet pans[1] are used by many manufacturers, especially in the central States. Their chief use is perhaps with the stiff-mud machines. Some brickmakers add hematite to their clay or molding sand in order to produce a better colored ware. One manufacturer, in New York, uses the tailings from the washing plant at a limonite mine.

MOLDING.

The primitive method of molding bricks by hand is still to be found

[1] Described under "Paving brick."

in small brick yards all over the United States, but in the larger works it has been superseded by the soft-mud machine, which is used throughout the Eastern States, and also in the South and West, and makes a very good grade of common brick.

There are several different types of soft-mud machine, but the principle of them is similar in all. The essential parts are an upright box of wood or iron containing a revolving shaft bearing arms. The clay is charged at the top and mixed in its passage to the bottom of the box, where a "mud wing" attached to the shaft forces it into the press box. The molds, previously sanded to prevent adherence of the clay, are put in at the rear of the machine and fed forward automatically underneath the press box, each one as it comes into place becoming filled with clay. A day's work for such a machine is 20,000 brick. The molds, after having the superfluity of clay scraped off, are emptied onto the drying floor.

Stiff-mud machines are used chiefly in the manufacture of paving brick, under which head they are described. They are used to a limited extent in the Eastern States for common brick, but more so farther west. Their greater capacity has weight with many large manufacturers.

DRYING.

Tunnel and other artificial driers are only used by larger firms. In nine tenths of the yards making soft-mud brick, drying is done in the open air in one of three ways:

1. *Open yards*, which are simply brick floors covered with sand, on which the bricks are deposited from the molds and dried by the direct heat of the sun for about twelve hours. During this period they are "spadded;" that is, stamped with a wooden tool on their sides and edges to preserve their shape. The following morning the bricks are stacked in double rows and the next day's production spread out.

2. *Covered yards.*—These are similar to the preceding, but inclosed by a sectional roof, which can be opened in fair weather to let the sunlight enter. The advantage is a prevention of washed brick, but the drying is slower; the cost of plant is greater.

3. *Pallet yards.*—The bricks are dumped from the molds onto wooden pallets, which are set on racks. The advantages are, much greater capacity, saving of washed brick, less handling of green brick. The objections are, slower drying, cost of pallets, and the clay has to be molded stiffer.

BURNING.

This is almost invariably done in skove kilns or other up-draft kilns. The bricks are set up in "arches" about 40 courses high, and each arch contains about 30,000 bricks. The open portion of the arch is 14 courses high, and 9 to 15 arches built side by side make up a kiln. The first row of bricks on top of the arch is the tie course, the first 14 courses above the arch are called the "lower bench," and those above that the "upper bench." In skove kilns a temporary wall of two rows of bricks is built around the kiln, and the whole daubed over with mud to prevent air from entering except through the doors set in the lower portion of the arches.

The object of the addition of coal dust to the brick is by its ignition, after the water has been driven from the brick, to contribute heat throughout the kiln. It takes six men one day to set an arch of brick. The fires are built in the arches, and the fuel used is generally wood or coal. Gas and oil have been tried, and in some cases successfully. In burning, the fires are gradually increased until sufficient heat is obtained to drive off both free and combined water and cause the particles of the brick to unite to form a solid, compact mass. This is carried to its greatest extent in the case of paving brick. When the heat is highest the iron becomes converted into the red oxide.

A number of interesting experiments have been recently made to determine the changes which a brick passes through after it is placed in the kiln. In the first stages of burning, the brick showed a decrease in weight, due to passing off of moisture; then a series of constant weights while the temperature increased to dull redness, and, lastly, subsequent loss at higher temperature, due to passing off of combined water. The second day, after the weight became constant, a sample of tin placed in the kiln melted, showing the temperature to be 455° F.; the third day lead, or 625° F.; the fourth day zinc, or 725° F.; the fifth day antimony, or 800° F. The brick had a constant weight all this time. The final loss was 2 ounces more. Other tests gave the final loss as 5 to 6 ounces.

In another series of experiments, made to determine the rate of drying in a down-draft kiln, a green brick was placed on an iron bar and slid into the kiln. Each day it was weighed and the temperature was determined with a Siemens copper ball pyrometer. In one brick from the twelfth course the temperature was 475° F. the third day after the constant weight had been obtained. The fifth day it was 550°, and the brick had lost 1 ounce. No further change was noticed during the sixth, seventh, and eighth day, except that the temperature had gone up to 750°. On the ninth day the loss was 4½ ounces and the temperature 1,075°. On the tenth day 1 ounce more was lost with a temperature of 1,400° F. The brick was then allowed to remain in the kiln until burned, and lost no more. The experiments seemed to show that combined water did not go off below 800° F.

REQUIREMENTS.

Common brick can be made from almost any clay, and with proper care a very fair product is obtained.[1] A common brick should have

[1] The method of using calcareous clays was described in Mineral Resources, 1893.

(1) smooth surfaces and parallel sides, and (2) be hard, compact, and uniform in texture. Soft-mud machines make good brick, but they are said to be less dense than stiff-mud or dry-clay brick. (3) They should not absorb over 10 to 15 per cent of water when hard-burned. (4) They should have a crushing resistance of at least 3,000 pounds per square inch.

TESTS.

Mr. E. S. Fickes, of Steubenville, Ohio, has recently made a large series of valuable tests of both paving and building bricks, and some of the important ones are given herewith:

Tests of bricks, made by Mr. E. S. Fickes.

Locality.	Total absorption.	Pressure per square inch at crushing.	Material used.	Machine used.
Cincinnati, Ohio	6.4	7,670	Yellow clay	Auger machine; end-cut arch brick.
Do	14.2	5,240	.....do	Auger machine; end-cut front brick.
Washington, D. C	8.5	6,580	Clay	Soft-mud machine; hard, common.
Steubenville, Ohio	6.4	7,980	Shale and clay	Auger machine; side-cut, repressed, hard, common.
Rochester, N. Y	12.2	8,460	Clay and sand	Soft-mud; hard, common.
Baltimore, Md	9.8	4,660	Clay	Soft-mud machine.
Fishkill, N. Y	14.8	5,840	.....do	Do.
New Haven, Conn	11.5	6,190	Red clay and sand.	Arch.
Philadelphia, Pa	7.2	7,510	Clay	Auger machine; end-cut, arch.
Do	10.5	6,710	.....do	Handmade; Philadelphia, stretcher.
Troy, N. Y	15.1	4,400	Clay and sand	Soft-mud machine; hard, common.
Milwaukee, Wis	24.0	3,600	.....do	Soft mud; pressed, buff.
Erie, Pa	10.3	5,000	Clay and shale	Dry press.
St. Louis, Mo	15.9	5,750	.....do	Dry press; dark red.
Do	10.1	8,860	.....do	Do.
Sioux City, Iowa	11.8	6,480	Semifire clay	Dry press; front brick.
Bradford, Pa	5.9	9,030	Shale	Dry press; red front.
Pittsburg, Pa	3.4	8,500	Fire clay	Auger machine; side-cut, puff front.

The conclusions drawn from Mr. Fickes's tests are:

1. The strength of the building brick, both transverse and crushing, varies in tolerably close inverse ratio with the quantity of water absorbed in twenty-four hours. The strongest brick absorb the least water.

2. Good building brick absorb from 6 to 12 per cent in twenty-four hours, and with no greater absorption than 12 per cent will ordinarily show from 7,000 to 10,000 or more pounds per square inch of ultimate crushing strength.

3. Poor building brick will absorb one-seventh to one-fourth of their weight of water in twenty-four hours and average a little more than one-half the transverse and crushing strength of good brick.

4. An immersed brick is nearly saturated in the first hour of immersion, and in the remaining twenty-three hours the absorption is only five-tenths to eight-tenths of 1 per cent of its weight as a rule.

5. The strength of brick in the kiln is least in the top courses and

increases quite rapidly for the first ten or twelve courses and afterwards more slowly down to the arch brick.

6. The size of brick varies much, and the weight varies from 3.84 to 6.34 pounds. Eastern brick are smaller than Western, and will even vary in the same locality.

7. Dry-press brick seem, as a rule, to be stronger than soft-mud brick, but exceptions exist.

Common brick are divided into three classes—arch, the hard burned ones from the lower portion of kiln; red from the middle, and salmon or insufficiently burned ones. Other intermediate terms are used, and the terms applied to the same class vary in different States.[1]

FRONT, PRESSED OR ORNAMENTAL BRICK.

The regulation cherry-red Philadelphia pressed brick no longer monopolizes the markets, the desire of the present day being a variety in color and shape of front brick. With this choice of color and pattern in front brick and the ability to procure any desired design in terra cotta, the architects are now erecting buildings which for taste and richness of decoration far excel stone structures. Pressed brick are now made in red, brown, white, yellow, buff, etc.

The Pompeiian brick is a mottled brick which has been much used during the past two years, especially in New York City. It is made from fire clay containing particles of pyrite, which in burning become converted to silicate of iron and gives the brick a speckled appearance.

Pressed brick are made from carefully prepared and thoroughly tempered clay. They are molded by hand in soft mud, or in stiff-mud machines, and then re-pressed, or else they are produced in one operation in dry-press machines. The soft-mud and stiff-mud machines have already been described.

The largest manufacturers of dry-press brick are at Chicago and St. Louis, and, indeed, throughout the entire West this style of front brick is practically the only one used.

Dry-press machines were introduced into the United States about twenty years ago. The method is rapidly gaining favor, and architects are losing their not wholly warranted aversion to bricks made by this method. All clays can not be molded in a dry-press machine, for causes not yet definitely understood. The clay is first pulverized in a dry-pan or Steadman disintegrator and then passes through an inclined screen to the hopper over the press while the tailings go back to the pulverizer. The machine proper consists of a massive frame of forged steel about 8 feet high. At a convenient height is the delivery table into which the press box is sunk. The charger slides back and forth on the delivery table, and is connected with the hopper by means of canvas tubes. It is filled on the backward stroke, and when it has

[1] For the correlation of these terms see Fifth Ann. Convention Proceedings, Nat. Brickmakers' Association, January, 1891.

reached a point over the press box or mold the clay drops into it. It then recedes to be filled and the upper plunger descends, pressing the clay into the mold. The lower plunger, which forms the bottom of the mold, ascends at the same time, so that the clay receives pressure from above and below. The upper plunger then rises, and the lower one does also, until the lower surface of the brick is even with that of the table. On its forward stroke to fill the mold again the charger shoves the green brick to the edge of the table, from whence it is taken and removed to the kiln. The pressure is applied by a toggle-joint arm, and one to six bricks are molded at a time.

Sometimes the green brick are set directly in the kiln and at others they are first dried in tunnels. The green brick contain about 15 per cent of water, and great care has to be exercised in drying to prevent cracking. Burning is usually done in down-draft kilns. By setting the brick directly in the kiln it takes longer to watersmoke. It is claimed by some manufacturers that one-fourth to one-sixth more fuel is required to burn dry-press bricks.

Dry-press bricks are the densest made, but they consist simply of an agglomeration of particles which owe their conjunction to pressure, and even though these particles may become vitrified in burning, they do not always unite.

WASHED BRICK.

When brick which are dried in the open air are exposed to a rainstorm their faces get a characteristic roughened appearance. These brick, if burned, are just as strong as others, but as there was no demand for them on account of their unsightly appearance they were generally thrown back into the machine. In the last year, however, they have been used in the fronts of several buildings in New York and Chicago, and have come into great favor. But owing to the lack of rain during the past season the demand has exceeded the supply; most of those used have come from Sayreville, N. J. Some manufacturers "wash" their brick by artificial means.

TERRA COTTA.

The name "terra cotta" is applied to clay products used for ornamentation in connection with brick or stone. Though used at first to overcome certain peculiarities of construction in buildings, its uses have spread, so that from a mere article of construction it has come to be one of the highest ornamental character. Its common use now is for string courses, sills, copings, etc., and sometimes for walls, in which case, in connection with steel, it supplants brickwork. Terra cotta, when made for this latter purpose, is more properly classed as terra-cotta lumber or hollow brick. As originally made, terra cotta was red, but the introduction of brick of different shades has necessitated a like change in its color.

Terra cotta is manufactured to a small extent by many minor brick concerns in this country, but the greater portion is produced by the following firms:

Perth Amboy Terra Cotta Company, Perth Amboy, N. J.
Standard Terra Cotta Company, Perth Amboy, N. J.
Mathewson & Harrison, Perth Amboy, N. J.
New York Architectural Terra Cotta Company, Long Island City, N. Y.
Boston Terra Cotta Company, Boston, Mass.
Stevens, Armstrong & Conkling, Philadelphia, Pa.
New Britain Terra Cotta Company, New Britain, Conn.
The Donnelly Brick Company, New Britain, Conn.
Glens Falls Terra Cotta Company, Glens Falls, N. Y.
Corning Terra Cotta Company, Corning, N. Y.
Northwestern Terra Cotta Company, Chicago, Ill.
American Terra Cotta Company, Chicago, Ill.
Indianapolis Terra Cotta Company, Indianapolis, Ind.

The value of ornamental terra cotta produced in the United States annually is about $2,000,000.

The requisite conditions of a clay for making terra cotta are: (1) Even shrinkage in burning, and not over 1 inch per foot; (2) it should burn to a hard product of even color; (3) it should not contain an excess of soluble salts which would cause it to "whitewash." Shrinkage is best regulated by the addition of grog (powdered brick or terra cotta). Sandy clays are often washed. This is done in a circular trough filled with water and containing revolving arms. The stirring of the mixture keeps the clay suspended while the sand settles. The suspended clay is drawn off to the settling vats. Weathering improves many clays for terra cotta, but some can be tempered when brought from the bank. The mixture of two different clays or of shale and clay often gives better results. The importance of pugging or mixing the material can not be overestimated, especially when large pieces of intricate design are to be made. After pugging the clay is often piled up and allowed to "cure," through which operation the excess of water evaporates and the mass, settling by its own weight, becomes denser. Some manufacturers give the clay an additional working over.

Molding is generally done by hand, sometimes by machine, the former for complicated patterns, the latter for simple ones. Hand molding is slow and difficult. The molds are of plaster and the forms remain in them until sufficiently shrunken to be removed. The more intricate the design the greater the number of sections to the mold. After removal from the latter the surface of the object is smoothed and trimmed. All large pieces of terra cotta are made hollow with cross partitions for rigidity. The ware is sometimes glazed or slipped.

Burning is done in down-draft kilns, and takes seven to nine days. Muffle kilns are sometimes used. Small articles are often burned in saggers. The burning has to proceed very slowly to prevent cracking of the ware, and test pieces of clay are placed just inside the door of the kiln. Coal is generally used for burning, but oil has been successfully tried.

Considerable quantities of glazed terra cotta have been used on the exterior of buildings in Chicago.

ROOFING TILE.

There are at the present day not over ten roofing-tile manufactories in the United States. This seems a small number, but popular opinion has not yet looked with great favor on a tile roof except for costly and highly decorated buildings. For artistic effect nothing can surpass a tile roof, and with all the various styles made the architect can design an infinite number of patterns. The advantages of a tile roof are beauty, resistance to heat and frost, and durability. The enormous strength of some of these tiles was mentioned in the Mineral Resources of the United States, 1892, page 724.

The objections to a tile roof are: Cost, as they are more expensive than iron or wood; and weight, due to the tile itself and the laying of it in cement. The manufacturer claims, however, that it is lighter than slate, as there is less overlapping.

Roofing tile must be made from a clay which will vitrify, and the finished product should have strength, lightness, and even form. The last condition is the most difficult to fulfill, as it is sometimes hard to get a clay or mixture of clays which when molded in very thin slabs will retain their shape in burning. Both clay and shale are used, or sometimes a mixture of the two. The material after tempering, with, in some instances, a previous washing, is molded into rough slabs or bars which are subsequently repressed to form the tile. The repressing is done either in hand-power machines of 1,500 daily capacity, or in steam-power represses with a capacity of about 15,000. Each tile after pressing is set on a platter slab, and these are placed on racks in the drying room. Some manufacturers have two drying rooms of different temperature. When dry the tiles are packed in saggers and burned in down-draft kilns.

DECORATIVE TILE.

These are of two types, ordinary panel and floor tile and encaustic tile.

PANEL TILE.

These are generally made of a composition similar to that used for white ware, and are prepared in a similar manner. The surface is decorated by glazes of different colors, which can be shaded by varying the thickness of it on different portions of the tile. The standard sizes are mostly made by the dry-press process, and larger panels from plastic clay by hand molding. In late years tile designers have devoted much attention to relief decoration, but in artistic tile painting little has been done in this country.

ENCAUSTIC TILE.[1]

These represent a much higher grade of work and skill. A separate body mixture is required for each color that appears in the finished tiles. The body is produced by uniting the clays, flint, spar, and metallic oxides, which are to produce the color, in a washing plant, and the thoroughly mixed ingredients are separated out by the filter press as in common pottery. The cakes from the press are dried in tunnels like brick and are then ground to fine powder by a high-speed disintegrator and the powder reduced by air blast as fast as it is removed sufficiently fine. This powder is then put away in brick-cemented bins, where it retains just the proper dampness for use. Each powder mixture is used in making a tile by just such means as the ground clay is used in making a pressed brick, except that where tile are made showing two or more colors, a separate operation has to be made for each color employed.

The presses used are of special construction. The burning of the ware is done in saggers which are placed in regular pottery kilns.

TERRA COTTA LUMBER.

This is made of a mixture of clay and sawdust. The chief ingredient is clay, such as will make a good quality of building brick, but fire clay is sometimes used. From 15 to 50 per cent of sawdust is added to the clay, according to the quality of product desired, and the use to which it is to be put. In burning, the sawdust is consumed, leaving the fireproof blocks of much lighter weight than would otherwise be the case. The sawdust and clay are usually pitted in layers and soaked, then crushed or disintegrated, and finally tempered in a pug mill. In some works wet pans are used instead of pug mills. Molding is usually done in a sewer-pipe press, but some manufacturers prefer to use an auger machine.

Terra-cotta lumber or fireproofing can be nailed and sawed similar to wood. It is used for fireproof arches, partition walls, ceilings, sheathing for roofs, jackets for iron girders, etc.; its weight is one-half that of brick and it can be laid much cheaper. It is also a poor conductor of heat and sound. The manufacture of terra-cotta lumber requires great care, for the mode of setting the blocks as arches in the ceilings of fireproof buildings demands that their shape shall be regular and exact, so that they will fit together closely and strongly. These floors have been tested in several instances by piling weights on them until they gave way, and the results show great strength.[2] Enormous quantities of terra-cotta lumber are used annually in the construction of fireproof buildings in all the large American cities.

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[1] Ohio Geol. Surv., VII, p. 240.

[2] Eng. Record, Apr. 14, 1894.

ENAMELED BRICK.[1]

The manufacture of enameled brick in the United States is confined chiefly to the following localities and corporations:

American Enameled Brick and Tile Company, South River, N. J.
Pennsylvania Enameled Brick Company, Oaks, Pa.
Philadelphia Enameled Brick Works, Philadelphia, Pa.
Tiffany Pressed Brick Company, Chicago, Ill.
Somerset and Johnsonbury Manufacturing Company, Somerset, Mass.
Somerset and Johnsonbury Manufacturing Company, Johnsonbury, Pa.
Sayre and Fisher Company, Sayreville, N. J.

The production in 1893 was about four and a half million, with an average selling price of $90 per 1,000.

The colors of enameled brick most in use are white, ivory, and buff, but almost any color can be produced, depending upon the skill and knowledge of the manufacturer. Brown, blue, and red are not uncommon.

Two sizes of enameled brick are made, the American, 8 inches by 4 inches by 2½ inches, and the English, 9 inches by 4½ inches by 3 inches, the latter being by far the most popular for almost every purpose, partly because of fashion and partly because larger surfaces may be laid with fewer joints.

Enameled brick is an excellent material for facing walls, both interior and exterior. It is largely used in lining elevator shafts, court-yards of buildings, stairway wells, public entrances, vestibules and lobbies, stables, and, in fact, all places where a clean, indestructible finish is desired. Its surface being impervious to moisture, renders it very suitable for the walls of dissecting rooms and hospitals, and many thousand have been used for this purpose. The clays used in making the body of the brick vary in different localities, but in general the best results are obtained, not in using any one clay, but by a proper mixture of several clays having different physical properties. The basis of the mixture is usually a refractory siliceous clay, to which one more plastic is added to render the molding more easy. The shrinkage in burning must also be controlled by the character of the clays in the mixture.

Enameled bricks are usually made with an indentation in the upper and lower faces. In laying a wall the mortar is put in this space in such quantity that when the bricks are pressed together a thin layer of it is forced out toward the edges and furnishes sufficient binding material. This does away with "pointing" the joints, and a wall properly laid should show almost no mortar between the courses. In consequence of this method of laying every brick should be true to the standard size in order to secure a regular and perfect bond. It is therefore necessary to know the exact shrinkage that occurs in burning and to allow for it by giving to the dies used in pressing the brick the proper amount of "oversize."

[1] Mr. Henry Burden, of the Pennsylvania Enameled Brick Company, has kindly furnished the writer with most of the above information.

In the best American brick the enamel with the glaze adheres so tenaciously to the body that it will not separate or crack under pressure until the body of the brick fails. This was proved by tests of specimens sawed from a brick made by the Pennsylvania Enameled Brick Company, of Oaks, Pa. The specimens were cubes, averaging about 1.88 inches on each edge, with the enamel on one face, and were tested on the Emory hydraulic testing machine at Columbia College, New York. The pressure was applied parallel to the face having the enamel on it. The specimens were crushed at an average pressure of 4,250 pounds per square inch, and in no case did the enamel crack or scale before the specimen failed. In this connection it will be noticed that the body of an enameled brick is very strong, as the best ordinary brick will withstand a crushing force of from 3,000 to 4,000 pounds per square inch of surface only.

The matter of glazing and enameling is the most difficult part of the manufacture of enameled brick, and as such is kept secret, as far as details are concerned, by the manufacturer. In general, however, it may be said that the enamel is simply a mixture of clays similar to that used in making good porcelain, and which is applied to the surface of the brick in the condition of a thick liquid or slip. The enamel, when dry, is coated with a fusible glaze, such as is used for ordinary porcelain. The body, enamel, and glaze are then fired as one piece, and probably a slight fusion of the body takes place at its junction with the enamel, as there is a small amount of alkali in the latter. This would account for the tenacity with which the enamel adheres to the body, as shown by the foregoing tests.

Peeling is a separation of the enamel from the brick.

Crazing is a cracking of the enamel or glaze. These, together with pin holes, are probably often caused by the unequal shrinkage of the body, enamel, and glaze.

In making the body the clay is usually tempered in a pug mill. It is then put through an auger machine and formed into bricks of approximately the right size, which are then re-pressed. The enamel is applied to this green brick by the latter being dipped into it with a sweeping motion. The excess of enamel is wiped off the sides of the brick, and the glaze is then applied over the enamel. The bricks are put in saggers, which are piled in down-draft kilns with a capacity of 6,000 to 7,000 brick; burning takes about six days; if the green brick is fired before the enamel and glaze are applied and then refired, the cost of manufacture is greatly increased, but in many instances the quality of the product is thereby somewhat increased.

HOLLOW WARE.

DRAINTILE.

Any clay that will make a good building brick will in most instances make a good draintile. Tempering is usually done in a pug mill. The tiles are molded in a sewer-pipe press or auger-brick machine, more often the latter, as it has a greater capacity and requires less power. The clay is forced out through the die in a bar of the desired size and shape and cut into the proper lengths. Draintiles are dried on ordinary pallet racks, slatted floors, or in tunnels. Burning is accomplished in up or down draft kilns; the smaller tile are set in the bottom and around the sides of the kiln, while the larger ones are placed in the center. When several sizes are burned in the same kiln they are sometimes nested.

The styles of tile made are horseshoe, sole (cylindrical with flat sole), and pipe tile (cylindrical tile like preceding, but with flange at one end). Pipe tile are the most used. Some consider horseshoe tile objectionable, as liable to break from lateral pressure of the soil. Glazing adds little to the quality of the ware. Draintile range in size from 2 to 12 inches in diameter and 1 to 3 feet in length.

The great draintile-producing region is that of the central States, Illinois, Iowa, Indiana, and Ohio. Draintile, sewer pipe, and terracotta lumber are often made at one factory, as all three can be molded in a sewer-pipe press.

SEWER PIPE.

The required qualities of a clay for this purpose are essentially those demanded of a paving-brick clay, and the preparation and tempering are done in the same manner, but more thoroughly. Molding is done in a sewer-pipe press, which consists of two vertical cylinders, one above the other. The upper one is the steam cylinder and has a diameter of about 40 inches; the lower or clay cylinder is usually less than half the diameter of the other. The piston of the steam cylinder is moved both upward and downward by steam. Clay is charged at the upper end of the clay cylinder, and issues from the lower end through a specially constructed die. Inside the cylinder, at its lower end, is the "bell," which regulates the internal dimensions of the pipe. The clay pipe issues from the press until of sufficient length, when the machine is stopped, and the pipe cut off and removed to the drying floor. The machine starts again and another length of pipe is allowed to issue. The pipe are set on slatted floors to dry slowly; there are often several of these floors, and the heat is provided by steam pipes arranged along the walls of the building. Burning is done in round or rectangular down-draft kilns and takes four to six days. Less time is required than with paving brick on account of the lesser thickness of material to vitrify.

All sewer pipe are glazed with salt, which is put into the fire holes and volatilizes, the vapors spreading through the kiln and uniting with the silica on the surface of the pipe to form a glazed coat. The following reaction occurs:

$$NaCl + H_2O = HCl + NaOH$$
$$NaOH + nSiO_2 = NaO_2nSiO_2 + H_2O$$

Glazing requires one to two hours. Some manufacturers add manganese to the salt in order to produce a glaze of the proper color.

The chief sewer-pipe manufacturing region is in the Ohio Valley, which produces not only the greatest quantity of pipe, but has also three of the largest factories in the world. Other producing districts are in New Jersey, Colorado, California, Maryland, and New York.

REFRACTORY MATERIALS.

FIRE BRICK.

There are about three hundred fire-brick factories in the United States, but the principal centers of production are Woodbridge, Perth Amboy, and Sayreville, N. J.; Mineral Point and Portsmouth, Ohio; St. Louis, Mo.; Beaver Falls, Farrandsville, and Pittsburg, Pa.; Boston, Mass.; Bridgeport, Conn.; Troy and Staten Island, N. Y.; Cleveland and Chattanooga, Tenn.; Bibbville, Ala.; Golden, Colo.; and Lincoln, Cal.

CLAY REQUIRED.

Fire clay should have a low percentage of fusible impurities, about 4 per cent being the limit. The color is extremely variable and not to be looked upon as an indication of the quality. Two varieties are recognized, viz, flint, or nonplastic, and plastic fire clays. The former are found in Kentucky and Ohio, and in the process of manufacture are generally mixed with the plastic clays. Plastic fire clay occurs as shale (which becomes plastic after grinding and addition of water) and as soft clay. On account of the necessary exposure of fire ware to high and changing temperatures and its required ability to resist fusion, shrinkage, and corrosion, the selection, mixture, and preparation of fire clay calls for care and skill. Coarse-grained ware resists a high temperature, but fine-grained material withstands corrosion better.

PREPARATION OF CLAY.

Ground, burned fire clay or cement clay is sometimes added to decrease porosity, and ground quartz or quartz sand may be added to counteract shrinkage. The clay is often weathered for several months, and the percentage of soluble impurities is somewhat reduced by this means.

Tempering.—This is accomplished in a dry pan and pug mill, or dry pan and wet pan, and some manufacturers soak the clay in addition. Ring pits are also used now and then, but the machines used and number of stages in tempering depend largely on the clay.

MOLDING.

Up to a few years ago all fire brick were molded by hand and then repressed, but at the present time only large and special sizes are molded in this manner, while the common sizes are molded in soft-mud machines. Stiff-mud machines can not be used, because the brick would be too dense and structurally defective. Repressing machine-made brick makes the method too costly to be applicable to any but the highest grades of fire brick.

DRYING.

Drying is done on floors (described under paving brick) or in tunnels, and burning is done in circular or rectangular down-draft kilns. Continuous kilns are being tried at a few localities, among them St. Louis, Mo., and Golden, Colo.

Dr. Joseph Struthers, of Columbia College, has kindly given me the following temperature determinations made by him on a fire-brick kiln at Woodbridge, N. J. The instrument used was a Le Chatelier's thermo-electric pyrometer:

No. 1. Over fireplace in kiln, 2,534° F.; temperature fairly constant, but at one time showed increase to 2,570° F. No. 2. Through sight-hole at back of furnace, 2,360° F.; temperature constant. No. 3. Same part of kiln as No. 1, 2,660° F.

GLASS POTS.

The manufacture of glass pots is one of the highest branches of the refractory-ware business, as they have to be made to stand a very high degree of heat, great extremes of temperature, and the corrosion of molten glass. The clay has to be of a very high grade, and most of it comes from Germany and St. Louis, Mo. Ohio and New Jersey furnish a small amount.

PREPARATION OF CLAY.

The clay is carefully broken up and hand picked to remove all impurities and then mixed with calcined flint clay and old pot shells. The whole is then ground and subjected to successive temperings in a pug mill and then piled up to sweat, sometimes for two years.[1] The pots are built by hand, piece by piece, and take about six weeks to reach completion.

DRYING.

Drying has to be done most carefully, first in tight rooms and subsequently in air.

BURNING.

The pots are burned after being set in place in the glass furnace. A more modern form consists of iron tank furnaces lined with blocks of the refractory clay.

[1] Mr. H. A. Wheeler informs me that the St. Louis clay is also washed.

GAS RETORTS.

Gas retorts are also made from a high grade of fire clay. They are built by hand, like glass pots, and when done have to be dried several weeks before burning in the kiln.

POTTERY AND PORCELAIN.

While no new features deserving special mention have been brought forward during the past year, nevertheless there has been a forward movement in the quality, soundness, and durability of American wares. The reduction of the tariff has caused a corresponding reduction in the selling price of American goods.

Potteries manufacturing common earthenware and stoneware are in operation in nearly every State. For the lower grades of earthenware local clays are used, while for stoneware the material has very often to be imported from other States.

The great centers of the porcelain and china industry are East Liverpool, Ohio, and Trenton, N. J. The first yellow or Rockingham ware was made at East Liverpool in 1838, but such progress has been made since that time that the products now include white graniteware, china, ironstone china, decorated tableware, and toilet sets. Some of the dinner and tea sets made at Trenton compare favorably in weight, translucency, and finish, with the best fabric of Limoges. The Belleek or eggshell china is of the highest quality.

The pottery industry at Trenton has a yearly output valued at about $4,000,000.

The product of the Rookwood potteries at Cincinnati is a true faience. Art pottery is also made at Cambridge, Mass., the product including vases, pedestals, etc., while at Baltimore, Md., parian and majolica ware are manufactured, the latter being equal to the famous Wedgewood of the same grade. Clay pipes are made at St. Louis, Mo.; Fulton, Ill.; Virginia, and New Jersey.

For a detailed account of the history of the pottery and porcelain industry in the United States, together with a description of the products now being made, the reader is referred to E. A. Barber's work on Pottery and Porcelain of the United States.[1] The different grades of pottery and porcelain were defined and their manufacture described in the Mineral Resources of the United States, 1892, p. 729.

The quality of the clay required increases with the grade of the ware. Earthenware can generally be made from nearly any plastic clay provided the color is suitable. The latter is an important item and is sometimes obtained by a mixture of several clays. Stoneware is also made from a natural clay, whose essential features are plasticity,

[1] Much valuable information concerning foreign wares and their manufacture is contained in Handbook of Collection of Pottery in Museum of Practical Geology, London, England.

sufficient refractoriness to enable it to stand up well in burning and while the glaze is being applied, ability to vitrify and burn to a uniform color.

Rockingham ware, like the preceding, is made from a natural clay which should be plastic, smooth, and contain enough iron to give the ware a fair color. It need not be refractory.

For C. C. ware, white granite and china, artificial mixtures are necessary. The general composition is kaolin for body, ball clay[1] for plasticity, silica to counteract shrinkage and feldspar to flux. Each potter uses different proportions, which are secret. C. C. wares call for a more inferior quality of clay than white granite or ironstone china. If the iron in the clay tends to produce a yellow color it is counteracted by the addition of cobalt which produces a greenish tint.

A number of valuable pyrometric measurements of the temperature of pottery kilns were recently made by Prof. E. Orton, jr.,[2] for the Ohio geological survey. The results are:

Determinations of temperature in pottery kilns by Prof. Edward Orton, jr.

Material.	Product.	Part of kiln.	Temp. F.
			Degrees.
Mixture	Earthenware	Hottest part at best heat	1,860
Fire clay	do	Heat measured when kiln cooling	1,922
Do	do	do	1,900
Do	do	Hottest part of kiln at best heat	2,922
Do	do	do	2,010
Do	do	Bottom part of kiln at best heat	1,950
Do	do	Hottest part of kiln at best heat	1,892
Do	do	Hottest part just after best heat	2,045
Do	do	do	2,045
Do	Yellow ware	Hottest part of kiln at best heat	1,710
Composition	C. C. ware	do	1,950
Do	White granite	do	2,160

WASHING CLAYS.

This has been done as a means of purifying clay in Switzerland, Germany, and England for many years. Few American manufacturers, except those of pottery and porcelain, use this method, and its wider application in this country is a recent one. The objects of washing are to eliminate sand, mica, iron, and alkalies in part, and to give a clay which is smooth and homogeneous throughout. The primitive method of washing clay consisted in boiling in iron pans, but the more modern method is to reduce the clay to a slip in a vat of wood or iron, and which contains an upright shaft, bearing blades which knead the clay to a pulp. The slip passes next to a rapidly shaking rectangular screen. The fine clay and water run through to the agitator and coarse particles remain behind. In the agitator the clay is kept suspended by agitation while it is being removed to the press by pumps.

[1] See Mineral Resources, 1891.
[2] Ohio Geol. Surv., Vol. VII, p. 253, 1893.

In Cornwall, England, the kaolin or china clay, which consists of disintegrated feldspar associated with quartz and mica, is broken up by picks and exposed to the action of running water. The water with the suspended clay passes through channels or "drags" where, owing to a slight check in its velocity, the quartz and mica are deposited, and then through other channels, known as "micas," which catch those particles of mica not already dropped. Large pits serve to receive the purified stream with its suspended clay, and after this has settled the water is used over again. The deposited clay is partially dried in stone tanks, and then more thoroughly on floors heated by flues underneath. When brought to these floors the clay has about 50 per cent of water, and this is reduced to about 12 per cent; 1,500 pounds of water evaporate from every ton of clay, and 168 pounds of coal are needed to do this.

SLIP CLAYS.

These are easily fusible clays which are used to coat stoneware The best known and most used is "Albany slip," which is said to neither crack nor craze. It is ordinary Hudson River clay, and contains a high percentage of fusible impurities. The practice of using slip clay has superseded the cheaper method of salt-glazing, because in drying the ware sulphate and carbonate of lime have a tendency to form a film on the surface which prevents the union of the salt with the silica. In the table of analyses is given the composition of Albany slip as well as that of several other slip clays.

ANALYSES.

The following table of analyses has been compiled from data collected by the writer and those furnished by the producers in connection with the statistical canvass recently made by this office, the results of which are given on page 517, and is intended to show as completely as possible the distribution of the different kinds of clays by States, counties, and localities. Wherever possible, the authority for the analysis is given. In a few instances the iron percentage has been determined as ferrous oxide. In these cases they have been put in the column headed ferric oxide and attention called to the fact by a footnote. Each analysis is placed under the heading corresponding to its most important use, but many of the clays can be and are used for making several kinds of products.[1]

[1] Analyses of standard foreign clays can be found in the clay report of the New Jersey Geological Survey, and in Crossley's Table of Clay Analyses; Indianapolis.

The following shows the division of the table by States and kinds of clay:

Distribution of analyses of clay by States and kinds of clay.

Kinds of clay.	Number of States in which found.	Number of analyses.
Fire	25	139
Kaolins	14	24
Pottery	11	37
Slip	4	6
Adobe soils	3	3
Brick	33	165
Paving brick	19	51
Terra cotta	6	8
Pipe	6	8
Residual	8	9
Total		450

Analyses of clays of the United States.

FIRE CLAYS.

State and county.	Town.	Material.	Silica. Com-bined.	Silica. Free.	Alumina.	Ferric oxide.
Alabama:						
Randolph	Louina	Clay	37.29		31.92	tr.
Calhoun	Jacksonville	White clay	44.60		38.92	0.78
Choctaw		Hard clay	36.30		5.12	1.60
Marion	Pikeville	Clay	47.20		37.76	.91
Arkansas:						
Poinsett			61.76		22.91	3.32
Greene			70.43		19.15	1.70
California:						
Amador	Carbondale	Washed clay	59.98		30.29	.27
Nevada	Grass Valley	do	57.75		30.60	.48
Placer	Lincoln	do	49.08		37.09	1.91
San Bernardino		do	12.54		42.97	.63
Lake	Sulphur Banks	Alum clay	66.75		37.35	.25
Trinity	Carville	Washed white clay.	88.30		.85	.15
Colorado:						
Jefferson	Edgemont		46.61		37.20	.15
Pueblo	Pueblo	Clay	28.76	34.46	24.72	.43
Jefferson	Golden		46.88		35.42	*a* 1.74
Do	do	Crucible clay.	71.81		15.09	*a* 1.75
Delaware:						
Newcastle	Wilmington		72.40		14.80	tr.
Do	New Castle		72.33		16.75	1.29
Georgia:						
Baldwin	Stephens Pottery		41.20		38.60	1.45
Do	do		54.32		30.24	.06
Illinois:						
Henry	Geneseo		62.55		29.10	1.67
Scott	Winchester		69.85		17.08	3.47
Mercer	New Windsor		76.10		15.04	*a* 1.08
Indiana:						
Lawrence	Huron	Indianaite	40.50		36.35	.15
Clay	Knightsville		67.87		12.70	7.24
Parke	Bloomingdale		69.82		14.27	2.13
Iowa:						
Woodbury	Sergeant Bluff		76.80		12.09	3.03
Dallas	Van Meter		86.63		10.92	.10
Do	do		55.11		26.71	4.29
Kentucky:						
Ballard	Blandville		74.84		16.58	1.40
Do	Wycliffe		73.24		15.76	1.92
Muhlenberg	Ross Mine		63.18		26.281	
	Thomas Bank		47.56		46.61	tr.
Carter	Boone Furnace		48.56		37.471	tr.
	Powdermill Hollow		62.92		20.735	3.82
Hickman	Columbus		85.18		10.26	1.12
Carter	Olive Hill		50.95		39.49	
Do	Gorman		49.75		35.16	.30
Boyd	Summit	Crucible clay.	67.99		25.00	
Carter	Louisville	Flint clay	47.20		39.90	
Do	Grahm's Station	Plastic clay	45.40		40.04	
Boyd	Ashland	Plastic	40.14		43.72	1.98
Do	do	Nonplastic	43.58		40.86	.76
Fulton		Tertiary clay.	81.06		13.609	
Graves		do	75.555		16.751	1.198
Union			73.90		17 60	3.00

a Iron present as ferrous oxide.

Analyses of clays of the United States.

FIRE CLAYS.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
	0.72		15.09					Trans. Inst. Min. Eng., X.
	1.03		13.38					Do.
0.46			6.60					Ala. Ind. and Sci. Soc., II.
tr.	tr.	tr.	14.24					Do.
.75	.90	1.00					Loss 8.75	Arkansas Geol. Surv., 1889, II, p. 139.
.52	tr.	1.84					Loss 24.27	Do.
.28		1.02	8.05					California State Min., 9th Rept.
.20	.10	1.30	10.15					Do.
.53			10.60					Do.
		4.70	38.40					Do.
.20		4.32						Do.
1.03	.48	5.07	5.40					Do.
.44	.25	1.23	13.65	.47				M. Moss, anal.
.30	.13	tr.	8.63	1.36	.40	.68	Loss 10.39	Steiger, anal.
.44	.20	1.19	14.10					Crossley, Analyses of Clays.
.14	.05	1.02	10.14					Denver Fire Brick Co.
.35		.85	.50				Loss 12.40	Indiana Geol. Surv., 1878, p. 158.
2.00	.07		7.98					Crossley, Analyses of Clays.
	.30	.11	16.70			1.95		Georgia Geol. Surv., 1893, p. 280.
.09	.81	.62	12.86		.34			H. C. White, anal.
tr.	tr.		7.50					E. A. Terpening, anal.
.28		1.10	4.40			.90		
.62	.30	1.55	5.20					Crossley, Analyses of Clays.
	.13	.14	22.60					
.72	.85	.25			MnO 1.95	SO_2 .29	Loss 6.80	Indiana Geol. Surv., 1878.
.90	.60	12.28						Helwig & Hobbs.
.40	2.90		4.70					J. H. Hurtz, anal.
			2.32					W. S. Robinson, anal.
			9.69				SO_3 .416	Do.
.269	.209	1.576	5.126					Kentucky Geol. Surv., Chem. Rept. A, Part III.
.325	.579	1.614	6.622					Do.
.203	.255	2.425	4.195			P_2O_5 .179	SO_3 3.282	Ibid., analysis No. 1613.
.280	.497	.717	10.036			P_2O_5 .49		Ibid., No. 1483.
.112	tr.	.572	13.03			P_2O_5 .55		Ibid., No. 1337.
.213	2.281	3.26	6.40			P_2O_5 .371		Ibid., No. 1478.
tr.	.064	1.10	2.276					Ibid., No. 2715.
.30	.28	.31	9.18					Crossley, Analyses of Clays.
.54	.15	.07	14.03					Do.
1.99	undeter.		2.15					Do.
tr.	tr.	.21	12.69					Do.
tr.	tr.	.21	14.35					Louisville Fire Brick Works.
1.60		5.216			Ign. 7.34			R. Peter, anal.
.29	.14	.24			Ign. 14.43			Do.
.314	.139	.252	.360		P_2O_5 .051			Kentucky Geol. Surv., n. s., I, p. 217.
tr.	.144	1.11	5.047					Ibid., p. 433.
.336	undeter.	.1	5.70					Kentucky Geol. Surv., o. s., I, p. 361.

Analyses of clays of the United States—Continued.

FIRE CLAYS—Continued.

State and county.	Town.	Material.	Silica. Combined.	Silica. Free.	Alumina.	Ferric oxide.
Kentucky—Cont'd.						
Carlisle	Milburn		76.54		14.82	.96
Calloway (N. W.)		White clay	46.02		38.98	
Graves	Boaz Station	Clay	61.92		30.06	.30
Marshall	Scale	do	52.58		31.07	1.51
Ballard	Lovelaceville	do	66.32		22.93	1.19
Maryland:						
Allegany	Mount Savage	Flint clay	50.46		35.90	a1.50
Missouri:						
Crawford	Oak Hill		64.32		22.82	1.75
St. Louis	Cheltenham		38.10	12.70	31.53	1.92
Do	Evens Mine, St. Louis		43.93	.60	40.09	.88
Do	St. Louis	Washed pot clay.	61.15	......	24.55	2.37
Audrain	Mexico		55.62		30.71	1.51
Minnesota:						
Blue Earth	Mankato	Cretaceous clay.	93.65		2.15	.25
Montana:						
Deerlodge	Blossburg		72.00		17.00	2.00
New Jersey:						
Middlesex	Woodbridge		61.60		28.38	.52
Do	Bonhamtown	Clay	17.90	57.35	15.50	1.20
Do	Woodbridge	Retort clay	40.50	6.40	35.90	1.10
Do	do	Clay	42.05	5.70	35.83	.77
Do	Raritan River	do	37.85	10.50	35.75	.95
Do	Sand Hills	do	39.80	8.10	36.34	1.01
Do	Eaglewood	do	40.40	5.20	38.40	1.20
Do	S. Amboy	Paper clay	42.71	.70	39.24	.46
Do	Burnt Creek	Washed clay	42.90	1.50	38.34	.86
Do	Sayreville	Clay	41.10	3.10	38.66	.74
Do	Martins Dock		45.10	.70	38.60	1.00
Do	Old Bridge		24.55	44.80	19.85	1.00
Mercer	Trenton		70.05		19.43	1.52
Gloucester	Conrad		29.50	34.50	23.30	1.50
New York:						
Richmond	Kreischerville		64.28		24.76	.83
North Carolina.						
Moore			75.34		17.06	a1.94
Harnett			70.60		20.46	1.82
North Dakota:						
Mercer	Plenty Coal Mine		60.79		16.23	4.49
Stark	Dickinson		72.66		17.33	1.05
Ward	Minot	Black clay	53.72		17.78	3.85
Ohio:						
Summit	Akron		51.21	8.132	27.62	tr.
Scioto	S. Webster		45.00		40.00	.80
Jefferson	Freeman		66.77		19.35	4.25
Trumbull	Niles		44.45		40.15	1.67
Jackson	Oak Hill		58.25		31.02	....
Tuscarawas	Mineral Point	Flint clay	35.39	17.13	31.84	.67
Scioto	Scioto	Clay	44.34	.26	40.05	.80
Columbiana	Salineville	Flint clay	59.92	......	27.56	1.03
Perry	Mocahala		49.20		37.78	....
Shelby	Ballou	Clay	31.07	27.71	26.47	1.22
Hocking	Phelps		60.77	......	25.74	1.61
Tuscarawas	Canal Dover		47.60		35.02	2.30
Jefferson	Steubenville		29.22	31.34	24.97	1.66
Pennsylvania:						
Fayette	Soisson Mine, Connellsville.		55.38		30.42	tr.
Clearfield	Woodland		45.29		40.067	1.074
Do	Curwensville	Bilger clay	43.92		38.195	a .81

a Iron present as ferrous oxide.

Analyses of clays of the United States—Continued.

FIRE CLAYS—Continued.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
tr.	.331	1.155	6.194					Kentucky Geol. Surv., Chem. Rep. A, Pt. III, No. 2570.
.773	.136	.481	13.610					Ibid., No. 2639.
tr.	.064	1.841	5.815					Ibid., No. 2665.
.137	.245	2.093	12.365					Ibid., No. 2760.
.437	.209	1.577	7.337					Ibid., No. 2778.
.13	.02		12.74					
.45	.12	.77			SO_3 .12			Chauvenet & Blair, anal.
	tr.	.40	11.30	2.50		1.50		Evans & Howard.
		.20	13.80	.50				Do.
tr.	.68		11.25					Christy Fire Clay Co.
.54	tr.	1.37			Ign. 10.56			St. Louis Samp. and Test. Works, anal.
.20	.12	tr.	2.25					Minnesota Geol. Surv. 1872, I.
2.00	3.00							Mullan Fire B. & T. Co.
.46	.36				Ign. 5.08	3.60		J. Pohle, anal., W. B. Dixon, Est.
		.17	4.90	1.30		1.60		New Jersey Clay Rept., 1878, p. 165.
		.44	12.80	1.50		1.30		Ibid., p. 82.
	.11	.44	12.20	1.50		1.10		Ibid., p. 94–96.
	tr.	.37	12.30	4.00		1.60		Ibid., p. 144.
	.04	.15	12.90	1.20				Ibid., p. 153.
.22	.25	.59	12.50	1.30				Ibid., p. 135.
.20		.89	13.32	1.58		1.60		Ibid., p. 200.
		.44	13.50	1.10		1.20		Ibid., p. 197.
		.46	13.55	1.00		1.20		Ibid., p. 188.
		2.49	10.90	1.00				Ibid., p. 170.
		2.22	5.70	.90		1.00		Ibid., p. 180.
		1.60	7.00					Ibid., p. 237.
		1.93	7.00	1.60				Ibid., p. 258.
.73	tr.	2.35						H. T. Vulte, anal.
2.56			3.10					Crossley, Analyses of Clays.
1.85			5.27					Do.
.65	1.02	.47	16.35					Rept. Labor Bureau 1891–92.
.13		.74	9.35					Do.
.81	.50	2.00	21.82					Do.
	.029	2.07						
.20			14.00					Webster Fire Brick Co.
.65	1.00		5.40		MnO 2.05			E. Orton, anal.
tr.	tr.		13.77					M. Shiras, anal.
			10.98					
.50	.19	.59	11.68	.69		1.68		Ohio Geol. Surv., VII, 1893.
.27	tr.	tr.	14.23					Do.
tr.	tr.	.67	9.70	1.12				Do.
			11.68					A. Tharp.
.59	.32	.99	9.96	1.04		.94		Ohio Geol. Surv., VII, 1893.
.89	.63	1.20	9.46					Do.
.54	.04		14.50					
.63	.40	.28	8.90	1.69		1.30		Ohio Geol. Surv., 1884.
	.52	.22						J. Soisson & Sons.
.257	.08	.048	13.184					Woodland Fire Brick Co.
.22	.054	.285	14.20			2.61		

Analyses of clays of the United States—Continued.

FIRE CLAYS—Continued.

State and county.	Town.	Material.	Silica. Combined.	Silica. Free.	Alumina.	Ferric oxide.
Pennsylvania—Cont'd.						
Clearfield	Clearfield (5 miles southwest).		44.05		37.51	*a* .819
Clinton	Queens Run	Raw hard clay.	46.65		36.36	1.19
Do	do	Calcined hard clay.	52.73		40.63	1.73
Somerset	Savage Mountain	Raw flint clay.	53.86		35.484	*a* 1.23
Do	do	Calcined flint clay.	59.16		38.70	*a* 1.36
Westmoreland	Hunker Station	Flint clay	52.58		33.12	.20
	Bradys Run		62.029		23.656	.896
Blair	Benezet	Raw clay	47.233		38.409	.391
Cambria	Figart	Hard fire clay.	48.878		32.002	3.629
Somerset	Keystone Junction		54.65		30.74	*a* .08
Clinton	Farrandsville		45.26		37.84	2.03
	Retort		42.32		37.01	*a* .95
Fayette	Brillskin Township	Flint clay	55.28		34.17	2.27
Clinton	Renovo		53.84		32.60	*a* 1.02
Armstrong	Kittanning		97.03			.90
Elk	Jay Township		67.57		21.042	*a* .621
Do	Glen Mayo Colliery		51.72		21.738	*a* 7.875
Clarion	New Bethlehem		44.61		38.01	*a* 1.251
	Sligo		56.63		28.85	*a* 1.26
Indiana	Bolivar		59.83		24.58	*a* 1.655
Westmoreland	Salina		51.92		31.64	*a* 1.134
Do	Laughlintown		55.68		29.18	*a* .837
Do	Jacobs Creek		56.78		26.89	*a* 3.22
Fayette	Meadow Run		52.23		31.31	*a* 1.008
Beaver	Vanporte		60.19		24.23	*a* 2.097
Do	Rochester		61.98		23.88	*a* 1.395
Indiana	Bolivar		50.84		30.745	*a* 3.213
Clarion	Climax		42.82		40.20	2.59
Cambria	Altoona		68.35		22.78	*a* .11
South Dakota:						
Pennington	Rapid City	Hard clay	84.42		9.41	1.07
Texas:						
Henderson			68.55		26.00	tr.
	Athens		31.82	37.06	20.71	1.01
Washington:						
King	Black Diamond Field.		57.50		34.37	1.24
Pierce	Green River Fields		69.71		18.39	1.44
Skagit			49.73		32.57	1.52
West Virginia:						
Fayette	Great Kanawha		55.67		30.39	.61
Kanawha	Charleston		39.90	16.90	30.08	1.33
Marion			45.86		44.23	
Monongalia			54.27		33.83	.01
Preston			68.16		24.11	.01
	Spragueville	Hard clay	47.88		33.985	1.368
	do	Soft clay	68.315		19.62	1.575
Wyoming:						
Albany	Rock Creek		59.78		15.10	2.40
Crook			61.08		17.12	3.17

a Iron present as ferrous oxide.

Analyses of clays of the United States—Continued.

FIRE CLAYS—Continued.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
.49	.181	.065	15.21		....	1.84	....	
.08	....	1.30	13.01		....	2.64	....	Queens Run Fire Brick Co.
.21	.04	1.83	....	....	....	2.94	....	Do.
302	.144	....	8.750		....	....	....	Welch, Gloninger & Maxwell.
.331	1.36	....	....	....	....	....	....	Do.
....	.29	.08	13.68		....	....	....	Westmoreland Fire Brick Co.
2.335	.819	1.661	8.049					G. G. Pond, anal.
	.192		13.775		....	....	....	Harbison & Walker.
.374	.079	1.742	....	....	Loss 15.609	....	....	G. G. Pond, anal.
.19	.13	.11	....	....	....	....	....	
.08	.02	1.26		13.30		Loss.20	....	J. B. Britton, anal.
.47	.16	1.29		17.74		3.83	Loss.23	E. E. Melick.
1.31	2.11	....	....	....	....	....	....	Soisson & Kilpatrick.
1.35	.10	59	5.89		....	4.62	....	Renovo Fire Brick and Clay Co.
....	.11	....	.15		....	....	....	
.100	.147	tr.	9.59		....	.93	....	
.060	2.378	4.581	10.78		....	.87	....	
.08	.407	1.735	13.63		....	1 02	....	
.26	.079	.694	11.85		....	.99	....	
.28	.872	3.114	7.83		....	1.17	....	Pennsylvania Geol. Surv., MM, p. 259.
.03	.443	.402	13.49		....	1.16	....	Do.
.13	.18	.245	12.49		....	1.49	....	Do.
.369	.987	3.92	8.38		....	....	....	Do.
.13	.165	.72	13.19		....	1.68	....	Ibid., p. 260.
.85	.036	1.669	9.015		....	2.345	....	Ibid., p. 263.
.04	.281	1.217	9.28		....	1.83	....	Ibid., p. 262.
.16	.288	.541	13.05		1.26		....	
tr.	.35	1.24	12.80	....	....	....	....	Climax Brick Works.
.82	.37	....	7.57		....	....	....	Otto Wuth, anal.
tr.	.39	....	3.42		....	....	....	Rapid City Steam Brick Works.
tr.	.11	tr.	6.00		....	....	....	Texas Geol. Surv., 1890, p. 197.
.22	.39	1.08	7.17	1.82	....	....	Ign.8.99	G. E. Ladd, anal.
.50	1.00	68	4.71		....	....	....	1891, Rep. Wyoming State Geol.
.35	.15	1.02	....	....	....	....	Loss	Do.
.42	1.28	1.10	12.38		$CaCO_3$ .43	$CaSO_4$ .10	8.94	Do.
.37	tr.	.12	12.87		....	....	....	
tr.	tr.	2.20	7.60	.90	....	1.15	....	W. A. Bradford.
.24	.36	tr.		9.05		....	....	Bull. on Min. Res. of West Virginia, 1893.
tr.	.02	1.00		11.01		....	....	Do.
tr.	tr.	tr.		7.51		....	....	Do.
.36	.346	.481		12.388		3.185	....	I. C. White, anal.
.10	.692	2.704		5.58		1.37	....	Do.
.73	4.14	....	16.26		....	....	....	Bull. 14, Wyoming Exper. Sta.
2.69	1.82	.20	12.10		....	....	SO_3.88	Do.

Analyses of clays of the United States—Continued.

KAOLIN. (*a*)

State and county.	own.	Material.	Silica. Combined.	Silica. Free.	Alumina.	Ferric oxide.
Alabama:						
Talladega	Talladega		43.21		37.27	tr.
Arizona:						
Graham	Clifton		42.40		32.50	16.17
Arkansas:						
Pike			48.87		36.54	.98
Pulaski			46.27		38.57	1.36
Ouachita			48.62		36.52	1.74
Colorado:						
Jefferson	Golden		56.41		26.37	
Florida:						
Lake	Palatlakaha		46.11		39.55	.35
Indiana:						
Clay			68.50		17.20	1.30
Lawrence			44.54		41.18	
Do	Huron		41.125		39.26	.20
Massachusetts:						
Hampden	Blandford		52.03		31.76	tr.
New Jersey:						
Middlesex	Perth Amboy			77.10	17.10	
Do	Washington			89.40	7.80	
New York:						
Richmond	Kreischerville		82.51		11.57	.63
Pennsylvania:						
Delaware	Brandywine Summit		46.278		36.25	1.644
Berks	Hunter Mine		66.173		19.89	*b* .783
Delaware			47.22		34.10	2.49
Lancaster	Chestnut Hill		67.10		20.10	3.90
Chester	East Nottingham		46.34		36.32	.64
Berks	Mertztown		54.62		28.18	2.24
Texas:						
Edwards			48.61		43.17	
Nueces			46.60		33.66	
Virginia:						
Nelson			69.50		19.10	
Wisconsin:						
Wood	Grand Rapids		78.83		13.43	.74
Do	do	Washed kaolin	49.94		36.80	.72

POTTERY CLAYS.

State and county.	own.	Material.	Silica. Combined.	Silica. Free.	Alumina.	Ferric oxide.
Georgia:						
Baldwin	Stephens Pottery		46.07		21.72	15.75
Illinois:						
Pope			46.90		31.34	.16
Indiana:						
Putnam	Reelsville		60.56		27.00	3.48
Clay	Martz		65.66		17.20	4.05
Porter	Sumanville	Blue clay	68.50		17.55	1.38
Fountain		Yellow clay	50.43		22.18	4.37
Vanderburg	Evansville	Clay	59.50		26.22	.80
Do	do	do	79.41		10.80	2.07
Kentucky:						
McCracken	Paducah (3 mi. S.)	do	59.50		24.96	.72
Calloway	Murray (6 mi. E.)	do	54.84		30.34	1.18
Graves	Bell City	do	56.98		32.16	2.16

a Mostly so-called kaolins. *b* Iron present as ferrous oxide.

Analyses of clays of the United States—Continued.

KAOLIN. (*a*)

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
0.11	0.10	0.68	18.50		...	...	...	U. S. Geol. Surv., Bull. 64.
2.17	tr.	...	...	...	...	...	...	
.19	.25	...	13.29		...	...	...	Min. Res., 1891.
.34	.25	.60	13.61		...	...	...	Do.
...	...	...	13.40		...	...	...	Do.
.29	.20	1.55	14.66		...	...	...	
...	.13	...	13.78		SO_3 0.07	...	...	Min. Industry, 1893.
.25	...	.79	.30		...	...	Loss 11.17	Indiana Geol. Surv., 1878, p. 158.
...		...	...	...	...	...	...	Do.
.365	...	...	19.05		...	...	...	Pennsylvania Mineral Co.
tr.	.54	tr.		15.55		...	...	Tech. Quart., 1890.
...	...	1.30	4.50	...	...	...	...	New Jersey Clay Rept., 1878, p. 129.
...	...	...	2.60	...	...	...	...	Ibid., p. 168.
.29	.78	2.66	...	...	...	...	...	H. T. Vulte, anal.
.192	.321	2.536	...	...	...	...	Loss 13.535	
.260	1.902	6.211	4.784		...		...	Pennsylvania Geol. Surv., D 3.
...	.39	1.91	13.68		...	...	...	Do.
.10	.70	2.00	5.90		...	...	...	Pennsylvania Geol. Surv., Ann. Rept., 1885.
.04	tr.	.77	13.75		...	...	...	Do.
.10	2.53	...	7.16		...	...	...	Booth, Garrett & Blair, anal.
.38	.10	1.78	6.05		...	...	...	Texas Geol. Surv., 1890, p. li.
.43	.96	1.65	4.53		...	...	...	Do.
...	...	1.00	1.00		Loss 11.12	...	...	Indiana Geol. Surv., 1878.
.64	.07	.44	5.45		CO_2 .01	...	...	Wisconsin Acad. Sci., 1870-1876, p. 1.
tr.	...	.59	11.62		...	...	...	Do.

POTTERY CLAYS.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
0.25	0.67	0.48	11.72		0.34	...	...	R. Peter, anal.
...	.10	.95	20.00		...	...	...	
.725	...	2.80	...	...	Loss 6.30	SO_2 .27	...	Indiana Geol. Surv., 1878, p. 159.
.365	...	2.72	...	...	Loss 8.10	SO_2 .74	MnO .80	Do.
1.20	.25	2.61	8.51		...	...	...	Crossley, Analyses of Clays.
6.58	1.74	2.08	12.62		...	...	...	Do.
.56	2.76	2.96	...	...	...	...	...	Uhles Pottery.
.60	.62	...		6.5		...	...	B. F. Harris.
.325	.396	2.22		11.879		...	...	Kentucky Geol. Surv., Chem. Rept. A., Pt. III, No. 2777.
.011	.050	1.137	9.442		...	...	...	Ibid., No. 2643.
tr.	2.09	.949	7.542		...	...	...	Ibid., No. 2666.

a Mostly so-called kaolins.

Analyses of clays of the United States—Continued.

POTTERY CLAYS—Continued.

State and county.	Town.	Material.	Silica. Com-bined.	Silica. Free.	Alumina.	Ferric oxide.
Kentucky—Continued.						
Madison	Wasco	Pottery clay	59.976		27.64	
Franklin	Frankfort	do	69.30		21.78	
Hickman		do	76.36		14.95	2.11
Butler		do	51.66		15.56	7.68
Ohio		do	70.06		17.94	.38
Madison		Black shale	62.56		24.78	1.80
Fulton			71.021		17.977	3.417
Graves	Pryorsburg		56.40		30.00	
Minnesota:						
Blue Earth	Mankato	Red clay	73.34		14.75	5.45
New Jersey:						
Sussex	Woodbridge	Stoneware clay	19.44	48.40	21.83	1.57
New York:						
Queens	Glen Cove	do	70.45		21.74	1.72
Do	Elm Point	do	62.06		18.09	5.40
Suffolk	Little Neck	do	62.66		18.09	.97
Pennsylvania:						
Beaver	New Brighton	Drift clay	57.67		27.52	*a* 1.494
Ohio:						
Muskingum	Roseville	Stoneware clay	25.60	43.73	19.08	1.26
Perry	Uniontown	do	29.35	35.85	23.05	.99
Summit	North Springfield	do	72.10		19.38	
Columbiana	East Liverpool	Yellow ware clay.	42.28	18.02	24.12	1.46
Stark	Greentown	Stoneware clay	72.26		19.23	
Muskingum	Zanesville	Cooking ware clay.	25.40	40.81	21.13	1.28
Summit	Akron	Stoneware clay	27.68	36.58	22.95	1.28
Columbiana	East Palestine	Yellow ware clay.	29.93	29.61	25.12	1.57
Do	Salineville	do	32.33	24.11	26.60	2.00
Tennessee	Loudon	Clay	45.06		30.03	*a* 4.50
Texas:						
Henderson	Athens	do	68.57		28.24	tr.
Marion	Linden Road	do	58.20		23.97	4.43

SLIP CLAYS.

State and county.	Town.	Material.	Silica. Com-bined.	Silica. Free.	Alumina.	Ferric oxide.
Michigan	Rowley	Clay	12.85	31.09	11.17	3.81
New York:						
Albany	Albany	do	14.33	46.26	12.46	5.79
Ohio:						
Summit	Brimfield	do	15.65	47.98	13.57	7.77
Hamilton	Sharonville	do	12.04	30.20	11.08	5.07
		Kaolite slip	12.00	48.40	10.42	5.36
Texas:						
Grimes	Piedmont Springs	Clay	58.50		18.39	3.29

ADOBE SOILS.

State and county.	Town.	Material.	Silica. Com-bined.	Silica. Free.	Alumina.	Ferric oxide.
Nevada	Humboldt City	P_2O_5 .94	26.67		13.19	{ 5.12 / *a*.64
New Mexico:						
Bernalillo	Fort Wingate	P_2O_5 .75	26.67		.91	.64
Utah:						
Summit	Salt Lake City	P_2O_5 .23	19.24		3.26	1.09

a Iron present as ferrous oxide.

Analyses of clays of the United States—Continued.

POTTERY CLAYS—Continued.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
$CaCO_3$ .28	.606	4.478	7.020		....	....	....	Kentucky Geol. Surv., Chem. Rept. A., Pt. I, No. 1876*a*.
.158	.331	2.936	5.435		P_2O_5 .06	....	....	Ibid., No. 2007.
$CaCO_3$ .33	.17	.71	4.31		....	....	....	Crossley, Analyses of Clays.
7.27	.82	3.57	13.44		....	....	....	Do.
tr.	.66	2.96	4.56		....	....	....	Do.
tr.	.32	3.57	6.87		....	....	....	Do.
1.019	.262	.95	5.276		....	....	....	Kentucky Geol. Surv., n. s., V, p. 430.
.40	tr.	5.27	7.93		....	....	....	R. Peter, anal.
.28	.05	tr.	4.71		....	....	....	Minnesota Geol. Surv., 1872-1882.
.28	.24	2.24	5.90	.80	....	....	....	New Jersey Clay Rept., 1878, p. 99.
.24	.30	5.00	....	....	....	....	....	H. T. Vulte, anal.
1.05	tr.	6.11	....	....	....	....	....	Do.
.79	....	2.33	....	....	....	....	....	Do.
.38	.122	.619	9.68		....	2.54	....	
.60	.63	2.16	5.57	.94	....	.29	....	Ohio Geol. Surv., V, 1884.
.58	.58	1.45	7.39	1.11	....	.55	....	Do.
1.38	.23	....	5.13	.112	....	....	....	Do.
.59	.68	2.42	7.77	.86	....	1.20	....	Do.
....	....	....	10.03	.83	....	....	....	Do.
.51	.18	1.80	6.29	1.65	....	....	....	Ohio Geol. Surv., VII, 1893.
.45	.37	1.96	6.74	2.05	....	....	....	Do.
.57	.51	1.95	7.75	2.63	....	....	....	Do.
.47	.63	3.46	7.59	2.48	....	....	....	Do.
4.70	4.80	....	10.10		....	....	....	Crossley, Analyses of Clays.
tr.	1.25	....	....	1.85	Loss .11	....	....	Miller Bros.
....	....	7.11	5.36		....	....	....	Texas Geol. Surv., 1890, p. 112.

SLIP CLAYS.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
11.64	4.7	3.61	3.90	15.66 and CO_2	....	....	....	Ohio Geol. Surv., VII, 1893.
6.84	3.28	4.39	4.36	1.46 and CO_2	....	....	....	Do.
2.55	1.47	2.63	4.75	2.90 and CO_2	....	....	....	Do.
15.99	6.36	2.68	4.58	12.00 and CO_2	....	....	....	Do.
9.88	4.28	.87	3.64	4.41 and CO_2	....	....	....	Do.
2.34	1.61	7.63	8.70		....	....	....	Texas Geol. Surv., 4th Ann. Rept.

ADOBE SOILS.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
} 13.91	2.96	2.30	2.26		Cl .14	MnO .13	CO_2 8.55	Bull. U. S. G. S., 64.
36.40	.51	tr.	2.26		org. mat. 5.10 Cl .07	SO_3 .82	CO_2 25.84	Do.
38.94	2.75	tr.	1.67		Cl .11	SO_3 .53	CO_2 29.57	Do.

Analyses of clays of the United States—Continued.

BRICK CLAYS.

State and county.	Town.	Material.	Silica. Combined.	Silica. Free.	Alumina.	Ferric oxide.
Alabama:						
Morgan	Lacon		75.52		12.945	*a*2.605
Arkansas:						
	Johnsons Ridge		56.91		19.80	6.68
Little River	Williams Lake		58.24		13.22	9.25
Sebastian	Nigger Hill, Fort Smith.		58.43		22.50	8.36
Do	Fort Smith		74.79		12.86	4.90
Poinsett	Harrisburg		81.37		8.52	2.88
Craighead	Jonesboro		79.49		8.71	3.43
Greene	Gainesville		71.17		18.44	2.77
Do	Paragould		79.07		8.79	2.54
Cross	Wittsburg		69.55		15.20	8.10
Hempstead	Hope		72.42		14.94	5.54
Sevier	Brownstown		79.07		10.53	5.27
California:						
Placer	Lincoln		44.82		34.54	1.86
Colorado:						
Pueblo	Pueblo		61		35	.25
District of Columbia	Washington	Shale	62.14		25.55	tr.
Florida:						
Escambia	Bluff Springs		52.05		18.87	2.49
Georgia:						
Bartow	Cartersville	Clay	58.63		20.47	8.58
Do	do	Slate	71.60		11.50	5.59
	McCamores Cave	Plastic clay	69.33		19.01	2.02
Do	Cartersville.	Alluvial clay	69.18		15.43	5.83
Floyd	Rome	Surface clay	67.80		13.82	5.74
Richmond	Augusta		54.55		18.04	*a*3.87
Illinois:						
La Salle	La Salle	Red clay	62		18.10	9.11
	Woodland		51.36		12.80	9.68
Livingston	Cornell		68.22		19.48	
Kane	Aurora		49.964		13.64	1.788
Peoria	Peoria		72.10		16.10	3.30
La Salle	Utica		56.65		26.45	2.10
Do	Ottawa	Clay	45.79		22.44	*a*tr.
Mercer	Griffin	No. 2 clay	75.83		15.04	1.08
Do	do	No. 1 clay	64.52		23.52	1.92
Indiana:						
Floyd	New Albany	Clay	52.18		19.27	3.13
Crawford	Wyandotte Cave	Red clay	48.50		19.50	12.30
Monroe	Bloomington	Clay	66.14		15.34	6.32
Do	do	do	55.23		29.66	4.63
Martin	Dover Hill		70.73		13.74	4.40
Jennings	Vernon	Clay	68.19		18.22	2.43
Warren	Covington		34.35		15.50	33.12
Do	do		66.44		22.09	2.16
Perry	Cannelton		66.83		22.94	2.64
Jackson	Brownstown		63.60		20.84	3.17
Union	Liberty		73.81		13.87	2.66
Clark	Jeffersonville		49.83		13.95	2.10
Vigo	Terre Haute		71.833		12.64	4.4

a Iron present as ferrous oxide.

Analyses of clays of the United States—Continued.

BRICK CLAYS.

Lime	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
0.867	0.936	....	5.50		....	....	....	Standard Brick and Tile Works.
4.76	.96	3.17	....	....	....	....	Loss 9.57	Arkansas Geol. Surv., 1888, II, p. 296.
4.55	4.19	3.22	....	....	....	....	Loss 8.96	Do.
.32	1.14	3.21	....	....	....	....	Loss 6.07	Do.
.38	.90	3.22	....	....	....	....	Loss 2.91	Do.
.44	.50	2.40	....	....	....	MnO_2 1.01	Loss 2.88	Ibid., 1889, II, p. 85.
	2.10		....	....	....	MnO_2 2.44	Loss 3.83	Ibid., p. 87.
.25	.44	.90	....	....	....	....	Loss 6.03	Ibid., p. 107.
.25	.23	1.89	....	....	....	MnO_2 3.68	Loss 3.55	Ibid., p. 112.
.58	.97	1.02	....	....	....	P_2O_5 .20	Loss 5.72	Ibid., p. 138.
	2.56		....	....	....	....	Loss 4.54	Arkansas Geol. Surv., 1888, p. 296.
	.70		....	....	....	....	Loss 4.43	Do.
1.55	.96	4.74		9.64		....	Loss .44	California State Min., XI Rept.
....	....	....		3.75		....	....	Stand. Fire Brick Co.
.49	....	5 60	....	....	....	....	....	Wellington Brick and Tile Co.
$CaCO_3$ 6,20	$MgCO_3$ 4.28	Chloride 15.32	....	....	....	....	P_2O_5 .79	J. W. Crary, jr., & Co.
....	1.71	1.98	6.83		....	....	....	Georgia Geol. Surv., 1893, p. 286.
....	1.30	4.55	3.95		....	1.10	MnO_2 .60	Ibid., p. 284.
tr.	.87	2.28	7.14		....	....	....	Ibid., p. 286.
tr.	1.42	4.00	7.26		....	....	....	Ibid., p. 280.
....	.81	2.55	7.60		....	1.67	....	Ibid., p. 287.
.94	....	4.01	5.41	....	4.82	....	P_2O_5 2.07	J. F. Elson, anal.
....	....	....	....	....	SO_3 .1	Loss 5.66	....	La Salle Pressed Brick Co.
....	....	....	....	....	....	....	....	Asst. State chemist anal.
1.16	1.67	3.82		3.86		....	....	J. F. Snyder.
23.20	9.433	4.01	4.59		....	Ign. 2	....	E. W. Cook, anal.
.61	.77	2.90	3.86		....	....	....	Peoria Brick Co.
....	.30	1.10	11.90		....	1.15	....	
6.35	9	3.99		.92		CO_2 11.51	....	Crossley Anal. of Clays.
.62	.36	1.55		5.20		....	....	H. A. Weber, anal. Griffin Brick, Tile, and Coal Works.
.07	.20	1.43	7.50		....	....	....	
.09	7.29	5.31	5.66		2.22	....	....	W. Finnegan Brick Mfg. Co.
1.79	.52	1.12	....	P_2O_5 .44	MnO 1.05	Loss 11.70	SO_2 1.11	Indiana Geol. Surv. Rept., 1878.
1.227	.921	....	10.07		....	....	....	St. Louis Works.
.80	1.96	....	7.72		....	....	....	G. Powell's yard.
1.17	1.29	....	8.60		....	....	....	
1.65	1.03	9.48	....	....	....	....	....	J. Owens's Works.
1.83	2.41	12.85	....	....	....	....	....	M. Carvite.
2.04	1.18	6.09	....	....	....	....	....	Do.
3.08	.858	7.43	....	....	....	....	....	
2.20	.64	....	9.65		....	....	....	P. White.
2.96	1.14	....	5.56		....	....	....	F. Snyder.
2.313	9.828	....	21.979		....	....	....	J. C. Summers.
1.17	1.29	....	8.60		....	....	....	S. Gray.

Analyses of clays of the United States—Continued.

BRICK CLAYS—Continued.

State and County.	Town.	Material.	Silica. Com-bined.	Silica. Free.	Alumina.	Ferric oxide.
Indiana—Continued.						
Wabash	Wabash		62.18		15.90	3.77
Fountain	Veedersburg		69.60		13.08	2.98
Daviess	Washington		81.71		9.81	3.8
Greene	Worthington		63.25		24.81	5.04
Jasper	Jasper		68.64		20.18	2.5
Parke	Montezuma		54.53		24.66	7.46
Dubois	Haysville		70.32		18.20	2.90
	Lodi		64.27		20.16	2.12
Martin	Cale		45.23		29.68	4.60
Washington	Salem		73.33		13.94	5.21
Madison	Anderson		63.20		23.11	3.8
Hamilton	Noblesville	Clay	74.33		12.94	5.2
Lawrence	Mitchell	do	68.14		19.05	4.08
Wells	Bluffton	do	51.95		30.36	2.88
Owen	Gosport	do	75.33		11.94	3.20
Madison	Frankton	do	73.19		16.21	2.18
Orange	Paoli	do	69.33		17.84	4.033
Washington	Salem	do	75.88		11.22	5.04
	Edwardsport	do	56.02		24.23	9.20
Warren	Williamsport	do	45.22		25.98	13.6
Fountain	Stone Bluff	do	73.10		12.64	3.16
Martin	Shoals		54.00		25.13	7.36
Putnam	Greencastle		66.14		15.34	6.32
Iowa:						
Cerro Gordo	Mason City	Blue shale	54.80		14.91	2.47; *a* 2.90
Kansas:						
Greenwood	Flint Ridge		58.20		29.80	*a* 5.40
Kentucky:						
Ballard	Wickliffe	Yellow clay	44.84		22.83	20.35
Graves	Lynnville	Clay	62.68		25.88	2.9
Marshall	Highland	do	60.98		18.48	7.5
Campbell	Newport	do	72.66		20.50	
Do	Mount Vernon		82.56		12.223	
Boone	Burlington	Clay	48.36		33.06	
Grayson	Canolaway Creek	Ferrug. clay	68.38		12.282	7.588
		Clay	61.58		23.946	5.814
Ohio	Elm Lick	do	70.86		19.24	3.12
Do	Bald Knob Church	do	62.76		26.42	1.58
Louisiana:						
Ouachita	Forksville (5 mi. E.)	Gray clay	58.43		22.45	3.23
Catahoula	Rosefield	do	61.91		18.38	2.14
Claiborne	Homer	Clay	82.83		6.48	1.42
Maine	Quinnipiac	do	63.69		17.02	10.18
Massachusetts:						
Middlesex	West Cambridge	Glacial clay	48.99		28.90	3.89
Dukes	Gay Head, south end	Red clay	57.50		31.21	
Michigan:						
Kent	Grand Rapids	Clay	58.70		25.95	
Marquette	Marquette		54.62		12.82	2
Minnesota:						
	Coon Creek		60.31		23.77	7.96
Blue Earth	Mankato	Clay shale	70.10		16.99	tr.
	do	Washed brick clay.	87.70		7.24	tr.
Mississippi	Clingscales		90.877		2.214	.126
Missouri:						
Marion	Hannibal		70		15.94	1.40
Montana:						
Deerlodge	Blossburg		72		17	2
Nebraska	Unknown		61.80		13.90	5.01

a Iron present as ferrous oxide.

Analyses of clays of the United States—Continued.

BRICK CLAYS—Continued.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
2.18	1.13	....	14.84		....	....	....	T. Graves.
1.00	.70	....	17.64		....	....	....	S. White.
.48	.26	....	3.91		....	....	....	P. Zike.
.485	1.009	....	7.33		....	....	....	S. Davis.
.70	.50	....	7.48		....	....	....	P. West.
.37	1.28	....	10.70		....	....	....	S. Schumake.
.70	.70	....	7.18		....	....	....	J. Weber.
.75	.60	....	13.10		....	....	....	A. Parks.
1.01	1 76	....	17.72		....	....	....	W. A. McBride.
.533	.984	....	5.98		....	....	....	G. Walters.
.50	.282	....	7.46		....	....	....	J. Klein.
.666	.861	....	5.97		....	....	....	H. Teller.
.80	2.26	....	5.22		....	....	....	J. W. Jones.
1.31	1.22	....	12.25		....	....	....	J. N. Goodyear.
.633	.894	....	3.97		....	....	....	J. Smith.
1.16	.60	....	6.60		....	....	....	H. Pierce.
1.633	.994	....	5.89		....	....	....	J. Peterson.
.476	.349	....	6.76		....	....	....	A. Shrunn.
.47	1.459	....	8.62		....	....	....	
.336	.21	....	15.20		....	....	....	S. Field.
.90	.90	....	9.30		....	....	....	J. W. Shuster.
.57	1.18	....	10.70		....	....	....	H. A. Barton.
1.22	.91	....	10.07		....	....	....	O. M. Johnson.
5.20	3.76	6.32	....	....	CO_2 4.80	....	....	Iowa Geol. Surv.
6	....	....	.60		....	....	....	Crossley, Analyses of Clays.
.101	.138	....	11.741		....		....	Kentucky Geol. Surv., Chem. Rept. A, pt. 3, No. 2568.
tr.	.319	2.075	6.146		....		....	Ibid., analysis No. 2663.
.78	1.128	2.891	7.841		....	....	....	Ibid., No. 2762.
$CaCO_3$ tr.	$MgCO_3$ .932	1.243	4.2		Loss .373	P_2O_5 .192	....	Kentucky Geol. Surv., Chem. Rept. A, pt. 1, No. 1319.
$CaCO_3$ .16	$MgCO_3$ tr.	.957	4.1		....	....	....	Ibid., analysis No. 1320.
3.057	.367	6.370	8.786		....	....	....	Ibid., No. 1697.
$CaCO_3$ 1.380	1.643	6.109	8.25		....	....	....	Ibid., No. 1789.
.201	.850	1.904	5.705		....	....	....	Ibid., No. 1873.
tr.	4.25	2.604	3.751		....	P_2O_5 tr.	....	Ibid., No. 2075.
.325	tr.	1.184	7.731		....	....	....	Ibid., No. 2076.
.840	.830	2.25	11.01		....	....	....	
.680	.490	1.80	14.18		....	....	....	
.150	.080	....	1.84		....	....	....	
.97	....	4.02	4.15		....	....	....	A. J. S. (3), XXXIV, p. 407.
7.10	3.66	4.73	3.31		....	....	....	J. Card, anal.
.19	.20	.40	....	....	....	Loss 9.83	....	7th Rept. U. S. G. S., p. 359.
1	.74	5.54	8.07		....	....	....	S. P. Sharpless, anal.
13.68	4.25	....	....	....	....	CO_2 and loss 12.01	....	Min. Res., Mich., 1889, p. 61.
2.50	1.75	2.42	1.79		....	....	....	J. Dunn.
....	....	10.69	1.98		....	SO_3 .23	....	Minnesota Geol. Surv., Final Rept., I, p. 438.
.67	.07	3.66	tr.		tr.	....	....	Ibid.
.14	tr.	....	6.93		....		....	Hilgard, Geol. Miss., 1890.
.66	....	7.04	....	....	....		....	G. Ross, anal.
2	3	....	....	....	....	....	....	Mullan Brk. and T. Co.
$CaCO_3$ 9.11	1.70	4.01	3.70		....	Loss .77	....	Phys. Geog. and Geol. of Nebr., 1880, p. 255.

Analyses of clays of the United States—Continued.

BRICK CLAYS—Continued.

State and county.	Town.	Material.	Silica.		Alumina.	Ferric oxide.
			Combined.	Free.		
New Jersey:						
Middlesex	Sayreville	Front brick clay.	28.30	27.80	27.42	2.68
Do	Cheesequake Creek		28.30	28.70	21.50	4.31
Burlington	Kinkora		25.50	31.80	17.70	6.40
New York:						
Suffolk	Southold	Clay	59.05		22.11	6.54
Do	Farmingdale	do	62.39		23.60	3.39
Do	Wyandance	Black clay	59.83		24.45	tr.
Do	Fishers Island	Brown clay	53.77		20.49	9.23
Do	West Neck	do	61.01		19.23	5.43
Queens	East Williston	Gray clay	69.73		16.42	2.58
Orange	Roseton	do	55		34.54	
Ulster	Rondout	do	57.80		22.60	
Columbia	Barrytown	do	59.81		22	
Clinton	Plattsburg	Red clay	65.14		13.38	7.65
Cortland	Homer	Clay	32.12	4.239	51.18	*a* 2.122
Tompkins	Newfield	do	51.30		12.21	3.32
Monroe	Rochester	do	50.55		15.46	4.38
Ontario	Canandaigua	do	62.23		16.01	6.96
Onondaga	Warners	Blue shale	57.79		16.15	5.20
St. Lawrence	Ogdensburg	Blue clay	49.20		17.47	6.23
Saratoga	Glens Falls	do	48.35		11.33	4.02
Do	do	Red clay	57.46		21.15	5.52
Chemung	Breesport	Clay	52.48		16.78	6.79
Erie	Buffalo	do	57.36		16.20	4.55
Orange	Warwick	do	53		23	7.2
Monroe	Rochester	Niagara shale.	28.35		10.47	1.90
North Carolina:						
Wilkes	Wilkesboro		54.808		30.924	*a* .787
Harnett	Spoutsprings	Purple clay	56.63		26.22	5.93
Robeson	Shoe Heel Depot		60.93		26.58	1.71
Lenoir			72.25		11.28	3.62
North Dakota:						
Grand Forks	Grand Forks		51.27		9.33	3.52
Burleigh	Bismarck		58.73		14.98	5.63
Williams	Williston	Clay with coal.	57.80		9.47	3.16
Ward	Minot (Cottons Mine)	Blue clay	56.86		25.03	6.11
Stark	Dickinson	Buff clay	56.03		24.23	9.46
Do	Lehigh Mine	White clay	55.77		12.15	4.27
Ohio:						
Stark	Canton	Shale	57.10		21.29	7.31
Do	Waynesburg	Shale	49.30		24	8.40
Franklin	Columbus	Clay	14.50	56.80	12.63	5.07
Pennsylvania:						
Montgomery	Norristown	Red shale	64.40		18.54	6.06
Cumberland	Pine Grove		74.97		13.86	*a* 2.70
Clinton	Lock Haven	do	56.55		21.46	9.72
Erie	Corry	do	46.491		33.119	2.84
Venango	Franklin	do	61.06		21.76	7.04
Indiana	Bells Mills	Plastic clay	68.49		18.46	*a* 1.566
Somerset	Hooversville	Clay	45.73		29.693	*a* 6.857
Huntingdon	Lewiston	Upper clay	73.90		13.07	*a* 6.1
Warren	Little Brokenstraw Valley.	Clay	65.12		15.939	*a* 5.464
Lehigh	Schneiders Mine	do	53.17		23.431	*a* 5.40
	Chapman Station		60.53		17.40	9.29
Monroe	Stroudsburg	Clay	64.70		28.39	1.28
South Dakota:						
Pennington	Rapid City	Soft shale	74.22		16.38	1.95

a Iron present as ferrous oxide.

Analyses of clays of the United States—Continued.

BRICK CLAYS—Continued.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
	.18	2.71	6.60	2.90		1		Sayre & Fisher.
	.82	1.90	8.04	1.70	SO_3 1	CO_2 3.8		Rept. on clays, New Jersey Geol. Surv., 1878, p. 317.
.16	.65	1.55	11.80	3.50	SO_3 .48	.90		Ibid., p. 317.
2.19	2.64	6.22						H. T. Vulte, anal.
.70	.10	5.89						Do.
.23	.59	8.75			4.28			Do.
2.04	4.22	9.60						Do.
.96	1.88	4.60						Do.
1.66	.69	6.27						Do.
5.33	3.43	.48	1.22					Jova Brick Works.
4.85	2.07		12.68					H. T. Vulte, anal.
4.35	2.29			8.26				Do.
2.18	2.36	8.51						Do.
$CaCO_3$ 2.063	$MgCO_3$ .088			6.7	1.277	Cl. .004	SO_3 .116	
11.63	4.73	4.33			1.50			H. T. Vulte, anal.
10.95	3.35	6.30						Do.
1.24	2.21	5.08						Do.
2.73	4.67	5.33		4.50		CO_2 3.42		R. Froehling, anal.
7.86	4.87	9.82						H. T. Vulte, anal.
15.38	3.17	6.05				Loss 1.18		Do.
3.65	1.50	4.72						Do.
6.63	3.59	7.16						Do.
5.34	3.90	6.98						Do.
.70	2.60	4.10	9.70			.50		New Jersey Geol. Surv., anal.
21.47	8.24	5.73						H. T. Vulte, anal.
.872	1.011	.678	7.148		3.772			Mound City Brick Co.
.30			10.92					Geol. North Carolina, I, p. 357.
.99	.35		9.44					Do.
	1.75		11.10					Do.
11.15	2.31	2.58						Rept. Labor Bureau, 1891-92.
2.10	.74	1.148	16.672					Do.
7.91	2.84							Do.
.71	.76	.66	10.014					Do.
	.31	.808	9.39					Do.
5.92	1.90	1.248	18.742					Do.
.29	1.53	4.05	6	1.30				Ohio Geol. Surv., V, 1884.
.56	1.60	4.10	9.40	1.20				Do.
1.05			7.30					Do.
.41	.46				Ign. 3.82			Perkiomen, Brick Co.
.12	1.02		2.05					Fuller Brick and Slate Co.
.474	1.68	5.37	4.48					Mill Hall Brick Works.
$CaCO_3$ 8.93	$MgCO_3$ 2.581	3.692			SO_3 2.847			J. F. Elson, anal.
.58	.23	4.55			Ign. 4.80			H. Froehling, anal.
.230	.551	2.775	6.31			2.15		Pennsylvania Geol. Surv., MM, p. 294.
.44	1.005	3.415	12.860					Ibid., HHH, p. 123.
.06	.526	.909	5.435					Ibid., HHH.
1.55	1.848	3.58	3.16			CO_2 2.81		Ibid., III.
.13	3.376	8.383	4.86			1.25		Do.
.08	1.92	5.27	5.51					Pennsylvania Geol. Surv., D, p. 53.
.32	.20	.23			Ign. 4.88			Monroe Brick and Tile Co.
.40	tr.	2.58	4.47					Rapid City Steam Brick Works.

a Iron present as ferrous oxide.

Analyses of clays of the United States—Continued.

BRICK CLAYS—Continued.

State and county.	Town.	Material.	Silica.		Alumina.	Ferric oxide.
			Combined.	Free.		
Tennessee:						
Scott	Robbins	Clay	70.57		15.19	7.97
Texas:						
Harrison	Marshall		71		20.20	2.20
Harris	Harrisburg		78		6.30	6.30
Grimes	Courtney	Clay	40.69		12.68	3.90
McCulloch	Milburn	do	57.60		19.34	6.14
	Waldrip Bed, Cisco division.		55.57		22.04	7.35
Cass	Queen City	Clay	82.60		10.25	2.25
Do	Gidean Story H'd't	do	66.70		11.43	3.77
Do	A. Duncan Headright	do	68.30		12.20	
Marion	A. Richardson H'd't	do	62.40		20.66	8.54
Smith	Garden Valley	do	69.05		22.60	1.40
Rusk	Henderson	do	64.40		24.17	3.23
Smith	Tyler	do	85.40		10.02	2.18
Panola	Carthage	do	82.80		9.83	2.77
Do	Tatum Station	Gray clay	57.80		18.94	7.55
Orange	Millville	Loamy clay	62		12.12	8.08
Do	West of Henderson	Dark clay	71.25		18.58	1.62
Washington:						
Pierce	Tacoma	White clay	62.43		18.79	4.20
West Virginia:						
Marshall	Moundsville		71.78		16.01	2.86
Wisconsin:						
Milwaukee	Milwaukee	Clay	38.22		9.75	2.84 a 1.16
Dane	Madison		75.80		11.07	3.53 a .31
	Whitneys Rapids		70.25		17.68	2.32
Milwaukee	Granville Station	Clay	52.18		19.27	3.13

PAVING-BRICK CLAYS.

State and county.	Town.	Material.	Silica. Combined.	Silica. Free.	Alumina.	Ferric oxide.
Arkansas:						
Sebastian	Fort Smith	Shale	57.10		23.74	8.18
California:						
San Mateo	San Francisco	Clay	56.51		21.33	.29
Colorado:						
Jefferson	Golden		52.41		32.21	a .66
Do	Morrison		71.80		15	3.29
Florida	Bartow		69.03		b 18.21	8.53
Illinois:						
Sangamon	Springfield		62.78		23.25	2.83
Scott	Winchester		23.15		17.08	
McLean	Bloomington		67.80		11.55	6.50
Indiana:						
Vermilion	Clinton	Shale	43.128		40.875	a 3.437
Clay	Brazil		68.83		23.11	1.84
Iowa:						
Lee	Burlington		77.40		11.74	12.31
Clinton	Clinton		73.82		15.88	.16
Kansas:						
Leavenworth	Leavenworth	Carb. shale	58.45		21.96	8.43
Maryland:						
Allegany	Mount Savage		39.90		30.08	.88
Missouri:						
St. Louis	Cheltenham	Clay	61.22		25.64	3.47
Do	do	do	38.10		31.53	4.31
Montgomery	Montgomery	do	43.93		40.09	1.70
Jackson	Kansas City	Carb. shale	64.37		19.73	9.07
Nebraska:						
Otoe	Nebraska City		61.63		21.41	7.03
New Jersey:						
Middlesex	Woodbridge		42.23		39.53	.50
Warren	Phillipsburg		56.78		17.38	.50

a Iron present as ferrous oxide. *b* Alumina present as silicate.

Analyses of clays of the United States—Continued.

BRICK CLAYS—Continued.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid	Miscellaneous.	Firm names, authority, or analyst.
.78	.32	2.30	....	....	....	....	....	Clay Worker, Dec., 1893.
....	....	7.40	....	....	....	....	....	2d Rept. on Iron Ore Dist., E. Texas, 1890.
tr.	....	7.41	....	....	Ign. 2	....	....	Texas Geol. Surv.
18.12	.92	1.14	H_2O and CO_2 22.55		....	....	....	4th Rept. Texas Geol. Surv.
1.22	....	4.75	1.70		Loss 7	....	....	Rept. on Col. Coal Field, Texas Geol. Surv.
.35	....	4.50	1.70		Loss 7.07	....	....	
tr.	....	4.46	....	....	....	....	....	1890 Rept. Texas Geol. Surv., p. 91.
1.30	.08	4	....	....	Loss 13	....	....	Do.
tr.	tr.	6.42	....	....	Loss 13.60	....	....	Do.
.40	tr.	8.89	....	....	....	....	....	Ibid., p. 111.
tr.	tr.	3.02	4.12		....	....	....	Ibid., p. 219.
tr.	tr.	3.50	7.25		SO_3 tr.	....	....	Do.
.10	....	tr.	1.95		....	....	....	Ibid., p. 229.
tr.	tr.	5.46	....	....	....	....	....	Do.
tr.	tr.	6.67	9.01		....	....	....	Do.
....	....	....	....	....	....	....	....	Ibid., p. 257.
tr.	.60	4	5.50		....	....	....	Do.
2.12	1.53	....	....	....	Ign.10.93	....	....	L. J. Clark.
.32	.43	1.98	5.45		....	....	....	Mound City Brick Co.
13.24 $CaCO_3$ 23.20	$MgCO_3$ 15.83	2.81	2.80		....	....	....	Geol. Wisconsin, II, p. 236.
.39 $CaCO_3$ 2.45	.17	3.14	3.70		....	....	....	Do.
.33	1.49	2.08	5.61		....	....	....	Ibid., p. 469.
.09	7.29	2.87	....	12.64	2.22	....	....	B. Schmidt & Co.

PAVING-BRICK CLAYS.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid	Miscellaneous.	Firm names, authority, or analyst.
0.53	1.04	2.40	....	....	....	....	Ign.7.31	
....	3.53	tr.	6.30		....	....	....	Byrnes on Roadways.
.20	.60	.61	14.05		....	....	....	Do.
3.8	....	....	8.3		....	....	....	Do.
tr.	....	....	....	4.20	....	....	....	Min Resources, 1893.
1.72	2.12	tr.	....	....	Ign. 6.69	....	....	J. S. Cary, anal.
....	.28	1.10	....	....	SO_2 6.30	1.20	P_2O_5 .90	Byrnes on Roadways.
8.90	5.32	2.42	.20		....	tr.	....	
$CaCO_3$ 2.009	.97	.99	9.482		....	....	....	J. F. Elson, anal.
.382	.551	....		17.11		....	....	S. B. Hart.
1.60	1.91	4.23	....	....	....	....	....	
tr.	tr.	4.5	3.5		....	....	....	
1.05	1.57	4	6.51		....	....	....	Clay Worker, Dec., 1893.
....	....	2.30	13.90		P_2O_5 1.15	....		
....	....	1.31	9.68		SO_3 .04	....	....	Byrnes on Roadways.
....	tr.	.40	13.80		....	1.50	....	Do.
....	....	.20	14.60		....	tr.	....	Do.
.82	2.32	3.78	....	....	....	....	....	Clay Worker, Dec., 1893
2.13	.94	.98	4.96	....	....	....	....	
.01	....	.49	13.59	1.21	....	1.40	....	New Jersey Clay Rept., 1878.
4.14	3.15	3.42	7	.60	SO_2 .89	P_2O_5 .13	....	Do.

Analyses of clays of the United States—Continued.

PAVING-BRICK CLAYS—Continued.

State and county.	Town.	Material.	Silica. Combined.	Silica. Free.	Alumina.	Ferric oxide.
New York:						
Onondaga	Warners	Clay	44.74		18.70	4.25
	do	Shale	52.30		18.85	6.55
Steuben	Hornellsville	do	67.29		15.85	6.16
Ohio:						
Athens	Glouster	Shale clay	57.15		20.26	7.54
Richland	Darlington	do	57.45		21.06	7.54
Franklin	Columbus	do	58.38		20.89	5.78
Stark	Canton	do	53.38		19.36	14.86
Do	North Industry	do	56.61		21.63	7.08
Columbiana		Fire clay	54.53		27.88	2.41
Jefferson		do	51.72		30.10	1.94
Do	Island Siding	do	51.82		28.69	2.77
Columbiana	East Palestine	do	57.80		25.54	2.51
Jefferson	Toronto	do	70		19.35	2.22
Do	Elliottsville	do	77.65		12.78	3.32
	do	do	59.20		26.10	2.70
	Croxton Run	do	58.10		29.60	1.20
Hocking	Haydensville	Shale	69.92		23.46	.20
Montgomery	Brookville	Clay	62.05		27.71	.60
Pennsylvania:						
Beaver	Monaca	Shale clay	63.37		19.08	6.42
Do	Rochester		66		23.10	.65
Mercer	Sharon	Red shale	62.86		20.65	9.21
Do	do	Blue shale	63.69		23.90	3.57
Beaver	Woodlawn	Clay	42.15		31.43	2.32
Do	New Brighton	do	67.36		22.05	5.61
Tennessee:						
	Powdes Station	do	68.35		12.96	6.44
Hamilton	Chattanooga	do	68.96		20.42	1.84
Scott	Robbins	do	70.57		15.19	7.97
Texas:						
Henderson	Morrison's	do	72.30		19.33	2.47
West Virginia:						
	Cumberland	do	69.02		22.07	4.53
Marion	Nuzums Mills	do	59.25		32.26	1.67

TERRA-COTTA CLAYS.

State and county.	Town.	Material.	Silica. Combined.	Silica. Free.	Alumina.	Ferric oxide.
California:						
Monterey	Jolon	Clay	85.07		7.85	1.16
Butte	Chico	do	88.70		4.50	.50
Colorado:						
Jefferson	Golden		68.40		18.88	1.56
New York:						
Allegany	Alfred Center	Chemung shale	53.20		23.25	10.90
Saratoga	Glens Falls. (See Brick clays.)					
Pennsylvania:						
Beaver	New Brighton		61.97		22.94	a1.818
Virginia:						
Augusta	Staunton		75.86		13.40	2.66
South Dakota:						
Pennington	Rapid City	Shale clay	70.78		16.73	2.78

Analyses of clays of the United States—Continued.

PAVING-BRICK CLAYS—Continued.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
11.25	1.29	1.20	9.25		SO_3 2.78	CO_2 7.50	....	
3.36	4.49	6		5.30		CO_2 3.04	MnO tr.	R. Froehling, anal.
.95	.19	8.71	....	....	....	....	....	
.90	1.62	3.63	5.50	2.70	....	....	....	Ohio Geol. Surv., VII, 1893, p. 134.
.29	1.22	3.66	5.90	1.90	....	....	....	Do.
.44	1.57	5.02	7.53	....	....	....	....	Do.
1.48	1.06	....	....	....	....	....	....	Do.
1.11	1.41	3.99	....	....	....	....	....	Do.
.42	.68	3.43	8.87	.76	....	1.26	....	Ibid., p. 137.
.62	.53	2.74	9.95	1.05	....	1.35	....	Do.
.77	1.41	2 82	9.67	1.72	....	.72	....	Do.
.25	.61	2.69	8.35	2.25	....	....	....	Do.
.15	.34	2.90	5.39	....	....	....	....	Do.
.55	.45	1.30	4.10	....	....	....	....	Do.
1.05	.75	1.53	8.55	....	....	....	....	Do.
.40	.54	1.75	8.70	....	....	....	....	Do.
.48	.40	1.43	3.84	....	....	....	....	Ibid., V, 1884, p. 139.
.15	.20	2.40	6.67		....	....	....	Do.
.06	.33	3.24	7.50		....	1.26	....	Monong. Fire Clay Co.
.41	1.18	2.19	5.38		FeS 1.09	....	....	Park Fire Clay Co.
.48	.34	....	....	....	Ign. 6.26	....	....	Eclipse Paving Brick and Clay Mfg. Co.
.44	tr.	....	....	....	Ign. 8.36	....	....	Do.
.32	2.01	....	10.60		....	1	....	
.86	.36	5.40	....	....	....	....	....	
.23	1	2.14	....	....	Ign. 7.8	MnO .9	....	J. W. Slocum, anal.
.16	.33	2.18	6.50	....	....	MnO tr.	....	Tennessee Paving Brick Co.
.78	.32	2.30	....	....	....	....	....	Clay Worker, Dec., 1893.
tr.	.50	4.44	....	....			....	Texas Geol. Surv., 1890, p. 199.
1.70	.38	2.68	....	....	....	....	....	Clay Worker, Dec., 1893.
7.16	....	....	6.30		....	....	....	Byrnes on Roadways.

TERRA-COTTA CLAYS.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
0.25	0.35	0.93	4.35		....	....	....	9th Rept. California State Min., p. 302.
.93	.36	.63	4.46		....	....	....	Do.
.55	.45	1.71	8.20		....	....	....	
1.01	.62	2.70	6.39	....	MnO .52	.91	SO_3 .41	Celadon Terra Cotta Co.
....	....	....	....	....	....	....	....	
.44	.522	1.75	8.85		....	1.975	....	Pennsylvania Geol. Surv., MM. p. 262.
.28	.822	1.737	5.206	....	SO_3 tr.	....	....	Terra Cotta Tile Works.
.21	.90	....	6.71		....	....	....	Rapid City Steam Brick Works.

Analyses of clays of the United States—Continued.

PIPECLAYS.

State and county.	Town.	Material.	Silica. Combined.	Silica. Free.	Alumina.	Ferric oxide.
Georgia:						
Baldwin	Stephens Pottery		52.78		32.30	0.05
Kentucky:						
Calloway	New Providence	White clay	61.68		28.50	1.68
Marshall	Pughs Place	Clay	62.92		29.88	
New Jersey:						
Middlesex	Woodbridge	do	67.70		19.91	1.69
	do	do	33	29.10	23.80	1.60
New York:						
Erie	Angola	Shale	65.15		15.29	6.16
North Dakota:						
Cavalier	Langdon	Clay	50.45		17.57	2.80
Ohio:						
Jefferson	Freeman. (See also analyses of Ohio paving-brick clays.)		39.03	15.50	27.88	2.41

RESIDUAL CLAYS.

Alabama:					
Calhoun	Morrisville	From Knoxville limestone.	55.42	22.17	8.30
Arkansas		From St. Clair limestone.	33.55	30.18	1.98
Georgia:					
Bartow	Cartersville		58.63	20.47	8.58
Polk	Rock Mart	Caen stone	61.66	19.64	7.54
Kentucky:					
Graves		From chert	76.78	14.74	1.64
Massachusetts:					
Hampden	Blandford		52.03	31.76	tr.
North Carolina:					
Wake	Cary		54.54	26.43	9.04
Pennsylvania:					
Lehigh	Fogelsville	From slate	72.164	21.764	.99
Wisconsin:					
Wood	Grand Rapids		70.83	18.98	1.24

Analyses of clays of the United States—Continued.

PIPECLAYS.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
...	0.42	0.55	13.54		0.36	...	...	H. C. White, anal.
.101	.136	1.98	5.923		...	...	...	Kentucky Geol. Surv., Chem. Rept. A, pt. 3, No. 2640.
tr.	.209	1.736	5.255		...	...	...	Ibid., No. 2763
...	.72	2.56	5.50	1	...	1	...	New Jersey Clay Rept., 1878, p. 82.
tr.	.57	2.77	6.70	1	...	1.70	...	Ibid., p. 113.
3.50	1.57	5.71	...	...	...	...	...	H. T. Vulte, anal.
.25	1.79	.93	22.55		Loss 3.66	...	...	Rept. Labor Bureau, 1891-92.
.42	.68	3.43	8.87	.76	...	1.26	...	Ohio Geol. Surv., V, 1884.

RESIDUAL CLAYS.

Lime.	Magnesia.	Alkalies.	Water. Combined.	Water. Free.	Organic matter.	Titanic acid.	Miscellaneous.	Firm names, authority, or analyst.
0.15	1.45	2.49	9.86		...	...	...	
3.89	.26	1.57	10.72		P_2O_5 2.53	...	...	From Ark. Geol. Surv., Rept. on manganese.
tr.	1.42	4.00	7.26		...	...	...	Georgia Geol. Surv., 1893.
tr.	tr.	2.32	...		...	...	...	Do.
tr.	.389	1.557	4.894		...	...	...	Kentucky Geol. Surv., Chem. Rept. A, Pt. III.
tr.	.54	...	15.55			...	...	Tech. Quart., 1890.
...	...	...	9.87		...	...	...	
.224	.698	5.139	4.758		...	...	...	Pennsylvania Geol. Surv., D, p. 13.
.24	.02	2.59	5.45		CO_2 1.02	...	...	Wisconsin Ac. Sci., 1870-1876.

CEMENT.

AMERICAN ROCK CEMENT.

By Uriah Cummings.

HYDRAULIC CEMENT.

INCREASED PRODUCT.

There was a slight increase in the production of natural-rock cement during 1894, which is very encouraging considering the prolonged business depression. The increase was confined mostly to Louisville, Ky., Milwaukee, Wis., and the Lehigh Valley district, in Pennsylvania. In most of the other districts there was a slight falling off in the production. The demand was steady throughout the season, and the volume was slightly above the average for the past five years.

PRICE.

There has been an advance of 4.2 cents per barrel over the prices for 1893, and they were a trifle above the average for the past five years.

Prices of natural-rock cement in bulk at mills.

	Cents per barrel.
1890	51.37
1891	47.26
1892	48.61
1893	43.87
1894	48.07

NEW DEVELOPMENTS.

A new plant with a capacity for producing about 250 barrels per day has been erected at Austin, Minn. The cement from this plant was placed on the market during the summer of 1894.

The works of the Howard Hydraulic Cement Company, at Cement, Ga., which were entirely destroyed by fire April 30, 1895, are being rebuilt on a much larger scale, and with all the modern appliances for a successful prosecution of the business.

PRODUCT.

The following table gives the amount and value of the hydraulic cement produced in the United States during 1893 and 1894. The values are based on the price per barrel in bulk at the various factories. The cost of package is always added to the price of the cement by the manufacturer. In the Eastern States the packages are almost wholly of wood, while in the Western States probably over 90 per cent of the cement is sold in jute or paper sacks. For these reasons the values in the table are given exclusive of packages:

Product of hydraulic cement in 1893 and 1894.

States.	1893.			1894.		
	Number of works.	Barrels.	Value.	Number of works.	Barrels.	Value.
Georgia	1	10,273	$7,182	1	9,266	$7,094
Illinois	2	522,972	153,039	2	446,267	133,880
Indiana and Kentucky	13	1,750,350	525,105	13	2,000,000	800,000
Kansas	1	60,000	21,000	1	50,000	25,000
Maryland and West Virginia	5	231,590	125,554	6	279,000	136,250
Minnesota	1	75,000	37,500	1	63,290	31,645
New Mexico	1	1,500	1,125		Idle.	
New York:						
Ulster County	17	2,738,884	1,506,386	17	2,659,601	1,595,760
Erie County	4	675,000	327,500	4	578,800	289,400
Onondaga County	8	161,308	57,394	8	187,929	78,303
Schoharie County	1	22,566	14,668	1	20,000	11,000
Ohio	3	68,000	43,550	3	55,023	33,598
Pennsylvania	6	567,110	265,159	5	605,812	269,701
Texas	1	10,000	25,000	1	12,000	18,000
Utah	1	5,000	6,250		Idle.	
Virginia	1	17,509	10,707	2	14,500	8,700
Wisconsin	2	494,753	124,638	2	582,000	197,400
Total	68	7,411,815	3,251,757	67	7,563,488	3,635,731

Production of cement of all kinds in the United States since 1880.

Years.	Production.	Value.
	Barrels.	
1880	2,072,943	$1,852,707
1881	2,500,000	2,000,000
1882	3,250,000	3,672,750
1883	4,190,000	4,293,500
1884	4,000,000	3,720,000
1885	4,150,000	3,492,500
1886	4,500,000	3,990,000
1887	6,692,744	5,674,377
1888	6,503,295	5,021,139
1889	7,000,000	5,000,000
1890	8,000,000	6,000,000
1891	8,222,792	6,680,951
1892	8,758,621	7,152,750
1893	8,002,467	6,262,841
1894	8,362,245	5,030,081

That the United States leads the world in the manufacture of natural-rock cement is unquestionably due to the undeniable fact that in no other country is the material to be found which combines within itself so many features of general excellence as to require no artificial manipulation for improving its quality.

The principal source of rock cements in Europe is from the Liassic, or Upper and Lower Blue Lias subdivision of the Jurassic rock formation, the uneven quality of which readily accounts for the recourse to artificial mixtures which has now so universally obtained in that country. The Blue Lias, from which the rock cements are obtained, consists in its lower portion of layers of blue and gray limestones, more or less argillaceous. These layers occur sometimes in even and sometimes in irregular bands, often nodular and interrupted, and they alternate with blue and brown marls, clays, and shales. Nowhere in the Lower Lias is there any marked band of rock which can be traced continuously for any great distance.

The upper portion of the Lower Lias consists of more or less micaceous blue clays, shales, and marls, with occasional septaria nodules and bands of earthy and shelly limestones and sandy layers. There is no rigid plane of demarcation between them and the mass of limestones beneath, while the clays pass upward into the lower beds of the Middle Lias, with no lithological break or divisional line. There is no layer of the rock used for cement purposes which does not vary in its proportion of clay, ofttimes as much as 20 per cent in individual quarries, and we find that while one layer may contain 8 per cent, the one next above or below may contain 50 per cent of clay. Clearly, it is not remarkable that a cement made from such an ill-assorted mass of material should lack in uniformity.

No experienced cement manufacturer in America would undertake to produce a rock cement from such a mixture of clays, shales, marls, nodules, limestones, and cement stones. It is not surprising that artificial mixtures were employed in an endeavor to meet and overcome the dissatisfaction unavoidably growing out of the use of such natural-rock cements. Contrasting these materials with our own massive cement-rock deposits, we find that we have immense beds of cement rock, absolutely free from any extraneous substances, perfectly pure and clean, with layer upon layer extending for thousands of feet without an appreciable variation in the proportions of ingredients.

Cement-rock quarries are worked in this country decade after decade without the necessity of rejecting a pound of the material, and the analyses taken during successive years show no marked changes whatever in the constituent parts. Had England and France possessed such cement-rock formations as are so well distributed throughout this country it is extremely doubtful if the production of artificial cement would have been resorted to. Under such circumstances there would have been no occasion for it.

The magnitude and value of the work done with the natural rock cements of this country is almost beyond comprehension. They have been used in the largest buildings, tunnels, bridges, dams, and aqueducts constructed in America, and a failure has yet to be reported and recorded. More than 100,000,000 barrels have been so used during the past twenty years.

To enumerate the engineering and architectural structures into which this enormous amount of cement has entered would require several volumes, and attention will be called to but a few, which will serve as a fresh reminder that we have here at home hydraulic cement which for cheapness, safety, durability, and positive excellence can not be surpassed by any cement, whether natural or artificial, that is now known to the world.

Among the structures built with native American rock cements we would call attention to the following as being a few of the many in various localities:

Washington, D. C.—State, War and Navy, Department building, Bureau of Engraving and Printing building, Patent Office, National Museum, Pension Office, Library of Congress, Boundary sewer system, etc.

New York.—The old and new Croton aqueducts, High Bridge over the Harlem, foundations and to high-water mark of the Brooklyn Bridge, the entire sewer system of New York and Brooklyn, nine-tenths of the tall modern buildings of lower Broadway, the elevated railroad system, and all of the older New York, the bridges across the Hudson at Poughkeepsie and Albany, the Albany capitol building, all the bridges over the Niagara River, the entire sewer and concrete paving and waterworks systems of Buffalo, and all the important buildings of that city, such as the City and County Hall, the Erie County Savings Bank building, etc.

Cleveland, Ohio.—The great viaduct, the waterworks tunnel under Lake Erie, and the vast sewer system, and nearly every important building in that city.

Chicago, Ill.—The Chicago Board of Trade building, Rialto office building, Pullman works entire, Rookery building, Home Insurance building, Marshall Field wholesale building, the immense Chicago Public Library building, and many other important structures, the several tunnels under the rivers and under Lake Michigan, the elevated railroads, etc.

Farther West.—The great bridges over the Mississippi, Missouri, and Ohio rivers, the public works of Cincinnati, Louisville, St. Louis, St. Paul, Minneapolis, Omaha, Sioux City, and lesser cities, constructed exclusively with American rock cements, together with the almost endless masonry work of the thousands of miles of railroads throughout the entire country, tell the story of the value of our homemade cements, and should stand as an ever-present rebuke to the advocates of imported cements, which, although they may set harder in a short length of time, are no harder after five years, and in process of time the fact will be universally acknowledged that a cement formed by rapid setting is in no manner equal in enduring qualities to one of slower and therefore more perfect setting, such as is found inherent in the natural-rock cements of this country.

PORTLAND CEMENT.

By Spencer B. Newberry.

INCREASED PRODUCT.

The production of Portland cement in the United States during the year 1894 reached a total of 798,757 barrels, as compared with 590,652 barrels in 1893, an increase of 208,105 barrels, or 35 per cent. The increase is not confined to any particular section of the country, but is generally distributed. It results in part from the establishment of new factories, of which 24 were in operation in 1894, as compared with 19 in 1893. The chief increase is, however, seen in the output of the older factories, notably in Lehigh County, Pa. From all sides come reports of the establishment of new works and extension of older plants, so that there is reason to expect a decided further increase in production in 1895. The imports for the year 1894 were 2,638,107 barrels, valued at $3,396,729, a slight decrease from the amount imported in 1893. The following table shows the relative proportion of Portland cement made in this country and imported during the past four years:

Comparison of the domestic production of Portland cement with the imports.

	1891.	1892.	1893.	1894.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
Production in the United States	454, 813	547, 440	590, 652	798, 757
Imports	2, 988, 313	2, 440, 654	2, 674, 149	2, 638, 107
Total	3, 443, 126	2, 988, 094	3, 264, 801	3, 436, 864
Exports	....	21, 536	14, 276	9, 725
Total consumption	3, 443, 126	2, 966, 558	3, 250, 525	3, 427, 139
Percentage of total consumption produced in the United States	13.2	18.4	18.2	23.3

From the above table it appears that the importation of cement into this country has remained nearly stationary since 1891, and that the domestic product has gained rapidly in comparison with the imported, until in 1894 nearly one-fourth of the Portland cement used was of American manufacture. There is little doubt that this gain will continue, and that within a very few years practically all the Portland cement required in this country will be manufactured at home. There is reason to expect a great increase in production during the year 1895, as several new factories are under construction and will be in operation before the close of the season. The low freight rate on cement from Europe to Chicago is no longer offered, and the price of foreign cement shows a decided advance at the beginning of the new year. There appears to be everywhere a decided scarcity of Portland cement, and there is reason to believe that the capacity of American factories will be taxed to its utmost during the next few months. Good American Portland is to be had at 50 cents to $1 per barrel less than the best German, and is being extensively adopted for large Government and private contracts. The battle between natural-rock and Portland cements has been fought out in England and Germany, and has resulted in the complete victory of Portland, and the practical disappearance of the natural-rock cement industry. The result in this country can hardly be so decisive, as most of the natural-rock cements produced here are certainly greatly superior to the Roman cements formerly made in Europe.

The following table shows the product of Portland cement, by States, in 1893 and 1894. In compiling the returns for the past year it was decided to calculate the values in bulk, instead of in barrels, owing to the fact that by far the larger part of the American cement produced is shipped in paper or cloth sacks, and not in barrels:

Product of Portland cement in the United States, 1893 and 1894.

States.	1893.			1894.		
	Number of works.	Product.	Value, including barrels.	Number of works.	Product.	Value, not including barrels.
		Barrels.			*Barrels.*	
California				1	19,300	$43,425
Colorado	1	10,000	$25,000	1	15,000	37,500
Dakota	1	33,739	69,502	1	43,500	80,475
Illinois				1	300	540
Indiana	1	20,000	45,000	1	4,000	7,200
New York	5	137,096	287,725	4	117,275	205,231
New Jersey	1	60,000	96,000	1	72,223	119,168
Ohio	3	36,500	85,500	4	80,653	144,425
Pennsylvania	6	285,317	521,411	7	437,106	718,009
Texas	1	8,000	28,000	1	8,000	24,000
Utah				2	1,400	3,500
Total	19	590,652	1,158,138	24	798,757	1,383,473

MATERIALS.

Portland cement is made from carbonate of lime and clay. These materials may be naturally mixed, as in the case of argillaceous limestones, or entirely separate. In all cases, however, it is necessary to bring the material to correct composition by artificial additions and thorough mixing. In England chalk is the form of carbonate of lime employed. In Germany the chief material is marl (mergel), by which is understood a more or less hard limestone rock containing clay. In some German factories a pure soft marl (wiesenkalk), or fresh-water chalk, is used, consisting chiefly of carbonate of lime and similar to the marl deposits of this country.

In the United States the materials used are very similar to those of Germany. Most of our clay limestones are highly magnesian, and therefore unsuitable for Portland cement, though they are used on an immense scale for natural-rock cements. At certain localities, however, as in Lehigh County, Pa., at Phillipsburg, N. J., and in the far West, limestones containing sufficient clay and nearly free from magnesia are abundantly found, and in the above localities and from this material most of our Portland cement is made. In the Lehigh County region, the chief seat of the American Portland cement industry, the different strata of rock are carefully selected and mixed in such proportions as to give a material of the right composition.

In central New York, and at a few points in Ohio and Indiana, large deposits of pure white marl are found. This is generally called "shell marl," and is supposed to result from the disintegration of fresh-water shells. In the opinion of the writer, however, these marl beds are generally pulverulent deposits from calcareous springs, and are not formed from shells. At the localities above mentioned this material, artificially mixed with clay, is largely used for the manufacture of Portland cement. Owing to the soft, fine-grained character of the marl the mixing can be much more cheaply done than in the case of limestone, though this advantage is largely compensated for by the necessity of drying out the 40 to 50 per cent of water which the marl generally contains.

As already stated, most American Portland cement is made from argillaceous limestone, as shown by the following table:

Number of cement factories using limestone compared with the users of marl.

Factories producing—	Number.	Quantity.
		Barrels.
Limestone	17	611, 829
Marl	7	186, 928
Total	24	798, 757

The first group includes 6 factories in the Lehigh County region, in Pennsylvania, producing over 400,000 barrels; one at Phillipsburg, N. J.; and 10 at other points. The second group, using marl, includes four factories in New York, two in Ohio, and one in Indiana.

PROCESSES.

There are four distinct forms of kiln used in burning Portland cement. These are (1) intermittent or dome kiln, (2) continuous kiln, of the Dietzsch or Shöfer type, (3) Hoffmann ring furnace, (4) rotary furnace. In the old-fashioned intermittent kiln the bricks of cement mixture are charged into the kiln with coke in alternate layers, and the whole allowed to burn out and cool down before emptying. The Dietzsch or

Shöfer continuous kiln is continuously charged with bricks of cement mixture and soft coal, and the burned clinker periodically withdrawn at the bottom. It presents the great advantage of cheaper fuel and economy of labor. The Hoffmann ring furnace consists of a number of chambers arranged around a central stack. These are filled with bricks of cement mixture and the fuel introduced through the openings in the top. This form of kiln is economical of fuel, but requires more labor than the other types of kiln. The Hoffmann ring furnace is used in this country to some extent in burning brick, sewer pipe, and lime, but not, so far as the writer can learn, in the manufacture of cement. The rotary furnace has been fully described in previous reports. Crude or fuel oil is used as a source of heat at all points where this kiln is employed.

In the United States most of the Portland cement produced is burned in the old-fashioned intermittent kilns. The Dietzsch kiln is used at Harper and Middle Branch, Ohio. The Shöfer kiln is to be used at new works now beginning operations at Glens Falls, N. Y. The rotary furnace is in operation at Colton, Cal.; Phillipsburg, N. J.; Coplay, Pa., and Sandusky Ohio. The following table shows the number of barrels of cement made during the past two years in vertical kilns (continuous and intermittent) and the rotary furnace:

Amount of Portland cement made in kilns of various kinds.

	1893.	1894.
	Barrels.	*Barrels.*
Rotary furnace	149,000	242,176
Vertical kilns (continuous and intermittent)	441,653	556,581
Total	590,653	798,757

It thus appears that the output of rotary furnaces has increased much more rapidly than that of vertical kilns. The recent rapid advance in the price of crude oil is a great obstacle to the use of the rotary furnace. Attempts are being made to substitute producer gas for crude oil in burning cement. There is no reason why this should not be successfully done, and the change will greatly reduce the cost of burning cement at all points where the rotary process is used.

For grinding the finished product the Griffin steel mill is used at the larger factories. Some of the older works still use buhrstones. The Griffin mill consists of a steel ring, against the inside surface of which a heavy steel roll revolving on a vertical shaft presses by centrifugal force. The mill is provided with screens which allow powder of the requisite fineness to pass through, while the coarser particles drop back into the mill. This mill is an American invention, and is rapidly finding its way into the leading cement works of Germany.

GENERAL NOTES ON THE PORTLAND CEMENT INDUSTRY.

California.—In 1894 a new factory began operations at Colton. The materials used are a white "coralline" limestone, stated to contain 99.30 per cent carbonate of lime and 0.38 per cent silica and graphite. The clay used contains 47.5 per cent silica, 32.6 per cent alumina and iron oxide, 10.4 per cent lime, and 1.02 per cent magnesia. The materials are mixed in the dry state and burned in a rotary furnace, using crude oil as fuel. The present capacity of the plant is stated to be 180 barrels per day. Enlargements are in progress which will give double this capacity by August, 1895.

New York.—The works of the Warner's Portland Cement Company were not in operation during 1894. New works are in process of erection at Cassadaga Lake, Chautauqua County. The bottom and shores of this lake are composed of white marl, which will be taken out by means of a dredge. At Glens Falls, N. Y., works were erected in 1893 for the manufacture of Portland cement, and began operations in April, 1894. The enterprise is under the direction of Capt. W. W. Maclay, formerly chief of the department of docks, New York City, and well known as an expert on cement testing. At these works limestone of the Devonian formation is used. This contains 93 per cent carbonate of lime and 2 per cent insoluble matter. The clay employed contains 59 per cent silica, 23 per cent alumina, and 6 per cent iron oxide. The dry process is used in mixing, and the burning is done partly in intermittent kilns and partly in continuous kilns of the Shöfer type. The total capacity of the works is stated to be about 350 barrels per day.

New Jersey.—The works of Thos. D. Whitaker at Phillipsburg were partly destroyed by fire January 20, 1894, and were shut down in consequence until May 15. Another factory is being erected at Phillipsburg by the Vulcanite Cement Company.

IMPORTS.

The following table shows the imports of all classes of cement into the United States during the fiscal years ending June 30, 1893 and 1894, arranged by ports.

Imports of cement, by ports, during the fiscal years ending June 30, 1893 and 1894.

Ports.	1893.		1894.	
	Pounds.	Value.	Pounds.	Value.
Atlantic coast.				
Aroostook, Me	8	$2	163,000	$853
Baltimore, Md	108,479,638	359,144	77,968,821	249,039
Bath, Me			8,400	54
Boston and Charlestown, Mass	61,346,305	208,783	62,072,160	198,653
Charleston, S. C	2,482,400	8,709	6,224,911	21,956
Georgetown, D. C	4,000	10	165,345	655
Newport News, Va			11,904,000	35,920
New York, N. Y	504,135,906	1,690,622	384,406,068	1,251,090
Passamaquoddy, Me	600	4		
Philadelphia, Pa	129,883,778	412,140	111,829,516	348,662
Portland and Falmouth, Me			1,699,608	5,246
Richmond, Va			200,000	613
Savannah, Ga	6,350,902	19,031	9,881,156	27,008
Wilmington, N. C	222,224	800		
Total	812,905,761	2,699,245	666,522,985	2,139,749
Gulf coast.				
Galveston, Tex	27,563,767	93,322	19,207,393	58,681
New Orleans, La	112,445,409	377,288	83,794,052	273,570
Pensacola, Fla	806,840	3,261	1,315,559	4,005
Tampa, Fla	936,000	3,225		
Total	141,752,016	477,096	104,317,004	336,256
Pacific coast.				
Los Angeles, Cal	11,027,183	36,068	6,658,448	21,637
Oregon, Oregon			399,980	1,277
Puget Sound, Wash	24,141,906	82,079	21,706,002	66,665
San Diego, Cal	22,744,180	79,300	14,761,600	48,802
San Francisco, Cal	82,643,856	279,478	135,889,312	433,364
Willamette, Oregon	14,652,325	49,706	47,560,684	155,222
Total	155,209,450	526,631	226,976,026	726,967
Lake.				
Buffalo Creek, N. Y	115	40		
Cape Vincent, N. Y	50,900	164	76,450	245
Champlain, N. Y	98,900	387		
Chicago, Ill	1,374,262	4,811	998,026	3,289
Cuyahoga, Ohio	40,000	136	194,000	808
Detroit, Mich	11,000	61	313,300	1,420
Huron, Mich			2,700	20
Miami, Ohio			412,500	1,750
Oswegatchie, N. Y	815,285	2,476	3,605	27
Oswego, N. Y	2,220	12	74,000	400
Total	2,392,682	8,087	2,074,581	7,959
Interior.				
Vermont	5,600	26	5,600	26
Cincinnati, Ohio	99,207	393		
Indianapolis, Ind			80,000	255
Kansas City, Mo	80,000	257	80,000	260
Louisville, Ky	266,138	1,008	200,000	618
St. Louis, Mo	12,223,701	47,701	14,877,677	52,997
Total	12,654,646	49,385	15,243,277	54,156
Grand total	1,124,914,555	3,760,444	1,015,133,873	3,265,087

ABRASIVE MATERIALS.

By Edward W. Parker.

BUHRSTONES.

Buhrstones, or millstones, are made from a quartz conglomerate rock occurring along the eastern slope of the Alleghany Mountains in New York, Pennsylvania, and North Carolina. It is known locally by various names. In Ulster County, N. Y., it is called "Esopus stone;" in Lancaster County, Pa., it is known as "cocalico stone;" in Montgomery County, Va., it is quarried as "Brush Mountain stone," and in Moore County, N. C., it goes by the name of "North Carolina grit." The industry has been on the decline for a number of years, the introduction of the roller process in flouring mills having cut off the chief market for buhrstones. Their use now is practically confined to the grinding of paint and cement rock. In remote regions of the Appalachian range, particularly in the Southern States, owners of mills which grind corn for the neighboring mountaineers use stones made from rock quarried in the vicinity. They usually work up the stones themselves, and there is no way of obtaining either the amount or value of the product. This small factor is not considered in the statistics of production.

Although classed as buhrstone, the domestic material is entirely distinct from any of the buhrs which are imported from France, Belgium, and Germany. The French buhr is considered the best. Both it and the Belgian buhr consist of small particles of silica mixed with calcareous material, and are hard and porous. The German buhr is said to be of basaltic lava. The domestic stone is a quartz conglomerate. All of the foreign stone is quarried in small pieces, which are shipped in the rough state at cheap freight rates to this country where they are dressed to conformable shapes, fitted together, and bound into solid wheels. The domestic stone is found in large bowlders, which are worked down to millstones of the required size, the chief advantage for these being in the fact that they are in one piece. The domestic stone is of much coarser grain than the foreign and is not suitable for grinding wheat, its use being limited to the coarser cereals, paints, cements, fertilizers, etc. During the past few years a new millstone made of emery ore, ground and cemented into solid wheels, has been introduced. It is said to be superior to any of the others, and has certainly been favorably received. The continued decrease in production indicates that the emery-rock millstones have superseded the domestic buhrstones to some extent already.

PRODUCTION.

The value of buhrstones of domestic production in 1894 was only $13,887, the smallest on record, and less than 10 per cent of the value of the product in 1884, ten years previous. The product was from New York, Pennsylvania, and Virginia. In the following table is exhibited the value of the millstones produced in the United States since 1880:

Value of buhrstones produced in the United States from 1880 to 1894.

Years.	Value.	Years.	Value.
1880	$200,000	1888	$81,000
1881	150,000	1889	35,155
1882	200,000	1890	23,720
1883	150,000	1891	16,587
1884	150,000	1892	23,417
1885	100,000	1893	16,639
1886	140,000	1894	13,887
1887	100,000		

IMPORTS.

Value of buhrstones and millstones imported into the United States from 1868 to 1894.

Years ended—	Rough.	Made into millstones.	Total.	Year ended—	Rough.	Made into millstones.	Total.
June 30, 1868..	$74,224	....	$74,224	June 30, 1882..	$103,287	$747	$104,034
1869..	57,942	$2,419	60,361	1883..	73,413	272	73,685
1870..	58,601	2,297	60,898	1884..	45,837	263	46,100
1871..	35,406	3,698	39,104	1885..	35,022	455	35,477
1872..	69,062	5,967	75,029	Dec. 31, 1886..	29,273	662	29,935
1873..	60,463	8,115	68,578	1887..	23,816	191	24,007
1874..	36,540	43,170	79,710	1888..	36,523	705	37,228
1875..	48,068	66,991	115,059	1889..	40,432	452	40,884
1876..	37,759	46,328	84,087	1890..	32,892	1,103	33,995
1877..	60,857	23,068	83,925	1891..	23,997	42	24,039
1878..	87,679	1,928	89,607	1892..	33,657	529	34,186
1879..	101,484	5,088	106,572	1893..	29,532	729	30,261
1880..	120,441	4,631	125,072	1894..	....	....	*a* 18,087
1881..	100,417	3,495	103,912				

a Not separately classified after 1893.

GRINDSTONES.

The total value of grindstones produced in the United States in 1894 was $223,214, against $338,787 in 1893, a decrease of $115,573, or a little more than 33 per cent. The decrease is attributed to the trade depression and the general decline in values.

The production of grindstones is limited to Ohio and Michigan. The following table shows the value of grindstones produced annually in the United States since 1880:

Value of grindstones produced in the United States, 1880 to 1894.

Years.	Value.	Years.	Value.
1880	$500,000	1888	$281,800
1881	500,000	1889	439,587
1882	700,000	1890	450,000
1883	600,000	1891	476,113
1884	570,000	1892	272,244
1885	500,000	1893	338,787
1886	250,000	1894	223,214
1887	224,400		

Grindstones imported and entered for consumption in the United States, 1868 to 1894, inclusive.

Years ended—	Finished.		Unfinished or rough.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Long tons.		*Long tons.*		
June 30, 1868		$25,640		$35,215	$60,855
1869		15,878		99,715	115,593
1870		29,161		96,444	125,605
1871	385	43,781	3,957.15	60,935	104,716
1872	1,202	13,453	10,774.80	100,494	113,947
1873	1,437	17,033	8,376.84	94,900	111,933
1874	1,443	18,485	7,721.44	87,525	106,010
1875	1,373	17,642	7,656.17	90,172	107,814
1876	1,681	20,262	6,079.34	69,927	90,189
1877	1,245	18,546	4,979.75	58,575	77,121
1878	1,463	21,688	3,669.41	46,441	68,129
1879	1,603	24,904	4,584.16	52,343	77,247
1880	1,573	24,375	4,578.59	51,899	76,274
1881	2,064	30,288	5,044.71	56,840	87,128
1882	1,705	30,286	5,945.61	66,939	97,225
1883	1,755	28,055	6,945.63	77,797	105,852
1884					*a*86,286
1885					50,579
Dec. 31, 1886					39,149
1887					50,312
1888					51,755
1889					57,720
1890					45,115
1891					21,028
1892					61,052
1893					59,569
1894					52,688

a Since 1884 classed as finished or unfinished.

OILSTONES AND WHETSTONES.

PRODUCTION.

The production of oilstones, whetstones, etc., in 1894, was about the same as that of 1893, being valued at $136,873, against $135,173, the difference being but little more than 1 per cent. Included in this production are the two grades of novaculite from Arkansas, known respectively as "Arkansas" and "Washita" stone; the fine-grained sandstone of Orange County, Ind., known as "Hindostan" or "Orange" stone; Lake Superior stone, a gray sandstone quarried in Cuyahoga County, Ohio; Labrador stone, similar to the Lake Superior article, from Cortland County, N. Y., and chocolate stone from Lisbon, N. H. It also includes scythestones, made from Indian Pond and Lamoille sandstone, quarried in Grafton County, N. H., and Orleans County, Vt., and from Berea "grit," quarried at Berea, Ohio.[1]

The production of finished oilstones, etc., in the United States is practically controlled by one firm—the Pike Manufacturing Company, of Pike Station, N. H. The contracts with other firms, mentioned in Mineral Resources for 1893 as having been dissolved, were renewed during 1894, the principal competitive concerns agreeing to close down for a series of years. In addition to the Pike company's output a comparatively small number of whetstones were made in New York and Ohio by other firms, and another firm in Michigan was engaged in the manufacture of scythestones.

The reports of production by the Pike Manufacturing Company, which have been furnished this office for publication, may be taken as indicative of the condition of the industry. This company owns quarries in Haverhill, Piermont, Orford, and Lisbon, N. H.; Westmore and Brownington, Vt.; Cummington, Mass.; French Lick, Ga., and Orangeville and Paoli, Ind., and about 1,000 acres of quarry land in Garland County, Ark., thus covering the entire field.

The following tables show the production, exports, and imports of oilstones, etc., by the Pike Manufacturing Company for three years:

Production of oilstones, etc., by the Pike Manufacturing Company in 1892, 1893, and 1894.

Kinds.	1892.		1893.		1894.	
	Output.	Value.	Output.	Value.	Output.	Value.
Washita stone..........pounds..	400,000	$60,000	300,000	$45,000	300,000	$45,000
Arkansas stone............do....	20,000	12,000	12,000	12,000	15,000	15,000
Labrador stone............do....	500	50	200	20	100	10
Hindostan stone...........do....	300,000	15,000	250,000	13,000	300,000	15,000
Sandstone.................do....	100,000	2,000	100,000	2,000	100,000	2,200
Chocolate stone...........do....	20,000	2,000	20,000	2,000	25,000	2,500
Scythestones..............gross..	16,000	50,000	13,000	40,000	15,000	45,000
Total value................	....	141,050	....	114,020	....	124,710

Estimated exports of oilstones, etc., in 1892, 1893, and 1894.

Kinds.	1892.		1893.		1894.	
	Amount.	Value.	Amount.	Value.	Amount.	Value.
Scythestones..............gross..	8,000	$20,000	8,000	$19,000	9,000	$20,000
Washita stone..........pounds..	150,000	20,000	180,000	21,000	200,000	30,000
Arkansas stone............do....	9,000	12,250	8,000	10,500	8,000	10,000
Hindostan stone...........do....	75,000	2,250	100,000	3,500	150,000	7,000
Sandstone.................do....	....	....	50,000	1,000	40,000	800
Total value................	....	54,500	....	55,000	....	67,800

[1] See paper on Berea grit, by M. C. Read, Mineral Resources, 1882, p. 478.

Estimated imports of oilstones, etc., in 1892, 1893, and 1894.

Kinds.	1892.		1893.		1894.	
	Amount.	Value.	Amount.	Value.	Amount.	Value.
Turkey stone............pounds..	1,000	$200	1,000	$200	2,000	$400
Scotch stones (all kinds)...do....	8,000	800	4,000	400	3,000	300
Razor hones..............dozen..	1,000	2,000	1,000	1,500	2,000	5,000
English scythestones ....gross..	50	300	25	150	100	600
Norway Ragg scythestones......	....	None.	....	None.	....	None.
German emery scythestones.....	50,000	1,000	30,000	500	30,000	450
Naxos emery scythestones......	....	....	....	....	5,000	200
Total value...............	....	4,300	....	2,750	....	6,950

IMPORTS.

The following table shows the total value of all kinds of hones and whetstones imported since 1880:

Imports of hones and whetstones since 1880.

Years ended—	Value.	Years ended—	Value.
June 30, 1880	$14,185	Dec. 31, 1888	$30,676
1881	16,631	1889	27,400
1882	27,882	1890	37,454
1883	30,178	1891	35,344
1884	26,513	1892	33,420
1885	21,434	1893	25,301
Dec. 31, 1886	21,141	1894	26,671
1887	24,093		

CORUNDUM AND EMERY.

PRODUCTION.

The total amount of corundum produced in 1894 was 945 short tons and that of emery 550 tons, an aggregate of 1,495 short tons, the combined value of which was $95,936. This was the smallest product since 1888, but the value, while less than that of either 1892 or 1893, was more than that of 1890 or 1891, when the product was considerably more. The corundum output was, as in 1893, from Rabun County, Ga., Macon and Jackson counties, N. C., and Hampden County, Mass. No corundum was mined in Chester County, Pa., in either 1893 or 1894. The production and use of Westchester County, N. Y., emery is increasing, and the material is growing in favor for the manufacture of emery wheels, etc., in competition with Turkish and Naxos emery. Five years ago the shipments of emery from Westchester County did not exceed 30 tons. In 1894 the shipments were over 500 tons. Most of the product is shipped in crude form for manufacture at other points, some going by rail and some by boat from Peekskill. The decreased production of corundum in 1894 was caused by the closing down, temporarily, of some mines in North Carolina, the suspension being partly due to unfavorable trade conditions, and partly to bad weather, which had rendered the mountain roads impassable for wagons during a good part of the time.

The distribution of deposits of emery and corundum throughout the United States has been discussed at length in previous volumes of Mineral Resources.[1] A number of writers have contributed to the literature bearing upon the relative merits of corundum and emery as abrasives, but unfortunately they have been, as a usual thing, identified with one or the other interest, and their opinions are necessarily somewhat prejudiced. Mr. T. Dunkin Paret, of the Tanite Company, Stroudsburg, Pa., in papers on emery wheels and on emery and other abrasives, read before the Franklin Institute[2] of Philadelphia, has ably presented the cause of emery, while Mr. Charles N. Jenks, of the Sapphire Valley Corundum Company, of Sapphire, N. C., in the Scientific American Supplement, December 8, 1894, presents equally strong arguments in favor of corundum.

The introduction of rock emery into the manufacture of millstones, supplanting French and other buhrs, is of interest. They are said to run easier per ton of output than any other grinders, and to require less attention. They possess a greater hardness than any other grinding material, and do not require dressing or sharpening. Some of the supporters of millstones made from rock emery are predicting the supplanting by them of the roller process in flouring mills.

The following table shows the annual product of corundum and emery since 1881:

Annual product of corundum and emery since 1881.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1881	500	$80,000	1888	589	$91,620
1882	500	80,000	1889	2,245	105,567
1883	550	100,000	1890	1,970	89,395
1884	600	108,000	1891	2,247	90,230
1885	600	108,000	1892	1,771	181,300
1886	645	116,190	1893	1,713	142,325
1887	600	108,000	1894	1,495	95,936

[1] See Mineral Resources, 1882, p. 476; 1883-84, p. 714; 1893, p. 674.

[2] Journal of the Franklin Institute, March, 1890, and May and June, 1894.

IMPORTS.

The following table shows the imports of emery from 1867 to 1894:

Emery imported into the United States from 1867 to 1894, inclusive.

Years ended—	Grains.		Ore or rock.		Pulverized or ground.		Other manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
	Pounds.		*Long tons.*		*Pounds.*			
June 30, 1867	....	....	428	$14,373	924,431	$38,131	....	$52,504
1868	....	....	85	4,531	834,286	33,549	....	38,080
1869	....	....	964	35,205	924,161	42,711	....	77,916
1870	....	....	742	25,335	644,080	29,531	....	54,866
1871	....	....	615	15,870	613,624	28,941	....	44,811
1872	....	....	1,641	41,321	804,977	36,103	....	77,424
1873	610,117	$29,706	755	26,065	343,828	15,041	$107	70,919
1874	331,580	16,216	1,281	43,886	69,890	2,167	97	62,366
1875	487,725	23,345	961	31,972	85,853	2,990	20	58,327
1876	385,246	18,999	1,395	40,027	77,382	2,533	94	61,653
1877	343,697	16,615	852	21,964	96,351	3,603	....	42,182
1878	334,291	16,359	1,475	38,454	65,068	1,754	34	56,601
1879	496,633	24,456	2,478	58,065	133,556	4,985	....	87,506
1880	411,340	20,066	3,400	76,481	223,855	9,202	145	105,894
1881	454,790	22,101	2,884	67,781	177,174	7,497	53	97,432
1882	520,214	25,314	2,765	69,432	117,008	3,708	241	98,695
1883	474,105	22,767	2,447	59,282	93,010	3,172	269	85,490
1884	143,267	5,802	4,145	121,719	513,161	21,181	188	148,890
1885	228,329	9,886	2,445	55,368	194,314	8,789	757	74,800
Dec. 31, 1886	161,297	6,910	3,782	88,925	365,947	24,952	851	121,638
1887	367,239	14,290	2,078	45,033	*a*144,380	6,796	2,090	68,209
1888	430,397	16,216	5,175	93,287	....	....	8,743	118,246
1889	503,347	18,937	5,234	88,727	....	....	111,302	218,966
1890	534,968	20,382	3,867	97,939	....	....	5,046	123,367
1891	90,658	3,729	2,530	67,573	....	....	....	71,302
1892	566,448	22,586	5,280	95,625	....	....	2,412	120,623
1893	516,953	20,073	5,066	103,875	....	....	3,819	127,767
1894	597,713	18,645	2,804	51,487	....	....	1,841	71,973

a To June 30, only; since, classed with grains.

INFUSORIAL EARTH.

OCCURRENCE.

Deposits of infusorial earth, or tripoli, occur in several of the Atlantic States, and it has been mined in Connecticut, New Hampshire, New Jersey, Maryland, and Virginia. It also occurs and has been mined in Napa county, Cal., and near Virginia City, Nev. At the latter place mining is not prosecuted regularly, enough being obtained in one year to supply the owners with sufficient crude material to last for from three to five years. The principal use for the material is in the manufacture of polishing powders, etc., though it has been used to a considerable extent as an absorbent in the manufacture of dynamite from nitroglycerine, and as a protective packing around steam boilers. Its use as an absorbent has been supplanted by sawdust, and the increased use of asbestos in boiler packing has militated against the use of infusorial earth. Other occurrences than those mentioned above have been noted, particularly in some of the Western States, but they have not been worked.

PRODUCTION.

The production of infusorial earth is very irregular. In 1880 the value of the product was $45,660. In 1883 it had dropped to $5,000, and remained at approximately that figure for four years. In 1887 it increased to $15,000, but fell again to $7,500 in the following year. It increased to $23,372 in 1889, and again to $50,240 in 1890. The next year it decreased to $21,988; nearly doubled that in 1892, and again decreased in 1893 to $22,582. The value of the product in 1894 was but little more than half of that of 1893, being $11,718. The decrease was due chiefly to the suspension of mining at Popes Creek and Dunkirk, Md., formerly the principal producing localities. The mines in Napa County, Cal., were also idle, and the production was limited to New Hampshire, Connecticut, New Jersey and Nevada. The total output was 2,584 short tons, valued at $11,718, the smallest in point of value since 1888. The following table exhibits the annual output since 1880:

Production of infusorial earth from 1880 to 1894.

Years.	Short tons.	Value.	Years.	Short tons.	Value.
1880	1,833	$45,660	1888	1,500	$7,500
1881	1,000	10,000	1889	3,466	23,372
1882	1,000	8,000	1890	2,532	50,240
1883	1,000	5,000	1891	....	21,988
1884	1,000	5,000	1892	....	43,655
1885	1,000	5,000	1893	....	22,582
1886	1,200	6,000	1894	2,584	11,718
1887	3,000	15,000			

GARNET.

OCCURRENCE.

Garnet is mined or quarried in New York State in and near the valley of the upper Hudson River, in Warren County, on the borders of the Adirondack region. It all appears to be of the common variety, almandite, and occurs in a formation of crystalline limestone, which constitutes the bed rock of the valley in the vicinity of North Creek and Minerva, and in gneissic rocks which adjoin or are intercalated with the crystalline limestone. It is found in segregated masses of sizes varying from that of a pigeon's egg to a diameter of 20 feet. It is commercially classified as massive garnet, shell garnet, and pocket garnet, the former being impure from the admixture of other minerals. The shell garnet is almost entirely pure, and the most valuable for industrial purposes. The pocket garnet is that which occurs in small segregations or incipient crystals in the gneiss. Garnet is also found in Delaware County, Pa., where it is quarried under the name of "Rose" garnet to the extent of about 1,000 tons annually. It occurs there in small crystals thickly disseminated through a quartzose gneiss. There is also a deposit of garnet at Chester, Pa., which is worked to some extent. Large deposits of the mineral have been found in North Carolina, but its quality is not considered as satisfactory as that from the Adirondack region. Other deposits are said to occur in Georgia and Alaska, but no definite information can be obtained concerning them. Connecticut is also mentioned as a source of garnet.

USE.

This garnet is used almost exclusively in the manufacture of sandpaper, or "garnet paper," as it is called, which is employed extensively for abrasive purposes in the manufacture of boots and shoes. It is also employed to some extent in the wood manufacturing industry. For metals garnet is not as good as emery, although some satisfactory results have been obtained from its use on brass. It has been experimentally mixed with emery in the manufacture of emery wheels, but without very satisfactory results.

In commercial use garnet is found to be harder, sharper, and more lasting than quartz, and is preferred to it for certain kinds of work, although it costs about eight times as much as quartz. The Adirondack garnet is said to be worth about $40 a ton at the railroad, although the average value of the mineral throughout the country is stated to be about $35. The superiority of garnet to quartz is probably due to the fact of its ready cleavage, which enables it to present as it breaks away new and sharp-cutting edges, whereas quartz, which has no cleavage, becomes dulled by friction. The only garnet now mined in the Adirondack region is the pocket garnet, which is used to make the better grade of garnet paper. Some of the massive garnet has been used to make sandpaper for woodworking, and also mixed with corundum to make emery wheels.

PRODUCTION.

The total production of garnet and garnet sand in 1894 was 2,401 short tons, valued at $90,660. This was the first time that the statistics of production of this mineral (except for gems) have been collected, and no comparisons can be made.

In addition to this there were 6,024 short tons of quartz crystal mined in 1894, and used principally for wood finishing. The total value was $18,054.

TRIPOLI.

The value of the various products obtained from the silicious deposit in Newton County, Mo., and somewhat erroneously called tripoli, amounted to $35,000. The manufactured articles consist of filter disks and cylinders, desk blotters, polishing powders, and soaps.

PRECIOUS STONES

By George Frederick Kunz.

Among the principal items of importance to the precious stone industry in 1894 is (1) an article by Prof. William H. Hobbs calling attention to the fact that the Wisconsin diamonds are probably distributed through the Kettle moraine, on the Green Bay Lobe of the Glacial Ice sheet; (2) the finding of a $10\frac{7}{8}$-carat diamond at Dowagiac, Mich.; (3) the developing of a new ruby mine near Franklin, Macon County, N. C.; (4) the fiuding of emeralds at Mitchell's Peak and near Earl Station, N. C.; (5) the memorial to Congress to preserve the world-renowned agatized forest in Arizona; (6) the finding of a remarkable compact variscite, giving a new ornamental stone, utahlite; (7) the smaller output of turquoise mines due to the depressed financial condition; and (8) the skillful financiering by which the output of diamonds has been regulated and sold for $17,500,000 for 1895, due to the efforts of Cecil Rhodes, organizer and life governor of the De Beers Diamond Mining Company.

DIAMONDS.

LOCALITIES.

Wisconsin.—A very interesting relation is coming to view among the occurrences of the diamonds occasionally announced from the drift region of the Northwest. In previous reports, reference has been made to several of these, particularly to the large one ($15\frac{12}{32}$ carats) found in 1876 in digging a well at Eagle, Waukesha County, Wis., and to the several small ones, none of a carat's weight, found in prospecting for gold along Plum Creek, Pierce County, Wis., from 1887 to 1889. In 1893 a diamond crystal of 3.83 carats was found in a clay bank at Oregon, Dane County, Wis., on the farm of Mr. Judson Devine; it is a rhombic dodecahedron, somewhat modified and distorted and much rounded. This is also the form of the Eagle stone, though the latter is yellowish in color, while the Oregon crystal is white. It now appears that another diamond of the same form, weighing $24\frac{1}{4}$ carats, wine-yellow in color, and strongly resembling the Eagle crystal, was found in 1884 at Kohlsville, Washington County, Wis., on the farm of Henry Endlich. It is now in the possession of his widow, who retains it as a memento of her husband. It measures three-fourths by one-half by three-eighths inches.

On comparing these several occurrences, it has been shown by Prof. William H. Hobbs, of Madison, in a paper read before the Wisconsin Academy of Sciences, December 30, 1893 (Amer. Geol., vol. 14; July, 1894; pp. 31 to 37), that the three larger and remarkably similar crystals from Eagle, Oregon, and Kohlsville, all occur in the Kettle moraine of the Green Bay Lobe of the Ice sheet. Those from Plum Creek, which are smaller and of different form, were from a stream bed some 20 miles from another lobe of the Kettle moraine, but within the area of the older drift. The source, or more probably the sources, of these drift-borne diamonds must of course lie to the northward, and may be to some extent indicated by the glacial striæ. Professor Hobbs points out that there are two regions where basic intrusive rocks have cut through carbonaceous shales, as in South Africa; one of these is in northwestern Wisconsin, in the Menominee district, and the other northwest of Lake Superior, in the vicinity of Pigeon River. The courses of the striæ from the Menominee region extend southward to the Green Bay moraine, and those from Pigeon River come down not far from the locality of Plum Creek. Somewhere in those regions it may be that diamond mines will yet be discovered, under conditions resembling the African; and occasional specimens will be encountered in the drift to the south.

Michigan.—An additional discovery bearing marked relations to these has lately been made on the other side of Lake Michigan. This is a diamond crystal of $10\frac{7}{8}$ carats, measuring 13 by 9 by 11 mm., a hexoctahedron, found in Glacial Drift at Dowagiac, Mich., and the finder, Mr. Fred. B. Blackmond, states that he made an extensive search, but that no other stone was found. Dowagiac is in southwestern Michigan, between Niles and Kalamazoo.

California.—Mr. W. P. Carpenter, of Placerville, Cal., who has from time to time reported the finding of diamonds in auriferous gravel, under the usual conditions of their occurrence on the Pacific Coast, has lately obtained two crystals, one weighing over 7 grains troy and the other 6, of rounded form and rough surface, each nearly one-fourth of an inch in diameter and faintly tinted, the larger with a greenish shade and the smaller with pale yellowish. As many as forty or fifty small diamonds have been taken from the gravel at this place from time to time in the past; but since stamp mills have been employed little is found but the crushed fragments encountered in "panning up" the amalgam taken from the batteries. Mr. Carpenter proposes to work his section of the channel by other means, and avoid the possible loss of diamonds of more value than the gold. The occurrence is similar to that of other California diamonds—in the hard compacted gold-bearing gravel occupying ancient river channels now filled and overlain by igneous rocks.

Montana.—At Deer Lodge, Mont., Mr. Owen Emerson obtained in 1894 a brilliant white diamond weighing $3\frac{7}{32}$ carats. Unfortunately it is flawed and would not cut a stone of much more than one carat.

The rumor that appeared in the press early in 1895 as to the discovery of brilliant diamonds at Mount Edgecombe, near Sitka, Alaska, was entirely without foundation. It was fully denied by Mr. John G. Brady, of Sitka, who informed this office that the report arose from his remarking that diamonds might possibly be found on Mount Edgecombe, where, he thought, the geological formation presented some resemblances to that of the South African diamond fields.

In the chapter in this report by Mr. George F. Becker on a Reconnaissance of the gold fields of the Southern Appalachians, he states (p. 272, Part III):

The direct association of gold and diamond anywhere in the world is known in only one instance, and this has never before been described in print. Professor Arzruni showed me the specimen, exhibiting it some years ago, and now gives me permission to make it known. In 1887 the Royal Polytechnic High School at Aachen acquired from Mr. Ernst Winter, a diamond dealer in Hamburg-Eimsbuttel, a gray, opaque, flawed, Kimberly diamond, which shows at two points inclusions of native gold in grains. It seems that this native gold must be considered as a constituent of the basic eruptive rock in which the Kimberly diamonds occur.

British Guiana.—In the gold fields of British Guiana Mr. E. P. Wood, commissioner of mines, reports the occasional finding of diamonds in panning gold, and hence judges that they may occur in some abundance in the auriferous gravels, and that search for them might be worth while, as only a few would be noticed in the ordinary washing for gold.

Australia.—A good deal has been said and hoped for as to the occurrence of diamonds in South Australia, and Mr. Calvert has published an article in a London mining journal on the prospect and probability of such discoveries, comparing the volcanic intrusions and the conglomerates of several South Australian localities with those of South Africa and Brazil. Recently the statement has appeared that a diamond has been forwarded to the government geologist of the province from Mount Kingston, where it was found by the sender in panning for gold. It is a perfect crystal, a little over one carat in weight, with curved faces and slightly tinted with yellow.

India.—It is announced that Dr. King, director-general of the geological survey of India, has been sent by the Indian Government to examine diamond mines in the native state of Panna, in Bundelkund, and report upon the best mode of operating them.

South Africa.—From the report of Gardner F. Williams, the manager of the De Beers diamond mine, we ascertain that from June, 1893, to June, 1894, the De Beers diamond mines produced $14,000,000 from 2,500,000 loads washed; 0.89 carat to a load, at a value of $6.10 a carat. The average yield per load, 16 cubic feet, was 1,600 pounds. The mining was done with a profit of $5,645,000, and a dividend was paid of

$4,935,000. The 2,606,362 loads of earth on the floor was valued at 84 cents a load. This was formerly counted at $1.26 a load; the lower cost is due to improved facilities and to changing the hours of labor from twelve to eight hours a day. For the past few years the entire output has been sold in rough to English dealers; that is, the rough diamonds have been sold in London.

In January of the present year the Antwerp and Amsterdam dealers formed a syndicate and endeavored to break the English control of the rough-diamond market by offering a higher figure than the English syndicate had bid for a three months' option on the entire output. The English syndicate then made a higher offer for the whole product of 1895, and a sale to them took place of over $17,500,000, the limit fixed for the output this year, thus by clever financiering adding stability to the price of diamonds in the face of the greatest panic of modern times. With increased American demand, the price may advance.

IMPORTS.

The following table shows the diamonds and other precious stones imported into the United States from 1867 to 1894:

Diamonds and other precious stones imported and entered for consumption in the United States, 1867 to 1894, inclusive.

Years ending—	Diamonds.			Diamonds and other stones not set.	Set in gold or other metal.	Total.
	Glaziers'.	Dust.	Rough or uncut.			
June 30, 1867	$906			$1, 317, 420	$291	$1, 318, 617
1868	484			1, 060, 544	1, 465	1, 062, 493
1869	445	$140		1, 997, 282	23	1, 997, 890
1870	9, 372	71		1, 768, 324	1, 504	1, 779, 271
1871	976	17		2, 349, 482	256	2, 350, 731
1872	2, 386	89, 707		2, 939, 155	2, 400	3, 033, 648
1873		40, 424	$176, 426	2, 917, 216	326	3, 134, 392
1874		68, 621	144, 629	2, 158, 172	114	2, 371, 536
1875		32, 518	211, 920	3, 234, 319		3, 478, 757
1876		20, 678	186, 404	2, 409, 516	45	2, 616, 643
1877		45, 264	78, 033	2, 110, 215	1, 734	2, 235, 246
1878		36, 409	63, 270	2, 970, 469	1, 025	3, 071, 173
1879		18, 889	104, 158	3, 841. 335	538	3, 964, 920
1880		49, 360	129, 207	6, 690, 912	765	6, 870, 244
1881		51, 409	233, 596	8, 320, 315	1, 307	8, 606, 627
1882		92, 853	449, 513	8, 377, 200	3, 205	8, 922, 571
1883		82, 628	443, 996	7, 598, 176	*a* 2, 081	8, 126, 881
1884	22, 208	37, 121	367, 816	8, 712, 315		9, 139, 460
1885	11, 526	30, 426	371, 679	5, 628, 916		6, 042, 547
Dec. 31, 1886	8, 949	32, 316	302, 822	7, 915, 660		8, 259, 747
1887	9, 027	33, 498	262, 357	10, 526, 998		10, 831, 880
1888	10, 025	29, 127	244, 876	10, 223, 630		10, 557, 658
1889	8, 156	68, 746	196, 294	11, 704, 808		11, 978, 004
1890	147, 227	179, 154	349, 915	*b* 12, 429, 395		13, 105, 691
1891	565, 623	125, 688	408, 198	11, 657, 079		12, 757, 079
1892	532, 246	144, 487	516, 153	13, 328, 965		14, 521, 851
1893	357, 939	74, 255	444, 137	9, 321, 174		10, 197, 505
1894	82, 081	53, 691	764, 554	5, 868, 067		6, 768, 393

a Not specified since 1883.
b Includes stones set and not specially provided for since 1890.

The greatest diamond of any time, surpassing even Tavernier's original Great Mogul, was found at the Jagersfontein mine in June, 1893. It weighs 971 carats, exceeding any diamond ever known; it is a fine blue-white in color, except one slight spot in the center. It is valued at $2,000,000, and it was believed would cut a drop stone of 600 carats or a brilliant of over 400. The Emperor William was looked upon as a probable buyer, but in February, 1895, it was said to have been presented by the President of the Orange Free State to Pope Leo XIII.

A very novel and interesting experiment was lately reported from London, viz, the burning of diamonds in liquefied oxygen, by Professor Dewar. He heated diamonds red-hot and dropped them in the liquid oxygen, but the intensely low temperature cooled them, and they sank without igniting. He then tried again, heating a diamond extremely with a blowpipe; this one caught fire on touching the liquefied gas, and burned steadily on the surface of the oxygen, the diamond became opaque from the carbon dioxide produced. Professor Dewar also performed the same experiment with graphite.

RUBY.

North Carolina.—The occurrence of rubies was noted in Mineral Resources, 1893 (page 693). In regard to the locality the following information is furnished by responsible parties: They are found in a valley some 3 miles long and one-half to five-eighths of a mile wide, traversed by a stream. The valley is occupied by the débris of calcareous rock, which occurs at its upper end. Rubies are found in the gravel, which forms a stratum from 2 to 10 feet thick, lying from 3 to 20 feet below the surface, and have also been traced into the limestone as their natural matrix. The latter rests upon granite.

Exploration and prospecting show the gravel to exist and to contain rubies throughout the entire valley, but not beyond it. The ruby crystals are of fine color, often of large size, and frequently transparent.

Material has been found that has yielded fine transparent cut rubies of three-fourths of a carat. If stones can be found of large size that combine color, transparency, and perfection this will prove a very important discovery, and it is thought that systematic search may bring larger material to light.

SAPPHIRE.

Montana.—Sapphires have recently been obtained in the alluvial gold washings near Judith River, Choteau County, Mont. These differ from those found near Helena and other localities, inasmuch as they are decidedly bluer—frequently as blue as a fair-colored Ceylonese stone—sometimes with a purplish tint.

Mr. T. E. Crutcher, of Helena, Mont., reports sapphire deposits existing 25 miles west of Phillipsburg, Mont., on the west fork of the Rock Creek, on the east slope of the Bitter Root range, comprising 1,500 acres in extent. Here 75 pounds of crystals were obtained; the gems were light shades—light blue, pink, yellow, and purple. The matrix is identical with that of the Missouri River deposits near Helena, a vesicular mica-augite andesite. Another mine is situated 5 miles east of the mining camp of Champion, in Deer Lodge County, on Dry Cottonwood Creek, on the western slope of the mountain range; but its 2,500 acres have never been worked except in a very small way.

A valuable contribution to science is the preliminary report on the corundum deposits of Georgia, by Mr. Francis P. King, published under the auspices of Prof. W. S. Yeates, State geologist of Georgia, by the State of Georgia, in 1894. This gives a fairly complete compilation of the history of corundum and its associated minerals, and will be followed by the corrected report at a later day.

EMERALD.

North Carolina.—In July, 1894, a new locality of true emeralds was discovered by Mr. J. L. Rorison, miner of mica, and Mr. D. A. Bowman, on the Rorison property, 14 miles from Bakersville and 14 miles from Mitchells Peak, Mitchell County, N. C. Here, at an elevation of 5,000 feet, on the Big Crabtree Mountain, occurs a vein of pegmatite some 5 feet wide, with well-defined walls, in mica schist. This vein carries a variety of minerals besides its component quartz and feldspar, among these being garnets; translucent reddish and black tourmaline, the latter abundant in slender crystals; beryls, white, yellow, and pale green; and the emeralds. These latter are chiefly small, 1 to 10 mm. wide by 5 to 25 mm. long, but some have been found two or three times greater than the larger sizes named. They are perfectly hexagonal, generally well terminated with basal planes, and are clear and of good color, with some promise for gems. They very strikingly resemble the Norwegian emeralds from Arendal. The vein outcrops for perhaps a hundred yards, with a north and south strike. The results thus far obtained are only from about 5 feet depth of working, so that much more may be looked for as the vein is developed.

South Carolina.—A little north of the crest of the Blue Ridge, and some 50 miles south of the emerald locality at Stony Point, Alexander County, N. C., a second new occurrence of emerald is reported by Mr. J. Meyer, of Charlotte, N. C., who had found near Earle Station, N. C., between Blacksburg, S. C., and Shelby, N. C., a broken fragment of emerald of good color, better than anything observed from North Carolina. Though somewhat flawed, it was cut into a faceted stone, of trapeziform or subtriangular shape, weighing $4\frac{15}{16}$ carats, that quite closely resembles the material from the Muzo mines of New Grenada.

BERYL.

Maine.—During the past year the Trenton Flint and Spar Company, of Topsham, Me., in mining for feldspar, came upon a number of pockets filled with remarkable crystals of beryl—green, yellow, and white. Some of these were doubly terminated crystals 5 inches long and an inch in diameter. Nearly all possessed more or less transparency, and would cut into gems, some of them being quite equal to those from the Ural Mountains. Their cutting is, in some cases, marred by what is nevertheless a very interesting mineralogical feature, viz, what appears to be a highly developed rhombohedral cleavage indicated by shadowy planes visible within the crystal. Their forms are also interesting; some are perfect quartzoids, with extremely regular hexagonal pyramids; others were slightly tapering, showing very acute scalenohedral planes.

QUARTZ GEMS.

The amethysts of the metamorphic belt of the Eastern United States appear to be of richer and deeper color than those found in igneous rocks, although the crystals are apt to be not uniform in color. They have been found at many localities from Maine to Alabama, in some cases quite as fine in color as those from Ceylon or the Urals. Such are those formerly found at Deer Hill and Stowe, Me. Other localities are in Pennsylvania, in Upper Providence Township, and elsewhere in Delaware County; in North Carolina, near Statesville, Iredell County, and in Burke and Lincoln counties, and in Rabun County, Ga.

Maine.—During 1894 Mr. George R. Howe, of Denmark, Me., has obtained many fine amethyst crystals, and has had a number of gems cut from them that were of a remarkably deep purple color.

Pennsylvania.—During the past year a quantity of amethyst was obtained at Upper Providence Township, Delaware County, Pa., and a number of fine gems were cut, one weighing 33 carats; a superb deep purple stone exceeding that weight now forms a part of the Lea collection in the United States National Museum.

North Carolina.—Prof. T. K. Brunner reports the following quartz gems as being found in North Carolina: Amethyst in Catawba, Macon, Wake, Lincoln, and other counties; smoky and citrine variety of quartz abundant in Iredell, Mitchell, and Alexander counties; rose quartz and asteriated quartz in Iredell and Cabarrus counties; hornblende in quartz in Iredell, Alexander, and Burke counties; rutilated quartz principally in Iredell and Alexander counties.

California.—Mr. Henry S. Durden, curator of the State mining bureau at San Francisco, reports hornblende in quartz from Tyler's ranch, Oleta, Amador County, Cal., and also from Fairplay, Eldorado County, and dumortierite 25 miles from Ogilby, San Diego County.

Wyoming.—Mr. H. E. Crane has opened a ledge of moss agate 6 inches thick in a limestone 5 feet wide and running half a mile, at Hartville, about 100 miles north of Cheyenne, Wyo., and but 9 miles from the railway. The agate as quarried is quoted at $200 a ton. The owner is J. M. Grogan, who was prospecting for copper.

Arizona.—A memorial[1] from the legislative assembly of Arizona has been presented to Congress, requesting that the lands covered by the

[1]An Appeal to Congress for the Preservation of a Forest Tract. Washington, February 19, 1895.

petrified forest be withdrawn from entry until the advisability of making a public park of it can be decided. The lands are in Apache County, are 10 miles square, and, according to the memorial, are covered by trunks of trees some of which measure over 200 feet in length and from 7 to 10 feet in diameter. The legislature represents that "ruthless curiosity-seekers are destroying these huge trees and logs by blasting them in pieces in search of crystals, which are found in the center of many of them, while car loads of the limbs and smaller pieces are being shipped away to be ground up for various purposes." The park, or "chalcedony forest," is annually visited by hundreds of scientific men and travelers from every State. To make it a public park would preserve the tract from vandalism and injure no one, as there are no settlers upon it. A cowboy rode over the agatized bridge with his horse, endeavering to break down the tree crossing the chasm, and was disappointed at not succeeding.

TURQUOISE.

Owing to the stringency of the times and the condition of one of the companies the output of turquoise, of which so large a quantity was mined during 1891 and 1892, was limited to not more than $30,000 for the year 1894. Turquoise has been found at several localities in Arizona, New Mexico, and more recently in Texas, north of El Paso, but no new mines of value have been opened.

A large amount of a remarkably beautiful sky-blue turquoise-like substance was found in an extensive vein near Phœnix, Ariz. This was at first supposed to be turquoise, but being too soft, it was chemically examined in the Geological Survey laboratory by Prof. F. W. Clarke, and proved to be a hard compact chrysocolla.

UTAHLITE.

Utah.—An interesting discovery has been made of compact nodular variscite in Cedar Valley, near old Camp Floyd, Utah, by Mr. Don Maguire. The rock is a crystalline limestone, with layers of black pyritiferous siliceous slate. In the latter occur the nodules, varying from the size of a walnut to that of a cocoanut. They are covered with a thin, lamellar, ferruginous crust, beneath which lies the compact variscite of various shades of rich green. This is a new form of occurrence for this species and has attracted considerable attention abroad, both as a novel mineral and an ornamental stone of quaint beauty. The locality, which is a spur of the Oquirrh Mountains, has been visited and examined by Mr. Maguire. He finds that it is somewhat abundant, but that only careful hand work can be used to extract the pieces from the rock. The writer suggests that the name utahlite would not be inappropriate for it. Mr. Maguire searched for traces of ancient working, but without success, though some stone articles and a rock with picture inscriptions were found in the vicinity.

GARNETS, ETC.

During the past few years the Indians on the Navajo Reservation have found a greater quantity of garnets and peridots than there has been demand for, and the result is that there is a large surplus stock on hand at the various agencies.

Tourmaline from a new locality was discovered by Albert C. Bates 1 mile from Moosup, Conn., of a light-green color and of transparent gem quality, one crystal being 9 inches long, three-fourths at the largest end and tapering gradually. About thirty smaller crystals were found, but all with poor terminations. The largest perfect gem was 9⅝ carats. From Eustis, Frontier County, Nebr., small pebbles from the Platte River were sent for examination. Among them were observed some grains of labradorite showing a beautiful chatoyancy quite equal to that from Labrador.

Lieut. Constant Williams, of the Navajo Agency at Fort Defiance, Ariz., obtained a quantity of dark, almost emerald-green, specimens of diopside that would cut into gems of from one to two carats each.

Cyanite, in rich blue and green blades, weathered out of the rock, has been found near Red Bluff, Madison County, Mont., by J. L. Ulerg.

OPAL AND HYALITE.

Utah.—Hyalite and banded opal are described by Mr. T. Beck, of Provo, Utah, as occurring in Beaver Valley, Utah, some 3 miles from Granite Peak. The locality is a low hill, covered by a laminated deposit of silica, partly opal and partly hyalite, of no great thickness, but covering several acres in extent. It is much disintegrated and decomposed, but with care the material can be taken out in slabs or plates sometimes a foot square, varying in color. What appear to be disintegrated and broken-down geyser-cones occur with this material, which is conformable to the slopes of the hill, and probably represents a deposit from ancient geysers. A few miles away are boiling springs and an extinct crater.

AMBER.

Texas.—Amber in small nodules was found near Pendennis, Lane County, Tex., by L. W. Hasting, mining expert, of San Antonio, Tex. The color of the amber is a rich brown, more closely resembling burmite.

JET.

New Mexico.—Mr. A. Monier reports from the vicinity of Santa Fe, N. Mex., a fine black jet, evidently found in some quantity.

PRODUCTION.

The product of precious stones in recent years is shown by the following table:

Estimated production of precious stones in the United States from 1883 to 1893.

Species.	1883.	1884.	1885.	1886.	1887.	1888.
	Value.	Value.	Value.	Value.	Value.	Value.
Diamond	....	$800	....	$60	....	....
Sapphire	$2,200	1,750	$500	750	$500	$500
Chrysoberyl	100	25	....	....	....	....
Topaz	1,000	500	1,250	1,000	2,000	600
Beryl (aquamarine, etc.)	500	700	750	5,500	3,500	800
Phenacite	....	....	....	....	....	650
Emerald	500	....	3,200	3,200	....	100
Hiddenite (lithia emerald)	600	....	2,500	4,500	....	....
Tourmaline	....	2,000	600	5,500	500	....
Smoky quartz	10,000	12,000	7,000	7,000	4,500	4,000
Quartz	11,500	11,500	11,500	11,500	11,500	11,150
Silicified wood	5,000	10,500	6,500	1,500	36,000	16,000
Garnet	6,000	4,000	2,700	3,250	3,500	3,500
Anthracite	2,500	2,500	2,500	2,500	2,000	1,500
Pyrite	2,000	3,000	2,000	2,000	2,500	2,500
Amazon stone	3,750	2,750	2,750	2,250	1,700	1,700
Catlinite (pipestone)	10,000	10,000	10,000	10,000	5,000	5,000
Arrow points	1,000	1,000	2,500	2,500	1,500	1,500
Trilobites	500	500	1,000	1,000	500	500
Hornblende in quartz	600	600	300	200	100	....
Thomsonite	750	750	750	400	750	500
Diopside	300	....	100	....	50	....
Agate	1,500	4,500	2,000	2,000	4,000	4,000
Chlorastrolite	1,500	1,500	....	1,009	800	800
Turquoise	2,000	2,000	3,500	3,000	2,500	3,000
Moss agate	21,000	3,000	2,500	2,000	950	950
Amethyst	2,250	2,250	2,100	2,100	2,100	2,500
Jasper	2,500	2,500	....	....	....	100
Sunstone	450	450	350	300	150	....
Fossil coral	750	750	....	1,000	2,000	3,000
Rutile	....	....	750	750	....	
Gold quartz	115,000	140,000	140,000	40,000	75,000	75,000
Rutilated quartz	....	....	250	1,750	....	....
Peridot	300	150	....	....	....	....
Total	206,050	221,975	209,850	118,519	163,600	139,850

Estimated production of precious stones in the United States from 1883 to 1893—Cont'd.

Species.	1889.	1890.	1891.	1892.	1893.
	Value.	Value.	Value.	Value.	Value.
Diamond	....	....	....	....	$125
Sapphire	$6,725	$6,725	$10,000	$20,000	10,000
Ruby	....	....	....	....	150
Topaz	400	....	100	1,000	100
Beryl (aquamarine, etc.)	747	....	1,000	1,090	500
Phenacite	200	....	....	....	....
Emerald	450	....	1,000	....	....
Tourmaline	2,250	2,250	3,000	3,000	5,000
Opal	....	....	5,000	10,000	5,000
Peridot	....	....	1,000	1,000	500
Smoky quartz	4,232	2,225	5,000	5,000	5,000
Quartz, rock crystal	14,000	14,000	10,000	10,000	10,000
Silicified wood	....	....	....	1,000	1,250
Garnet (pyrope, almandite, and essonite)	2,308	2,308	3,000	5,250	2,000
Anthracite	....	....	....	3,000	3,000
Pyrite	2,000	2,000	1,500	1,500	1,500
Amazon stone	500	500	....	1,000	1,000
Catlinite (pipestone)	5,000	5,000	5,000	5,000	5,000
Arrow points	....	....	....	1,000	....
Thomsonite	400	400	200	500	500
Diopside	....	....	....	500	105
Agate	....	....	....	2,000	1,000
Chlorastrolite	500	400	500	500	500
Turquoise	23,675	28,675	150,000	175,000	143,136
Moss agate	....	....	....	1,500	2,000
Amethyst	98	....	....	200	75
Fossil coral	700	700	1,000	1,000	1,000
Rose quartz	600	200	....	200	100
Gold quartz	9,000	9,000	6,000	15,000	10,000
Rutilated quartz	30	....	....	....	....
Dumortierite in quartz	250	250	....	....	....

Estimated production of precious stones in the United States from 1883 to 1893—Cont'd.

Species.	1889.	1890.	1891.	1892.	1893.
	Value.	Value.	Value.	Value.	Value.
Quartz coating chrysocolla	$4, 000	$2, 000		$500	
Chrysoprase	200	200		100	
Agatized and jasperized wood	53, 175	6, 000	$2, 000	10, 000	$20, 000
Banded and moss jasper	630				
Obsidian				100	
Fluorite	500	500			
Azurite and malachite	2, 037			1, 000	
Prehnite				200	
Zircon (*a*)	16, 000				
Gadolinite, fergusonite, etc. (*a*)	1, 500				
Monazite (*a*)	1, 000				
Spodumene (*a*)	200				
Wooden ornaments decorated with minerals (*b*)	15, 500	15, 500	15, 000	15, 000	15, 000
Staurolite crystals					500
Miscellaneous minerals (*c*)	20, 000	20, 000	15, 000	20, 000	20, 000
Total	188, 807	118, 833	235, 300	312, 050	264, 041

a Used to extract the rarer elements for chemical purposes.
b Such as clocks, horseshoes, boxes, etc.
c Collection and souvenir minerals.

Estimated production of precious stones in the United States in 1894.

Species.	Value.	Species.	Value.
Diamond	$200	Dumortierite	$100
Corundum:		Diaspore	200
Ruby	2, 500	Olivine (chrysolite, peridot)	500
Sapphire	10, 000	Pyrite	1, 800
Topaz	1, 000	Opal, noble (precious)	500
Beryl:		Feldspar:	
Aquamarine	1, 000	Microcline (amazon stone)	1, 200
Emerald	250	Oligoclase (sunstone)	100
Golden-colored	50	Orthoclase (moonstone)	100
Garnet:		Obsidian (volcanic glass)	100
Almandine (precious)	2, 300	Marekanite (mountain mahogany)	100
Pyrope (Bohemian)	2, 000	Chondrodite	400
Tourmaline:		Turquoise	30, 000
Green and blue	1, 800	Diopside	150
Rubellite	500	Willemite	100
Iolite staurolite	500	Chlorastrolite	500
Quartz:		Prehnite	300
Rock crystal, "pebble"	1, 300	Thomsonite	500
Amethyst	500	Titanite (sphene)	100
Smoky quartz, cairngorm stone, Scotch topaz, Spanish topaz	5, 000	Rhodonite	100
Rose quartz	200	Malachite	500
Gold quartz	10, 000	Chrysocolla	1, 000
Onegite	500	Catlinite (pipestone)	3, 000
Rutilated quartz	100	Fossil coral	1, 000
Agate:		Arrowheads	1, 000
Carnelian	2, 000	Anthracite	3, 000
Moss agate	500	Mineral ornaments	10, 000
Chrysoprase	100		
Agatized wood	10, 000	Total	120, 250

FERTILIZERS.

PHOSPHATE ROCK.

Summary.—The commercial situation in the phosphate industry may be summarized by the fact that, with a total product practically the same as the preceding year, the value for the year ending December 31, 1894, decreased by nearly a million dollars. Another prominent step in the industry is shown by the fact that the relative proportions of the supply contributed by Florida and South Carolina were reversed, Florida contributing a little more than half of the total supply, just as South Carolina did in 1893. The total of 976,059 long tons includes 19,188 tons from west Tennessee, which will henceforth undoubtedly continue to contribute a slowly increasing quantity.

The mining conditions in South Carolina have remained practically unchanged, and in Florida there has been no more considerable change in this respect than the transfer of the base of operations of the French company from Anthony to the similar plate-rock deposits in the neighborhood of Luraville. The commercial situation in Florida has been markedly improved by the consolidation of the river-pebble producers into one company and better cooperation among the land-pebble producers. As this took place at the close of the year, its effect will be felt in 1895. Prices for the present year must also be improved in the hard-rock region by the consolidation of some nineteen independent phosphate companies and the practical cooperation of a number of others, all of whom agreed to shutting down their mines at the bidding of the association early in April, 1895.

PRODUCTION.

The record of production and values in late years is given in the following tables:

Product of phosphate rock from 1891 to 1894.

States.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
Florida:	*Long tons.*		*Long tons.*	
Hard rock	}		*a* 155,908	$859,276
Soft rock	} 57,982	....	6,710	32,418
Land pebble	}		21,905	111,271
River pebble	54,500	....	*b* 102,820	415,453
Total	112,482	$703,013	287,343	1,418,418
South Carolina:				
Land rock	344,978	2,187,150	243,653	1,236,447
River rock	130,528	760,978	150,575	641,262
Total	475,506	2,948,138	394,228	1,877,709
Grand total	587,988	3,651,151	681,571	3,296,227

States.	1893.		1894.	
	Quantity.	Value.	Quantity.	Value.
Florida:	*Long tons.*		*Long tons.*	
Hard rock	215,685	$1,117,732	326,461	$979,383
Soft rock	13,675	64,626	....	....
Land pebble	86,624	359,127	98,885	296,655
River pebble	122,820	437,571	102,307	390,775
Total	438,804	1,979,056	527,653	1,666,813
South Carolina:				
Land rock	308,435	1,408,785	81,996	299,436
River rock	194,129	748,229	347,222	1,362,581
Total	502,564	2,157,014	429,218	1,662,017
Tennessee	....	....	19,188	67,158
Grand total	941,368	4,136,070	976,059	3,395,988

a Includes 52,708 tons of land rock carried over in stock from 1891.
b Includes 12,120 tons of river pebble carried over in stock from 1891.

Detailed statement of total foreign and coastwise shipments and local consumption of South Carolina rock since July 1, 1874.

[Long tons.]

Periods	Shipments and consumption.	Beaufort.	Charleston.	Total.	Total for each year.
June 1, 1874, to May 31, 1875	Foreign ports	44, 617	25, 929	70, 546	122, 790
	Domestic ports	7, 000	25, 560	32, 560	
	Consumed	....	19, 684	19, 684	
June 1, 1875, to May 31, 1876	Foreign ports	50, 384	25, 431	75, 815	132, 896
	Domestic ports	9, 400	28, 831	38, 231	
	Consumed	....	18, 850	18, 850	
June 1, 1876, to May 31, 1877	Foreign ports	73, 923	28, 844	102, 767	163, 220
	Domestic ports	6, 285	40, 768	47, 053	
	Consumed	....	13, 400	13, 400	
June 1, 1877, to May 31, 1878	Foreign ports	100, 619	21, 123	121, 742	208, 323
	Domestic ports	8, 217	60, 729	68, 946	
	Consumed	....	17, 635	17, 635	
June 1, 1878, to May 31, 1879	Foreign ports	97, 799	21, 767	119, 566	199, 365
	Domestic ports	8, 618	52, 281	60, 899	
	Consumed	....	18, 900	18, 900	
June 1, 1879, to May 31, 1880	Foreign ports	47, 157	14, 218	61, 375	190, 763
	Domestic ports	13, 346	94, 002	107, 348	
	Consumed	....	22, 040	22, 040	
June 1, 1880, to May 31, 1881	Foreign ports	62, 200	8, 568	70, 768	266, 734
	Domestic ports	65, 895	91, 929	157, 824	
	Consumed	....	38, 142	38, 142	
June 1, 1881, to May 31, 1882	Foreign ports	89, 581	22, 905	112, 486	332, 077
	Domestic ports	65, 340	111, 314	176, 654	
	Consumed	....	42, 937	42, 937	
June 1, 1882, to May 31, 1883	Foreign ports	94, 789	28, 251	123, 040	378, 380
	Domestic ports	62, 175	150, 545	212, 720	
	Consumed	....	42, 620	42, 620	
June 1, 1883, to May 31, 1884	Foreign ports	132, 114	20, 539	152, 653	431, 779
	Domestic ports	41, 040	181, 363	222, 403	
	Consumed	5, 800	50, 923	56, 723	
June 1, 1884, to May 31, 1885	Foreign ports	111, 075	11, 495	122, 570	395, 403
	Domestic ports	44, 130	161, 700	205, 833	
	Consumed	12, 000	55, 000	67, 000	
June 1, 1885, to Dec. 31, 1885	Foreign ports	105, 761	8, 581	114, 342	277, 789
	Domestic ports	16, 321	112, 126	128, 447	
	Consumed	5, 000	30, 000	35, 000	
Jan. 1, 1886, to Dec. 31, 1886	Foreign ports	153, 443	5, 926	159, 369	430, 549
	Domestic ports	14, 622	187, 558	202, 180	
	Consumed	9, 000	60, 000	69, 000	
Jan. 1, 1887, to Dec. 31, 1887	Foreign ports	189, 995	9, 740	199, 735	480, 558
	Domestic ports	15, 905	181, 918	197, 823	
	Consumed	13, 000	70, 000	83, 000	
Jan. 1, 1888, to Dec. 31, 1888	Foreign ports	124, 474	3, 611	128, 085	448, 567
	Domestic ports	20, 404	212, 078	232, 482	
	Consumed	13, 000	75, 000	88, 000	
Jan. 1, 1889, to Dec. 31, 1889	Foreign ports	137, 102	5, 900	143, 002	541, 645
	Domestic ports	60, 000	248, 643	308, 643	
	Consumed	15, 000	75, 000	90, 000	
Jan. 1, 1890, to Dec. 31, 1890	Foreign ports	72, 241	55, 000	127, 241	463, 998
	Domestic ports	15, 000	213, 757	228, 757	
	Consumed	13, 000	85, 000	98, 000	
Jan. 1, 1891, to Dec. 31, 1891	Foreign ports	94, 528	4, 655	99, 183	475, 506
	Domestic ports	22, 000	252, 083	274, 083	
	Consumed	14, 000	88, 250	102, 250	
Jan. 1, 1892, to Dec. 31, 1892	Foreign ports	105, 150	5, 052	110, 202	394, 228
	Domestic ports	30, 425	148, 600	179, 025	
	Consumed	15, 000	90, 000	105, 000	
Jan. 1, 1893, to Dec. 31, 1893	Foreign ports	156, 257	175	156, 432	502, 564
	Domestic ports	22, 872	160, 942	183, 814	
	Consumed	15, 000	147, 318	162, 318	

Phosphate rock (washed product) mined by the land and river mining companies of South Carolina.

Years ending—	Land companies.	River companies.	Total.
	Long tons.	*Long tons.*	*Long tons.*
May, 1867	6	....	6
1868	12, 262	....	12, 262
1869	31, 958	....	31, 958
1870	63, 252	1, 989	65, 241
1871	56, 533	17, 655	74, 188
1872	36, 258	22, 502	58, 760
1873	33, 426	45, 777	79, 203
1874	51, 624	57, 716	109, 340
1875	54, 821	67, 969	122, 790
1876	50, 566	81, 912	132, 478
1877	36, 431	126, 569	163, 000
1878	112, 622	97, 700	210, 322
1879	100, 779	98, 586	199, 365
1880	125, 601	65, 162	190, 763
1881	142, 193	124, 541	266, 734
1882	191, 305	140, 772	332, 077
1883	219, 202	159, 178	378, 380
1884	250, 297	181, 482	431, 779
1885	225, 913	169, 490	395, 403
Dec. 31, 1885 (from June 1)	149, 400	128, 389	277, 789
1886 (calendar year)	253, 484	177, 065	430, 549
1887	261, 658	218, 900	480, 558
1888	290, 689	157, 878	448, 567
1889	329, 543	212, 102	541, 645
1890	353, 757	110, 241	463, 998
1891	344, 978	130, 528	475, 506
1892	243, 652	150, 575	394, 228
1893	308, 425	194, 129	502, 564
1894	81, 996	347, 222	429, 218

IMPORTS.

The following table shows the imports of fertilizers of all kinds into the United States from 1868 to 1894:

Fertilizers imported and entered for consumption in the United States, 1868 to 1894.

Years ending—	Guano.		Crude phosphates and other substances used for fertilizing purposes.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Long tons.		*Long tons.*		
June 30, 1868	99, 668	$1, 336, 701	....	$88, 864	$1, 425, 625
1869	13, 480	217, 004	....	61, 529	278, 533
1870	47, 747	1, 414, 872	....	90, 817	1, 505, 689
1871	94, 344	3, 313, 914	....	105, 703	3, 479, 617
1872	15, 279	423, 322	....	83, 342	506, 664
1873	6, 755	167, 711	....	218, 110	385, 821
1874	10, 767	261, 085	....	243, 467	504, 552
1875	23, 925	539, 808	....	212, 118	751, 926
1876	19, 384	710, 135	....	164, 849	874, 984
1877	25, 580	873, 459	....	195, 875	1, 069, 334
1878	23, 122	849, 607	....	285, 089	1, 134, 696
1879	17, 704	634, 546	....	223, 283	857, 829
1880	8, 619	108, 733	....	317, 068	425, 801
1881	23, 452	399, 552	....	918, 835	1, 318, 387
1882	46, 699	854, 463	133, 956	1, 437, 442	2, 291, 905
1883	25, 187	537, 080	96, 586	798, 116	1, 335, 196
1884	28, 090	588, 033	35, 119	406, 233	994, 266
1885	20, 934	393, 039	40, 068	611, 284	1, 004, 323
Dec. 31, 1886	13, 520	306, 584	82, 608	1, 179, 724	1, 486, 308
1887	10, 195	252, 265	53, 100	644, 301	896, 566
1888	7, 381	125, 112	36, 405	329, 013	454, 125
1889	15, 991	313, 956	35, 661	403, 205	717, 161
1890	4, 642	59, 580	31, 191	252, 787	312, 367
1891	11, 937	199, 044	29, 743	214, 671	413, 715
1892	3, 073	46, 014	92, 476	666, 061	712, 075
1893	5, 856	97, 889	106, 549	718, 871	816, 760
1894	5, 757	105, 991	126, 820	904, 247	1, 010, 238

THE TENNESSEE PHOSPHATES.

By Charles Willard Hayes.

INTRODUCTION.

The occurrence of phosphates in Tennessee was briefly described in Mineral Resources for 1893. At the close of that year no shipments had been made and no development on a commercial scale undertaken. During the year 1894 the development of this field has been rapid. The first shipments were made toward the end of June, and since that time up to the end of the year 19,188 tons have been marketed. Prospecting has been active and the limits of the workable deposits are now fairly well known, as well as their geologic and economic relations.

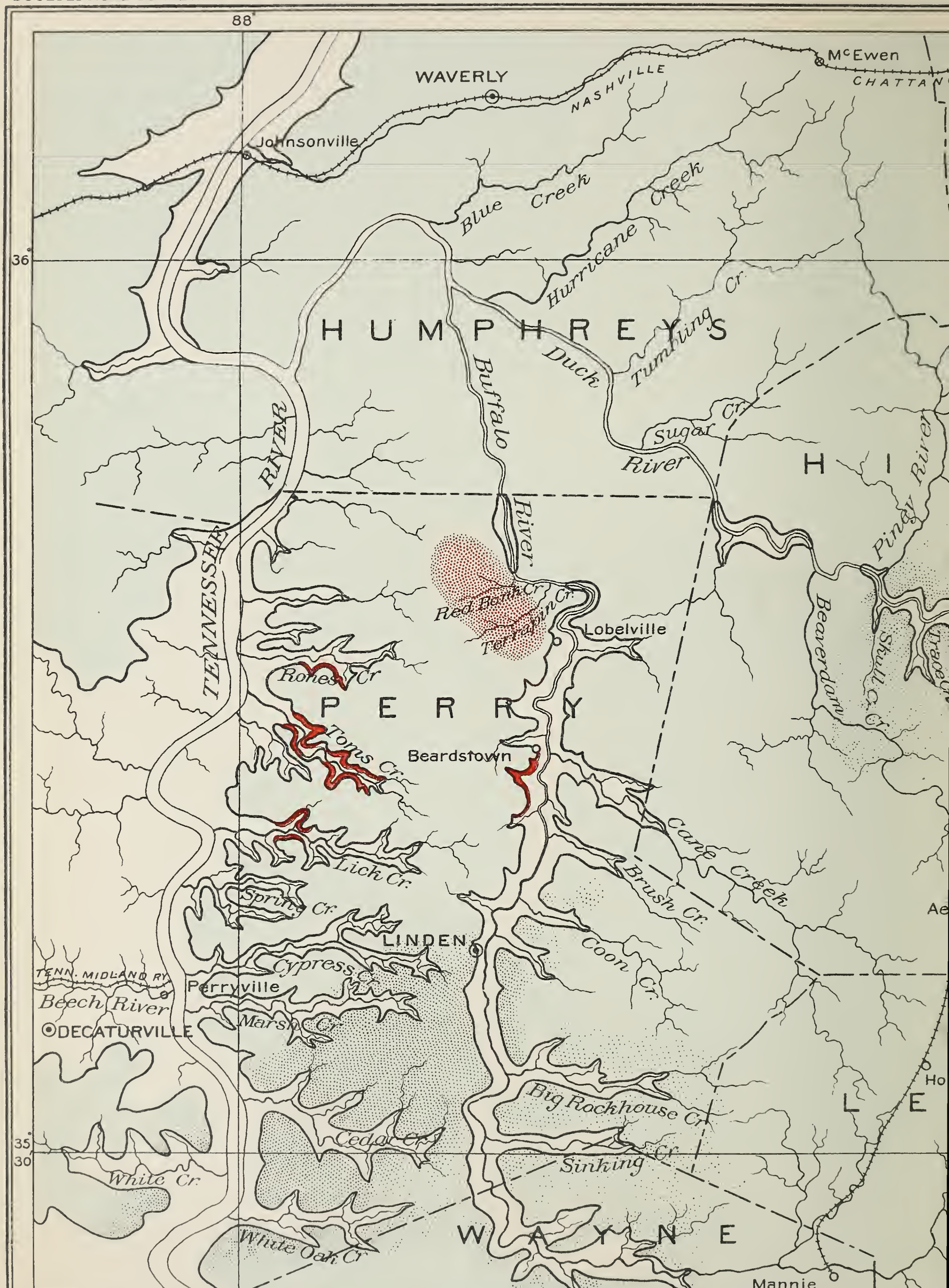
In addition to the account of these phosphates by Dr. J. M. Safford, referred to in the last volume of Mineral Resources, there have appeared during the year several other papers on the subject. The most complete is that which was read at the Bridgeport meeting of the American Institute of Mining Engineers, October, 1894, by Thomas C. Meadows and Lytle Brown, and published in the transactions of the institute. An abstract of this paper appeared in the Engineering and Mining Journal of October 20, 1894. This paper deals with the discovery of the phosphate, its geographical distribution, its geological relations and its economic aspects. It is also accompanied by a small scale map of the phosphate region.

An article in the American Fertilizer of October, 1894, by T. C. Meadows, C. E., gives an account of the development of the Swan Creek district, with a map of the same. In addition to these entirely trustworthy descriptions many more or less accurate accounts of these phosphates and their development have appeared in the newspapers. Since the papers referred to above are not accessible to all, a brief general account of the entire Tennessee phosphate field will be given. This account is based chiefly on personal examinations in the field by the writer, but he is also indebted for many facts to Dr. Safford and Messrs. Meadows, Brown, and Meminger.

CLASSIFICATION OF THE PHOSPHATES.

The Tennessee phosphate occurs in four distinct varieties, viz: (1) Black nodular phosphate; (2) black bedded phosphate; (3) white breccia phosphate; (4) white bedded phosphate. Of these four varieties only the first two have been described in the papers mentioned above, and only the second has been developed commercially. Before describing these varieties more in detail it may be said that the first two are

U.S.GEOLOGICAL SURVEY.



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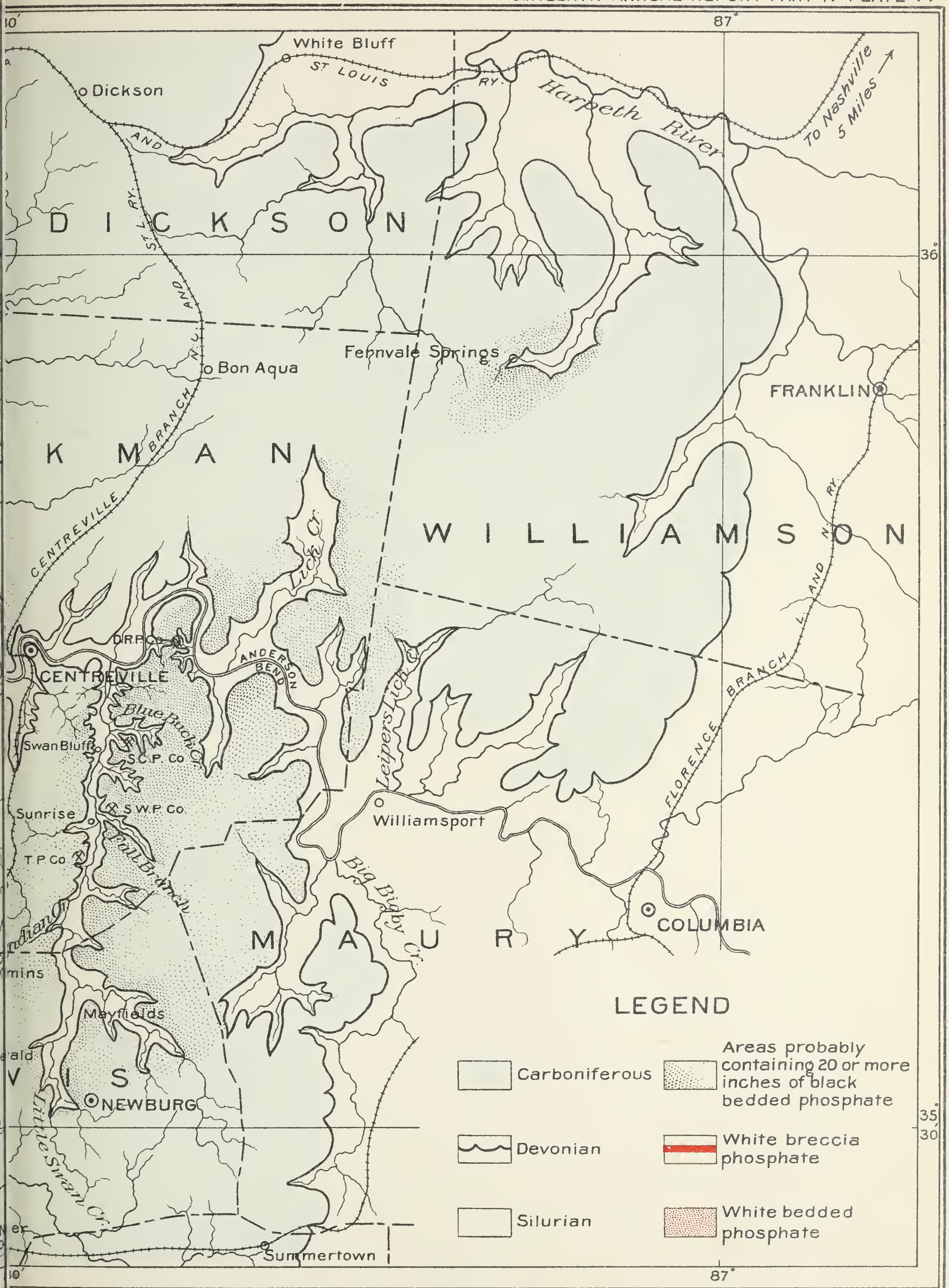


TNNESSEE PHOSPHATE REGION

C. Hayes

Sale

10 MILES

of Devonian age, the third is a secondary and comparatively recent deposit, while the fourth is interbedded with rocks of Carboniferous age, but may be of secondary origin. It may also be said that so far as at present known the extent of territory within which the different varieties have been found varies in the order above given, the nodular phosphate being the most widely distributed, and the white bedded rock confined within the narrowest limits.

BLACK NODULAR PHOSPHATE.

Although this variety is not at present of great commercial importance, and is mined only under certain conditions of association with the black-bedded rock, its geological relations are of considerable interest, and it will therefore be briefly considered along with the Chattanooga (Devonian) black shale. This shale, although only a few feet in thickness, is perhaps the most persistent and uniform of all the Paleozoic formations of the South. It extends over the whole of middle Tennessee from the Tennessee River to the eastern edge of the Cumberland plateau and southward across northwest Georgia and northern Alabama, its present outcrops indicating an original extension over at least thirty-eight or forty thousand square miles. The formation probably extends toward the west and south beneath the Cretaceous and Tertiary sediments of the Mississippi embayment, so that its extent may quite possibly be double the visible area. In east Tennessee, east of the Knoxville meridian, the formation increases rapidly in thickness and is supplemented by a great mass of shaly sandstone. The formation also thickens northward in Kentucky, where it loses most of its peculiar southern characteristics. Along the southeastern border of the Paleozoic area in Georgia and Alabama the Chattanooga black shale appears to be wanting and the Devonian is there represented by coarse sandstones. In Arkansas the Silurian and Carboniferous rocks are separated by a few feet of sandstone and shale—the Sylamore sandstone and the Eureka shale of the Arkansas survey—and these formations undoubtedly represent the southwestern extension of the Chattanooga. Throughout that portion of the Appalachian area outlined above the formation is remarkably uniform, particularly in its lithologic character. It varies from 25 feet in east Tennessee to 6 or 8 feet in middle Tennessee and Alabama. The upper part of the formation, a bed 2 or 3 feet thick in east Tennessee and 12 or 14 inches thick in middle Tennessee, is made up of a bluish or greenish gray matrix, in which phosphatic nodules are embedded. This matrix is a fine-grained sandstone with an irregular shaly structure. It is seen under the microscope to be made up largely of angular quartz grains, with some argillaceous or clayey material and iron oxide. It contains some grains of a colorless mineral which is not doubly refracting—and in this resembles a glass—and a mineral which may be feldspar, although the rock is too much altered by weathering to determine it with certainty. It also contains rather abundant grains of a green mineral, possibly chlorite, which gives the rock its peculiar color. The phosphatic nodules are undoubtedly concretionary. They are composed of a nearly amorphous substance which has very minute radial, globular, and mammilary forms. The irregular spaces between these radial forms are generally filled with secondary quartz, though sometimes empty. There are also numerous globular shells of radially arranged material surrounded by a flocculent granular substance and filled within by quartz. In some of the nodules, though not generally, there is an arrangement of the material in separable concentric shells. More often there is only a slight difference in density and amount of coloring matter at different distances from the center.

In the Batesville region of Arkansas a thin stratum of rock, having almost identically the same appearance as that in Tennessee described above, is mentioned by Penrose[1] as occupying a corresponding stratigraphic position immediately below the Carboniferous. A thin section of this rock was examined by Dr. Wolff, of Harvard University, who "found evidence pointing to the possibility of its being composed partly of volcanic ash."

While the thin sections of the Tennessee material above described do not afford conclusive evidence that the green shale is an ash bed, they suggest the possibility that such is the case. The peculiar appearance of this stratum, its very wide distribution and great uniformity in thickness and composition, and the striking difference in the character of its materials from those above and below are all points which are easy of explanation if the material is a volcanic ash, and difficult on any other hypothesis. If this is an ancient ash bed, however, it must have been deposited on the ocean bottom, so that it is also a stratified formation and has been subjected to the sorting, solvent, and, possibly, wearing action of water.

The "small siliceous concretions, an eighth of an inch to 1 inch in diameter," which Penrose describes as occurring in the supposed Arkansas ash bed, have recently been examined by Professor Williams, of Yale University, and found to be highly phosphatic. This adds a strong point in confirmation of the supposed identity of the deposits in Tennessee and Arkansas, so that if it can be proven that one is composed of volcanic ash it may fairly be assumed that the other is also.

Above this ash bed, if such it be, there is everywhere an abrupt transition to the overlying Carboniferous beds; in east Tennesse to the Fort Payne heavy bedded cherts; in middle Tennessee to the Harpeth calcareous cherty shales, and in Arkansas to the Boone cherty limestones. Although there is thus a total change in lithologic character, and the beds must have been deposited under entirely different conditions of sedimentation, there is apparently no unconformity

[1] Arkansas Geological Survey: Ann. Rep., 1890, Vol. I, p. 126.

between them. The change in conditions was not produced by elevation above sea level and subsequent depression, for there has been no erosion of the underlying beds. The simplest explanation of this abrupt change without unconformity is that the cycle of extremely slow sedimentation marked by the underlying black shale was brought to a close by a sudden volcanic eruption which spread its ejected material over the entire southern Appalachian sea and produced permanent changes in the currents and other conditions of sedimentation such as to completely change the character of subsequent deposits.

Excepting the upper bed above described, the Chattanooga black shale, as its name implies, is composed of highly carbonaceous, homogeneous material. The shaly structure is not generally pronounced, though more so in the weathered than unweathered portions. It always contains more or less pyrite, so that weathered outcrops are generally stained with iron oxide and sulphate, and the shale gives rise to many mineral springs. The lower portion of the formation contains at various places beds of sandstone or conglomerate, and in middle Tennessee the phosphate beds, which will be described later.

The relations of the Chattanooga to the underlying Silurian formations are much less simple and uniform than to the overlying Carboniferous beds. In east Tennessee the black shale is underlain by the Rockwood formation, red or brown sandstones grading westward through sandy and calcareous shales to blue limestone in middle Tennessee. About the central basin the limestones immediately under the Devonian contain Trenton fossils, according to Safford, while farther west, along the Buffalo and Tennessee rivers, they contain Niagara and Helderberg fossils. The broad relations of these formations, therefore, indicate that there is an unconformity at the base of the Devonian, and at some points the unconformity is visible. Thus, at Chattanooga, the Devonian is underlain by a greenish-yellow shale, the Rockwood, containing thin siliceous layers which are truncated by the overlying beds at an angle of about 5 degrees. The contact is also marked by lenses of ferruginous flinty sandstone. At Guntersville, Ala., on the eastern side of the Sequatchie anticline, there are indications of an unconformity similar to those at Chattanooga, in thin beds or lenses of coarse sandstone and conglomerate which occur at the base of the black shale. With these conglomerate lenses there occur thin seams of coal from a quarter to half an inch in thickness, and slightly thicker layers of blue clay shale. The presence of this coal proves the existence of an abundant vegetation, and, while it may be formed wholly from marine plants, it is suggestive of land conditions either at this locality or near at hand. The regularity of the surface on which the Chattanooga is deposited precludes the idea of a land surface with any considerable amount of relief, and is more suggestive of submarine than of subaerial erosion. In Arkansas the corresponding contact of the Sylamore sandstone with the underlying formations appears from descriptions referred to above to be much less regular and more like an old land surface. This unconformity at the base of the Chattanooga will be again referred to on a subsequent page, and its bearing on the probable conditions under which the adjacent formations were deposited will be more fully discussed.

As stated above, phosphatic nodules are always found embedded in the greenish shale or ash bed at the top of the Chattanooga, and over most of the area in which the Chattanooga is found they are confined to this upper bed. They are nearly spherical bodies, from ½ to 1½ inches in diameter, in some places packed closely together, and in others sparingly scattered through the matrix. They usually weather more easily than the matrix, and form a gray powder in the center, inclosed in a harder and darker colored shell. In Floyd and Chattooga counties, Georgia, the nodules extend downward into the upper portion of the black shale, though less abundant there than in the green shale, but considerably larger.

Although so widely distributed the nodules reach their greatest development and become of possible economic importance only in the region to which the black bedded phosphate is confined, in western middle Tennessee. Here they are not confined to the upper portion of the Chattanooga, although still most abundant in that position, but are found in all parts of the formation, usually in irregular layers from 3 to 12 inches thick. They sometimes even occur below the base of the black shale in the upper portion of the bedded phosphate. The nodules vary widely in size and shape from spherical bodies an inch in diameter to irregular flattened concretions 2 feet in length. The most abundant are irregular ellipsoids, flattened on their lower sides, from 3 to 9 inches on the longest diameter and about half as thick.

The nodules have a fine granular structure and a bluish-black color when fresh, and are quite homogeneous throughout. Fractured surfaces show under a hand glass many small spherical bodies embedded in the granular ground mass. These appear to be calcite, and when broken across show bright cleavage surfaces. Many minute pyrite grains are also scattered through the ground mass. On weathering, the nodules become lighter in color, sometimes almost white, and often show a distinct concentric banding of different shades of gray. Their texture becomes quite porous and the globules of calcite are removed, leaving spherical cavities.

The nodules contain from 60 to 70 per cent of lime phosphate, a little more in weathered than in unweathered specimens. They are not known to occur at any point in sufficient quantity to pay for separate mining apart from the bedded rock. When, however, the latter is mined by stripping off the overburden the nodules are saved without additional cost, being easily separated from the inclosing shale, and they will thus make it possible to work with profit a thinner bed than could be worked if they were not present.

BLACK BEDDED PHOSPHATE.

The chief economic interest centers in this variety, for it is the only one of the four varieties of Tennessee rock which has yet been developed on a commercial scale and will probably continue to be the most important. The black bedded phosphate is confined, so far as at present known, to an oval area southwest of Nashville, having Centerville about in its center. This oval area lies west of the central basin of Tennessee, between the line of the Nashville, Chattanooga and St. Louis Railway on the north and a line through the northern portions of Lawrence and Wayne counties on the south, and extends westward a short distance beyond the Tennessee River. It thus covers portions of Hickman, Williamson, Maury, Lewis, Wayne, Perry, and Decatur counties. By no means all, or even the greater part, of this area contains workable phosphate, since the deposit shows great variation in character and thickness, in some places becoming too poor in phosphate to be utilized and in others too thin for profitable working; also many of the streams have cut down through the phosphate bed and removed it from their valleys. For these and other reasons it is not probable that more than a small part of this area, perhaps 1 or 2 per cent, will ever be actually productive territory.

The phosphate region is a part of the highland rim lying west of the great lowland basin of middle Tennessee. Its topography is that of a dissected plateau, whose higher portions reach nearly 1,000 feet above sea level, and within which the streams have sunk their channels from 300 to 500 feet. The contours of the surface are generally smooth and flowing and the drainage is well adjusted to the surface over which it flows. Narrow strips of bottom land border the larger streams and in most cases extend well up toward the head waters of the tributaries. These valleys are fertile, while the surface of the plateau bears the suggestive name of "the barrens."

The geologic structure of this region is quite simple. Lying upon the western side of the arch or dome which gives rise to the central basin of Tennessee, the strata have a general westerly dip. This general westward inclination is modified by several very gentle folds, whose axes extend in a northeast-southwest direction, approximately parallel with the axis of the central Tennessee dome and of the sharp folds in east Tennessee. The extreme depth of these folds is only a few hundred feet, and the dips are usually not sufficiently steep to be noticeable. One of the anticlinal axes passes through Centerville and another through Linden and Dickson. Between these axes a gentle syncline carries the Devonian below drainage. Northwest of the Linden-Dickson axis the Devonian is again carried below the level of Buffalo and Duck rivers.

The rocks of the region are Silurian, Devonian, and Carboniferous. Except in the gentle synclines above mentioned, the valleys of the larger streams are cut in the blue, flaggy limestone, which, according to Safford, carries Niagara and Helderberg fossils on the side toward the Tennessee River and Trenton or Hudson River fossils on the side toward the central basin. Above the Silurian limestone is the Chattanooga (Devonian) shale, with its associated phosphatic rocks, while above the Chattanooga shale are lower Carboniferous rocks, called Harpeth shale by Safford, but not differing essentially from the Fort Payne chert of east Tennessee. To these Carboniferous cherts are due the most striking characteristics of the country. They cover the surface of the plateau with a deep, residual mantle, which extends downward upon the sides and across the bottoms of the valleys, generally concealing the outcrops of the underlying formations. The streams flow over great accumulations of the chert-gravel, which is supplied from the valley sides more rapidly than it can be removed by their currents.

The sections given herewith (Pl. XXIX) will serve to show the thickness of the phosphate bed at various points and the character of the rock with which it is immediately associated.

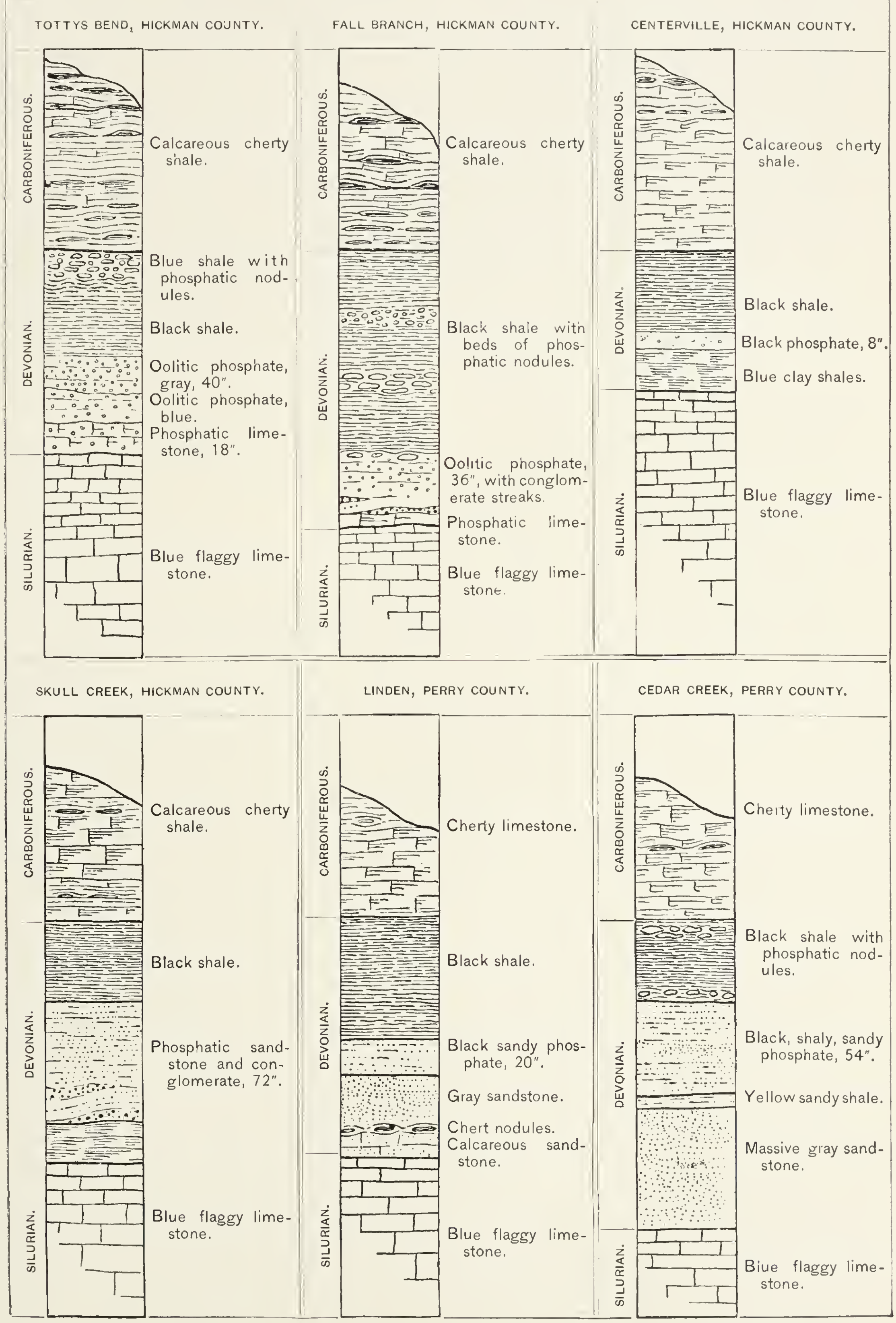
In general, the most rapid variations in the black phosphate occur in passing east and west, while upon north and south lines considerable uniformity is found. This, however, must be taken only in a general way, for there are many exceptions. The principal injurious constituents found in the phosphate rock are (1) carbonate of lime and (2) silica. On the one hand the rock grades into a more or less phosphatic limestone, and on the other into a phosphatic sandstone. The rock richest in phosphate, containing in some places as high as 81 per cent lime phosphate, occurs on a line extending through the Swan Creek Valley northward through Totty's Bend, and perhaps crosses Duck River to the vicinity of Fernvale Springs, in Williamson County. The rock in this region reaches a thickness of 40 inches, and averages 30 inches over considerable areas. From this line of thick and rich rock the bed thins westward to about 8 inches at Centerville. Thence westward it thickens to fully 6 feet at Skull Creek, 8 miles west of Centerville, but at the same time becomes much more siliceous, and at the point of greatest thickness is simply a phosphatic sandstone, containing perhaps 35 per cent or less of lime phosphate. Still farther west, in Perry County, along Buffalo River, is apparently another line of minimum thickness, though not so well located as those farther east.

West of this, or rather southwest, the bed again thickens from 20 inches at Linden to 3 feet at the head of Cedar Creek and 6 feet or more near the Tennessee River.

In the Swan Creek district, which may be taken as the type locality, the phosphate rock has a bluish black or gray color, weathering to a rusty yellow. At Tottys Bend the bed is separated into two distinct layers, which are mined and marketed separately. The upper is gray and the lower blue-black, the former containing a somewhat higher

SECTIONS SHOWING THE RELATIONS OF THE TENNESSEE PHOSPHATE TO ADJACENT FORMATIONS.

Scale: 1 inch = 10 feet.



percentage of phosphate than the latter. This, however, is an exceptional occurrence, and at all the other openings in the district the bed has a uniform color from top to bottom, though it generally varies somewhat in texture in its different portions. The typical rock has a somewhat oolitic structure, composed largely of small rounded or flattened grains, with black glazed surfaces. The oolitic appearance is increased by the presence among the round grains of numerous casts of very small coiled shells. Although the oolitic structure is common in the best rock, it is not always present, and hence it can not be taken as a criterion of quality. From the distinctly oolitic rock there are all gradations through that in which only occasional round grains are seen to one which is composed of compact, fine-grained, homogeneous earthy material. In addition to the minute coiled shells, some fossil bones have been found in the phosphate bed, 10 or 12 inches in length and half an inch in thickness. These are doubtless the remains of large fishes which lived while the phosphate was being deposited.

At Fall Branch and elsewhere the lower portion of the phosphate bed contains thin streaks of conglomerate, which thicken to several inches and then entirely disappear within a few yards. The larger pebbles, sometimes half an inch or more in diameter, are composed of well-rounded fragments of black shale or of phosphate rock, and these are mingled with rather coarse quartz grains. The surface of limestone on which the phosphate bed rests is much more uneven at Fall Branch, where these conglomerate beds occur, than at Tottys Bend, where they are absent.

Immediately below the main phosphate bed there is in the Swan Creek district generally a bed of phosphatic limestone which should probably be included in the Devonian along with the phosphate bed. At Tottys Bend this stratum is about 18 inches thick and contains between 30 and 40 per cent lime phosphate. At Fall Branch it is not so thick where present, and at some points is wanting. It contains numerous black rounded grains similar to those composing the oolitic rock, and also the same minute coiled shell casts.

Southward from Fall Branch the phosphate bed outcrops along the sides of Swan Creek Valley to about the center of Lewis County. It holds nearly a uniform thickness of 36 inches to Little Swan Creek, beyond which it decreases to 20 inches where it passes below drainage. The bed varies more in composition than in thickness, becoming sandy on Indian Creek, with 39 to 58 per cent lime phosphate, while at Mayfields, near the mouth of Little Swan Creek, it contains over 70 per cent, being almost as rich as at Tottys Bend. The region east of Swan Creek Valley drained by streams flowing into Duck River has not been thoroughly prospected, but the phosphate bed has been reported at various points in the western part of Maury County with a thickness of about 36 inches, and containing from 30 to 65 per cent lime phosphate. Also little prospecting has been done north of Duck River, but the bed has been reported at Fernvale Springs, in the western part of Williamson County, as 36 inches in thickness and containing from 53 to 64 per cent lime phosphate.

West of Centerville the phosphate bed thickens to a maximum of 6 feet on Skull Creek, but the conglomeratic streaks which form an inconspicuous feature in the Swan Creek region become gradually more abundant till they form the greater part of the bed. The larger pebbles, as well as many of the smaller grains, are well-rounded fragments of compact, fine-grained phosphate. Among these are more or less abundant quartz sand grains and many smaller concretions of pyrite. Casts of the small coiled shells are also found in this rock, but they are very much less abundant than in the oolitic variety. In the finer-grained portions of the bed shells of lingulæ are quite abundant, and these, on the other hand, are rare in the oolitic rock. Although this conglomeritic variety is always lower in phosphate and more variable in composition than the oolitic variety, it doubtless contains much rock which can be utilized. It is often found on careful examination to be much less siliceous than appears at first sight. The quartz grains are most conspicuous, but frequently make up only a small portion of the rock. The great thickness of the bed at Skull Creek and the cheapness with which it can be mined compensate in some degree for its lower content of lime phosphate. The strata dip westward from Skull Creek carrying the Devonian rocks below drainage. They rise to the surface in the valley of Buffalo River, which cuts diagonally across a low anticline, the axis passing a short distance east of Linden. The Devonian outcrops are from 10 to 15 feet above the level of Buffalo River at Linden, and about 70 feet higher on the sides of the tributary valleys a few miles to the east. The phosphate at Linden, as shown in the plate of sections, is about 20 inches thick and is underlain by several feet of gray sandstone. This sandstone thickens toward the southwest to about 6 feet on Cedar Creek and other streams flowing into the Tennessee River. It there forms a prominent feature in the topography, modifying the slopes of the hillsides and often standing out as a continuous rocky ledge. It renders the tracing of the phosphate outcrop a very simple matter where it would otherwise be difficult, on account of the mantle of residual chert which covers the outcrops of all soft beds.

The phosphate bed also increases in thickness toward the southwest from 20 inches at Linden to 24 inches at the head of Cedar Creek, to 4½ feet on Grooms prong and to a considerable greater thickness near the Tennessee River. At the time this region was examined, in November, 1894, no artificial openings had been made, so that it was impossible to determine thicknesses exactly. At one point near the mouth of Cedar Creek the phosphate bed is exposed with a clear face of 6 feet, and it is probable that its total thickness is here at least 8 or 10 feet. The phosphate bed has also been found, though somewhat thinner, on Marsh and White Oak creeks, which lie on either side of Cedar Creek and also on the tributaries of Buffalo River as far up as Forty-eight Mile Creek. The bed is also said to occur high up in the hills west of the Tennessee River, but its character and thickness there are not known. Northwest of Linden, on Spring, Lick, and Tom creeks, both the phosphate bed and the underlying sandstone disappear, the former being represented by a few feet of blue phosphatic shales.

The phosphate rock wherever it has been observed in Perry County has a tolerably uniform composition and appearance. No oolitic rock has been found; on the other hand, the bed everywhere has the appearance of a rather fine-grained black sandstone. It varies somewhat from place to place in the size of the component grains and in the character of the bedding, in some cases being quite massive, but more generally having a rather shaly structure, the beds being from half an inch to 8 or 10 inches thick. The coiled shells have not been observed in the phosphate of this region, but some portions of the bed contain lingulæ in great numbers. Some analyses have been made of this rock which show it to contain from 50 to 68 per cent lime phosphate. It is probable, however, that the average of rock from considerable areas and all parts of the bed would not be much above 50 per cent.

Notwithstanding the lower grade of this rock the Cedar Creek district has certain advantages which will make it a formidable rival of the Swan Creek district. The chief of these are, first, the cheapness with which the rock can be mined by reason of the thickness of the bed and the position which it occupies in the hills, and, second, the cheapness with which it can be marketed by reason of its close proximity to water transportation.

The practical questions of economic development are considered elsewhere by Mr. Memminger and need not be dwelt on at length here.

The microscopic structure of the black-bedded phosphate is somewhat important, since it affords some indication of the conditions under which the rock formed and of the source from which the phosphoric acid was derived.

The color of the rock is seen to depend directly on the abundance of fine grains of black carbonaceous matter which it contains. In the gray rock from Tottys Bend this black material is almost entirely wanting, while in the black rock from Fall Branch and elsewhere it is very abundant, sometimes rendering the section quite opaque. The lime phosphate, when the carbonaceous matter is absent, consists of colorless or yellowish flocculent grains, and is entirely amorphous. This material forms the oolitic grains and fossil casts which can be readily seen with the hand glass. When the coloring matter is absent the outlines of these bodies are rather indistinct in the section. In some cases they are closely crowded together, and in others are embedded in a ground mass of the flocculent grains and fine oolitic granules. A majority of the larger oolitic grains show evidence of having been casts of the interiors of shells, but are generally worn to an oval form, and their original shape is often nearly obliterated. In addition to the casts of shells there are numerous fragments of corals which also show the effect of wear by currents or waves, being generally well rounded. In some cases they are made up wholly of phosphate, the internal structure being preserved and brought out by different amounts of carbonaceous coloring matter. In others the septa, or partitions, are composed of calcite as they were originally, while the perforations in which the animal lived are filled with phosphate. In the phosphatic limestone, which at Tottys Bend and elsewhere underlies the main phosphate bed, the same rounded shell casts and oolites are seen scattered through a mass of calcite grains. In most cases very fine crystals of calcite occur more or less abundantly embedded in the phosphate grains.

Thin sections of the siliceous phosphate which occur in the Skull Creek district and in Perry County show an ordinary sandstone structure. The grains, particularly the larger ones, are well rounded, and in their forms suggest wind-blown and polished rather than water-worn sands. A large proportion of the grains are quartz and lime phosphates. The relative abundance of the two constituents varies widely, but in the Skull Creek district the ratio of quartz to phosphate grains is fairly constant, from one or two of the former to three of the latter. Some of the phosphatic conglomerates which appear to be very sandy are seen in thin sections to contain comparatively few grains of quartz. The phosphate grains are partly black and opaque and partly light yellow. They occasionally show the outline of fossil casts and also the internal structure of corals, but are more often without any trace of organic origin. In some cases the rock appears to have been originally a clean-washed sand, while in others it was evidently a sandy mud, and the rounded grains are embedded in a groundmass of fine, angular quartz fragments with granular lime phosphate and clay.

ORIGIN OF THE BLACK PHOSPHATES.

No explanation which is entirely satisfactory has yet been offered to account for the local accumulation of the phosphate. The deposit has some features in common with the South Carolina land rock, though the differences are greater than the resemblances. It is quite different from all varieties of the Florida rock, and its accumulation appears to be in no way connected with the recent leaching of a phosphatic limestone or with the replacement of any other constituent by lime phosphate. It appears rather that the explanation of the deposit must be sought in the conditions of sedimentation which prevailed in this region during the Devonian. The extreme thinness of the Devonian rocks in the southern Appalachian region has already been described, and this characteristic may be in some way intimately connected with the accumulation of the phosphates. Various hypotheses might be suggested to account for the absence of Lower Devonian formations in the southern Appalachian region. The one which has been perhaps most commonly advanced accounts for the absence of sediments by reason of the great depth of the sea which covered the region. It is well known that in the abyssal depths of the ocean sedimentation is extremely slow, so that many geologic periods might have no sedimentary record under such conditions. But the great ocean basins, with sufficient depth for nondeposition, if not permanently fixed, at least require long periods for deepening and shoaling, and a gap in the sedimentary record caused by such conditions should show no abrupt breaks, but a gradual transition on either side from shallow-water deposits, through those which characterize deepening water to the gap which marks the abyssal conditions. This transition, however, is conspicuously absent in the region under consideration. The rocks immediately below the stratigraphic break in some places are sandstones or sandy shales, in others flaggy, fossiliferous limestones, all of which are comparatively shallow-water formations. In like manner the overlying rocks contain in their very lowest portions beds of conglomerate which would require the presence of strong currents capable of carrying pebbles up to an inch in diameter. Other reasons might be given for rejecting the hypothesis of abyssal depths, but the above seem amply sufficient. The second hypothesis, like the first, assumes that the region was covered by sea, but accounts for the absence of deposits not by the conditions prevailing in the sea itself but in the land adjacent. When a land area remains for a very long time without elevation or depression its surface is worn down very near to sea level, the base level of erosion. Its streams become sluggish and are no longer able to carry sand or mud to the sea, and the accumulation of the corresponding sediments ceases for lack of a supply of fresh material. But long after the streams cease carrying mechanical particles to the sea they continue carrying a large amount of matter, chiefly calcareous, in solution. The adjacent seas are thus furnished with an abundant supply of lime, and their clear waters are highly favorable for the growth of animals whose remains form beds of limestone even near shore in shallow water. Thus base-level conditions on land are marked by the formation of limestones in adjacent seas, not by the absence of deposits of any kind, as in the present case.

The third hypothesis assumes that the entire region from which the Lower Devonian formations are absent was a land area during the corresponding geologic period; that the land extended continuously westward from the southern portion of the old Appalachian continent across the Mississippi embayment to Arkansas, Texas, and beyond, leaving upon the north an interior sea, open, perhaps, only toward the northwest. It assumes that the surface of this land was but little above sea level, and that toward the end of Devonian time it was depressed, so that the sea transgressed a long distance upon the land and laid down the Chattanooga black shale, with its associate phosphates, upon what had formerly been a land surface. In describing the relations of the Chattanooga to the underlying formations the existence of an unconformity below the Devonian was shown to be highly probable. But this unconformity shows few, if any, of the features which would be expected to characterize an old land surface. It is difficult to imagine such a surface without some sort of residual accumulation, or to imagine a sea encroaching upon a land without working over the surface material and forming basal conglomerates. But, so far as known, there are no such deposits; for, although conglomerates occur above the unconformity, they contain no pebbles derived from the underlying formations, but only such as were derived from some foreign source or from other portions of the same formation in which they are found.

The fourth hypothesis assumes that the region was almost, if not quite, continuously covered by a shallow sea in which strong currents and a feeble supply of material prevented deposition. It assumes that the conditions over the southern Appalachian region during late Silurian and early Devonian time were similar to those at present prevailing in the trough of the Gulf Stream. According to Alexander Agassiz, the sea bottom is there swept clear of all sediment and consists of hard limestone. Such currents might have swept in from the southwest from a sea into which little if any detrital matter was being carried and have had sufficient strength to carry away any sediment resulting from the remains of animals living in the waters of the region itself.

The strongest objection to this hypothesis is the wide extent of the region in which no deposits were formed during early Devonian time. The general conditions are the same in the Arkansas region and on the northwestern border of the Mississippi basin as in the southern Appalachians. It is quite possible, however, that the absence of Devonian formations in other parts of the Mississippi basin may be due to land conditions, and the explanation here suggested is intended to apply only to the region which has been specially studied in connection with the phosphate deposits. Not enough is known of the position of shore lines in late Silurian and Devonian time to enable one to state with certainty the direction of the ocean currents. The interior sea, however, was probably cut off from the North Atlantic by a land barrier stretching across from the Canadian highlands to the Appalachian continent, so that if currents came from the south or southwest they could not have passed out in that direction, but must have been diverted to the northwest between the Cincinnati arch and the land probably existing in Missouri. The Devonian sediments in the northern Appalachians appear to have come from the northeast, and the abrupt southward termination of the great mass of these rocks may be connected with such currents. Sediments which would naturally have spread over the southern Appalachian sea bottom and formed gradually thinning representatives of the northern Devonian formations may have been swept away past the southern point of the Cincinnati arch and distributed over the western Mississippi basin.

This period of complete nondeposition in the southern Appalachian sea was followed by one of extremely slow accumulation, probably produced by the emergence of land in the Arkansas region which supplied a small quantity of detritus to the northeastward current and also modified its velocity. The sandstone of Perry County was then deposited, thinning out to a feather-edge toward the northeast. Following the deposition of the sandstone were conditions favorable to the growth of organisms such as lingulæ, which secrete phosphate of lime in their shells. These shells accumulated upon the sea bottom, where they were subjected to the rolling of currents and the solvent action of sea water. The carbonate of lime, being more easily soluble, was largely removed, and the phosphate remained either in its original form or, more generally, replacing the organic matter which filled the shell and thus producing the interior casts so abundant in the phosphate bed. Slightly different conditions in different portions of the region gave rise to the differences in the deposit. Thus the working over by exceptionally strong currents of deposits once solidified with the introduction of foreign sand grains would account for the phosphatic conglomerates of Skull Creek. The presence of fine sand in currents of varying strength would give rise to the sandy, shaly phosphate of Perry County.

Following the period of most active accumulation of phosphate was apparently one in which the currents were still further checked so that but little foreign matter was brought in, while the conditions became less favorable for the growth of phosphate-secreting animals and more favorable for vegetable growth, probably seaweeds, whose remains furnished the carbonaceous matter contained in the Chattanooga black shale. Phosphatic organisms continued to inhabit the waters, though in diminishing numbers, and the lime phosphate thus extracted from the sea water was segregated into the nodules of the black shale, while the lime carbonate was almost entirely removed by solution.

Finally these conditions were brought to an end by a widespread volcanic eruption, the ejected matter forming the blue shale at the top of the Chattanooga—an eruption ushering in a new set of conditions which produced a complete change in the character of succeeding formations. While numerous objections may be found to this hypothesis, it is offered as the one which explains the largest number of the facts. Further study will doubtless modify it to a considerable extent and possibly show it to be erroneous in its essential features.

THE WHITE PHOSPHATES.

Shortly after the discovery of black phosphate on Swan Creek, in Hickman County, Tenn., prospectors familiar with the Florida phosphate came to the region and began the search for rock similar to that found in Florida. Among these was Mr. E. Slattery, who located at Linden, in Perry County. He gave a piece of the Florida rock to Mr. C. C. Sutton, and the latter discovered on Toms Creek a deposit which bore a strong resemblance to the sample. This proved to be the phosphate breccia, described below, and the country was carefully examined to determine the extent of the deposit. A short time after, Mr. P. L. Smothers discovered in the same way, on Red Bank Creek, another deposit bearing even stronger resemblance to the Florida rock. This was the white-bedded phosphate.

As indicated above, there are two varieties of the white phosphate, distinct in appearance, mode of occurrence, and origin, namely, the brecciated rock and the white-bedded rock. Both varieties, so far as known, are restricted to Perry County, although future prospecting may greatly extend their range.

WHITE BRECCIA PHOSPHATE.

LOCATION OF THE DEPOSITS.

This variety is most highly developed on Toms Creek and upon the west side of Buffalo River, north of Linden. It has been reported, also, from Spring and Lick creeks, south of Toms, and from Rones Creek, on the north. These streams are northwest of Linden, in Perry County, and flow westward to the Tennessee River in rather wide valleys, from which the intervening remnants of the plateau rise with gentle, rounded slopes. The phosphate breccia is found upon these slopes within a vertical range of from 30 to 50 feet, and following the windings of the valley sides with slight variation in altitude. Its upper limit appears to be the outcrop of the Devonian black shale; but this is somewhat difficult to determine, since the overlying chert deeply covers the surface, and outcrops of the black shale are extremely rare. The outcrops of the phosphate rock are not continuous. In some places occasional bowlders only are found, while at others the material covers the entire surface. No work has been done to determine its depth. At some places it appears to rest upon an eroded surface of Silurian limestone, but more often it is simply embedded in the residual chert. The rock nowhere shows any trace of bedding, either within its own mass or in its relations as a whole to the formations with which it comes in contact.

COMPOSITION AND PHYSICAL APPEARANCE.

The phosphate rock occurs in irregular masses, composed of small, angular fragments of Carboniferous chert embedded in a matrix of phosphate of lime. The chert fragments vary in diameter from a fraction of an inch to 3 or 4 inches. They are in every respect similar to the fragmental chert which so abundantly covers the hillsides. The phosphatic matrix, when unstained by exposure to the weather, is generally white or slightly reddish and rather soft—somewhat harder than compact chalk. In some cases the phosphate shows a laminated structure, as though the cavities between the chert fragments had been filled by the deposition of successive layers of material from solution, and sometimes the cavities were only partially filled. Where this concentric structure is shown, the phosphate is more dense and also purer than the structureless variety. In most of the breccia examined, the chert fragments make up about 50 per cent of the rock. At the Ledbetter place on Toms Creek, and also near Beardstown, some rather large masses were observed which appeared to be nearly free from chert. They closely resemble some forms of travertine which are being deposited by calcareous springs, and suggest an analogous origin. These detached masses may be portions of a more extensive deposit of similar material, almost entirely covered by the mantle of chert.

Not enough prospecting has yet been done to afford a basis for an accurate estimate as to the available amount of phosphate of this variety, but some idea may be gained by considering the length of actual outcrop. Assuming for the deposit a uniform width of 75 feet, it is estimated that in the territory thus far known there are between 40 and 50 acres which would be actually productive. On a very moderate assumption as to the depth of the deposit, this would yield several hundred thousand tons of the material. Of course, careful prospecting may show this estimate to be far above or below the mark.

It is quite probable that further exploration will extend the known area within which this breccia occurs. On long exposure to the weather the matrix crumbles away, freeing the chert fragments, which cover the surface and are indistinguishable from other portions of the widespread and almost universal mantle of chert covering this portion of Tennessee. Hence, where only a few bowlders of the breccia are now found at the surface, there may be a more or less continuous deposit beneath the superficial mantle. It is also probable that other deposits may exist which now present at the surface no indication whatever of their presence. This would be especially likely of such as contain an exceptionally small proportion of chert, as the travertinoid rock above described.

UTILIZATION OF THE DEPOSITS.

Analyses of the breccia matrix show it to be a high-grade phosphate, and it would probably be found, in most cases, when carefully separated from the associated chert, to contain 80 per cent of lime phosphate. A sample of the travertinoid rock, from the vicinity of Beardstown, gave 80.92 per cent of lime phosphate. Neglecting exceptional occurrences, the ordinary rock matrix and chert together give about 40 per cent of lime phosphate. This is too low a percentage to be utilized by present methods in the manufacture of fertilizers. The problem for the mining engineer is therefore to devise some cheap method by which the crude material can be freed from a portion, at least, of the chert. As stated above, the matrix is rather soft, and shows a tendency to crumble to a powder when the rock is crushed. The chert, on the other hand, is much harder, and breaks into smaller fragments without shattering or crumbling. Hence it appears to the writer probable that if the rock were crushed so as to pass through an inch mesh, and then passed over a screen with a quarter or third inch mesh, the greater part of the phosphate would pass through with comparatively little chert. If only half the chert were thus removed, the proportion of lime phosphate would be raised from 40 to 53 per cent. This would bring it above the limit of availability for use by methods now employed in the manufacture of fertilizers.

ORIGIN OF THE DEPOSITS.

From the appearance of these deposits and their relations to adjacent formations there can be little doubt that they are recent and superficial, the result of the leaching of the black phosphate and redeposition near its outcrop. It seems probable that surface water containing a large proportion of carbonic acid reached the black shale through the overlying porous covering of chert. The lime phosphate associated with the black shale was dissolved by the percolating acidulated water, which subsequently reached the surface at the outcrop of the shale. The dissolved phosphate was then redeposited, partly in the interstices of the fragmental chert covering the surface and partly as a solid deposit with but slight intermixture of chert. The former mode of deposition produced the more abundant breccia, while the latter gave rise to the travertinoid masses. Subsequent erosion has doubtless lowered the valleys throughout the region, and removed much of the phosphatic deposits thus formed.

If this theory of its formation be correct, the deposits will be found only near the surface in shallow pockets; and although there is unquestionably a large amount of the material in sight, mining will be attended with the uncertainties which invariably accompany the working of pocket deposits.

WHITE BEDDED PHOSPHATE.

LOCATION OF THE DEPOSIT.

So far as at present known, this variety is confined to a small area in Perry County. It has been found only in the valleys of Red Bank and Terrapin creeks, which flow eastward into Buffalo River. The extreme outcrops lie within an area about 3 miles long by a little over a mile broad. Within this area numerous outcrops occur, though the rock has not been traced continuously from one to another, and it is only inferred that they form a continuous bed.

The northward dip of the strata carries the Devonian down to the level of Buffalo River, above the mouth of Red Bank Creek, so that the dissected plateau is here composed wholly of the lower portion of the Carboniferous, which consists mostly of chert beds in calcareous, sandy shale.

The phosphate is found about 70 feet above the Devonian black shale, interbedded with the Carboniferous chert. At the Spencer place, on Red Bank Creek, the phosphate and chert crop out in a ledge about 20 feet high, above which occur numerous though not continuous exposures, making a total thickness of at least 30 feet. Of this the lower 20 feet consists of alternate beds of phosphate and chert. The latter appears in lenticular beds from 4 to 12 inches thick, its contact with the phosphate being somewhat indistinct. Portions of the phosphate are highly siliceous, approaching chert in appearance and probably in composition. The appearance is that of an incomplete replacement of the chert by the phosphate. According to an approximate estimate of this portion of the formation, the chert beds appear to make up about 30 per cent of the mass, the remainder being more or less siliceous phosphate.

The upper 10 feet, although not so well exposed, appears to be made up almost entirely of obscurely bedded phosphate, without any considerable portion of chert. The phosphate in this part of the formation is also whiter, softer, and evidently less siliceous.

In Stone Quarry Hollow, on the south side of Terrapin Creek, the phosphate is exposed about 40 feet in thickness. As upon Red Bank Creek, the lower portion consists of alternating beds of stony chert and hard siliceous phosphate, while the upper portion, perhaps 10 or 15 feet in thickness, is free from chert beds, or, if present, they do not appear at the surface.

At the Myatt place, on Terrapin Creek, the formation is at least 30 feet in thickness; but the bedding is less distinct than at the points above described, and there does not appear to be so marked a difference between the upper and the lower portion, although this may be due to less complete exposure.

PHYSICAL APPEARANCE.

The phosphate rock is much harder than ordinary lime phosphate, and breaks with an extremely rough, irregular surface. It has a finely granular structure, some portions resembling a very fine quartzitic sandstone, but grading into translucent chert. The patches of gray chert surrounded by the white granular rock give a mottled appearance to the fresh surfaces. The chert is not in the form of sharply defined fragments, such as occur in the phosphatic breccia, but merges into the granular ground mass, which consists of a skeleton of silica holding soft white lime phosphate. It is the presence of this siliceous skeleton which gives the apparently granular material its great hardness. Many small irregular cavities occur in the rock, and these are generally lined with minute quartz crystals. Thin sections of the phosphatic rock exhibit under the microscope a more or less continuous ground mass of chalcedonic or crypto-crystalline silica, embedded in which are rhombohedral crystals. In portions of the rock, which appear as compact chert, they are very minute (often less than one one-hundredth mm. in diameter) and widely scattered, but perfect, sharply defined rhombohedrons. In the granular portions of the rock the crystals are larger, appearing as sections of rhombohedrons, which are not perfectly independent, but are segregated into irregular groups, surrounded and penetrated by the ground mass of silica. These rhombohedral crystals have the external form of calcite, but are entirely isotropic, and hence are not calcite. The smaller crystals are quite clear and transparent, while the larger are composed of an aggregate of very minute transparent grains, with fine dustlike opaque particles, probably iron oxide. Many aggregates of similar transparent grains, but without definite crystal outlines, occur in the ground mass. Analyses of the rock make it evident that the material forming the crystals and the granular aggregates must be lime phosphate. The crystal forms are evidently those of calcite, and the crystals are therefore, in all probability, pseudomorphs, in which the lime phosphate has replaced the carbonate. The presence of a small amount of carbonate, shown in the table of chemical analyses below, indicates that the replacement has not been complete.

CHEMICAL COMPOSITION.

The following analyses[1] give a fair idea of the composition of this variety of phosphate:

Analyses of Tennessee white bedded phosphate.

	14*c*.	14*i*.	14*k* and *l*.	14*m*.	15*d*[1].	15*d*[2].
Silica, SiO_2	61.34	49.43	54.30	54.88	50.18	56.46
Lime, CaO	20.30	26.40	22.87	22.76	25.57	22.01
Phosphoric acid, P_2O_5	12.55	15.12	14.86	15.30	15.21	13.15
Corresponding to:						
Lime phosphate, $Ca_3P_2O_8$	27.40	33.00	32.45	33.40	33.20	28.60
and						
Lime carbonate, $CaCO_3$	9.75	15.21	9.36	8.23	13.45	11.56

14*c*.—Stone Quarry Hollow, south of Terrapin Creek. Phosphate and chert 2 feet from base of exposure; represents a bed 8 inches thick between thinner beds of chert.

14*i*.—Stone-Quarry Hollow. Represents the upper 10 feet of the deposit, above the interbedded chert and phosphate.

14*k* and *l*.—Stone Quarry Hollow. Represents 10 feet of outcrop, 20 to 30 feet above its base.

14*m*.—Stone Quarry Hollow. Represents 6 feet of outcrop, 30 to 36 feet above its base.

15*d*[1] and 15*d*[2].—Red Bank Creek, Spencer Place. Represents upper 10 feet of the deposit, from 20 to 30 feet above the base of the exposure.

Only the silica, lime, and phosphoric acid were determined; but in each case there was an excess of lime over that required for combination with the phosphoric acid to form the neutral phosphate, and this

[1] Analyses made for the United States Geological Survey by the chemical department of Columbian University, Washington, D. C., under the direction of Prof. C. E. Monroe.

excess was regarded as present in the rock as carbonate. Considering the lime as part carbonate and part phosphate, the proportions of these compounds, together with the silica, amount to from 96 to 98 per cent of the rock. The remaining 2 to 4 per cent is probably iron and alumina, which were not determined.

UTILIZATION OF THE DEPOSIT.

It will be seen from these analyses that the content of the lime phosphate is too low for utilization by methods at present employed in the manufacture of fertilizers, 50 per cent rock being about the lowest grade now used. Whether other processes may be devised for utilizing this low-grade material is a question which can not be answered now. The abundance of the rock, the ease of mining, and the availability of cheap water transportation to points of consumption are important factors in the problem. But, whether utilized or not, this deposit is of interest as suggesting the possibility of other deposits of higher grade in rocks not hitherto suspected of containing phosphates, namely, the widespread carboniferous chert formations of Tennessee, Alabama, Kentucky, Missouri, and Arkansas. From this point of view the origin of the deposit becomes a matter of considerable importance; for it is scarcely credible that the conditions under which this deposit was formed should not have been present elsewhere in this extensive region.

ORIGIN OF THE DEPOSIT.

Is the phosphate an original deposition accumulated during the deposition of the accompanying chert? The characteristics which point to original deposition in the case of the black Devonian phosphate are wholly absent here. Although some portions of the Fort Payne chert are highly fossiliferous, others are entirely barren, and, unlike the black phosphates, no traces of organic remains were observed in these or the associated cherts. Moreover, the great thickness of this deposit and its apparently local development are in striking contrast with the very wide distribution of a comparatively thin bed in the case of the black phosphate. If not an original deposit, this must be a secondary impregnation, and partial replacement of some original constituent, by lime phosphate. The microscopic structure of the rock affords strong evidence, if not conclusive proof, of this secondary replacement of the originally contained calcite by secondary phosphate. Such a replacement is precisely what would be expected to take place if a solution of lime phosphate were to come in contact with the carbonate, namely, the less soluble compound would be deposited and the more soluble one taken up.

The source of the phosphoric acid is not so easily determined as the fact that replacement has occurred. Limestones generally contain a small amount of phosphoric acid, and some of the overlying Carboniferous limestones contain a very considerable percentage. This seems the most probable source, although there is a possibility that the phosphate may have come from older Devonian and Silurian rocks, raised to a higher level by the gentle folding which the strata of the region have suffered.

Probably the replacement was a phase of weathering, and took place after the superincumbent strata had been largely removed, so that percolating waters had access to these beds. It is impossible at present to say what the particular conditions may have been which determined the local accumulation of phosphate at this point, and no sufficiently detailed examination has been made to decide whether or not these conditions can be recognized and so definitely formulated as to be of value in future prospecting. It will be readily understood that the brief study which has been given thus far to these interesting deposits is wholly inadequate to answer the many questions suggested.

COMMERCIAL DEVELOPMENT OF THE TENNESSEE PHOSPHATE.

By C. G. Memminger.

PRODUCTION.

The first shipments of Tennessee phosphate were made in the latter part of June, 1894, and four companies are now (December, 1894) actively engaged in mining and shipping, with a total average daily output of about 160 tons. These companies are the Southwestern Phosphate Company, the Duck River Phosphate Company, the Tennessee Phosphate Company, and the Swan Creek Phosphate Company.

The Southwestern Phosphate Company's mines are located on Falls Branch, Hickman County, about 5 miles northeast of Ætna station, on the Nashville, Chattanooga and St. Louis Railroad. The developments at these mines consist of a mill building containing a McCulley crusher and a Sturtevant rock emery mill for grinding the rock to a powder for direct application to the soil or use in composts. The mining developments show a bed averaging 30 inches in thickness. The rock is hauled to the railroad 5 miles in wagons, the daily output being 30 to 40 tons. The Duck River Phosphate Company's mills lie 9 miles east of Centerville, Hickman County, in Tottys Bend. This company has erected a storehouse and a number of dwellings for employees. On this property the most considerable mining development is noted, and the vein has been uncovered by stripping for several hundred yards. The stripping has been carried back to a depth of 20 feet. An extremely regular vein is exposed, averaging 36 inches in thickness. This company is mining and shipping about 100 tons per day. During the summer months about 100 wagons were employed in hauling the rock to the railroad. Two 25-ton lighters have been built to float the rock down Duck River to Centerville, and in October this method of transportation was substituted for wagons with satisfactory results. From the size of Duck River the permanent success of this method seems in doubt. The Tennessee Phosphate Company is mining its Nunn tract on Swan Creek, Hickman County, 4 miles from Ætna station. The average output is 50 tons per day. The bed is 18 to 20 inches in thickness. This company has surveyed a line of railroad 12 miles in length from near Summertown, on the Florence branch of the Louisville and Nashville, to its property on the Upper Swan Valley, Lewis County. No mining has been done at this point, but the prospect cuts expose a 30-inch bed.

The Swan Creek Phosphate Company's properties lie near the mouth of Blue Buck Creek, in Swan Valley, Hickman County. This company began mining in October, hauling the rock by wagon about 4 miles to the nearest point on the Nashville, Chattanooga and St. Louis Railway, a mile south of Centerville.

METHODS OF MINING.

The present method of mining consists in stripping off the overburden. Along the outcrops of the bed in some cases the stripping is carried back to a depth of 20 feet. The material removed consists of 1 to 2 feet top earth and the balance shale, sometimes very hard; blasting is always necessary in this stripping. The phosphate bed, after being uncovered, is loosened up by small shots and removed by picks, crowbars, and gads. Mining by stripping can not be looked upon as a permanency, the amount of stripping ground along the outcroppings being limited. The ultimate method of mining will be by drifts; this will materially increase cost of production.

To mine successfully, compressed-air drills must be employed. The rock as brought to bank from the mines requires only to be crushed to sizes, say 3 inches in diameter, to be ready for shipment. No drying or washing is necessary, as with Florida and South Carolina phosphates, the rock being intermixed with no extraneous matter and containing not above 2 per cent of moisture when mined. These are the strong points in favor of the Tennessee phosphates. At present the cost of mining and putting rock on board cars, ready for shipment, is as follows:

Cost at Duck River Phosphate Company's mines.

	Per long ton.
Mining	$1.00
Hauling (9 miles) to railroad	1.50
Breaking	.25
Total cost f. o. b. cars	2.75

Cost at Tennessee and Southwestern Company's mines.

	Per long ton.
Mining	$1.00
Hauling to railroad (4 miles)	1.00
Breaking	.25
Total	2.25

These estimates do not include brokerage, 10 cents per ton, or management, office expenses, and interest. The rock is now being sold in Atlanta, Ga., at $6 per ton, delivered.

Average cost f. o. b. cars	$2.50
Railroad freight to Atlanta	2.91
Cost, delivered	5.41

The margin of profit does not appear large. The present method of hauling to railroad in wagons is not only expensive but is not practicable during the winter months; consequently, if the industry is to be a permanent one, railroads must be built to the mines. The indications are that this will shortly be done. The crude method of breaking by hand must be abandoned and crushers used. With railroads to the mines the cost of marketing the rock will be materially reduced, but in future, to offset this reduction, the present cheap method of mining by stripping must be superseded by the more expensive drift mining; consequently it does not appear that present total figures of cost will in future be materially changed. The Nashville, Chattanooga and St. Louis Railroad people have shown a most commendable spirit as regards freight charges and the present rates are extremely low as compared with those in force in Florida.

OUTLETS.

The nearest port of shipment to these deposits is Pensacola, Fla., distant about 450 miles. It is also claimed that New Orleans is practical as a port of shipment, the rock to be taken down the Tennessee and Mississippi rivers in barges, but as yet no attempt has been made to market the rock abroad. From their geographical position it would appear that these phosphate beds, even with low rates to the Gulf ports, can not compete, either in Europe or in the markets of our Eastern States, with Florida and South Carolina phosphates. It is in the interior States that the consumption of this phosphate must take place. The demands in this territory are as yet small, but the rich lands of the central States are slowly but surely becoming exhausted. The use of chemical manures is increasing, and eventually large superphosphate manufactories will be erected at such points as Chicago, Cincinnati, etc. To the agricultural interests of the Middle States the phosphate beds will prove of much value. The raisers of Tennessee phosphates must restrict their output to keep within the present demand and await the development of the interior superphosphate industry and consumption. Overproduction must render the business unprofitable.

CHEMICAL COMPOSITIONS OF BLACK PHOSPHATE.

The appended analyses were not made for scientific research, but for ordinary commercial purposes, and are consequently not complete, but show fully the character of the phosphate:

Analyses of Tennessee black phosphates.

[Per cent.]

	1	2	3	4	5	6	7	8	9	10
Moisture at 100° C	1.35	2.00	2.10	.53	.91	1.22	1.40	1.27	.56	2.52
Insoluble and silicious matter	4.67	1.69	2.32	2.55	3.07	2.56	3.16	......	......	3.29
Iron oxide	......	.86	1.04	1.43	1.28	2.47	.99	1.54	1.68	1.27
Alumina	......	1.92	1.60	.71	.35	.16	.86	.74	1.38	1.70
Iron combined as pyrite	1.80	1.88	1.75	1.93	2.78	1.75	1.84	.91	......	.70
Sulphur	2.63	2.55	2.30	......	......	......	......	......	......	......
Calcium sulphate	......	......	......	......	......	......	5.65	......	......	......
Carbonic acid	2.53	2.72	......	......	......	......	1.85	......	.43	......
Calcium carbonate	5.75	6.18	......	......	......	......	4.20	......	.98	......
Phosphoric acid (P_2O_5)	33.81	32.91	......	33.55	30.46	31.41	33.00	35.69	26.75	34.28
Fluorine, titanium, magnesium	......	......	......	......	......	......	......	......	......	......
Organic matter and combined water	......	......	......	......	......	......	......	......	......	......
Bone phosphate on dry basis	74.80	73.40	......	73.23	67.32	69.33	72.96	78.80	58.65	76.66

	11	12	13	14	15	16	17	18	19	20
Moisture at 100° C	......	1.34	1.68	1.29	......	......	.91	.48	1.38	1.14
Insoluble and silicious matter	......	......	2.22	3.93	6.15	1.81	......	5.15	2.44	3.64
Iron oxide	......	4.34	3.14	1.40	......	......	......	......	1.59	2.78
Alumina	......	2.57	.96	1.50	......	......	......	......	.57	.86
Iron combined as pyrite	......	.78	.31	1.65	......	......	......	......	2.13	1.73
Sulphur	......	......	......	......	......	......	......	......	......	......
Calcium sulphate	......	......	......	......	......	......	......	......	......	......
Carbonic acid	......	......	1.17	......	......	......	......	......	......	......
Calcium carbonate	......	......	2.66	......	......	......	......	......	......	......
Phosphoric acid (P_2O_5)	31.63	34.56	35.02	32.23	32.04	36.89	31.81	30.64	32.65	33.74
Fluorine, titanium, magnesium	......	......	......	......	......	......	......	......	......	......
Organic matter and combined water	......	......	......	......	......	......	......	......	......	......
Bone phosphate on dry basis	68.95	76.36	77.63	71.18	69.85	80.42	69.96	67.14	72.18	74.41

NOTE.—Analyses Nos. 1 to 7 by C. G. Memminger; Nos. 7 to 20 by Lucius P. Brown; Nos. 17 and 18 are bowlders or kidneys lying in and above black slate. These analyses are from Tennessee Phosphate Company, Swan Creek Phosphate Company, and Southwestern Phosphate Company, and represent material actually being mined and shipped. Nos. 12 and 13 are from outer edge of vein; the material is oxidized and mixed probably with clay from above.

It will be noted that FeS_2, pyrite, or, more strictly speaking, "marcarsite," is present in every sample analyzed, and its presence is characteristic of this phosphate. Alumina is present in only small amount. Fluorine was found in each case, but not determined quantitatively. Titanium in small amounts was also found. In making analyses of these phosphates determinations of both forms of iron should always be made and the results so obtained distinctly stated. Actual working tests show that the rock mixes well and gives a mechanically good product.

It is an unsettled question as to what action the pyrite will have in reversion of soluble phosphoric acid when the material is allowed to stand after mixing. In case of foreign consumption this is an important matter. The writer reasons as follows:

In mixture of the superphosphate the first action when Fe_2O_3 is present is: $3Ca_3P_2O_3+Fe_2O_3+6H_2SO_4$ becomes $3CaH_4P_2O_3+6CaSO_4+$

Fe_2O_3; and on standing this "reverts," thus forming, by reason of slow action of the basic oxide, $3Ca_2H_2P_2O_8+3CaSO_4+Fe_2SO_4$. Then if pyrite is present it is found that 155° acid does not act on *this* pyrite at common temperatures and not when boiled 155° C; hence the formula, $3Ca_3P_2O_8+FeS_2+6H_2SO_4 3CaH_4P_2O_8+6CaSO_4+FeS_2$. If this pyrite is altered, as it will in time, it acts thus: $2(FeS_2)+15O$ & $H_2O=Fe_2(SO_4)_3+H_2SO_4$, so that not only is there no basic oxide to take up SO_3 from $CaSO_4$, but there is formed additional H_2SO_4 to prevent this action of some of the Al_2O_3 or Fe_2O_3 which may be present along with the FeS_2 in the rock. Consequently the FeS_2 would appear to be rather an advantage than otherwise.

Although the analyses show an average of over 70 per cent of bone phosphate of lime, it is probable that on a large working scale cargo lots will run between 65 and 70 per cent.

SULPHUR AND PYRITES.

By Edward W. Parker.

SULPHUR.

OCCURRENCE.

Sulphur occurs native in several States, but none of commercial value is found east of the Mississippi River. The unimportant localities in the Eastern States are at Cayuga, N. Y.; at Put-in-Bay Island, Ohio; at Tampa, Fla., and about 25 miles above Washington, on the Potomac River. It has been mined in California, Nevada, and Utah—principally the last. Many and costly attempts have been made to develop the properties near Lake Charles, La., but without success. The sulphur lies at a considerable depth and is overlaid by quicksands, which prevent mining by ordinary methods. Sulphur has also been reported in western Texas and in Kansas.[1]

The entire domestic product since 1891 has been from the mines of the Utah Sulphur Company (formerly the Dickert & Myers Sulphur Company), in Beaver County, Utah. This product is restricted to a comparatively limited local consumption, owing to the low prices at which Sicilian sulphur is brought to the Atlantic seaboard and the importations of Japanese sulphur on the Pacific Coast. Sulphur is now also imported from England, being obtained from alkali waste reclaimed by the Chance process, described in the 1887 volume of this series. The bringing in of this factor, as well as the increased use of pyrites for acid making, has caused the supply of Sicilian sulphur to exceed the demand, with a consequent reduction in price.

[1] Efforts are now being made to mine the sulphur at Lake Charles by a new and patented process. The patent is owned by Cleveland, Ohio, parties. The method consists in the introduction of superheated water through pipes into the sulphur deposit, the sulphur being liquefied and pumped out. The parties interested were still engaged in making tests of the process at the time this report goes to press (June, 1895). A limited amount of sulphur only has been produced, the operations being hampered by defective machinery. Enough has been done to show that it is possible to obtain sulphur by this method, but the question as to whether it is practicable as a commercial enterprise is not yet determined.

PRODUCTION.

The total amount of sulphur produced in the United States in 1894 was 500 tons, valued at $20,000, the smallest output in any year since 1889, except 1890, when no product at all was obtained. The production of sulphur in the United States has varied considerably from year to year, but has never reached great proportions, the largest product being in 1887, when 3,000 tons were mined. During 1888, 1889, and 1890 the mines of the Dickert & Myers Company, in Beaver County, Utah, were in litigation and not operated, the small product in 1889 being from the mines of the Barnes Sulphur Company, near Frisco, Utah, and the Wise mine, in Nevada. Neither of these properties has been worked since that year. In 1891 the Utah Sulphur Company succeeded the Dickert & Myers Company and began working the mines, producing in that year 1,200 tons of sulphur. In the following year the product increased to 2,688 tons, but owing to the unfavorable trade conditions the output in 1893 declined again to 1,200 tons, and still further in 1894 to 500 tons.

The following table shows the product of sulphur in the United States since 1880:

Sulphur product of the United States since 1880.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	600	$21,000	1888	....	....
1881	600	21,000	1889	450	$7,850
1882	600	21,000	1890	....	....
1883	1,000	27,000	1891	1,200	39,600
1884	500	12,000	1892	2,688	80,640
1885	715	17,875	1893	1,200	42,000
1886	2,500	75,000	1894	500	20,000
1887	3,000	100,000			

REVIEW OF THE INDUSTRY.

In proportion to the amount of sulphur consumed in the United States, the domestic product is of slight importance. This fact is due, not to any scarcity of the mineral, but to the remoteness of the deposits from the principal markets and the cost of transportation. Under existing conditions the sulphur from Sicily and England can be sold in the Eastern markets and even as far west as the Mississippi River at less cost than the Utah mines can profitably dispose of their product; while, as before stated, the markets on the Pacific Coast are supplied by Japanese sulphur. Our importations show a considerable increase in the volume of business done during the past fifteen years, though market fluctuations are shown from year to year. Taking the tables of imports as compiled by the Bureau of Statistics of the Treasury Department it is seen that the total imports of crude sulphur have increased from

87,837 long tons in 1880 to 125,241 long tons in 1894, reaching as high as 162,674 long tons in 1890. Practically all of the sulphur imported prior to 1886 was from Sicily, and since that year the amount received from other sources seems insignificant when compared with the Sicilian sulphur, though amounting to considerable proportions when considered independently, and eclipsing the domestic product several times. In 1886 imports from Japan assumed considerable proportions, amounting to nearly 5,000 long tons. This increased over 20 per cent, or to 6,146 long tons, in 1887. In the two following years the imports from Japan were about the same as in 1887, being 6,332 long tons in 1888 and 6,441 in 1889. In 1890 they more than trebled, reaching a total of 21,031 long tons. This large increase was not maintained, however. During 1891 the imports from Japan were nearly 9,000 tons less than in 1890, but still about double those of 1888 and 1889. They were nearly the same in 1892, but declined to 8,307 long tons in 1893 and 4,777 tons in 1894.

A new source of supply was found in 1887. This was the recovery of sulphur from alkali waste. It was the result of thirty years' effort on the part of Mr. William Gossage, of England, supplemented by six years of study and investigation on the part of Mr. A. M. Chance. Mr. Gossage proved that the calcium sulphide of alkali waste could be decomposed by the carbonic acid gas produced in lime burning, and hydrogen sulphide liberated. Mr. Chance perfected the process and made it economically valuable. This process is fully described in Mineral Resources for 1887. Facilities for using the process were adopted at most of the alkali works in England, but it was not until 1890 that the sulphur thus obtained was brought into commerce in appreciable quantity. During that year England exported to the United States 4,898 long tons of sulphur. In 1891 we imported from the same source, 5,613 tons; in 1892, 6,522 tons; in 1893, 8,777 tons, and in 1894, 12,435 tons. The sulphur obtained from this source was without doubt the direct cause of the decrease in imports of Japanese sulphur in 1891, 1892, 1893, and 1894. This is borne out by the fact that the imports from Japan fell off to the demand of the Pacific Coast, all of the Japanese sulphur in 1893 and 1894 being received at the ports of San Francisco, Cal., and Willamette, Oregon.

IMPORTS.

The following tables show the total amount of sulphur imported into the United States from 1867 to 1894, the countries from which it was received, and customs districts through which it was imported:

Sulphur imported and entered for consumption in the United States, 1867 to 1894.

Years ended—	Crude.		Flowers of sulphur.		Refined.		Ore. (a)	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Value.	
	Long tons.		*Long tons.*		*Long tons.*			
June 30, 1867	24, 544	$620, 373	110	$5, 509	251	$10, 915	....	$636, 797
1868	18, 151	446, 547	16	948	65	2, 721	....	450, 216
1869	23, 590	678, 642	97	4, 576	645	27, 149	....	710, 367
1870	27, 380	819, 408	76	3, 927	157	6, 528	$1, 269	831, 132
1871	36, 131	1, 212, 448	66	3, 514	92	4, 328	754	1, 221, 044
1872	25, 380	764, 798	36	1, 822	57	2, 492	....	769, 112
1873	45, 533	1, 301, 000	55	2, 924	36	1, 497	....	1, 305, 421
1874	40, 990	1, 260, 491	51	2, 694	57	2, 403	....	1, 265, 588
1875	39, 683	1, 259, 472	18	891	....	....	....	1, 260, 363
1876	46, 435	1, 475, 250	41	2, 114	44	1, 927	....	1, 479, 291
1877	42, 963	1, 242, 888	116	5, 873	1, 171	36, 962	....	1, 285, 723
1878	48, 102	1, 179, 769	159	7, 628	150	5, 935	....	1, 193, 332
1879	70, 370	1, 575, 533	138	6, 509	69	2, 392	....	1, 584, 434
1880	87, 837	2, 024, 121	124	5, 516	158	5, 262	....	2, 034, 899
1881	105, 097	2, 713, 485	98	4, 226	71	2, 555	....	2, 720, 266
1882	97, 504	2, 627, 402	159	6, 926	59	2, 196	....	2, 636, 524
1883	94, 540	2, 288, 946	79	3, 262	115	4, 487	....	2, 296, 695
1884	105, 112	2, 242, 697	178	7, 869	126	4, 765	....	2, 255, 331
1885	96, 839	1, 941, 943	121	5, 351	114	4, 060	....	1, 951, 354
1886	117, 538	2, 237, 989	213	8, 739	116	3, 877	....	2, 250, 605
1887	96, 882	1, 688, 360	279	9, 980	84	2, 383	....	1, 700, 723
Dec. 31, 1888	98, 252	1, 581, 583	128	4, 202	27	734	....	1, 586, 519
1889	135, 933	2, 068, 208	15	1, 954	10	299	....	2, 070, 461
1890	162, 674	2, 762, 953	12	1, 718	103	3, 060	....	2, 767, 731
1891	116, 971	2, 675, 192	206	6, 782	10	1, 997	133, 250	2, 817, 221
1892	100, 938	2, 189, 481	158	5, 439	26	4, 106	587, 981	2, 787, 007
1893	105, 539	1, 903, 198	241	5, 746	43	1, 017	721, 699	2, 631, 660
1894	125, 241	1, 703, 265	173	4, 145	45	1, 207	590, 905	2, 299, 522

a Latterly classed under head of pyrites.

Statement by countries and by customs districts, showing the imports into the United States of crude sulphur or brimstone each fiscal year from 1876 to 1894.

Countries whence exported and customs districts through which imported.	1876.		1877.		1878.		1879.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES.	*Long tons.*		*Long tons.*		*Long tons.*		*Long tons.*	
Dutch West Indies and Guiana	1, 515	$15, 427	......	....	......	....	......	....
England	30	1, 211	425	$14, 631	(?)	$16	2	$335
Scotland	24	910	472	13, 231	160	3, 961	806	19, 287
Gibraltar	......	....	290	7, 789	......	....	......	....
Quebec, Ontario, Manitoba, etc	......	....	......	....	12	264	......	....
Italy	46, 941	1, 439, 839	41, 819	1, 194, 000	47, 494	1, 161, 367	64, 420	1, 453, 138
Japan	456	16, 291	437	13, 137	256	7, 548	224	4, 528
Portugal	......	....	......	....	......	....	467	10, 410
Total	48, 966	1, 473, 678	43, 443	1, 242, 788	47, 922	1, 173, 156	65, 919	1, 487, 698
DISTRICTS.								
Baltimore, Md	5, 157	157, 828	3, 882	105, 175	5, 455	138, 202	6, 969	157, 243
Barnstable, Mass	......	....	......	....	......	....	600	13, 780
Boston and Charlestown, Mass	5, 031	154, 883	3, 931	101, 215	5, 795	131, 945	7, 841	173, 506
Charleston, S. C	......	....	......	....	526	12, 267	605	13, 812
Delaware, Del	450	13, 500	......	....	......	......	890	21, 907
Huron Mich	......	....	......	....	12	264	......	....
Newark, N. J	......	....	1, 071	31, 802	462	13, 240	443	10, 175
New Orleans, La	172	5, 705	150	4, 750	......	....	100	2, 087
New York, N. Y	24, 524	721, 092	21, 867	654, 997	28, 240	690, 989	36, 543	827, 193
Philadelphia, Pa	12, 549	385, 671	9, 216	256, 224	6, 657	167, 222	11, 704	263, 467
Providence, R. I	600	18, 232	1, 739	45, 487	519	11, 479	......	....
San Francisco, Cal	483	17, 367	862	27, 768	256	7, 548	224	4, 528
Savannah, Ga	......	....	725	15, 370	......	....	......	....
Total	48, 966	1, 473, 678	43, 443	1, 242, 788	47, 922	1, 173, 156	65, 919	1, 487, 698

Statement by countries and by customs districts, showing the imports into the United States of crude sulphur or brimstone each fiscal year from 1876 to 1894—Continued.

Countries whence exported and customs districts through which imported.	1880.		1881.		1882.		1883.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES.	*Long tons.*		*Long tons.*		*Long tons.*		*Long tons.*	
England	1	$22					13	$379
Scotland	1,664	36,444	1,668	$43,311	755	$20,294	3	88
France	988	23,580			526	13,770	34	858
French West Indies					2	8		
Greece					500	13,927		
Italy	80,301	1,862,712	102,771	2,645,293	92.944	2,504,862	92,861	2,248,870
Japan	282	4,744	691	16,253	2,980	66,356	1,038	23,714
San Domingo					240	7,875		
Spain			308	8,637			500	12,856
Spanish possessions in Africa and adjacent islands					9	310	87	2,030
Total	83,236	1,927,502	105,438	2,713,494	97,956	2,627,402	94,536	2,288,795
DISTRICTS.								
Baltimore, Md	13,827	313,342	16,477	430,917	13,781	364,384	11,977	286,438
Beaufort, S. C					540	13,889		
Boston and Charlestown, Mass	8,207	183,486	8,860	226,801	7,467	194,317	7,756	173,569
Charleston, S. C	1,061	25,398	3,065	78,741	6,025	161,281	4,051	106,235
Middletown, Conn					9	310		
New Orleans, La	280	7,121	100	2,646	220	6,516	423	10,378
New York, N. Y	46,657	1,083,784	57,608	1,463,082	46,531	1,260,222	45,385	1,110,313
Philadelphia, Pa	10,679	254,892	17,987	477,547	14,839	408,611	22,772	549,095
Providence, R. I	1,255	31,155	650	17,507	1,244	33,036	535	13,830
Richmond, Va					660	17,760		
San Francisco, Cal	1,270	28,324	691	16,253	6,054	151,234	1,072	24,572
Savannah, Ga					586	15,842	560	14,365
Total	83,236	1,927,502	105,438	2,713,494	97,956	2,627,402	94,536	2,288,795

Countries whence exported and customs districts through which imported.	1884. (*a*)		1885.		1886.		1887.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES.	*Long tons.*		*Long tons.*		*Long tons.*		*Long tons.*	
Belgium			190	$4,766	60	$1,718		
Danish West Indies							861	$5,250
England			606	15,084	81	2,535	162	4,437
France							290	6,951
Quebec, Ontario, Manitoba, and the Northwest Territory						9		
Italy			94,370	1,894,858	112,283	2,166,565	89,924	1,588,146
Japan			1,541	25,683	4,972	66,505	6,146	83,576
Spain			134	1,552				
Total	105,143	$2,242,678	96,841	1,941,943	117,396	2,237,332	97,383	1,688,360
DISTRICTS.								
Baltimore, Md	15,037	303,226	14,505	285,006	19,307	364,958	12,547	225,669
Barnstable, Mass	650	16,163	480	11,040	1,617	35,385	1,152	22,816
Beaufort, S. C	600	13,259	610	12,847				
Boston and Charlestown, Mass	5,294	112,152	5,125	99,712	3,681	69,898	4,850	85,575
Champlain, N. Y						9		
Charleston, S. C	6,125	132,570	8,525	169,564	13,350	265,265	12,420	220,598
New Orleans, La			102	2,282	250	5,102		
New York, N. Y	52,478	1,135,725	45,537	909,123	58,758	1,115,519	46,711	792,114
Philadelphia, Pa	18,786	401,568	18,696	381,010	15,568	300,749	15,267	269,216
Providence, R. I	651	15,517	1,840	37,422	1,265	25,930	600	11,291
San Francisco, Cal	5,522	112,598	1,421	33,937	3,600	54,517	3,176	50,521
All other customs districts							660	10,560
Total	105,143	2,242,678	96,841	1,941,943	117,396	2,237,332	97,383	1,688,360

a Sources not reported.

Statement by countries and by customs districts, showing the imports into the United States of crude sulphur or brimstone each fiscal year from 1876 to 1894—Continued.

Countries whence exported and customs districts through which imported.	1888.		1889.		1890.		1891.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES.	*Long tons.*		*Long tons.*		*Long tons.*		*Long tons.*	
Belgium	83	$1,993	180	$4,086	182	$3,995	267	$6,576
Danish West Indies	....	....	....	....	550	9,076	....	....
England	310	7,200	305	8,337	4,898	101,100	5,613	127,976
Scotland	....	....	....	....	20	487	....	....
Italy	92,528	1,499,720	123,260	1,935,368	115,240	1,800,585	101,660	2,140,516
Japan	6,332	72,729	6,441	77,853	21,031	221,316	12,763	168,073
Other countries	....	....	....	....	....	....	501	8,372
Total	99,253	1,581,582	130,191	2,025,644	141,921	2,136,559	120,804	2,451,513
DISTRICTS.								
Baltimore, Md	11,989	182,769	15,791	234,693	21,198	322,018	9,339	247,324
Beaufort, S. C	500	9,000	600	9,213	....	....	1,300	26,951
Boston and Charlestown, Mass	3,760	62,298	6,446	104,257	7,410	135,044	6,381	136,402
Charleston, S. C	12,005	199,048	23,377	364,859	15,752	255,106	28,281	557,384
Mobile, Ala	....	....	....	....	....	....	750	14,863
New Orleans, La	200	3,845	....	....	200	3,397	1,300	30,474
New York, N. Y	50,486	816,286	60,922	959,872	66,359	983,754	44,027	910,075
Pensacola, Fla	....	....	....	....	....	....	1,399	23,206
Philadelphia, Pa	10,519	173,699	13,288	202,357	13,919	210,576	10,842	216,763
Providence, R. I	1,310	21,012	570	8,581	1,240	19,160	....	....
San Francisco, Cal	6,352	78,732	4,539	57,925	8,223	87,391	8,819	115,637
Savannah, Ga	....	....	2,345	44,244	5,560	86,826	5,245	99,717
Willamette, Oreg	....	....	....	....	....	....	288	11,852
Wilmington, N. C	1,532	25,893	1,753	28,443	2,040	32,800	2,832	60,843
All other customs districts	600	9,000	560	11,200	20	287	1	22
Total	99,253	1,581,582	130,191	2,025,644	141,921	2,136,559	120,804	2,451,513

Countries whence exported and customs districts through which imported.	1892.		1893.		1894.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES.	*Long tons.*		*Long tons.*		*Long tons.*	
England	6,522	$162,616	8,777	$186,914	12,435	$228,300
Scotland	....	....	1,452	27,288	....	....
France	1	23	....	....	....	....
Quebec, Ontario, etc	1	49	8	269	....	....
Italy	90,668	2,147,942	103,146	958,303	68,854	1,031,690
Spain	....	....	....	....	899	15,343
Japan	12,227	213,776	8,307	133,455	4,777	62,567
Total	109,419	2,524,406	121,690	2,305,464	86,965	1,337,900
DISTRICTS.						
Baltimore, Md	9,981	263,293	13,759	271,949	9,854	132,272
Boston and Charlestown, Mass	9,086	221,033	11,001	224,624	12,649	227,976
Charleston, S. C	14,651	364,593	10,885	209,246	10,560	163,358
Mobile, Ala	....	....	....	....	774	12,740
New Orleans, La	2,118	47,165	2,441	43,970	2,407	34,184
New York, N. Y	52,647	1,191,169	57,474	1,085,289	35,319	548,742
Philadelphia, Pa	9,380	211,570	12,625	241,293	5,149	73,980
Portland, Me	2,000	42,460	....	....	....	....
Providence, R. I	....	....	....	....	700	9,063
San Francisco, Cal	7,256	127,797	7,766	125,507	4,424	59,790
Savannah, Ga	....	....	4,650	86,562	2,712	42,439
Willamette, Oreg	398	6,866	541	7,948	559	6,647
Wilmington, N. C	1,900	48,388	540	8,807	1,858	26,709
Vermont	....	....	8	269	....	....
All other customs districts	2	72	....	....	....	....
Total	109,419	2,524,406	121,690	2,305,464	86,965	1,337,900

As will be seen from the foregoing table, the principal source of our supply of sulphur is from Italy, or more properly the island of Sicily.

In this connection the subsequent tables of exports of this mineral from Sicily and the imports of Sicilian sulphur into the United States will be found interesting. The total production of sulphur in Italy in 1893 (the latest year for which the figures are obtainable) was, according to the official reports, 417,671 metric tons, valued at $5,616,018. The sulphur imported from England is chiefly reclaimed sulphur from alkali waste by the Chance process (see Mineral Resources, 1887, p. 607). The only other countries from which sulphur was imported in 1894, according to the Bureau of Statistics of the Treasury Department, were Spain and Japan. The amount imported from Japan in 1894 was 4,777 long tons, practically all of which was received at San Francisco. Japan's total product of sulphur in 1892 was 21,403 metric tons.

SICILIAN SULPHUR.

The figures in the following tables, showing exports of sulphur from Sicily, the countries to which exported, and the ports through which the imports into the United States were received, have been furnished by Mr. A. S. Malcomson, of New York:

Total exports of sulphur from Sicily since 1883.

Countries.	1883.	1884.	1885.	1886.	1887.	1888.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
United States	96, 629	94, 929	99, 378	98, 590	89, 419	128, 265
France	63, 602	65, 098	58, 264	54, 280	56, 222	52, 083
Italy	66, 810	56, 292	49, 415	48, 658	48, 997	47, 664
United Kingdom	41, 788	40, 760	33, 402	30, 236	30, 007	35, 634
Greece	10, 494	7, 033	13, 664	19, 697	18, 370	5, 809
Portugal	15, 298	11, 018	17, 760	30, 943	16, 587	15, 851
Russia	10, 413	12, 831	13, 420	10, 570	13, 441	22, 043
Germany	7, 232	6, 622	6, 103	8, 689	9, 700	12, 402
Austria	4, 915	6, 037	5, 965	5, 800	6, 702	8, 942
Turkey	3, 043	1, 285	3, 077	4, 598	6, 238	1, 457
Spain	5, 242	3, 920	2, 243	5, 890	5, 873	3, 433
Belgium	7, 660	6, 793	9, 516	6, 580	5, 318	6, 951
Holland	1, 256	696	1, 237	2, 999	1, 747	2, 793
Sweden	1, 010	744	328	1, 916	1, 169	3, 004
South America					710	95
Australia					600	885
Denmark			810		202	464
Other countries						
Total	335, 392	314, 058	314, 582	329, 446	311, 302	347, 775

Countries.	1889.	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
United States	109, 008	106, 656	97, 520	84, 450	83, 901	105, 773
France	67, 340	71, 790	56, 168	73, 176	89, 736	56, 932
Italy	43, 523	40, 231	42, 212	38, 711	54, 486	49, 895
United Kingdom	39, 203	26, 213	23, 408	24, 853	27, 453	22, 165
Greece	10, 158	18, 103	11, 414	14, 845	13, 840	16, 870
Portugal	16, 799	16, 695	11, 439	13, 490	14, 545	8, 670
Russia	17, 678	17, 158	11, 930	14, 178	19, 730	17, 977
Germany	15, 401	15, 703	10, 629	14, 326	16, 259	16, 437
Austria	8, 984	8, 746	10, 575	9, 096	10, 169	11, 494
Turkey	2, 231	4, 231	3, 000	(*a*)	(*a*)	(*a*)
Spain	6, 586	5, 679	3, 845	7, 382	3, 499	3, 445
Belgium	7, 752	7, 279	5, 089	5, 133	4, 358	5, 644
Holland	2, 424			2, 183	2, 957	2, 365
Sweden	3, 899	3, 314	2, 252	4, 561	6, 579	7, 887
South America	23					
Australia				1, 200		
Denmark	443	400	300	(*b*)	(*b*)	(*b*)
Other countries		2, 565	3, 542	3, 152	1, 680	3, 376
Total	351, 451	344, 763	293, 323	309, 536	349, 192	328, 930

a Included in exports to Greece. *b* Included in exports to Sweden.

The ports in the United States to which such shipments were made, together with tne amount shipped to each since 1883, and the quality of the shipments since 1886, are shown in the following tables:

Ports in the United States receiving Sicilian sulphur and the amount received by each.

Ports.	1883.	1884.	1885.	1886.	1887.	1888.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
New York	41,238	46,460	50,814	49,952	45,979	60,706
Charleston	5,425	7,706	12,416	10,556	14,324	22,496
Philadelphia	23,123	19,234	12,153	15,662	11,764	11,793
Baltimore	16,175	13,986	16,435	15,680	10,306	17,330
Boston	5,864	4,723	4,200	3,800	3,300	6,300
Wilmington, N. C					1,020	2,355
Savannah						3,545
Pensacola						
Port Royal	600	610	680	660	1,000	600
Providence	650	1,140	1,370	1,180	630	1,250
Sundries	670				600	480
San Francisco	1,884	500			296	
New Orleans	350	100	250		200	250
Woods Holl	650	470	1,060	1,100		1,160
Mobile						
Delaware Breakwater						
Portland						
Norfolk						
Total	96,629	94,929	99,378	98,590	89,419	128,265

Ports.	1889.	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
New York	55,939	37,390	49,023	49,090	43,396	46,875
Charleston	12,399	27,563	21,646	4,510	13,525	15,296
Philadelphia	14,334	11,094	6,856	10,400	8,160	5,400
Baltimore	15,316	16,700	11,365	12,355	9,950	15,300
Boston	4,950	2,500	1,950	3,325	500	4,317
Wilmington, N. C	2,040	1,309	2,600		1,140	1,890
Savannah	3,240	5,920	1,550	1,170	5,330	9,795
Pensacola		1,390				
Port Royal		600	700			800
Providence	590	650				1,500
Sundries						
San Francisco						
New Orleans	200	800	1,200	2,000	1,900	2,400
Woods Holl						
Mobile		740				800
Delaware Breakwater			630			
Portland				2,000		
Norfolk						1,400
Total	109,008	106,656	97,520	84,850	83,901	105,773

Quality of Sicilian sulphur received at the different ports of the United States since 1886.

Ports.	1886. Best unmixed seconds.	1886. Best thirds.	1887. Best unmixed seconds.	1887. Best thirds.	1888. Best unmixed seconds.	1888. Best thirds.	1889. Best unmixed seconds.	1889. Best thirds.	1890. Best unmixed seconds.	1890. Best thirds.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
New York	36,352	13,600	29,919	16,060	35,573	25,133	32,983	22,956	20,801	16,589
Charleston	7,506	3,050	8,875	5,449	15,485	7,011	6,325	6,074	20,873	6,690
Philadelphia	4,660	11,002	2,127	9,637	3,050	8,743	2,000	12,334	1,000	10,094
Baltimore	7,325	8,355	4,463	5,843	11,380	5,950	7,656	7,660	5,930	10,770
Boston	600	3,200	200	3,100	700	5,600	750	4,200	200	2,300
Savannah	......	......	......	......	2,130	1,415	2,790	1,450	2,750	3,170
Wilmington, N. C	......	......	1,020	......	2,355	......	2,040	......	1,309	......
New Orleans	......	......	......	......	......	......	......	......	......	......
Other ports	1,180	1,760	106	2,620	1,500	2,240	200	590	1,540	2,640
Total	57,623	40,967	46,710	42,709	72,173	56,092	53,744	55,264	54,403	52,253

Ports.	1891. Best unmixed seconds.	1891. Best thirds.	1892. Best unmixed seconds.	1892. Best thirds.	1893. Best unmixed seconds.	1893. Best thirds.	1894. Best unmixed seconds.	1894. Best thirds.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
New York	29,358	19,665	34,390	14,700	29,146	14,250	33,150	13,725
Charleston	17,196	4,450	4,010	500	11,665	1,860	3,273	12,023
Philadelphia	450	6,406	3,600	6,800	1,900	6,260	350	5,050
Baltimore	4,510	6,855	900	11,455	2,050	7,900	600	14,700
Boston	1,300	650	1,825	1,500	500	....	1,017	3,300
Savannah	850	700	600	570	3,450	1,880	5,695	4,100
Wilmington, N. C	1,900	700	....	....	....	1,140	....	1,890
New Orleans	....	....	....	....	1,900	....	2,400	....
Other ports	1,200	1,330	4,000	....	....	....	800	3,700
Total	56,764	40,756	49,325	35,525	50,611	33,290	47,285	58,488

PYRITES.[1]

PRODUCTION.

Sympathizing with the trade depression in 1893, the production of pyrites for acid making decreased to 75,777 long tons from 109,788 long tons in 1892. The industry recovered its usual proportions in 1894, with an output of 105,940 long tons, with a value larger than at any time in its history. The product was slightly less than in either 1891 or 1892, but this was more than compensated for in the increased value, and as at the close of the year producers reported the demand more than equal to the supply, the prospects for pyrites in the future are very encouraging, and this in the face of a heavy decline in the value of imported sulphur and increased importations. The imports of crude sulphur in 1893 were 105,539 long tons, valued at $1,903,198, an average of about $18 per ton, and in 1894, 125,241 long tons, valued at $1,703,265, an average of $13.60 per ton.

[1] See report on acid making from pyrites by R. P. Rothwell, Mineral Resources, 1886; also abstract from a paper by Karl F. Stahl, Mineral Resources, 1893.

Production of pyrites in the United States from 1882 to 1894.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Long tons.			*Long tons.*	
1882	12, 000	$72, 000	1889	93, 705	$202, 119
1883	25, 000	137, 500	1890	99, 854	273, 745
1884	35, 000	175, 000	1891	106, 536	338, 880
1885	49, 000	220, 500	1892	109, 788	305, 191
1886	55, 000	220, 000	1893	75, 777	256, 552
1887	52, 000	210, 000	1894	105, 940	363, 134
1888	54, 331	167, 658			

IMPORTS.

The following table shows the imports of pyrites containing not more than 3½ per cent of copper from 1884 to 1894:

Imports of pyrites containing not more than 3.5 per cent of copper from 1884 to 1894 (*a*).

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Long tons.			*Long tons.*	
1884	16, 710	$50, 632	1891	100, 648	$392, 141
1885	6, 078	18, 577	1892	152, 359	587, 980
1886	1, 605	9, 771	1893	194, 934	721, 699
1887	16, 578	49, 661	1894	163, 546	590, 905

a Previous to 1884 classed among sulphur ores; 1887 to 1891 classed among other iron ores; since 1891 includes iron pyrites containing 25 per cent and more of sulphur.

SALT.

By Edward W. Parker.

PRODUCTION.

The salt product of the United States in 1894 was 12,967,417 barrels of 280 pounds, against 11,897,208 barrels in 1893. In addition to the fact that the total output in 1894 was more than that of 1893, there was a larger production of the finer grades of table and dairy salts, and, consequently, a greater comparative increase in the value, from $4,154,668 in 1893 to $4,739,285 in 1894. The total product of salt from brine (including salt contents of brine used for making soda ash) in 1894 was 10,700,811 barrels, while the output of rock salt was 2,266,606 barrels, against 10,013,063 barrels of brine salt and 1,884,145 barrels of rock salt in 1893.

The increased production of the finer grades of salt by American manufacturers is gratifying, in the face of conditions by no means encouraging to the industry. Prices for several years have ruled so low that few producers have found a profitable market for their output. In 1893 the average net price for all the salt produced in the United States was 34½ cents per barrel of 280 pounds. In 1894, with the increased production of table and dairy salts the average price was about 37½ cents per barrel. In comparing the statistics of production in 1893 and 1894 with those of previous years, it must be remembered that in stating the value of the product in the last two years the cost of packages has been uniformly deducted. The returns for previous years include in most cases the cost of packages in which the product is sold, and due allowance must be made for a seemingly large decrease in value.

Previous to 1893 no record was obtained of the different grades of salt produced, and, owing to the fact that the grading of salt differs in different States, the following distribution is not absolutely correct.

It is sufficiently exact for practical purposes and for comparison with the product of 1893:

Production of salt in 1894, by States and grades.

States.	Table.	Common fine.	Dairy.	Common coarse.	Packers.	Solar.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
California	29, 929	2, 771	11, 786	98, 314	32, 857	121, 071
Illinois		50, 000				
Kansas		60, 100	889, 496			
Louisiana						
Michigan	114, 667	3, 026, 497	25, 883	127, 379	16, 081	29, 500
Nevada	179	500		1, 548		
New York	923, 750	1, 232, 146	611, 028	69, 094	33, 617	434, 591
Ohio	50, 000	352, 884	96, 699	22, 428	3, 500	
Pennsylvania		160, 000		28, 236	15, 000	
Texas	4, 379	138, 478				
Utah	42, 764	21, 429	25, 729	82, 121	1, 986	2, 143
Virginia	3, 601	51, 667		8, 954		
West Virginia	9, 250	185, 282				
Total	1, 178, 519	5, 281, 754	1, 660, 621	438, 074	103, 041	587, 305

States.	Rock.	Milling.	Other.	Total.	Value.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	
California	24, 864	8, 857	1, 797	332, 246	$172, 678
Illinois				50, 000	27, 500
Kansas	432, 813			1, 382, 409	529, 392
Louisiana	186, 050			186, 050	86, 134
Michigan			1, 418	3, 341, 425	1, 243, 619
Nevada		1, 443		3, 670	4, 030
New York	1, 616, 629		*a* 1, 349, 733	6, 270, 588	1, 999, 146
Ohio			3, 485	528, 996	187, 432
Pennsylvania				203, 236	83, 750
Texas				142, 857	101, 000
Utah	6, 250	85, 321	443	268, 186	209, 077
Virginia				64, 222	43, 580
West Virginia				194, 532	51, 947
Total	2, 266, 606	95, 621	*a* 1, 356, 876	12, 967, 417	4, 739, 285

a Includes salt contents of brine used in manufacture of chemicals.

Production of salt in 1893, by States and grades.

States.	Table.	Dairy.	Common fine.	Common coarse.	Packers .
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
California	14, 286	3, 571	3, 571	32, 143	21, 487
Illinois			59, 161		
Kansas			*a* 959, 466		
Louisiana					
Michigan	157, 148	21, 483	2, 619, 244	206, 384	20, 017
Nevada	381	181	52	13	
New York:					
Onondaga district			105, 372		
Warsaw district	782, 031	479, 139	922, 960	103, 126	30, 672
Rock salt					
Ohio	65, 000	130, 000	304, 839	30, 000	14, 124
Pennsylvania		33, 000	217, 343	20, 000	10, 000
Texas			*b*126, 000		
Utah	5, 357	100, 000	*c* 81, 507	1, 071	357
West Virginia			158, 975	51, 761	
Total	1, 024, 203	767, 374	5, 558, 490	444, 498	96, 657

a Includes all grades, except the rock salt product.
b Includes table, dairy, and common coarse.
c Includes some table, dairy, and milling.

Production of salt in 1893, by States and grades—Continued.

States.	Solar.	Rock.	Milling.	Agricultural.	Total product.	Total value.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	
California	*a* 214, 229	3, 571			292, 858	$137, 962
Illinois					59, 161	30, 168
Kansas		317, 714			1, 277, 180	471, 543
Louisiana		191, 430			191, 430	97, 200
Michigan	30, 000			3, 622	3, 057, 898	888, 837
Nevada			5, 141	791	6, 559	4, 481
New York:						
Onandaga district	*a* 1, 865, 344				1, 970, 716	582, 893
Warsaw district				2, 000	2, 319, 928	909, 191
Rock salt		1, 371, 430			1, 371, 430	378, 000
Ohio					543, 963	209, 393
Pennsylvania					280, 343	136, 436
Texas					126, 000	110, 267
Utah	714				189, 006	130, 075
West Virginia					210, 736	68, 222
Total	2, 110, 287	1, 884, 145	5, 141	6, 413	11, 897, 208	4, 154, 668

a The salt classed as "solar" in California and New York includes all not otherwise classified by producers.

In reporting production some operators use the bushel as a unit of measurement, some the short ton, and some the barrel. For the sake of convenience the product of each State in the preceding and following tables has been reduced to one unit, the barrel, containing 280 pounds, or 5 bushels of 56 pounds, and a ton being equal to $7\frac{1}{7}$ barrels.

Comparative table of production of salt in States and Territories from 1883 to 1894.

States and Territories.	1883.		1884.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	2, 894, 672	$2, 344, 684	3, 161, 806	$2, 392, 536
New York	1, 619, 486	680, 638	1, 788, 454	705, 978
Ohio	350, 000	231, 000	320, 000	201, 600
West Virginia	320, 000	211, 000	310, 000	195, 000
Louisiana	265, 215	141, 125	223, 964	125, 677
California	214, 286	150, 000	178, 571	120, 000
Utah	107, 143	100, 000	114, 285	80, 000
Nevada	21, 429	15, 000	17, 857	12, 500
Illinois, Indiana, Virginia, Tennessee, Kentucky, and other States and Territories (*a*)	400, 000	377, 595	400, 000	364, 443
Total	6. 192, 231	4, 251, 042	6, 514, 937	4, 197, 734

States and Territories.	1885.		1886.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	3, 297, 403	$2, 967, 663	3, 677, 257	$2, 426, 989
New York	2, 304, 787	874, 258	2, 431, 563	1, 243, 721
Ohio	306, 847	199, 450	400, 000	260, 000
West Virginia	223, 184	145, 070	250, 000	162, 500
Louisiana	299, 271	139, 911	299, 691	108, 372
California	221, 428	160, 000	214, 285	150, 000
Utah	107, 140	75, 000	164, 285	100, 000
Nevada	28, 593	20, 000	30, 000	21, 000
Illinois, Indiana, Virginia, Tennessee, Kentucky, and other States and Territories (*a*)	250, 000	243, 993	240, 000	352, 763
Total	7, 038, 653	4, 825, 345	7, 707, 081	4, 825, 345

a Estimated.

Comparative table of production of salt in States and Territories, etc.—Continued.

States and Territories.	1887.		1888.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	3, 944, 309	$2, 291, 842	3, 866, 228	$2, 261, 743
New York	2, 353, 560	936, 894	2, 318, 483	1, 130, 409
Ohio	365, 000	219, 000	380, 000	247, 000
West Virginia	225, 000	135, 000	220, 000	143, 000
Louisiana	341, 093	118, 735	394, 385	134, 652
California	200, 000	140, 000	220, 000	92, 400
Utah	325, 000	102, 375	151, 785	32, 000
Kansas	....	....	155, 000	189, 000
Other States and Territories (*a*)	250, 000	150, 000	350, 000	143, 999
Total	8, 003, 962	4, 093, 846	8, 055, 881	4, 374, 203

States and Territories.	1889.		1890.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	3, 856, 929	$2, 088, 909	3, 837, 632	$2, 302, 579
New York	2, 273, 007	1, 136, 503	2, 532, 036	1, 266, 018
Ohio	250, 000	162, 500	231, 303	136, 617
West Virginia	200, 000	130, 000	229, 938	134, 688
Louisiana	325, 629	152, 000	273, 553	132, 000
California	150, 000	63, 000	62, 363	57, 085
Utah	200, 000	60, 000	427, 500	126, 100
Kansas	450, 000	202, 500	882, 666	397, 199
Other States and Territories (*a*)	300, 000	200, 000	300, 000	200, 000
Total	8, 005, 565	4, 195, 412	8, 776, 991	4, 752, 286

States and Territories.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	3, 966, 784	$2, 037, 289	3, 829, 478	$2, 046, 963
New York	2, 839, 544	1, 340, 036	3, 472, 073	1, 662, 816
Ohio	(*b*)	(*b*)	} 899, 244	394, 720
West Virginia	(*b*)	(*b*)		
Louisiana	173, 714	102, 375	200, 000	100, 000
California	200, 949	90, 303	235, 774	104, 938
Utah	969, 000	265, 350	1, 292, 471	340, 442
Nevada	60, 799	39, 898	22, 929	22, 806
Kansas	855, 536	304, 775	1, 480, 100	773, 989
Illinois	39, 670	34, 909	60, 000	48, 000
Virginia	70, 442	70, 425	60, 000	50, 000
Pennsylvania	....	....	25, 571	10, 741
Texas	....	....	121, 250	99, 500
Other States and Territories (*a*)	811, 507	430, 761	....	....
Total	9, 987, 945	4, 571, 121	11, 698, 890	5, 654, 915

States and Territories.	1893.		1894.	
	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Barrels.*	
Michigan	3, 057, 898	$888, 837	3, 341, 425	$1, 243, 619
New York	5, 662, 074	1, 870, 084	6, 270, 588	1, 999, 146
Ohio	543, 963	209, 393	528, 996	187, 432
West Virginia	210, 736	68, 222	194, 532	51, 947
Louisiana	191, 430	97, 200	186, 050	86, 134
California	292, 858	137, 962	332, 246	172, 678
Utah	189, 006	130, 075	268, 186	209, 077
Nevada	6, 559	4, 481	3, 670	4, 030
Kansas	1, 277, 180	471, 543	1, 382, 409	529, 392
Illinois	59, 161	30, 168	50, 000	27, 500
Virginia	....	....	64, 222	43, 580
Pennsylvania	280, 343	136, 436	203, 236	83, 750
Texas	126, 000	110, 267	142, 857	101, 000
Other States and Territories	....	....	....	....
Total	11, 897, 208	4, 154, 668	12, 967, 417	4, 739, 285

a Estimated. *b* Included in "Other States."

CALIFORNIA.

The total amount of salt produced in California in 1894 was 332,246 barrels, valued at $172,678, against 298,858 barrels, valued at $137,962, in 1893. Of the product in 1894, 24,864 barrels were rock salt mined in San Bernardino County. The remainder is obtained by solar evaporation of sea water. The sea water is run into ponds at high tide by means of water gates, the ponds covering from 50 to 150 acres. The water remains in these ponds until a brine of proper strength is obtained, when it is drawn off into settling ponds, and from the settling ponds into the crystallizing ponds, the length of time for each operation depending upon the condition of the weather.

Salt product of California since 1883.

Years.	Barrels.	Value.	Years.	Barrels.	Value.
1883	214,286	$150,000	1889	150,000	$63,000
1884	178,571	120,000	1890	62,363	57,085
1885	221,428	160,000	1891	200,949	90,303
1886	214,285	150,000	1892	235,703	104,788
1887	200,000	140,000	1893	292,858	137,962
1888	220,000	92,400	1894	332,246	172,678

ILLINOIS.

The output of salt in Illinois during 1894 was 50,000 barrels, valued at $27,500, against 59,161 barrels, valued at $30,168 in 1893. Statistics of salt production in Illinois were not obtained prior to 1891. Since that time the output, which is all obtained from brine, has been as follows:

Salt product of Illinois since 1891.

Years.	Barrels.	Value.
1891	39,670	$34,909
1892	60,000	48,000
1893	59,161	30,168
1894	50,000	27,500

KANSAS.

Kansas produced 1,382,409 barrels of salt in 1894, of which 949,596 barrels were from brine and 432,813 barrels were rock salt. In 1893 the total product was 1,277,180 barrels, which included 959,466 barrels of brine and 317,714 barrels of rock salt. All of the brine salt is manufactured into the finer grades, particularly dairy salt, and a large portion of the rock salt, which in some places is very pure, is ground for table use.

The records of salt production date back only as far as 1888. In that year the total product reported was 155,000 barrels. In 1889 it had increased to 450,000 barrels; in 1890 to 822,666 barrels, and in 1894 it had reached 1,382,409 barrels, or nearly nine times the output six years before.

Salt product of Kansas since 1888.

Years.	Barrels.	Value.	Years.	Barrels.	Value.
1888	155,000	$189,000	1892	1,480,100	$773,989
1889	450,000	202,500	1893	1,277,180	471,543
1890	822,666	397,199	1894	1,382,409	529,392
1891	855,536	304,775			

LOUISIANA.

The entire salt production of Louisiana is rock salt from the Petite Anse mine, a full description of which will be found in Mineral Resources for 1882. Another salt formation is found in the northwestern part of the State. This is a group of salty flats or "licks," which are also described in the report for 1882. The early settlers of Louisiana obtained their supplies of salt here by artificial evaporation of the brine, but for thirty or forty years the localities have been deserted.

The salt of Petite Anse stands well in the opinion of meat packers in the South on account of its quick action in the process of curing. The following table shows the annual output from this mine since 1882:

Production of the Petite Anse salt mine since 1882.

Years.	Short tons.	Years.	Short tons.
1882	25,550	1889	45,588
1883	37,130	1890	39,979
1884	31,355	1891	24,320
1885	41,898	1892	28,000
1886	41,957	1893	26,800
1887	47,750	1894	26,047
1888	25,214		

MICHIGAN.

Until 1893 Michigan held first place in the list of salt-producing States, but was supplanted in that year by New York. The product in 1894 was 3,341,425 barrels, an increase of about 10 per cent over that of 1893.

The following table is brought forward from the previous volumes. It gives the amount of salt reported by the inspectors for the fiscal years ending November 30. They do not represent the actual production, as the contents of the bins at the beginning and close of the year have to be deducted and added to obtain the product. For instance, in 1893 the amount inspected is given at 3,514,485 barrels. To this must be added the amount in the bins November 30, 1893, which was 506,402 barrels, making a total of 4,020,887 barrels, and from this should be deducted the amount of salt in bins at the beginning of the year, 1,001,780 barrels, showing the production to have been, according to the inspectors, 3,019,107 barrels, as compared with 3,057,898 barrels reported to the Survey for the calendar year. In 1894, the total amount of salt made for the fiscal year, according to the inspectors' report, was 3,485,428 barrels for the fiscal year, against 3,341,425 for the calendar year reported to the Survey. The amount of salt in bins November 30, 1894, was 852,889 barrels:

Grades of all salt produced in Michigan, as reported by the inspectors, from 1869 to 1894, inclusive.

Years.	Fine.	Packers.	Solar.	Second quality.	Common coarse.	Total for each year.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
1869	513, 989	12, 918	15, 264	19, 117	....	561, 288
1870	568, 326	17, 869	15, 507	19, 650	....	621, 352
1871	655, 923	14, 677	37, 645	19, 930	....	728, 175
1872	672, 034	11, 110	21, 461	19, 876	....	724, 481
1873	746, 762	23, 671	32, 267	20, 706	....	823, 346
1874	960, 757	20, 090	29, 391	16, 741	....	1, 026, 979
1875	1, 027, 886	10, 233	24, 336	19, 410	....	1, 081, 865
1876	1, 402, 410	14, 233	24, 418	21, 668	....	1, 462, 729
1877	1, 590, 841	20, 389	22, 949	26, 818	....	1, 660, 997
1878	1, 770, 361	19, 367	33, 541	32, 615	....	1, 855, 884
1879	1, 997, 350	15, 641	18, 020	27, 029	....	2, 058, 040
1880	2, 598, 037	16, 691	22, 237	48, 623	....	2, 685, 588
1881	2, 673, 910	13, 885	9, 683	52, 821	....	2, 750, 299
1882	2, 928, 542	17, 208	31, 335	60, 222	....	3, 037, 307
1883	2, 828, 987	15, 424	16, 735	33, 526	....	2, 894, 672
1884	3, 087, 033	19, 308	16, 957	38, 508	....	3, 161, 806
1885	3, 230, 646	15, 480	19, 849	31, 428	....	3, 297, 403
1886	3, 548, 731	22, 221	31, 177	71, 235	3, 893	3, 677, 257
1887	3, 819, 738	19, 385	13, 903	73, 905	17, 378	3, 944, 309
1888	3, 720, 319	18, 126	26, 174	87, 694	13, 915	3, 866, 228
1889	3, 721, 099	19, 780	17, 617	93, 455	4, 978	3, 856, 929
1890	3, 655, 331	20, 337	18, 896	143, 068	....	3, 837, 632
1891	3, 764, 108	11, 400	17, 335	121, 269	13, 559	3, 927, 671
1892	....	....	....	....	....	3, 812, 054
1893	3, 421, 607	16, 550	11, 893	64, 435	....	3, 514, 485
1894	3, 072, 241	15, 944	7, 744	44, 012	....	3, 138, 944

NEVADA.

A large part of the salt product of Nevada is used by the silver smelters. The closing down of many of these works has caused a great falling off in salt production from 22,929 barrels in 1892 to 6,559 barrels in 1893 and 3,670 barrels in 1894. Milling salt decreased from 5,141 barrels in 1893 to 1,443 barrels in 1894.

NEW YORK.

In 1893 New York took first place in the production of salt, and will probably continue to hold that position for some time to come. The returns for 1894 show a total product of 6,270,588 barrels, with a net value of $1,999,146, against 5,662,074 barrels in 1893, valued at $1,870,-084. The product in 1894 included 1,616,629 barrels, or 226,328 short tons, of rock salt, and 4,653,959 barrels of salt from brine. Brine salt is obtained from two localities, the Onondaga Reservation, in the vicinity of Syracuse, and the Warsaw district, so named from the town of Warsaw, situated in its center. In the Onondaga district the brine is supplied to the manufacturers by the State, the State receiving 1 cent per bushel for all salt inspected. Most of the product of this region is coarse salt obtained by solar evaporation, though there are a few manufacturers who make fine salt in open pans and grainers. In the Warsaw district manufacturers work independently, obtaining their own brine and producing the finer qualities of salt. The rock salt mined at Le Roy, Retsof, Mount Morris, Piffard, Greigsville, etc., is shipped chiefly in bulk and used for curing fish and meats and for other purposes where fineness of grain and exceptional purity are not important.

NEW YORK BRINE SALT.

As stated above, there are two regions in New York producing salt from brine, the Onondaga Reservation, near Syracuse, Onondaga County, and the Warsaw district, in Warsaw County.

ONONDAGA DISTRICT.

Since 1797, nearly one hundred years ago, salt has been made from brine furnished by the State. For nearly half a century the product was entirely fine salt made by artificial evaporation, the production of solar salt not beginning until 1841. The production of fine salt on the reservation reached its maximum in 1862, when a little over 7,000,000 bushels, or 1,400,000 barrels, were made. From 1862 to 1885 it averaged about 5,000,000 bushels annually, reaching as high as 6,804,295 in 1869, and as low as 3,083,998 in 1876. Since 1885 the production of fine salt has shown a rapidly declining tendency, the output in 1893 being but 733,854 bushels and in 1894 871,859 bushels. The production of solar or coarse salt, which began in 1841, had not reached a million bushels up to 1857, but in 1858 jumped to over 1,500,000 bushels. In 1867 it amounted to a little over 2,000,000 bushels, and continued at something above that average until 1881 and 1882, in which years it was a little more than 3,000,000, and passed that figure again in 1887, 1888, and 1892. As in the production of fine salt, 1893 and 1894 were both bad years, the output being in each year a little over 2,300,000 bushels. The State has in the past derived considerable revenue from the tax of 1 cent per bushel on all salt made from brine furnished by it on the reservation, but for several years it has ceased to be profitable. Competition has been very keen, particularly since the development of the Warsaw district in 1883, and the seemingly small tax of 1 cent on a bushel has been enough to cause a number of producers to close down. The decrease in production has cut off much of the revenue, and in 1893 and 1894 the expenses of maintenance by the State have largely exceeded the income. In 1893 the total revenue derived was only $30,659, while the expenses for maintenance were $74,165, leaving a deficit of $43,506, nearly one and a half times the total revenue. In 1894 the revenue was $32,278 and the expenses $61,405, leaving a deficit of $29,127.

At the last constitutional election held in the State the legislature was empowered to provide for the sale of the Salt Springs Reservation, and it is probable that this will be done.

The following table shows the total product of the Onondaga Salt Springs Reservation since 1797:

Production of the Onondaga district, 1797 to 1894.

[Bushels of 56 pounds.]

Years.	Solar.	Fine.	Total.	Years.	Solar.	Fine.	Total.
1797		25, 474	25, 474	1846	331, 705	3, 507, 146	3, 838, 851
1798		59, 928	59, 928	1847	262, 879	3, 688, 476	3, 951, 355
1799		42, 704	42, 704	1848	342, 497	4, 394, 629	4, 737, 126
1800		50, 000	50, 000	1849	377, 735	4, 705, 834	5, 083, 569
1801		62, 000	62, 000	1850	374, 732	3, 894, 187	4, 268, 919
1802		75, 000	75, 000	1851	378, 967	4, 235, 150	4, 614, 117
1803		90, 000	90, 000	1852	633, 595	4, 288, 938	4, 922, 533
1804		100, 000	100, 000	1853	577, 947	4, 826, 577	5, 404, 524
1805		154, 071	154, 071	1854	734, 474	5, 068, 873	5, 803, 347
1806		122, 577	122, 577	1855	498, 124	5, 584, 761	6, 082, 885
1807		175, 448	175, 448	1856	709, 391	5, 257, 419	5, 966, 810
1808		319, 618	319, 618	1857	481, 280	3, 830, 846	4, 312, 126
1809		128, 282	128, 282	1858	1, 514, 554	5, 518, 665	7, 033, 219
1810		450, 000	450, 000	1859	1, 345, 022	5, 549, 250	6, 894. 272
1811		200, 000	200, 000	1860	1, 462, 565	4, 130, 682	5, 593, 247
1812		221, 011	221, 011	1861	1, 884, 697	5, 315, 694	7, 200, 391
1813		226, 000	226, 000	1862	1, 983, 022	7, 070, 852	9, 053, 874
1814		295, 000	295, 000	1863	1, 437, 656	6, 504, 727	7, 942, 383
1815		322, 058	322, 058	1864	1, 971, 122	5, 407, 712	7, 378, 834
1816		348, 665	348, 665	1865	1, 886, 760	4, 499, 170	6, 385, 930
1817		408, 665	408, 665	1866	1, 978, 183	5, 180, 320	7, 158, 503
1818		406, 540	406, 540	1867	2, 271, 892	5, 323, 673	7, 595, 565
1819		548, 374	548, 374	1868	2, 027, 490	6, 639, 126	8, 666, 616
1820		458, 329	458, 329	1869	1, 857, 942	6, 804. 295	8, 662, 237
1821		526, 049	526, 049	1870	2, 487, 691	6, 260, 422	8, 748, 113
1822		481, 562	481, 562	1871	2, 464, 464	5, 910, 492	8, 374, 956
1823		726, 988	726, 988	1872	1, 882, 604	6, 048. 321	7, 930, 925
1824		816, 634	816, 634	1873	1, 691, 359	5, 768, 998	7, 460, 357
1825		757, 203	757, 203	1874	1, 667, 368	4, 361, 932	6, 029, 300
1826		811, 023	811, 023	1875	2, 665, 955	4, 522, 491	7, 179, 446
1827		983, 410	983, 410	1876	2, 308, 679	3, 083, 998	5, 392, 677
1828		1, 160, 888	1, 160, 888	1877	2, 525, 335	3, 902, 648	6, 427, 983
1829		1, 129, 280	1, 129, 280	1878	2, 788, 754	4, 387, 443	7, 176, 197
1830		1, 435, 446	1, 435, 446	1879	2, 957, 744	5, 364, 418	8, 322, 162
1831		1, 514, 037	1, 514, 037	1880	2, 516, 485	5, 482, 265	7, 998, 750
1832		1, 652, 985	1, 652, 985	1881	3, 011, 461	4, 905, 775	7, 917, 236
1833		1, 838, 646	1, 838, 646	1882	3, 032, 447	5, 307, 733	8, 340, 180
1834		1, 943, 252	1, 943, 252	1883	2, 444, 374	5, 053, 057	7, 497, 431
1835		1, 209, 867	1, 209, 867	1884	2, 353, 860	4, 588, 410	6, 942, 270
1836		1, 912, 858	1, 912, 858	1885	2, 439, 332	4, 494, 967	6, 934, 299
1837		2, 167, 287	2, 167, 287	1886	2, 772, 348	3, 329, 409	6, 101, 757
1838		2, 575, 033	2, 575, 033	1887	3, 118, 974	2, 576, 823	5, 695, 797
1839		2, 864, 718	2, 864, 718	1888	3, 115, 314	2, 542, 053	5, 657, 367
1840		2, 622, 305	2, 622, 305	1889	2, 916, 922	2, 448, 117	5, 365, 039
1841	220, 247	3, 120, 520	3, 340, 767	1890	2, 726, 471	2, 201. 651	4, 928. 122
1842	163, 021	3, 128, 882	2, 291, 903	1891	2, 113, 727	1, 735, 186	3, 948, 914
1843	318, 105	2, 809, 395	3, 127, 500	1892	3, 122, 789	1, 282, 885	4, 405, 674
1844	332, 418	3, 671, 134	4, 003, 552	1893	2, 332, 052	733. 854	3, 065, 906
1845	353, 455	3, 408, 903	3, 762, 358	1894	2, 355, 394	871, 859	3, 227, 254

WARSAW DISTRICT.

Salt production in the Warsaw district began in 1883, with an output of 600,000 bushels, or 120,000 barrels. In the following year it more than trebled its initial production, with an output of 2,000,000 bushels. In 1887 it exceeded the production of the Onondaga reservation, and in 1893 its output was more than four times that of the reservation. The annual production, in bushels, since 1883 has been as follows:

Production of salt in the Warsaw district, New York, since 1883.

Years.	Bushels.	Years.	Bushels.
1883	600, 000	1889	6, 000, 000
1884	2, 000, 000	1890	7, 732, 060
1885	4, 589, 635	1891	10, 248, 505
1886	6, 056, 060	1892	12, 954, 705
1887	6, 072, 000	1893	11, 599, 640
1888	5, 935, 000	1894	13, 809, 270

The following table shows the total output of salt from brine in both regions since 1883. It does not include salt used in the manufacture of chemical preparations. The brine from which the chemicals are made is obtained from the same salt formation as that of the Onondaga reservation, but the works are on private property, and as the product does not appear in the market as salt it is not included in the reports to the superintendent:

Product of salt from brine in New York since 1883.

Districts.	1883.	1884.	1885.	1886.	1887.	1888.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Onondaga reservation..	7,497,431	6,942,270	6,934,299	6,101,757	5,695,797	5,657,367
Warsaw district........	600,000	2,000,000	4,589,635	6,056,060	6,072,000	5,935,000
Total	8,097,431	8,942,270	11,523,934	12,157,817	11,767,797	11,592,367
Districts.	**1889.**	**1890.**	**1891.**	**1892.**	**1893.**	**1894.**
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Onondaga reservation..	5,365,039	4,928,122	3,948,914	4,405,674	*a*3,065,906	*a*3,041,956
Warsaw district........	6,000,000	7,732,060	10,248,505	12,954,705	11,599,640	13,809,270
Total	11,365,039	12,660,182	14,197,419	17,360,379	*a*14,665,546	*a*16,851,226

a Not including salt used in the manufacture of chemicals.

The following table shows the total production in the State from 1883 to 1894:

Production of salt in New York since 1883.

Years.	Barrels.	Value.	Years.	Barrels.	Value.
1883..............	1,619,486	$680,638	1889................	2,273,007	$1,136,503
1884..............	1,788,454	705,978	1890................	2,532,036	1,266,018
1885..............	2,304,787	874,258	1891................	2,839,544	1,340,036
1886..............	2,431,563	1,243,721	1892................	3,472,073	1,662,818
1887..............	2,353,560	936,894	1893................	5,662,074	1,870,084
1888..............	2,318,483	1,130,409	1894................	4,986,874	1,615,032

PENNSYLVANIA, TEXAS, AND WEST VIRGINIA.

During 1894 Pennsylvania produced 203,236 barrels of salt, valued at $83,750, against 280,343 barrels, valued at $136,436, in 1893. Texas produced 142,857 barrels in 1894, valued at $101,000, compared with 126,000 barrels, worth $110,267, in 1893. The output from West Virginia was 194,532 barrels, against 210,736 barrels in 1893. The product in each State was brine salt.

UTAH.

The product of salt in Utah during 1894 was about 80,000 barrels in excess of that of 1893, but still far short of the yield in 1891 or 1892. The decreased product in the last two years has been due to the depression in the silver-smelting industry, which consumed the greater portion of the product in earlier years. A comparative increase is shown in the value of the output in 1893 and 1894, due to the larger proportionate production of the finer grades of salt.

Most of the salt produced in Utah is obtained from Great Salt Lake, though some rock salt (6,250 barrels in 1894) is mined in Sanpete County. The salt from brine is obtained by overflowing the lowlands on the shores of the lake in the spring, shutting the water in by dirt walls, and using solar heat for evaporation. The salt obtained at one "harvest" of this kind is sometimes sufficient to supply the demand for several years. The salt thus obtained is afterwards refined for table and dairy purposes. That for use in smelting works is taken without retreatment. The product in the table below does not consider the amount harvested, but only that refined and sold:

Production of salt in Utah since 1883.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Barrels.			*Barrels.*	
1883	107, 143	$100, 000	1889	200, 000	$60, 000
1884	114, 285	80, 000	1890	427, 500	126, 100
1885	107, 140	75, 000	1891	969, 000	265, 350
1886	164, 285	100, 000	1892	1, 292, 471	340, 442
1887	325, 000	102, 375	1893	189, 006	130, 075
1888	151, 785	32, 000	1894	268, 186	209, 077

IMPORTS AND EXPORTS.

The imports of salt into the United States have shown an almost constant decrease since 1881. The decrease has been particularly noticeable in the imports of refined salt, due in great measure to the improvements recently inaugurated in the manufacture of table and dairy salts by American producers, which has placed the domestic product on a line with if not ahead of salts of foreign make:

Salt imported and entered for consumption in the United States, 1867 to 1894, inclusive.

Years ended—	In bags, barrels, and other packages.		In bulk.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
June 30, 1867	254, 470, 862	$696, 570	229, 304, 323	$336, 302
1868	308, 446, 080	915, 546	219, 975, 096	365, 458
1869	297, 382, 750	895, 272	256, 765, 240	351, 168
1870	288, 479, 187	797, 194	349, 776, 433	507, 874
1871	283, 993, 799	800, 454	274, 730, 573	355, 318
1872	258, 232, 807	788, 893	257, 637, 230	312, 569
1873	239, 494, 117	1, 254, 818	388, 012, 132	525, 585
1874	358, 375, 496	1, 452, 161	427, 294, 209	649, 838
1875	318, 673, 091	1, 200, 541	401, 270, 315	549, 111
1876	331, 266, 140	1, 153, 480	379, 478, 218	462, 106
1877	359, 005, 742	1, 059, 941	444, 044, 370	532, 831
1878	352, 109, 963	1, 062, 995	414, 813, 516	483, 909
1879	375, 286, 472	1, 150, 018	434, 760, 132	532, 706
1880	400, 970, 531	1, 180, 082	449, 743, 872	548, 425
1881	412, 442, 291	1, 242, 543	529, 361, 041	658, 068
1882	329, 969, 300	1, 086, 932	399, 100, 228	474, 200
1883	312, 911, 360	1, 035, 946	412, 938, 686	451, 001
1884	340, 759, 010	1, 093, 628	441, 613, 517	433, 827
1885	351, 276, 969	1, 030, 029	412, 322, 341	386, 858
Dec. 31, 1886	319, 232, 750	966, 993	366, 621, 223	371, 000
1887	275, 774, 571	850, 069	343, 216, 331	328, 201
1888	238, 921, 421	620, 425	272, 650, 231	246, 022
1889	180, 906, 293	627, 134	234, 499, 635	249, 232
1890	172, 611, 041	575, 260	243, 756, 044	252, 848
1891	150, 033, 182	492, 144	220, 309, 985	224, 569
1892	150, 799, 014	488, 108	201, 366, 103	196, 371
1893	98, 037, 648	358, 575	146, 945, 390	63, 404
1894	60, 793, 685	206, 229	101, 525, 281	86, 718

Salt imported and entered for consumption in the United States, etc.—Continued.

Years ended—	For the purpose of curing fish.		Not elsewhere specified.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
June 30, 1867					$1,032,872
1868					1,281,004
1869					1,246,440
1870	68,597,023	$87,048			1,392,116
1871	64,671,139	66,008			1,221,780
1872	57,830,929	60,155			1,161,617
1873	86,756,628	86,193			1,866,596
1874	105,613,913	126,896			2,228,895
1875	110,294,440	119,607			1,869,259
1876	118,760,638	126,276			1,741,862
1877	132,433,972	140,787			1,733,559
1878	100,794,611	96,898			1,643,802
1879	94,060,114	95,841			1,778,565
1880	109,024,446	119,667			1,848,174
1881	133,395,065	144,347			2,044,958
1882	134,777,569	147,058			1,708,190
1883	142,065,557	154,671			1,641,618
1884	126,605,276	122,463			1,649,918
1885	140,067,018	121,429			1,538,316
Dec. 31, 1886	103,360,362	94,721			1,432,714
1887	105,577,947	107,089			1,285,359
1888	113,459,083	111,120			977,577
1889	97,960,624	100,123			976,489
1890	98,279,719	96,648			924,756
1891	103,990,324	89,196			805,909
1892	105,192,086	90,327			774,806
1893	103,536,135	87,749			509,728
1894	93,723,885	79,482	178,112,857	$263,707	636,136

Salt of domestic production exported from the United States from 1790 to 1894, inclusive.

Years ended—	Quantity.	Value.	Years ended—	Quantity.	Value.
	Bushels.			*Bushels.*	
Sept. 30, 1790	31,935	$8,236	June 30, 1862	397,506	$228,109
1791	4,208	1,052	1863	584,901	277,838
1830	47,488	22,978	1864	635,519	296,088
1831	45,847	26,848	1865	589,537	358,109
1832	45,072	27,914	1866	670,644	300,980
1833	25,069	18,211	1867	605,825	304,030
1834	89,064	54,007	1868	624,970	289,936
1835	126,230	46,483	1869	442,947	190,076
1836	49,917	31,943	1870	298,142	119,582
1837	99,133	58,472	1871	120,156	47,115
1838	114,155	67,707	1872	42,603	19,978
1839	264,337	64,272	1873	73,323	43,777
1840	92,145	42,246	1874	31,657	15,701
1841	215,084	62,765	1875	47,094	16,273
1842	110,400	39,064	1876	51,014	18,378
June 30, 1843 (*a*)	40,678	10,262	1877	65,771	20,133
1844	157,529	47,755	1878	72,427	24,968
1845	131,500	45,151	1879	43,710	13,612
1846	117,627	30,520	1880	22,179	6,613
1847	202,244	42,333	1881	45,455	14,752
1848	219,145	73,274	1882	42,085	18,265
1849	312,063	82,972	1883	54,147	17,321
1850	319,175	75,103	1884	70,014	26,007
1851	344,061	61,424	1885	*b*4,101,587	26,488
1852	1,467,676	89,316	Dec. 31, 1886	4,828,863	29,580
1853	515,857	119,729	1887	4,685,080	27,177
1854	548,185	159,026	1888	5,359,237	32,986
1855	536,073	156,879	1889	5,378,450	31,405
1856	698,458	311,495	1890	4,927,022	30,079
1857	576,151	190,699	1891	4,448,846	23,771
1858	533,100	162,650	1892	5,208,935	28,399
1859	717,257	212,710	1893	5,792,207	38,375
1860	475,445	129,717	1894	10,853,759	46,780
1861	537,401	144,046			

a Nine months. *b* Pounds from 1885.

FLUORSPAR.

OCCURRENCE.

Fluorspar occurs in workable quantity in but one locality in the United States, near Rosiclare, Ill. The deposits have been thoroughly described by Prof. S. F. Emmons in a paper contributed to the Transactions of the American Institute of Mining Engineers, 1892.

The product in 1894 was less than in any year since 1888, amounting to 7,500 short tons, valued at $47,500. In 1893 the output was 12,400 tons, the largest ever obtained, though the value in 1892, when the product was 150 tons less than in 1893, exceeded that of the latter year by $5,000.

USES.

The mineral is used largely in metallurgical operations, being considered greatly superior to ordinary limestone for fluxing purposes. It is also used in the manufacture of opalescent glass and of hydrofluoric acid. When intended for glass or acid making the fluorspar is crushed and ground before selling. For other purposes it is sold in lumps as mined. The use of fluorspar for metallurgical purposes is discussed at length in Mineral Resources, 1889–90.

PRODUCTION.

The following table shows the annual production of fluorspar since 1882:

Production of fluorspar in the United States from 1882 to 1894.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1882	4,000	$20,000	1889	9,500	$45,835
1883	4,000	20,000	1890	8,250	55,328
1884	4,000	20,000	1891	10,044	78,330
1885	5,000	22,500	1892	12,250	89,000
1886	5,000	22,000	1893	12,400	84,000
1887	5,000	20,000	1894	7,500	47,500
1888	6,000	30,000			

CRYOLITE.

This mineral is used to a considerable extent in the manufacture of alum and sodium salts, for making white, porcelain-like glass, and other technical purposes. In the preparation of alum and sodium salts from cryolite, alumina is left as a residue; and from this, metallic aluminum is extracted by electrolytic process. The only source of supply for the mineral is Greenland, although traces of this mineral were long ago shown by Cross and Hillebrand to occur in the neighborhood of Pikes Peak, Colo. The imports of cryolite for a series of years are shown in the following table:

Imports of cryolite from 1871 to 1894.

Years ended—	Amount.	Value.	Years ended—	Amount.	Value.
	Long tons.			*Long tons.*	
June 30, 1871	....	$71, 058	June 30, 1883	6, 508	$97, 400
1872	....	75, 195	1884	7, 390	106, 029
1873	....	84, 226	Dec. 31, 1885	8, 275	110, 750
1874	....	28, 118	1886	8, 230	110, 152
1875	....	70, 472	1887	10, 328	138, 068
1876	....	103, 530	1888	7, 388	98, 830
1877	....	126, 692	1889	8, 603	115, 158
1878	....	105, 884	1890	7, 129	95, 405
1879	....	66, 042	1891	8, 298	76, 350
1880	....	91, 366	1892	7, 241	96, 932
1881	....	103, 529	1893	9, 574	126, 688
1882	3, 758	51, 589	1894	10, 684	142, 494

MICA.[1]

CONDITION OF INDUSTRY.

The unsatisfactory condition of the mica-mining industry mentioned in the report for 1893 continued throughout 1894, and the product obtained was the smallest on record. The depressed condition of the industry was due in great measure to placing imported mica on the free list, which, added to the other disadvantages, such as long hauls over mountain roads, crude mining methods, etc., makes the domestic product a poor competitor with India mica, which is brought into the country in the rough, and usually at very low freight rates.

PRODUCTION.

The following tables show the annual production of domestic mica since 1880 and the imports of foreign mica (all unmanufactured) since 1869:

Production of mica since 1880.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Pounds.			*Pounds.*	
1880	81,669	$127,825	1889	49,500	$50,000
1881	100,000	250,000	1890	60,000	75,000
1882	100,000	250,000	1891	75,000	100,000
1883	114,000	285,000	1892	75,000	100,000
1884	147,410	368,525	1893	51,111	88,929
1885	92,000	161,000	1893..tons scrap	156	
1886	40,000	70,000	1894	35,943	52,388
1887	70,000	142,250	1894..tons scrap	191	
1888	48,000	70,000			

[1] See Mineral Resources, 1893, for historical notes on mica mining in various sections of the United States.

IMPORTS.

The following table shows the imports of unmanufactured mica from 1869 to 1894:

Unmanufactured mica imported and entered for consumption in the United States, 1869 to 1894, inclusive.

Years ending—	Value.	Years ending—	Value.
June 30, 1869	$1,165	June 30, 1882	$5,175
1870	226	1883	9,884
1871	1,460	1884	28,284
1872	1,002	1885	28,685
1873	498	Dec. 31, 1886	*a* 56,354
1874	1,204	1887	*a* 49,085
1875	....	1888	*a* 57,541
1876	569	1889	*a* 97,351
1877	13,085	1890	*a* 207,375
1878	7,930	1891	95,242
1879	9,274	1892	218,938
1880	12,562	1893	147,927
1881	5,839	1894	126,184

a Including mica waste.

GYPSUM.

By Edward W. Parker.

OCCURRENCE.

Large deposits of gypsum are found in many of the United States. East of the Mississippi River the principal localities are in New York, where it occurs in beds of great thickness and extent in a line of counties extending westward from Oneida to Niagara; in Ohio, near the city of Sandusky; in Michigan, on the Grand River, near Grand Rapids, and at Alabaster Point, Iosco County, and in Bay County; in Virginia, along the north fork of the Holston River, and in Smyth and Washington counties. Gypsum is also reported in Alabama and Louisiana, but the deposits are not worked at the present time. West of the Mississippi River and east of the Rocky Mountains extensive gypsum deposits are found in Iowa, Kansas, Arkansas, Texas, Oklahoma, and the Indian Territory. Operations are carried on in Webster County, Iowa; Barber, Saline, Marion, Marshall, and Dickinson counties, Kans.; at Quanah, Tex., and at Okarche, Okla.

The Rocky Mountain States producing gypsum are Colorado, Montana, Utah, South Dakota, and Wyoming, and deposits are reported in Arizona, Idaho, and New Mexico. Among the Pacific States California is the only producer of gypsum, and the product from there in the past few years has been greatly reduced, owing to the fact that the largest manufacturers of plaster of paris in San Francisco have found it to their advantage to obtain their supplies of crude material from Mexico.[1]

In nearly all cases the gypsum deposits are found in close proximity to those of salt. This is particularly the case in New York, Virginia, Kansas, Texas, and in Bay County, Mich., gypsum being present in brine solutions from which the salt is obtained.

PRODUCTION.

The total amount of gypsum produced in the United States in 1894 was 239,312 short tons, against 253,615 short tons in 1893, a decrease of 14,303 short tons or 5.6 per cent. The value increased, however, from $696,615 in 1893 to $761,719 in 1894, an increase of $65,104, or about 8.5 per cent. The decrease in product was due to a falling off of nearly

[1] For detailed descriptions of the gypsum deposits of the United States see Mineral Resources, 1882, 1883-84, 1885, and 1886.

50,000 tons in the output of Michigan; 3,500 tons in that of Iowa, and over 4,000 tons in New York. The increased value was due to larger production of calcined plaster in Kansas and New York. The increased production of calcined plaster in Kansas, where nearly all of the product is made into plaster of paris or "stucco" at the point of production, is equivalent to an increase of crude mineral, and this in part offsets the decreased production in other States. The product of crude gypsum in Kansas in 1894 was 64,889 short tons, of which all but 647 short tons was calcined. The product of calcined plaster in Kansas during 1894 was nearly 20,000 tons in excess of that of 1893. As will be seen in the following table, the value of the gypsum product is taken at the condition in which it is first sold, so that an increase or decrease in the product of calcined plaster will show a material difference when comparing the total product with the total value:

Product of gypsum in the United States in 1894, by States.

States.	Total product.	Sold crude.		Ground into plaster.		Calcined into plaster of paris.			Total value.
		Quantity.	Value.	Quantity.	Value.	Before calcining.	After calcining.	Value of calcined plaster.	
	Short tons.	*Short tons.*		*Short tons.*		*Short tons.*	*Short tons.*		
Iowa	17,906	....	....	1,900	$2,700	16,006	13,000	$42,000	$44,700
Kansas	64,889	87	$174	560	1,680	64,242	49,273	300,030	301,884
Michigan	79,958	20,000	40,000	11,982	21,127	47,976	38,555	128,493	189,620
New York	31,798	10,554	7,885	16,804	36,993	4,440	3,335	15,384	60,262
Ohio	20,827	2,955	6,410	3,472	10,416	14,400	11,472	52,771	69,597
South Dakota	4,295	500	750	460	1,850	3,335	2,660	13,450	16,050
Texas	6,925	....	....	....	....	6,925	4,750	27,300	27,300
Virginia	8,106	600	900	6,728	20,853	778	623	2,678	24,431
Other States(*a*)	4,608	6	30	90	325	4,512	3,490	27,520	27,875
Total	239,312	34,702	56,149	41,996	95,944	162,614	127,158	609,626	761,719

a Includes California, Colorado, Montana, Oklahoma Territory, Utah, and Wyoming. In each of these States the output is reported from only one company.

For the purposes of comparison the following tables, showing the statistics of production during 1891, 1892, and 1893, and the total product and value for the past six years, are given:

Product of gypsum in the United States in 1893, by States.

States.	Total product.	Sold crude.		Ground into plaster.		Calcined into plaster of paris.			Total value.
		Quantity.	Value.	Quantity.	Value.	Before calcining.	After calcining.	Value of calcined plaster.	
	Short tons.	*Short tons.*		*Short tons.*		*Short tons.*	*Short tons.*		
Iowa	21,447	109	$82	2,853	$2,296	18,485	14,273	$53,160	$55,538
Kansas	43,631	196	510	57	114	43,378	29,975	180,975	181,599
Michigan	124,590	31,000	62,000	16,263	28,562	77,327	62,031	213,359	303,921
New York	36,126	10,979	8,198	22,802	49,221	2,345	1,813	7,973	65,392
South Dakota	5,150	....	....	50	150	5,100	4,080	12,400	12,550
Virginia	7,014	22	66	5,579	19,181	1,413	1,131	5,112	24,359
Other States(*a*)	15,657	502	1,004	2,804	6,841	12,351	9,624	45,411	53,256
Total	253,615	43,108	72,010	50,408	106,365	160,399	122,937	518,390	696,615

a Includes Ohio and Texas. In each of these States the output is reported from only one company.

Product of gypsum in the United States in 1892, by States.

States.	Total product.	Sold crude.		Ground into land plaster.		Calcined into plaster of paris.			Total value.
		Quantity.	Value.	Quantity.	Value.	Before calcining.	After calcining.	Value of calcined plaster.	
	Short tons.	*Short tons.*		*Short tons.*		*Short tons.*	*Short tons.*		
Kansas	46,016	420	$840	....	....	45,596	31,961	$194,357	$195,197
Michigan	139,557	47,500	71,250	14,458	$22,026	77,599	53,105	213,251	306,527
New York	32,394	7,887	5,661	24,407	55,039	100	75	400	61,100
Virginia	6,991	400	800	5,028	20,357	1,563	1,250	7,050	28,207
Other States (*a*)	31,301	1,873	2,246	3,775	8,825	25,653	19,750	93,390	104,461
Total	256,259	58,080	80,797	47,668	106,247	150,511	106,141	508,448	695,492

a Includes Colorado, Iowa, Ohio, Texas, and Utah. In each of these States the output is reported from only one company.

Product of gypsum in the United States in 1891, by States.

States.	Total product.	Sold crude.		Ground into land plaster.		Calcined into plaster of paris.			Total value.
		Quantity.	Value.	Quantity.	Value	Before calcining.	After calcining.	Value of calcined plaster.	
	Short tons.	*Short tons.*		*Short tons.*		*Short tons.*	*Short tons.*		
California, Ohio, Utah, and Wyoming	17,115	....	....	988	$3,336	16,127	14,085	$90,810	$94,146
Iowa	31,385	....	....	4,822	4,845	26,563	21,049	53,250	58,095
Kansas	40,217	640	$1,280	70	210	39,497	28,468	159,832	161,322
Michigan	79,700	11,000	22,000	15,100	28,550	53,600	44,860	173,175	223,725
New York	30,135	6,730	5,058	23,405	53,513	....	....	....	58,571
South Dakota	3,615	....	....	1,560	4,680	2,055	1,544	4,938	9,618
Virginia	5,959	204	352	5,755	22,222	....	....	....	22,574
Total	208,126	18,574	28,690	51,700	117,356	136,727	110,006	482,005	628,051

Comparative statistics of gypsum production for six years.

States.	1889.		1890.		1891.	
	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Colorado	7,700	$28,940	4,580	$22,050	....	....
Iowa	21,789	55,250	20,909	47,350	31,385	$58,095
Kansas	17,332	94,235	20,250	72,457	40,217	161,322
Michigan	131,767	373,740	74,877	192,099	79,700	223,725
New York	52,608	79,476	32,903	73,093	30,135	58,571
Ohio	....	....	....	....	....	....
South Dakota	320	2,650	2,900	7,750	3,615	9,618
Texas	....	....	....	....	....	....
Virginia	6,838	20,336	6,350	20,782	5,959	22,574
Other States	29,420	109,491	20,235	138,942	17,115	94,146
Total	267,769	764,118	182,995	574,523	208,126	628,051

States.	1892.		1893.		1894.	
	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Colorado	....	....	....	....	....	....
Iowa	(*a*)	(*a*)	21,447	$55,538	17,906	$44,700
Kansas	41,016	$195,197	43,631	181,599	64,889	301,884
Michigan	139,557	306,527	124,590	303,921	79,958	189,620
New York	32,394	61,100	36,126	65,392	31,798	60,262
Ohio	....	....	....	....	20,827	69,597
South Dakota	....	....	5,150	12,550	4,295	16,050
Texas	....	....	....	....	6,925	27,300
Virginia	6,991	28,207	7,014	24,359	8,106	24,431
Other States	31,301	104,461	15,657	53,256	4,608	27,875
Total	256,259	695,492	253,615	696,615	239,312	761,719

a Included in other States.

The following table shows the annual production of gypsum in the United States since 1880. It will be noticed that the largest production, both in amount and value, was in 1889. The next largest production was in 1893, though the value in that year was less than in 1894:

Production of gypsum in the United States since 1880.

Years.	Product.	Value.	Years.	Product.	Value.
	Short tons.			*Short tons.*	
1880	90,000	$400,000	1888	110,000	$550,000
1881	85,000	350,000	1889	267,769	764,118
1882	100,000	450,000	1890	182,995	574,523
1883	90,000	420,000	1891	208,126	628,051
1884	90,000	390,000	1892	246,374	671,548
1885	90,405	405,000	1893	253,615	696,615
1886	95,250	428,625	1894	239,312	761,719
1887	95,000	425,000			

IMPORTS.

The imports of gypsum are chiefly from Canada, the product from the Dominion being very pure and well adapted for the manufacture of plaster of Paris. The following table exhibits the total amount and value of gypsum imported into the United States since 1867:

Gypsum imported into the United States from 1867 to 1894.

Years ended—	Ground or calcined.		Unground.		Value of manufactured plaster of paris.	Total.
	Quantity.	Value.	Quantity.	Value.		
	Long tons.		*Long tons.*			
June 30, 1867		$29,895	97,951	$95,386		$125,182
1868		33,988	87,694	80,362		114,350
1869		52,238	137,039	133,430	$844	186,512
1870		46,872	107,237	100,416	1,432	148,720
1871		64,465	100,400	88,256	1,292	154,013
1872		66,418	95,339	99,902	2,553	168,873
1873		35,628	118,926	122,495	7,336	165,459
1874		36,410	123,717	130,172	4,319	170,901
1875		52,155	93,772	115,664	3,277	171,096
1876		47,588	139,713	127,084	4,398	179,070
1877		49,445	97,656	105,629	7,843	162,917
1878		33,496	89,239	100,102	6,989	140,587
1879		18,339	96,963	99,027	8,176	125,542
1880		17,074	120,327	120,642	12,693	150,409
1881		24,915	128,607	128,107	18,702	171,724
1882	5,737	53,478	128,382	127,067	20,377	200,922
1883	4,291	44,118	157,851	152,982	*a* 21,869	218,969
1884	4,996	42,904	166,310	168,000		210,904
1885	6,418	54,208	117,161	119,544		173,752
1886	5,911	37,642	122,270	115,696		153,338
1887	4,814	37,736	146,708	162,154		195,890
Dec. 31, 1888	3,340	20,764	156,697	170,023		190,787
1889	5,466	40,291	170,965	179,849		220,140
1890	7,568	55,250	171,289	174,609		229,859
1891	9,560	97,316	110,257	129,003		226,319
1892	6,882	75,608	181,104	232,403		308,011
1893	3,363	31,670	164,300	180,254		211,924
1894	2,027	16,823	162,500	179,237		196,060

a Not specified since 1883.

As the imports of gypsum into the United States are principally from the Provinces of Ontario, New Brunswick, and Nova Scotia, in the Dominion of Canada, the following table, showing the production in and exports from the Dominion, will be found interesting:

Production and exports of Canadian gypsum from 1886 to 1894.

Years.	Production.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
1886	162, 000	$178, 742	142, 833	$155, 213
1887	154, 008	157, 277	132, 724	146, 542
1888	175, 887	179, 393	125, 508	121, 389
1889	213, 273	205, 108	178, 182	194, 404
1890	226, 509	194, 033	175, 691	192, 254
1891	203, 545	192, 096	172, 496	184, 977
1892	226, 568	225, 260	175, 518	194, 304
1893	192, 568	196, 150	176, 489	178, 979
1894	223, 631	202, 031	....	....

MONAZITE.

By H. B. C. Nitze.

BRIEF DESCRIPTION OF THE MINERAL.

Monazite is essentially an anhydrous phosphate of the rare earth's cerium, lanthanum, and didymium (Ce, La, Di), PO_4. It also contains almost invariably small percentages of thoria (ThO_2) and silicic acid (SiO_2), which may be present in combination as thorite or orangite ($ThSiO_4$), or the thoria may exist as the phosphate, either in combination with the cerium, etc., or as an isomorphous mixture. Other occasional accessory constituents are the yttrium and erbium earths, zirconia, alumina, magnesia, lime, iron oxides (Fe_2O_3 and FeO), manganous oxide, tin and lead oxides, fluorine, titanic acid, and water, usually in fractional percentages.

It is a subtranslucent to subtransparent mineral, light yellow, reddish yellow, brownish, or greenish in color, and has a resinous luster. Brittle; fracture conchoidal to uneven. Its hardness is from 5 to 5.5, and its specific gravity from 4.9 to 5.3. It crystallizes in the monoclinic system.

HISTORICAL SKETCH AND NOMENCLATURE.

The following names have been applied to the mineral by independent discoverers and workers: Turnerite, monazite, mengite, edwardsite, eremite, cryptolite, monazitoid, phosphocerite, urdite, and kararfveite. It was not long, however, before the identity of these newly described mineral species was recognized, and at the present time the general name in use is monazite.

The name "turnerite" was given in 1823 by A. Levy[1] in honor of the English chemist, E. H. Turner, in whose collection the first specimens were found. The locality of these was Dauphiny. They had been classed as sphene, on account of their color, accompaniment (adularia and lamellary crichtonite), and the locality; but Levy found their hardness to be less than that of sphene, and a good cleavage in one direction. He gives as the primary crystallographic form an oblique rhombic prism with different dimensions from that of sphene. G. vom Rath[2]

[1] The Annals of Philosophy, London, 1823, vol. 5, p. 241.
[2] Poggendorff, Annalen, 1864, vol. 122, p. 407.

has also called attention to the fact that titanite (sphene) may be confounded with turnerite from general resemblance. In the fifth edition of his Mineralogy (American edition, Boston, 1844) Phillips says that monazite is occasionally known among mineralogists under the name of "pictite," which is one of the early names for titanite, with which it was doubtless confounded.

The date 1823, then, may be taken as that of the earliest recognition of a new mineral species which was later shown to be identical with monazite. Thus, in 1866, J. D. Dana[1] demonstrated the identity of turnerite and monazite by similarity of crystal form and physical properties. No chemical examination of turnerite had yet been made at that time. In 1870 this was substantiated by G. vom Rath,[2] and although he recognized the priority of Levy's name, turnerite, he did not feel justified in abandoning the name monazite, inasmuch as the latter belonged to a chemically as well as a crystallographically known mineral, while the composition of turnerite was not yet so well known. In 1873 Des Cloizeaux,[3] by the orientation of the optical axes, and Pisani,[3] by the chemical determination of P^3O^4 and Ce^5O^6, concluded that monazite and turnerite were the same species. In 1876 Trechmann[4] showed that the optical properties of turnerite and monazite were the same. In 1826 Menge discovered some crystals in the Ilmen Mountains, near Miask, Siberia, which he held for a variety of zircon. Fiedler[5] gives the more exact locality of these specimens as being not in the Ilmen Mountains proper, but in their southern extension, in the so-called Tscheremtchanka. The first scientific description of these was given by Breithaupt[6] in 1829. He gave it the name, "monazite" (monazit, monacite), from the Greek, meaning "to be solitary." In 1831 H. J. Brooke,[7] in describing specimens from Menge's locality in the Urals, gave the name mengite, in honor of the discoverer.

Prof. C. U. Shepard[8] in 1837 gave a description of "edwardsite," a new mineral from Norwich, Conn., which he named in honor of the governor of the State. Later in the year[9] he described another new mineral from Watertown, Conn., under the name of "eremite," after the Greek, meaning "solitude," but he did not then recognize its identity with edwardsite. Prof. J. D. Dana published in 1838 his crystallographic measurements of eremite, which agree with those of monazite.[10] In 1840 Gustav Rose[11] proved the identity, crystallographically and

[1] Am. Jour. Sci., vol. 42, 1866, p. 420.
[2] Poggendorff, Annalen, Erg.-Bd. 5. 1871, p. 413; Sitzungsber. Bayer, Akad. Wiss., 1870, vol. 2. p. 271.
[3] Zeitschr. Deutsch. geol. Gesell., Berlin. Vol. XXV, 1873, p. 568.
[4] Neues Jahrbuch, 1876, p. 593.
[5] Poggendorff, Annalen, 1832, vol. 25, p. 332.
[6] Schweigger-Seidel, Journal der Chemie u. Physik, 1829, vol. 55, part 3, p. 301.
[7] Poggendorff, Annalen, 1831, vol. 23, p. 362, Philos. Mag. and Annals, vol. 10, p. 187.
[8] Am. Jour. Sci. (1), 1837, vol. 32, p. 162; Poggendorff, Annalen, 1838, vol. 43, p. 148.
[9] Am. Jour. Sci. (1), 1837, vol. 32, p. 341.
[10] Am. Jour. Sci. (1), vol. 33, 1838, p. 70.
[11] Poggendorff, Annalen, 1840, vol. 49. p. 223.

physically, of edwardsite and monazite. And in the second edition of his Mineralogy (1844) Shepard places both edwardsite and eremite under the head of monazite.

In 1842 Rose[1] gave a detailed description of the Russian monazite.

Woehler,[2] in 1846, discovered some small needle-like crystals invisibly included in the apatite of Arendal, Norway. They were of a pale-yellow color, specific gravity approximately 4.6, and, according to analysis, were composed of phospate of cerium, but contained no thoria, and in this he distinguished the mineral from monazite, calling it "cryptolite," from the Greek, meaning "concealed." Although the forms of these crystals are different in appearance from that of ordinary monazite, Mallard,[3] in 1887, by careful goniometric measurements, established the identity of the two minerals.

Hermann,[4] in 1847, applied the name "monazitoid" to certain brown colored bent and broken crystals, of the specific gravity 5.28, from Lake Ilmen, near Miask, which contain less phosphoric acid (only 18.7) than monazite, besides some tantalic acid (3.75 to 6.27 per cent). Kokscharow[5] believed that monazitoid was simply impure monazite, the tantalic acid having been derived from columbite and samarskite, with which the crystals are intergrown.

Blomstrand[6] analyzed specimens from probably the same locality as Hermann's monazitoid, but found no tantalic acid.

In 1850 Watts[7] described a new mineral occurring in the cobalt ore of Johannisberg, Sweden, which he showed to be a phosphate of cerium (including lanthanum and didymium). He proposed the name "phospho-cerite." Its physical and chemical characters identify it beyond doubt with monazite.

Forbes and Dahll,[8] in 1855, described a mineral occurring in the granite of Urda, near Nötterö, Norway, under the name of "urdite," which E. Zschau[9] determined to be monazite.

F. Radominski,[10] in 1874, found a mineral inclosed in albite at Kararfvet, near Falun, Sweden, which resembled monazite, but on analysis was found to contain a notable quantity of fluorine (4.35 per cent), and for that reason he proposed to class it as a separate species under the name "kararfveite." Blomstrand[11] made an analysis of specimens from the same locality, and found only 0.33 per cent fluorine. He concluded that it was but an impure form of monazite.

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[1] Reise nach dem Ural und Altai, Vol. II, pp. 87 and 482, Berlin, 1842.

[2] Poggendorff, Annalen, 1846, vol. 67, p. 424.

[3] Bull. Soc. Min., 1887, vol. 10, p. 236.

[4] Jour. prakt. Chemie, Vol. XL, 1847. p. 21; Annuaire de Chimie, 1848, p. 146.

[5] Materialien zur Mineralogie Russlands, Vol. IV, 1862, p. 7–34.

[6] Zeitschr. für Kryst., vol. 20, 1892, p. 367; Lunds Universitets Årskrift, 1888 (24).

[7] Quart. Jour. Chem. Soc. London, 1850, Vol, II, p. 131.

[8] Nyt Mag. Naturvidenskaberne, vol. 8, 1885, p. 227; Am. Jour. Sci., vol. 22, 1856, p. 262.

[9] Allg. deutsche naturh. Zeitung, Dresden, 1857, p. 208; Am. Jour. Sci., II, vol. 25, 1858, p. 410.

[10] Compt. Rend., 1874, vol. 78, p. 764.

[11] Zeitsch. für Kryst., Vol. XIX, 1891, p. 109; Geol. Föreningens Förhandl. Stockholm, 1889, Vol. II, p. 174.

CRYSTALLOGRAPHY.

MORPHOLOGICAL.

The primary form of monazite and its equivalents, turnerite, edwardsite, and mengite, was early stated to be the oblique rhombic prism of the monoclinic system. The crystallographic studies of the mineral by Koksharow, Des Cloizeaux, Websky, Dana, Vom Rath, and others have shown the occurrence of the following forms:

Observed forms of monazite.

Pinacoids.	Prisms.	Hemi-domes.	Hemi-pyramids.
$0P$	∞P	$+P\bar{\infty}$	$+P$
$\infty P\bar{\infty}$	$\infty P\bar{2}$	$-P\bar{\infty}$	$-P$
$\infty P\grave{\infty}$	$\infty P\bar{3}$	$-7P\bar{\infty}$	$+\frac{1}{2}P$
	$\infty P\grave{2}$	$-\frac{3}{5}P\bar{\infty}$	$-\frac{1}{2}P$
		$P\grave{\infty}$	$+P\bar{2}$
		$2P\grave{\infty}$	$+2P2$
		$\frac{1}{2}P\grave{\infty}$	$+3P\bar{3}$
			$+2P\grave{2}$
			$-2P\grave{2}$

Of these, the more common forms are the ortho- and clino-pinacoids and domes, the unit prism, and the unit pyramids. The basal pinacoid is rare, having been observed only on crystals from the Urals[1] and from Alexander County, N. C.[2]

Among the rarer forms are: $-\frac{3}{5}P\bar{\infty}$, found by Trechmann on turnerite from the Binnenthal, Switzerland; $-7P\bar{\infty}$ and $-\frac{1}{2}P$, found by Miers in Cornwall; and $\frac{1}{2}P\grave{\infty}$, on crystals from Nil St. Vincent, Belgium, and western Siberia.

The usual crystal habit is tabular, parallel to $\infty P\bar{\infty}$; also short columnar, and sometimes elongated parallel to ∞P. Cryptolite occurs always in very small crystals, elongated parallel to ∞P. The crystals are usually well developed and free from distortion. They vary in size from the microscopic needles of cryptolite, which have a thickness of .004 to .016 mm. (0.00015 to 0.00062 inch), to the abnormally large monazite crystals that have been found in Amelia County, Va., 5 inches in length. The more general variation lies between one-twentieth and 1 inch. Irregular masses of monazite, devoid of crystal planes, as large as 15 to 20 pounds, have been found in Amelia County, Va., and in rounded masses up to $12\frac{1}{4}$ pounds at the Villeneuve mica mine in Ottawa County, Quebec.

Twins are not common. The twinning plane is parallel to $\infty P\bar{\infty}$; also to $0P$ (Zirkel, Vol. I, p. 432.) Twins are sometimes cruciform.

The axial ratio has been determined on specimens from different localities, as follows:

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[1] N. von Koksharow, Materialien zur Mineralogie Russlands, Vol. IV, 1862, pp. 7-34.

[2] G. vom Rath, Zeitschr. für Kryst., Vol. XIII, 1888, p. 596.

Axial ratios of monazite from various localities.

$\breve{a}$	$\bar{b}$	$\acute{c}$	$\beta(0P \wedge \infty P \bar{\infty})$	Localities.	Determined by—
			° ′		
0.9742	1	0.9227	103 46	Watertown, Conn. (eremite)	J. D. Dana.
0.9705	1	0.9221	103 46	Ural Mountains, Sanarka	Koksharow.
0.9658	1	0.9217	103 28	Laacher See (turnerite)	Vom Rath.
0.9609	1	0.9081	103 26½	Hiddenite mine, N. C	Do.
0.9693	1	0.9255	103 40	Milhollands Mill, N. C	E. S. Dana.
0.9735	1	0.9254	103 37	Schüttenhofen, Bohemia	Scharizer.
0.9718	1	0.9233	103 42	Nil St. Vincent	Franck.

Some of the principal angular measurements are :

Angular measurements of monazite.

$\infty P \bar{\infty} \wedge 0P$	$0P \wedge P \bar{\infty}$	$\infty P \bar{\infty} \wedge 0P$	$\infty P \breve{\infty} \wedge P$	$\infty P \bar{\infty} \wedge P \bar{\infty}$	Localities.	Measured by—
° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″		
43 25 0	....	76 14 0	....	39 20 0	Watertown, Conn. (eremite).	J. D. Dana.
43 18 30	37 11 0	76 14 0	59 37 0	39 03 0	Ural Mountains, Sanarka.	Koksharow.
43 12 30	37 12 30	76 32 0	59 42 30	39 20 30	Laacher See (turnerite).	Vom Rath.
43 17 10	37 07 40	76 20 0	59 40 0	39 12 30	Milhollands Mill, N. C.	E. S. Dana.
43 25 0	37 03 0	76 23 0	59 36 0	39 20 0	Schüttenhofen, Bohemia.	Scharizer.

PHYSICAL CRYSTALLOGRAPHY.

The cleavage is most perfectly developed parallel to the basal pinacoid (0P); it is also distinct as a rule parallel to $\infty P \bar{\infty}$; sometimes parallel to $\infty P \breve{\infty}$, imperfect; parallel to $-P\bar{\infty}$ (noticed by vom Rath on turnerite from Laacher See[1]). Parting sometimes developed parallel to 0P and ∞ P. Brittle with a conchoidal to uneven fracture. The hardness is 5 to 5.5. Specific gravity varies from 4.64 to 5.3. The luster is resinous to waxy. Crystal face, splendent in fresh, pure specimens; dull in weathered, impure specimens. The color is honey yellow, yellowish brown, amber brown, reddish brown, brown or greenish yellow. Derby[2] describes specimens of *lusterless*, *whitish* grains in muscovite granite of São Paulo, Brazil, which he proved to be cerium phosphate.

The monazitoid of Hermann is of a dark-brown color, due to impurities. In weathered specimens of impure monazite the surface is rough, dull, and sometimes covered with a light-brown earthy substance.

The purest specimens of monazite are transparent, becoming translucent and even totally opaque in the impure varieties.

It is frequently difficult to distinguish monazite, in fine grains, from certain other minerals by the uninitiated eye. Some varieties of yellowish-brown quartz are quite easily confounded with monazite; so also, at times, sphene, zircon, epidote, corundum, etc. For the benefit of the unscientific prospector it may be stated that the chief macroscopic dis-

[1] Poggendorff, Annalen, 1871, Erg.-Bd. 5, p. 413; Sitzungsber. Bayer. Akad. Wiss. 1870, vol. 2, p. 271.
[2] Am. Jour. Sci. (3), vol. 37, 1889, p. 109-114.

tinctions are those of color, hardness, and specific gravity. The color is usually yellowish, inclined to reddish, brownish, or more rarely greenish tints. The fresh unaltered grains are transparent or translucent. The larger crystals are frequently dull in luster and opaque.

The hardness is from 5 to 5.5, between that of apatite and orthoclase (feldspar). Thus it can be scratched by a fragment of ordinary feldspar (hardness 6) or quartz (hardness 7). The hardness of sphene is 5 to 5.5, of zircon 7.5, of epidote 6 to 7, of corundum 9. The specific gravity of monazite is 4.64 to 5.3, that of quartz is only 2.6, of sphene 3.5, of zircon 4.7, of epidote 3.25 to 3.5, of corundum 3.95 to 4.10.

OPTICAL CRYSTALLOGRAPHY.

Thin sections, by transmitted light, are colorless to yellowish. Pleochroism generally scarcely noticeable. Absorption $\mathfrak{b} > \mathfrak{c} = \mathfrak{a}$. The plane of the optic axes is perpendicular to the plane of symmetry $\infty P \grave{\infty}$. The positive acute bisectrix lies in the obtuse angle β; hence sections parallel to 0P show the full interference figure.

Optical measurements of monazite.

$b=\mathfrak{b}$	Localities.	Measured by—
° ′		
$\acute{c} \wedge \mathfrak{c}$ = 1 04	(Turnerite) Tavetsch, Switzerland	Trechmann.
= 3 00	Arendal, Norway	Wülfing.
= 3 46	Norwich, Connecticut	Des Cloizeaux.
= 5 54	Schüttenhofen, Bohemia	Scharizer.

The optical angle is small; various measurements give:

Optical measurements of monazite.

2 E (red).	2 E (yellow).	2 E (violet).	2 V (red).	2 V (yellow).	Dispersion.	Localities, etc.
° ′	° ′	° ′	° ′	° ′		
29 04	....	28 48	....	....	$\rho > v$	Norwich, Conn., Des Cloizeaux.
31 08½	....	31 43½	....	....	$\rho < v$	Sibera, Des Cloizeaux.
25 22	24 56	....	....	12 44	$\rho > v$	Schüttenhofen, Bohemia, Scharizer.
29 07	28 25	....	14 50	14 29	....	Pisek, Bohemia, Urba.
34 12	....	....	....	....	$\rho < v$	Turnerite, Tavetsch, Trechmann.

The dispersion is weak and horizontal. The single refraction is high; double refraction considerable.

Optical measurements.

α	β	γ	$\gamma - \alpha$	$\gamma - \beta$	$\beta - \alpha$	Localities, etc.
1.9285	1.9465	....	....	....	....	Schüttenhofen, Bohemia, Scharizer.
1.7957	1.7965	1.8411	0.0454	0.0446	0.0008	Arendal, Norway, E. Wülfing.

CHEMICAL COMPOSITION.

COMPOSITION AND ANALYSES.

The earlier discoverers had very little knowledge of the true chemical composition of monazite. Breithaupt,[1] in 1829, concluded from the high specific gravity of the Siberian monazite that it was a metallic oxide or acid in combination with some of the earths. Shepard[2] stated in 1835 that monazite was inferred to consist of the oxide of uranium with some one or more of the earths (according to blowpipe tests of Breithaupt). At the same time turnerite, according to blowpipe experiments of Mr. Children, was supposed to contain chiefly Al_2O_3, CaO, MgO, and a little iron, with traces of SiO_2. In 1837 Shepard published an analysis of his edwardsite (see table, anal. No. 29), in which he first pointed out the existence of cerium. He deduced the relationship P_2O_5: CeO = 1: 1½, making the mineral a basic sesqui-phosphate of cerium protoxide. He also found 7.77 per cent ZrO_2, but it is doubtful whether this is an original constituent; more probably it may be referred to the presence of the mineral zircon as an impurity in the sample, which is an almost constant accompaniment of monazite. He found further Al_2O_3, SiO_2, FeO, MgO, and a trace of glucina.

Kersten,[3] in 1839, analyzed the specimens from the Ural Mountains, previously determined by Breithaupt to be a combination of uranium oxide with some of the earths, but found no trace of uranium. He did find it to be essentially a phosphate of cerium and lanthanum oxides, and was the first to show the presence of La_2O_3, ThO_2, SnO_2, MnO, CaO, and traces of TiO_2 and K_2O. (See table, anal. No. 20.)

In 1846 Woehler[4] published an analysis of cryptolite from Arendal, Norway, determining it to be a phosphate of cerium oxide. (See table, anal. No. 21.) He could find neither ZrO_2 nor ThO_2, from which he concluded that the absence of ThO_2 distinguished cryptolite from monazite and edwardsite.

In 1847 Hermann[5] came to the conclusion that monazite was the neutral phosphate of cerium, in which a large part of the cerium was replaced by lanthanum and a small part by CaO, MgO, and MnO in the varieties of lighter specific gravity, while the heavier varieties (sp. gr. 5.281) contained less P_2O_5, and a large part of the stannic acid was replaced by tantalic acid (Ta_2O_5). (See table, anal. No. 17.) This variety he called monazitoid, which occurs at Lake Ilmen, near Miask, Siberia. It is of a dark brown color as distinguished from the lighter color of monazite. At first Hermann denied the presence of thoria in monazite and monazitoid, but later he found as high as 32.44

[1] Schweigger-Seidel, vol. 55, 1829.
[2] Treatise on Mineralogy, 1st edition, vol. 2, 1835.
[3] Poggendorff, Annalen, vol. 47, 1839, p. 385.
[4] Poggendorff, Annalen, vol. 67, 1846, p. 424.
[5] Jour. prakt. Chemie, vol. 40, 1847, p. 21.

per cent ThO_2 in a specimen. (See table, anal. No. 19.) Monazite and monazitoid, he says, have the same form, and are therefore heteromeric, having different composition. Like all heteromeric minerals they show a tendency to mix, and thus give a series with slight difference in specific gravity. Koksharow[1] believed that monazitoid was simply an impure variety of monazite, where the tantalic acid was derived from columbite and samarskite, in which the crystals of monazitoid were intergrown, and this appears most probable. Blomstrand[2], in his analysis of specimens from the Ilmen Mountains (same locality as Hermann's monazitoid), found 16.64 per cent ThO_2, but no tantalic acid. (See table, anal. No. 15.)

In 1850 Watts[3] published an analysis of his phosphocerite, which he determined to be a phosphate of cerium protoxide, including lanthanum and didymium.

Websky,[4] in 1865, in making blowpipe tests on monazite from the Riesengebirge, found cerium, phosphoric acid, and titanic iron; the latter, however, must have been an impurity in the powder, probably from the ilmenite, which is mentioned as occurring as an associated mineral in this locality.

Radominsky's variety of monazite, kararfveite, from Sweden, was found by him to contain 4.33 per cent fluorine.[5] (See table, anal. No. 16.) Blomstrand's analysis of a specimen from the same locality showed only 0.33 per cent fluorine. (See table, anal. No. 11), and he concluded that the so-called kararfveite was simply an impure variety of monazite.

Scharizer[6] first pointed out, in 1887, the presence of an element of the erbium group in the monazite from Schüttenhofen, Bohemia. His determination was made on a thin section by means of a spectroscopic attachment to the microscope.

Genth,[7] in 1889, published an analysis of monazite from the Villeneuve mica mine in Canada, in which he determined 4.76 per cent of $(Y, Er)_2 O_3$. (See table, analysis No. 37.)

Blomstrand,[8] in 1889, also showed the presence of yttrium in the monazite from southern Norway; and he first pointed out here the presence of lead oxide.

Below is given a table containing a number of analyses of monazite from various localities, with references:

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[1] Materialien zur Mineralogie Russlands, vol. 4, 1892, pp. 7–34.

[2] Zeitschr. für Kryst., vol. 20, 1892, p. 367.

[3] Quart. Jour. Chem. Soc. London, vol. 2, 1850, p. 131.

[4] Zeitschr. Deutsch geol. Gesell., Berlin, vol. 17, 1865, p. 567.

[5] Compte Rendu, vol. 78, 1874, p. 764.

[6] Zeitschr. für Kryst., vol. 12, 1887, p. 255.

[7] Am. Jour. Sci., vol. 38, 1889, p. 203; Zeitschr. für Kryst., vol. 19, 1891, p. 88.

[8] Zeitschr. für Kryst., vol. 15, 1889, p. 99; Geol. Föreningens, Förhandl., Stockholm, vol. 9, 1887, p. 160.

Analyses of monazite from various localities.

[Per cent.]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
P_2O_5	28.62	29.41	27.07	26.37	28.27	27.99	27.55	28.94	23.85	27.28	25.56	26.59	27.32	25.09	19.13	27.38	17.94	28.05	28.15
Ce_2O_3	32.52	36.63	25.82	31.23	28.06	30.98	29.20	30.58	27.73	30.46	37.92	29.62	31.31	34.90	22.88	}	*a* 49.35	*a* 37.36	} 35.85
La_2O_3	29.41	26.78	30.62	24.51	29.60	25.88	26.26	29.21	21.96	24.37	20.76	26.43	31.86	17.60	14.69	} 67.40	21.30	27.41	}
Di_2O_3																}			
Y_2O_3	2.04	1.81	2.03	1.83	1.82	2.76	3.82	.78	2.86	1.58	.83	2.54	.52	.43	1.71				
ThO_2	4.54	3.81	9.60	9.20	9.34	9.03	9.57	7.14	9.05	11.57	8.31	10.39	5.55	17.82	16.64				32.45
SiO_2	1.51	.93	1.85	2.10	1.65	1.58	1.86	1.32	5.95	2.02	2.48	2.16	1.37	2.90	9.67				
Al_2O_3	.22	.12	.15		.16			.18			.41		.13		2.90				
Fe_2O_3	.36	.33	1.01	1.97	.66	1.25	1.13	.42	4.63				.26	.43		.32	Tr.		
FeO										1.10	.36	.75			3.56				
MnO			.08	.28						.24					4.89				
CaO	.84	.34	.91	.93	.53	.55	.69	1.19	4.83	1.05	1.17	.88	.55	.36	1.25	1.24	1.50	1.46	1.55
MgO			.03	.16											.40	Tr.	Tr.	.80	
ZrO_2									.66										
SnO_2	.22	.09		.21						.08	.13		.95	.43	.40			1.75	Tr.
PbO			.58					.33		.26	.34	.31							
F											.33					4.35			
Ta_2O_5																	6.27		
TiO_2																			
H_2O	.27	.18	.35	1.53	.21	.20	.52	.09	1.61	.38	1.65	.52	.41	.56	.71	Some.	1.36		1.50

a CeO.

1 to 10, inclusive. From pegmatite veins of southern Norway, by C. W. Blomstrand, Geol. Föreningens Förhandl., Stockholm, 1887, vol. 9, p. 160; Zeitschr. für Kryst., vol. 15, 1889, p. 99.
11. From Kararfvet, Sweden, by C. W. Blomstrand.
12. From Holma, Sweden, by C. W. Blomstrand, Geol. Föreningens Förhandl., Stockholm, 1889, vol. 11, p. 171; Zeitschr. für Kryst., 1891, vol. 19, p. 109.
13 to 15, inclusive. From Ilmen Mountains, by C. W. Blomstrand, Lunds Universitets Årskrift, 1888, vol. 24; Zeitschr. für Kryst., 1892, vol. 20, p. 367.
16. From Kararfvet, Sweden, by F. Radominski, Compte Rendu, 1874, vol. 78, p. 764.
17. Monazitoid from Lake Ilmen, Miask, by R. Hermann, Jour. prakt. Chemie, 1847, vol. 40, p. 21.
18. From Ilmen Mountains, Siberia, by R. Hermann, Kok., Materialien zur Mineralog. Russ., vol. 4, 1862; Rammelsberg's Handbuch d. min. Chemie, 2d ed., 1875, p. 305.
19. Rammelsberg's Handbuch d. min. Chemie, 2d ed., 1875, p. 305.

Analyses of monazite from various localities—Continued.

[Per cent.]

	20	21	22	23	24	25	26	27	28
P_2O_5	28.50	27.37	28.78	29.66	28.40	25.09	24.61	29.10	28.70
Ce_2O_3	26.00		27.73		59.1	36.64		*a* 46.14	31.30
La_2O_3	23.40	73.70	39.24	67.38	8.9	30.21		24.5	39.9
Di_2O_3							68.08		
Y_2O_3									
ThO_2	17.95					1.23			
SiO_2			1.60			3.21			
Al_2O_3						3.11			
Fe_2O_3			1.30	*b* 2.95					
FeO		1.51							
MnO	1.86					Tr.			
CaO	1.68		.90						
MgO						Tr.			
ZrO_2									
SnO_2	2.10								
PbO									
F									
Ta_2O_5									
TiO_2	*c* Tr.								
H_2O									

	29	30	31	32	33	34	35	36	37
P_2O_5	26.66	28.18	29.28	26.12	29.32	26.05		26.95	26.86
Ce_2O_3	*a* 56.53	33.54	31.38	29.89	37.26				24.80
La_2O_3		28.33	30.88	26.66	31.60				26.41
Di_2O_3						73.82		64.45	
Y_2O_3									*d* 4.76
ThO_2		8.25	6.49	14.23	1.48		18.6		12.60
SiO_2	3.33	1.67	1.40	2.85	.32		2.7	5.85	.91
Al_2O_3	4.44								
Fe_2O_3	Tr.								1.07
FeO									
MnO									
CaO									1.54
MgO	Tr.								.04
ZrO_2	7.77								
SnO_2									
PbO									
F									
Ta_2O_5									
TiO_2									
H_2O		.37	.20	.67	.17	.45		.91	.78

a CeO. *b* Fe_3O_4. *c* $TiO_2 + K_2O$. *d* $Y_2O_3 + Er_2O_3$.

20. From Ilmen Mountains, near Miask, by C. Kersten, Poggendorff, Annalen, vol. 47, 1839, p. 385.
21. Cryptolite from Arendal, Norway, by F. Woehler, Poggendorff, Annalen, 1846, vol. 67, p. 424.
22. Monazite from Arendal, by C. F. Rammelsberg, Zeitschr. Deutsch. geol. Gesell., Berlin, 1877, vol. 29, p. 79; Zeitschr. für Kryst., 1879, vol. 3, p. 101.
23. From Johannisberg, Sweden, by H. Watts, Quart. Jour. Chem. Soc. London, 1850, vol. 2, p. 131.
24. Turnerite from Luzerne, by F. Pisani, Zeitschr. für Kryst., 1877, vol. 1, p. 405.
25 to 26, inclusive. From county of Gough, New South Wales, by A. Liversidge, Zeitschr. für Kryst., 1884, vol. 8, p. 87.
27. From Antioquia, New Granada, by Damour, Ann. Chem. Phys. (3), vol. 51, p. 445.
28. From Caravellas, Brazil, by H. Gorceix, Zeitschr. für Kryst., 1887, vol. 12, p. 643.
29. Edwardsite from Norwich, Conn., by C. U. Shepard, Am. Jour. Sci., 1837, vol. 32, p. 162; Poggendorff, Annalen, 1838, vol. 43, p. 148.
30. From Portland, Conn., by S. L. Penfield, Am. Jour. Sci., vol. 24, 1882, p. 250; Zeitschr. für Kryst., vol. 7, 1883, p. 366.
31. From Burke County, N. C., by S. L. Penfield, Am. Jour. Sci., vol. 24, 1882, p. 250; Zeitschr. für Kryst., vol. 7, 1883, p. 366.
32. From Amelia County, Va., by S. L. Penfield, Am. Jour. Sci., vol. 24, 1882, p. 250; Zeitschr. für Kryst., vol. 7, 1883, p. 366.
33. From Alexander County, N. C., by Penfield and Sperry, Am. Jour. Sci., vol. 36, 1888, p. 322; Zeitschr. für Kryst., vol. 17, 1890, p. 407.
34. From Amelia County, Va., by G. A. König, Proc. Acad. Nat. Sci. Phila., 1882, p. 15; Zeitschr. für Kryst., vol. 7, 1883, p. 423.
35. From Amelia County, Va., by F. P. Dunnington, Am. Jour. Sci., vol. 24, 1882, p. 153; Zeitschr. für Kryst., vol. 7, 1883, p. 423.
36. From Ottawa County, Quebec, by G. C. Hoffmann, Am. Jour. Sci., vol. 34, 1887, p. 73; Zeitschr. für Kryst., vol. 15, 1889, p. 127.
37. From Ottawa County, Quebec, by F. A. Genth, Am. Jour. Sci., vol. 38, 1889, p. 203; Zeitschr. für Kryst., vol. 19, 1891, p. 88.

Below are also given the thoria contents of a number of samples from North Carolina, which were analyzed for the writer by Dr. Charles Baskerville, chemist of the North Carolina geological survey. These analyses are not made on the pure mineral, but on the commercial monazite sand, which contains up to about 67 per cent monazite, the remainder being quartz, garnet, zircon, and other accessory minerals.

Thoria contents of North Carolina monazite.

[Per cent.]

	1	2	3	4	5	6	7	8	9
ThO_2.......	0.175	0.225	2.15	2.25	0.40	6.54	0.125	0.29	2.48
	10	11	12	13	14	15	16	17	18
ThO_2.......	0.26	1.27	6.30	5.19	5.87	6.26	1.75	1.93	3.40

1. Bennett's Mill, Silver Creek, Burke County.
2. Northeast side Brindle Ridge, Burke County.
3. White Bank gold mine, Burke County.
4. Hall's Creek, at Morganton road crossing, Burke County.
5. Bailey's Mill Creek, 3 miles southwest of Glen Alpine Station, Burke County.
6. Linebacher place, Silver Creek, Burke County.
7. Mac Lewrath place, Silver Creek, Burke County.
8. East fork of Satterwhite Creek, Burke County.
9. Mac Lewrath Branch, McDowell County.
10. Bracket town, South Muddy Creek, McDowell County.
11. Long Branch, McDowell County.
12. Alexander Branch, McDowell County.
13. Daniel Peeler's farm, near Bellwood, Cleveland County.
14. Proctor's farm, near Bellwood, Cleveland County.
15. Wade McCurd's farm, Carpenter's Knob, Cleveland County.
16. Tailings from No. 15.
17. Henrietta, Rutherford County.
18. Fallston, Cleveland County.

METHOD OF ANALYSIS OF MONAZITE SAND.

The method of analysis employed by Dr. Baskerville is given below in his own words.[1] He claims only "approximate results, and absolute accuracy can not be vouched for." It is substantially the same as Prof. S. L. Penfield's methods[2] with a few modifications.

The pulverized sand, 2 grams, is weighed into a small flask holding about 100 c. c.; 10 c. c. H_2SO_4 (1:1) are added, and the whole cooked on a sand bath with frequent agitation, until the acid becomes concentrated and fumes arise. A small funnel is used in the neck of the flask to prevent loss by spitting and bubbling. It is allowed to cool, and if not completely decomposed, a fresh amount of H_2SO_4 is added, and the previous operation repeated. Add a little water, keeping the temperature down as well as possible. The insoluble silicates are removed by filtering and washing with cold water. The clear filtrate is diluted to 400 or 500 c. c., and an excess of oxalic acid added, whereby the oxalates of the cerium metals and thorium are precipitated.

[1] From a letter to the writer, March, 1895.
[2] Am. Jour. Sci. (3), vol. 24, 1882, p. 253.

This is done in the hot solution, allowing the same to boil a few moments after adding the oxalic acid. It is then allowed to remain in the cold for twelve hours, when it is filtered and washed with cold water.

The precipitated oxalates are ignited by heating slightly above faint redness. After all the carbon is burned off, the contents of the crucible are turned into a platinum or porcelain dish, washing the crucible with H_2SO_4 (1:1). On heating, the oxides are usually dissolved completely; the excess of H_2SO_4 is gotten rid of by gentle heat. To accomplish this, the disk is placed on a triangle inside of an iron dish to which the lamp flame is applied. The sulphates, which are almost invariably colored red, yellow, or orange, are dissolved in water. The whole mass is usually completely soluble in about 15 c. c. H_2O, but on further dilution a precipitate is formed. The solution is made up to 200 or 300 c. c., i. e., sufficient water is added to hold all the thorium sulphate in solution; it is then boiled and filtered. If the filtrate is acid, it is neutralized with NH_4OH, and the thorium is precipitated out by means of $Na_2S_2O_3$. The filtered precipitate is burned to ThO_2 and weighed as such in a platinum crucible.

CHEMICAL AND BLOWPIPE REACTIONS.

Monazite is with difficulty and incompletely soluble in hydrochloric acid. It is attacked completely by sulphuric acid, and by potassium acid sulphate. It is infusible before the blowpipe flame, turning gray. When moistened with H_2SO_4 it colors the flame bluish green (phosphorus reaction). The borax and salt of phosphorus beads are yellowish when hot, and colorless on cooling; the saturated borax bead becomes enamel white on flaming. Fused with soda, the mass treated with water and filtered, the residue dissolved in a little HCl, the solution gives with oxalic acid a precipitate, which on ignition becomes brick red (cerium oxide). With soda on charcoal a little tin is sometimes obtained.

MICRO-CHEMICAL REACTIONS.[1]

For cerium.—The dilute solutions of cerium sulphate or chloride give, with oxalic acid or ammonium oxalate, a precipitate, which is at first flocculent but soon becomes crystalline, being composed of fine, doubly terminated, often forked and serrated prisms; in more concentrated solutions these form themselves into radial groups. The little crystals have an oblique extinction and a high double refraction. In hot, very dilute solutions thin rhomboidal plates are precipitated, whose acute angle is about 86°; they have a tendency to form rectangular intergrowths, and appear to be monoclinic.

For phosphorus.—Phosphoric acid is precipitated in a solution of the sulphate by the addition of ammonium molybdate, which on drying gives little crystals resembling rhombic dodecahedrons, yellow in reflected and greenish in transmitted light.

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[1] H. Rosenbusch, Mikroscopische Physiographie, Vol. I., 3d ed., 1892, p. 266.

Derby[1] has found that these micro-chemical tests are the best means of identifying monazite.

SPECTROSCOPIC TESTS.

Scharizer[2] tested the absorption spectrum of a basal cleavage plate of the Shüttenhofen monazite by replacing the ocular of the microscope with a spectroscope à vision directe. The illumination was obtained by the reflection of direct sunlight from a concave mirror. The spectrum showed a broad absorption band in the yellow between the Fraunhofer lines C and D, corresponding to didymium, and a less broad one at the end of the green near the line F, corresponding to erbium.

CHEMICAL MOLECULAR CONSTITUTION OF MONAZITE.

Penfield,[3] in his analyses of Connecticut, North Carolina, and Virginia monazite (anal. Nos. 30, 31, 32, 33, at p. 675), deduces the relation

$$(Ce, La, Di)_2O_3 : P_2O_5 = 1:1$$
$$ThO_2 : SiO_2 = 1:1$$

The former corresponds to the normal phosphate of the cerium metals ($R_2P_2O_8$); the latter corresponds to that of normal thorium silicate, which, in combination with a small percentage of water, makes the mineral thorite or orangite ($ThSio_4H_2O$). He concludes, then, that monazite is essentially a normal phosphate of the cerium metals, in which thorium silicate is present in varying proportions as an impurity in the form of the mineral thorite or orangite.

Dunnington[4] had somewhat previously come to the same conclusion.

Rammelsberg's[5] formula of thorium-free monazite from Arendal, Norway, was $R^2P^2O^8 = (Ce, La, Di)_2P_2O_8$, thus agreeing with Penfield.

Blomstrand,[6] from his analyses of Norwegian and Siberian monazite (see anal. No. 1–10, 13–15, at p. 675), concludes that the mineral is a normal tribasic phosphate, an excess of bases being combined with SiO_2. Thus: $m\,(3RO, P_2O_5) + 2RO, SiO_2 + pH_2O$, where $m = 5$ to 20, and $p =$ less than 1 usually.

He does not believe, as Penfield does, that the thoria is originally combined with silica as thorite, but that it is a primary constituent, present as the phosphate, either in combination with the cerium or as an isomorphous mixture, thus:

$$\overset{IV}{Ce}.\overset{III}{Ce}\,(O_3PO)_2 \text{ and } \overset{\prime\prime}{R}\overset{IV}{Th}\,(O_3PO)_2;$$

and that it is altered to the silicate by siliceous waters.

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[1] Am. Jour. Sci. 3, vol. 37, 1889, p. 109–114. Zeitschr. für Kryst., vol. 19, 1891, p. 78.

[2] Zeitschr. für Kryst., vol. 12, 1887, p. 264.

[3] Am. Jour. Sci. (3), vol. 24, 1882, p. 250; vol. 36, 1888, p. 322. Zeitschr. für Kryst., vol. 7, 1883, p. 366; vol. 17, 1890, p. 407.

[4] Am. Chem Jour., vol. 4, 1882, p. 138.

[5] Zeitschr. Deutsch. geol., Gesell Berlin, vol. 29, 1877, p. 79. Zeitschr. für Kryst., vol. 3, 1879, p. 101.

[6] Zeitschr. für Kryst., vol. 9, 1887, p. 160; vol. 20, 1892, p. 367.

Rammelsberg[1] has explained the analyses of Kersten and Hermann (see anal. Nos. 19, 20, at p. 675), respectively, by the formulæ:

$$\left\{\begin{matrix} 5R^3P^2O^8 \\ Th^2P^2O^9 \end{matrix}\right\} \text{ and } \left\{\begin{matrix} 3R^3P^2O^8 \\ Th^3P^4O^{10} \end{matrix}\right\}$$

which does not, however, appear to express a constant molecular constitution.

ARTIFICIAL PRODUCTION OF MONAZITE.

In 1875 Radominsky[2] produced monazite artificially by treating a solution of impure cerium salt with sodium phosphate, adding an excess of chloride of cerium, and heating to redness. After cooling and crystallization, long yellow prisms with striated surfaces were formed. The specified gravity was 5.09, and the compound, by analysis, was found to agree in composition with that of the mineral monazite.

GEOLOGICAL AND GEOGRAPHICAL OCCURRENCE.

The following table presents the salient features of the geographical, geological, and mineralogical occurrences of monazite. All known localities at which the mineral monazite and its equivalents, turnerite, cryptolite, etc., have been found up to the present time are tabulated here. It is placed at the beginning of this chapter as a general introduction, and for the purpose of convenient reference, to what is to follow.

Conditions of occurrence of monazite.

Localities.	Country rocks.	Associated minerals.
UNITED STATES.		
East Blue Hill, Me	Gneiss	
Wakefield, N. H	do	Rutile, cassiterite.(?)
Westerly, R. I	Granite	
Narragansett Pier, R. I	do	
Westford, Mass	Gneiss	Xenotime.
Ayer, Mass	do	Zircon, rutile.
Norwich, Conn	do	Sillimanite.
Chester, Conn	do	Do.
Watertown, Conn	Granite	(In albite.) Apatite, zircon, tourmaline.
Portland, Conn		
Yorktown, N. Y		Sillimanite.
Amelia Court House, Va	Albitic granite	Microlite, amazonite, beryl, apatite, orthite, columbite, manganese tantalate.
Deake mica mine, Mitchell County, N. C.	Mica schist	Antunite, uraninite, gummite, garnet.
Ray mica mine, Yancey County, N. C.		(In orthoclase.) Beryl, garnet.
Mars Hill, Madison County, N. C.		
Boomer, Wilkes County, N. C		Quartz, garnet, zircon, rutile, magnetite, ilmenite.
Milholland's Mill, Alexander County, N. C.	Garnetif. Mica schist.	Rutile.
Emerald and hiddenite mine, Alexander County, N. C.		In quartz.
Burke, Rutherford, Cleveland, Polk, Catawba, and Lincoln counties, N. C.	In gneiss, and stream placers.	Quartz, garnet, zircon, rutile, brookite, xenotime, fergusonite, corundum, epidote, beryl, cyanite, magnetite, pyrite, menaccanite.

[1] Handbuch der mineral. Chemie, 1875, p. 305.
[2] Comptes Rendus, vol. 80, 1875, p. 304.

Conditions of occurrence of monazite—Continued.

Localities.	Country rocks.	Associated minerals.
UNITED STATES—continued.		
Crowders Mountain, Gaston County, N. C.	....	
Todd's Branch, Mecklenburg County, N. C.	Gold placers	Garnet, zircon, diamond.
Spartanburg County, S. C.	Gneiss, and stream placers.	Same as Burke, etc., Counties, N. C.
"The Glades," Hall County, Ga.	Gold placers	Quartz, rutile, garnet, etc.
CANADA.		
Villeneuve mica mine, Ottawa County, Quebec.	Pegmatite	Garnet, tourmaline, uraninite.
SOUTH AMERICA.		
Rio Chico, Antioquia, United States of Colombia.	Gold placers	
Alcobaca, Province of Bahia, Brazil.	Beach sands	
Caravellas, Province of Bahia, Brazil.	.....do	
Salabro, Province of Bahia, Brazil.	Diamond sands	Quartz, zircon, garnet, disthene, staurolite, corundum.
Province of Minas Geraes	.....do	Magnetite, ilmenite, pyrite.
Province of Minas Geraes, Rio de Janeiro, and Sao Paulo, Brazil.	Gold placers	
Province of Bahia, Minas Geraes, Rio de Janeiro, and São Paulo, Brazil.	Porphyritic, granulitic, and schistose gneisses, red syenite, granite dikes.	Apatite, magnetite, ilmenite, rutile, garnet, zircon, sillimanite.
Buenos Ayres, Argentine Republic.	River sands	Zircon.
Cordoba, Argentine Republic	Gneiss and granite	
ENGLAND.		
Cornwall	Clay slates	Quartz, albite.
SWEDEN.		
Holma	....	
Kararfvet	Albitic granite	Gadolinite, hjelmite, emerald.
Johannisberg	Cobalt ore	
NORWAY.		
Dillingsö, Moss, Lonnesby, Arendal, Narestoe, Hitteroe, Hvalö.	Pegmatite	
Arendal and Midbö	....	Cryptolite in apatite.
Nötterö	Granite	In feldspar, enveloped by orthite.
Helle	....	
FINNISH LAPMARK.		
Ivalo	Gold sands	Zircon.
RUSSIA.		
Ilmen Mountains	Albitic granite	Zircon, columbite, samarskite.
Sanarka River	Placers	
BELGIUM.		
Nil St. Vincent	....	
FRANCE.		
Le Puys, near St. Christophe, Dauphiné.	....	Adularia, crichtonite, sphene, anatase.
SWITZERLAND.		
Binnenthal	....	
Olivone, near Mte. Camperio	Quartz vein, traversing mica schist.	Rutile.
Tessin	....	
Perdatsch	....	
Santa Birgitta, near Ruaras, Tavetsch Valley.	....	

Conditions of occurrence of monazite—Continued.

Localities.	Country rocks.	Associated minerals.
GERMANY.		
Laacher See, near Coblentz	Druse in sanadine bomb.	
AUSTRIA.		
Josephinenhuette, Riesengebirge, Silesia.	Pegmatite	(In black mica.) Ilmenite, fergusonite, yttrium spar, zircon.
Schreiberhau, Silesia		Gadolinite, yttrium spar, xenotime, fergusonite.
Schüttenhofen, Bohemia	Pegmatite	Apatite.
Pisek, Bohemia		In beryl and feldspar.
AUSTRALIA.		
Vegetable Creek, County Gough, New South Wales.		

Monazite is an accessory constituent of the granitic eruptives and their derived gneisses. It has been found in these rocks over widely separated areas of the earth's surface, and further search and study is liable to reveal its probable universal presence, in varying proportions, in all granites and granite gneisses. Thus Derby[1] has found monazite as a constant accessory constituent in the porphyritic, granulitic, and schistose gneisses of the provinces of Bahia, Minas Geraes, Rio de Janeiro, and São Paulo, in Brazil, representing 300 miles along the axis of the great gneiss region of the Maritime Mountains. The granite dikes, intersecting the gneiss, also carry monazite.

The gneisses of the South Mountain region in North Carolina, covering an area of some 2,000 square miles, in Burke, McDowell, Rutherford, Cleveland, Polk, Catawba, Lincoln, and Gaston counties, and extending into Spartanburg County, S. C., have been shown to contain monazite.[2] I have since identified the mineral in the thin sections of several specimens of mica gneiss collected in that locality. The rocks are granitic mica gneisses, hornblende gneisses, which approach more nearly to diorite gneisses, and pegmatites.

Monazite has recently been found in Hall County, Ga., near The Glades, a postoffice about 10 miles northeast of Gainesville, on the north side of Chattahoochee River. It occurs in the gold placers of Flat Creek and its tributaries, the Glade, Stockeneter, Hamilton, and Huram branches.

Derby,[3] by examining the heavy residues of a number of hand specimens, selected at random from the collection in the National Museum, of Washington, D. C., described the occurrence of monazite in certain granites and gneisses of Maine, New Hampshire, Rhode Island, and Massachusetts.

The monazite of Chester, Portland, and Watertown, Conn., is an accessory constituent of the granites and gneisses. In Amelia County, Va., it is found in albitic granite; also in the Ilmen Mountains of Russia.

[1] Am. Jour. Sci., vol. 37, 1889, pp. 109-114.
[2] Trans. Am. Inst. Min. Engr., Mar., 1895.
[3] Proc. Rochester Acad. Sci., vol. 1, 1891, pp. 204-206.

The pegmatites of southern Norway, Silesia, and Bohemia, and of some of the mica mines in Canada and North Carolina, also contain monazite.

Derby (in paper above cited) has found monazite in a red syenite at Serra do Stauba, in the province of Bahia, Brazil. The basic eruptives (diabase, quartz-diorite, mica-diorite, and minette) thus far examined by him in Brazil showed no traces of monazite.

The turnerite of the Laacher See (which is an extinct volcanic crater), near Coblentz, in Prussia, was found in a druse of a sanadine bomb, the only known occurrence of monazite in an undoubted volcanic rock.[1] It was grown into and upon a crystal of orthite.

The turnerite of Olivone, Switzerland, occurs in a quartz vein, 20 to 30 cm. thick, traversing crystalline schists.[2] The percentage of monazite in these rocks is exceedingly small, often infinitesimal; thus Derby (in paper above cited) states that the granite dikes in the gneiss of Serra de Tingua, near Rio, are rich in the yellow mineral, carrying 0.02 to 0.03 per cent, and a fine-grained granite dike on the outskirts of Rio de Janeiro showed 0.07 per cent monazite.

The cryptolite of Norway occurs as inclusions of very fine, needle-shaped crystals in apatite.

While making a reconnoissance trip through the North Carolina region the writer, in company with Messrs. H. A. J. Wilkens, M. E., and John R. Kirksey, discovered on June 19, 1895, the interesting and, so far as known, new occurrence of monazite in cyanite. The locality where first observed was at the Peeler and Ivester placers on a branch of Knob Creek, about 16 miles north of Shelby, in Cleveland County, N. C. Numerous fragments of a light blue-gray cyanite, usually less than 1 inch, but occasionally as large as 3 inches in longest dimension, were found in the tailing dumps from the bottom gravels that had been washed in the sluice boxes. The fragments of pure cyanite contained intimately intergrown crystals of monazite, the latter constituting as much as 50 per cent of the mass at times, though some pieces of the cyanite were practically barren. The bed rock and outcropping ledges near here were carefully examined in the hope of finding the original source of this monazite-bearing cyanite, but without success. It probably occurs in irregular nests and veinlets through the pegmatitic mica gneiss which forms the country rock.

Derby thinks (in paper above cited) that there is "a reasonable probability that zircon, and to a less degree monazite, may prove to be guide minerals by which eruptives and their derivatives can be certainly identified, no matter what degree of alteration they may have suffered."

Monazite has not been found in the sedimentary rocks, although it may be present in some of these as a secondary mineral of transportation.

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[1] G. vom Rath., Poggendorff, Annalen, 1871, Erg.-Bd., 5, p. 413.

[2] G. Seligman, Zeitschr. für Kryst., vol. 9, 1884, p. 420.

The economically valuable deposits of monazite are found in the placer sands of streams and rivers, and even in the irregular sedimentary sand deposits of old stream beds and bottoms. The decomposition and disintegration of the crystalline rocks, the original source of the mineral, has proceeded to considerable depths, particularly in the southern, unglaciated countries. By erosion and secular movement the material is deposited in the stream beds and there undergoes a natural process of sorting and concentration, the heavy minerals being deposited first and together. The richer portions of these stream deposits are thus found near the head waters. Such deposits have been described from North and South Carolina in the United States, from Brazil, and from the Sanarka River, in Russia.

The beach sand deposits along the coast of Brazil, in the province of Bahia, have a similar explanation, the concentration there being brought about by the action of the waves.

ACCESSORY MINERALS.

The main constituent of the granitic rocks (quartz, feldspar, and mica) all contain the monazite as intergrowths, though it appears to be more generally confined to the feldspar.

Zircon may be regarded as a constant associate; in fact, it is even a more important and generally accessory constituent of the rocks than monazite. Among the other usual associated minerals, of coeval origin with the monazite, are xenotime, fergusonite, sphene, rutile, brookite, ilmenite, cassiterite, magnetite, and apatite; sometimes beryl, tourmaline, cyanite, corundum, columbite, samarskite, uraninite, gummite, autunite, gadolinite, hjelmite, and orthite.

The association of monazite with orthite, gadolinite, samarskite, uraninite, and hjelmite is interesting as suggesting the possibility of some genetic relationship.

Among the principal secondary and metamorphic minerals found in association with monazite are rutile, brookite, anatase, epidote, orthite, garnet, sillimanite, and staurolite.

ECONOMIC USE.

The economic value of monazite lies in the incandescent properties of the oxides of the rare earths—cerium, lanthanum, didymium, and thorium—which it contains. These are utilized, principally the thoria, together with limited quantities of the lanthanum and didymium, in the manufacture of the Welsbach and other incandescent gaslights. The cerium goes to the drug trade as the oxalate.

The Welsbach light consists of a cylindrical hood or mantle composed of a fibrous network of the rare earths, the top of which is drawn together and held by a loop of platinum wire. It is permanently suspended over the flame of a specially-devised burner, constructed on the principles of the Bunsen burner, in which the gas is burned with the access of air, thus utilizing the heating and not the illuminating power of the hydrocarbons. The mantle becomes incandescent, glowing with a brilliant and uniform light.

The method of manufacturing this mantle is in brief as follows: A cylindrical network, about 1½ inches in diameter, is woven out of the best and strongest cotton thread. This is first washed in ammonia and then in warm water, being wrung out in a mechanical clothes wringer each time. It is then soaked in a solution of the rare earths and dried in a revolving hot-air bath. After being cut to the proper lengths, each cylinder is shaped over a wooden form, and the upper end is drawn together by a loop of platinum wire. The cotton fiber is then burned off under the flame of a Bunsen lamp, which leaves a network of the rare oxides exactly resembling the original woven cylinder, each fiber being identically preserved, excepting that the size is somewhat reduced by shrinkage. After a series of tempering and testing heats of various intensities the mantle is ready for use. The exact composition of the solution of the rare earths is not known, being one of the trade secrets; but it is a well-known fact that monazite rich in thoria is sought after, and the natural inference is that this element constitutes one of the most important ingredients.

METHODS OF EXTRACTION AND CONCENTRATION.

The commercially economical deposits of monazite are those occurring in the placer sands of the streams and adjoining bottoms and in the beach sands along the seashore. The geographical areas over which such workable deposits have been found up to the present time are quite limited in number and extent. In the United States the placer deposits of North and South Carolina stand alone. This area includes between 1,600 and 2,000 square miles, situated in Burke, McDowell, Rutherford, Cleveland, and Polk counties, N. C., and the northern part of Spartanburg County, S. C. The principal deposits of this region are found along the waters of Silver, South Muddy, and North Muddy creeks, and Henrys and Jacobs Forks of the Catawba River in McDowell and Burke counties; the Second Broad River in McDowell and Rutherford counties; and the First Broad River in Rutherford and Cleveland counties, N. C., and Spartanburg County, S. C. These streams have their sources in the South Mountains, an eastern outlier of the Blue Ridge. The country rock is granitic biotite gneiss and dioritic hornblende gneiss, intersected nearly at right angles to the schistosity by a parallel system of small auriferous quartz veins, striking about N. 70° E., and dipping steeply to the NW. Most of the stream deposits of this region have been worked for placer gold. The existence of monazite in commercial quantities here was first established by Mr. W. E. Hidden, in 1879. The thickness of these stream gravel deposits is from 1 to 2 feet, and the width of the mountain streams in which they occur is seldom over 12 feet. The percentage of monazite in the original sand is very variable, from an infinitesimal quantity up to 1 or 2 per cent. The deposits are naturally richer near the head waters of the streams.

The monazite is won by washing the sand and gravel in sluice boxes exactly after the manner that placer gold is worked. The sluice boxes are about 8 feet long by 20 inches wide by 20 inches deep. Two men work at a box, the one charging the gravel on a perforated plate fixed in the upper end of the box, the other one working the contents up and down with a gravel fork or perforated shovel in order to float off the lighter sands. These boxes are cleaned out at the end of the day's work, the washed and concentrated monazite being collected and dried. Magnetite, if present, is eliminated from the dried sand by treatment with a large magnet. Many of the heavy minerals, such as zircon, menaccanite, rutile, brookite, corundum, garnet, etc., can not be completely eliminated. The commercially prepared sand, therefore, after washing thoroughly and treating with a magnet, is not *pure* monazite. A cleaned sand containing from 65 to 70 per cent monazite is considered of good quality. From 20 to 35 pounds of cleaned monazite sand per hand, that is, from 40 to 70 pounds to the box, is considered a good day's work. The price of labor is 75 cents per day.

But very few regular mining operations are carried on in the region. As a rule each farmer mines his own monazite deposit and sells the product to local buyers, often at some country store in exchange for merchandise.

At the present time the monazite in the stream beds has been practically exhausted, with few exceptions, and the majority of the workings are in the gravel deposits of the adjoining bottoms. These deposits are mined by sinking pits about 8 feet square to the bed rock and raising the gravel by hand labor to a sluice box at the mouth of the pit. The overlay is thrown away excepting in cases where it contains any sandy or gritty material. The pits are carried forward in parallel lines, separated by narrow belts of tailing dumps, similar to the methods pursued in placer gold mining.

At the Blanton and Lattimore mines on Hickory Creek, 2 miles northeast of Shelby, Cleveland County, N. C., the bottom is 300 to 400 feet wide, and has been partially worked for a distance of one-fourth of a mile along the creek. The overlay is from 3 to 4 feet, and the gravel bed from 1 to 2 feet thick. The methods of mining and cleaning are much more systematic in Spartanburg County, S. C., than in the North Carolina regions. Although the raw material contains on an average fully as much garnet, rutile, titanic iron ore, etc., as that in the North Carolina mines, a much better finished product is obtained, and more economically, by making several grades. Two boxes are used in washing the gravel, one below the other. The gravel is charged on a perforated plate at the head of the upper box, and the clean-up from this box is so thoroughly washed as to give a high grade sand, often up to

85 per cent pure. The tailings discharge directly into the lower box, where they are rewashed, giving a second grade sand. At times the material passes through as many as five washing treatments in the sluice boxes. Even after these grades are obtained as clear as possible by washing, the material, after being thoroughly dried, is further cleaned by pouring from a cup, or a small spout in a bin, in a fine, steady stream from a height of about 4 feet, on a level platform; the lighter quartz and black sand with the fine-grained monazite (tailings) falls on the periphery of the conical pile and is constantly brushed aside with hand brushes; these tailings are afterwards rewashed. Instead of pouring and brushing, the material is sometimes treated in a winnowing machine similar to that used in separating chaff from wheat.

Although the best grade of sand is as high as 85 per cent pure, its quantitative proportion is small as compared with the second and other inferior grades, and there is always considerable loss of monazite in the various tailings. It is impossible to conduct this washing process without loss of monazite, and equally impossible to make a perfect separation of the garnet, rutile, titanic iron ore, etc., even in the best grades. The additional cost of such rewashing and rehandling must also be taken into consideration.

If the material washed contains gold, the same will be collected with the monazite in concentrating. It may frequently pay to separate it, which can easily be accomplished by treating the whole mass over again in a riffle box with quicksilver.

It has been shown that the monazite occurs as an accessory constituent of the country rock, and that the latter is decomposed to considerable depths, sometimes as much as 100 feet. On account of the minute percentage of monazite in the mother rock, it is usually impracticable to economically work the same in place, by such a process as hydraulicking and sluicing, for instance. However, even hillside mining has been resorted to. Such is the case at the Phifer mine, in Cleveland County, N. C., 2 miles northeast of Shelby. The country rock is a coarse mica (muscovite and biotite) gneiss, and the small monazite crystals may at times be distinctly seen, unaided by a magnifying glass, in this rock. It is very little decomposed and still quite hard, and the material that is mined for monazite is the overlying soil and subsoil, which is from 4 to 6 feet thick. This is loaded on wheelbarrows and transported to the sluice boxes below the water race. The yield is fairly good, and the product very clean, though the cost of working, of which, unfortunately, figures could not be obtained, must be considerably in excess of that of bottom mining. Where the rock contains sufficient gold, as it sometimes does, to be operated as a gold mine, there is no reason why the monazite can not be saved as a valuable by-product.

As the percentage of thoria is variable in different sands, the value of the sand consequently varies in a measure also It is stated that the transparent greenish and yellowish brown varieties are often rich in thoria, but this can not be depended on.

Hidden[1] has suggested that the difference in cleavage may be an indication of the presence or absence of thoria, that crystals with the cleavage best developed parallel to $\infty P \bar{\infty}$ are the pure phosphate of the cerium earths, free from thoria, while those in which the cleavage is best developed parallel to 0P, contain thoria. But the cleavage is rarely observable in the rolled grains, and if it were the above statement is by no means a proven fact. He also makes the suggestion (in paper above cited) that the density may afford a test of the approximate comparative amount of thoria present, and in support of this he mentions the following examples:

Relation of thoria contents to density in monazite.

Specific gravity.	ThO_2.	Localities.	References.
	Per cent.		
5.30	14.23	Amelia Court-House, Va	Table, p. 676 anal. No. 32.
5.20–5.25	8.25	Portland, Conn	Table, p. 676 anal. No. 30.
5.10	6.49	Burke County, N. C	Table, p. 676 anal. No. 31.

However, this will scarcely hold, for in other instances monazite of the specific gravity 4.64 has been shown to contain as much as 9.20 per cent thoria (from Moss, Norway; see p. 675, anal. No. 4); and again, monazite of the specific gravity 5.19 contained but 3.18 per cent thoria (from Dillingsö, Norway; see p. 675, anal. No. 2). On the whole, there is no method of determining even the probable percentage of thoria, excepting by chemical analysis. Some monazite contains practically no thoria. The best North Carolina sands (highest in thoria) came from Burke and Cleveland counties. Some of the highest grade sand from Brindletown, Burke County, runs from 4 to 6.60 per cent thoria; sand from Gum Branch, McDowell County, is reported to run 3.30 per cent; sand from the vicinity of Bellwood and Carpenter's Knob, in Cleveland County, runs from 5 to 6.30 per cent. The fluctuation of the thoria percentage is, however, considerable even in the same locality. It also depends, of course, in a measure on the degree of concentration of the sand.

OUTPUT AND VALUE.

The price of North Carolina monazite has varied from 25 cents per pound in 1887 to as low as 3 cents for inferior grades and 6 to 10 cents for the best grades in 1894 and 1895. It is only during the past two years that the mining and concentration of monazite sand in the South Mountain region has grown to a regular industry, and it is at present progressing with increased vigor, and the price for the highest grades has risen

[1] Am. Jour. Sci., vol. 32, 1886, p. 207. Zeitschr. für Kryst., vol. 12, 1887, p. 507.

to 10 cents per pound. In 1887 Mr. Hidden shipped from the Brindletown district, in Burke County, N. C., 12 tons of monazite sand. And during 1888 and 1889 a number of tons (exact quantity unknown) were shipped from North Carolina to the Welsbach Light Company in Philadelphia. The product and value of the sand during 1893 and 1894 is given below. It was shipped in part to the Welsbach Light Company and in part to Europe (Germany and Austria).

Product and value of monazite in 1893 and 1894.

1893.		Value at mines.	1894.		Value at mines.
Quantity.	Price.		Quantity.	Price.	
Pounds.	*Cents.*		*Pounds.*	*Cents.*	
110,000	6	$6,600	460,000	....	$31,050
20,000	5	1,000	80,000	....	4,800
			6,855	....	343
130,000	....	7,600	546,855	....	36,193

In Brazil considerable deposits of monazite occur in the beach sands along the seashore. The largest of these is found in the extreme southern part of the Province of Bahia, near the island of Alcobaca. The surf as it breaks against the cliffs washes away the lighter earths and minerals, leaving naturally concentrated deposits of monazite along the beach. Sacks filled with this sand were shipped to New York in 1885, the deposit having been taken for tin ore. Its true character was, however, soon recognized, and since then a number of tons have been shipped in the natural state, without any further concentration or treatment, as ballast, mainly to the European markets. It is reported to contain 3 to 4 per cent thoria. Very little exact information concerning these Brazilian deposits is at present available. Monazite has also been found in the gold and diamond placers of the Provinces of Bahia (Salabro and Caravellas), Minas Geraes (Diamantia), Rio de Janeiro, and São Paulo. It has been found in the river sands of Buenos Ayres, Argentine Republic, and also in the gold placers of Rio Chico, at Antioquia, in the United States of Colombia.

In the Ural Mountains of Russia monazite is found in the Bakakui placers of the Sanarka River. The placer gold mines of Siberia are reported to be rich in monazite, which is rafted down the Lena and the Yenesei rivers to the Arctic Ocean, and thence to European ports.

Economic deposits of monazite are also reported to exist in the pegmatic dikes of Southern Norway. It is picked by the miners while sorting feldspar at the mines. It is not known to exist in placer deposits. The annual output is stated to be not more than one ton, which is shipped mainly to Germany.[1]

[1] U. S. Consular Report; vol. 48, No. 179, Aug. 1895, p. 550.

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MINERAL PAINTS.

By Edward W. Parker.

MINERALS USED AS PIGMENTS.

The number of mineral substances which are used in the manufacture of mineral paints is quite large. They include peculiar qualities of iron ore used in making red and brown pigments, and classed as metallic paints; clay and other earthy substances containing iron, and known as ochers, umbers, and siennas, producing yellow and brown colors; barytes or barium sulphate, producing a white pigment, used as a substitute for or adulterant in white lead; graphite and slate, used for making black paints; terra alba, as its name implies, a white paint made from gypsum of pure quality; asbestos, used in making fireproof paints, soapstone, etc. The foregoing are all made into paints direct from the crude mineral and may be considered natural pigments. Ultramarine is another natural pigment made from lapus lazuli, but owing to the rarity of that mineral and the expensive nature of the genuine article an artificial color made of a mixture of silica, alumina, sulphuric acid, soda, and iron oxide is usually substituted. The genuine ultramarine is the most beautiful blue color known in the arts, and has been known to sell for over $100 an ounce. Zinc white is also made directly from the ores. To the pigments mentioned should be added the preparations made from lead, white lead, red lead, litharge, and orange mineral; venetian reds, made from iron sulphate by roasting; vermilion or artificial cinnabar, blanc fixe or artificial barytes, and chrome yellow, made from potassium bichromate.

The amount of lead used in the manufacture of white lead, etc., is included in the production of pig lead. The production of vermilion is included in the production of cinnabar, and that of chrome yellow in that of chromium. Blanc fixe is manufactured from crude barytes most of which is imported.

PRODUCTION.

The following table shows the production of natural pigments in 1893 and 1894. There was an increase in the total product of 4,202 short tons, but a decline in value of over $32,000. The increase was almost entirely in the production of metallic paint, though the value was less, than in 1893. Ocher decreased both in amount and value, as did umber, soapstone, and slate. Venetian reds decreased in amount and increased in value:

Production of mineral paints in 1893 and 1894.

Kinds.	1893.		1894.	
	Short tons.	Value.	Short tons.	Value.
Ocher	10,517	$129,393	9,768	$96,935
Umber	480	7,560	265	3,830
Sienna	150	4,875	160	3,250
Metallic paint	19,960	297,289	25,375	284,883
Venetian reds	3,214	64,400	2,983	73,300
Mineral black	70	840	650	14,000
Soapstone	100	700	75	525
Slate	3,183	24,727	2,650	21,370
Other colors	50	600		
Total	37,724	530,384	41,926	498,093

OCHER, UMBER, AND SIENNA.

PRODUCTION.

Ocher was produced in ten States in 1894, namely, Alabama, Georgia, Kentucky, Maryland, Massachusetts, Missouri, Pennsylvania, Vermont, Virginia, and Wisconsin. All of the umber and sienna produced in 1894, as in 1893, was from Pennsylvania. The following table shows the production in 1894, by States:

Production of ocher, umber, and sienna in 1894, by States.

States.	Short tons.	Value.
Georgia	1,690	$17,840
Missouri	1,800	23,160
Pennsylvania	4,975	47,830
Vermont	336	3,384
Alabama and Kentucky	268	2,731
Maryland and Virginia	1,065	8,490
Massachusetts and Wisconsin	59	580
Total	10,193	104,015

For the purposes of comparison the production in the preceding five years is shown in the following table. Prior to 1889, when the statistics were compiled for the Eleventh Census, the production for each State was not published:

Production of ocher, umber, and sienna from 1889 to 1893, by States.

States.	1889.		1890.		1891.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Alabama	336	$3,500	350	$4,100	524	$5,840
Colorado	50	150	1,000	15,000		
Georgia	2,512	29,720	800	12,800	600	9,000
Maryland	616	12,000				
Massachusetts	80	750	300	2,700	300	2,700
Missouri			2,200	30,000	1,850	27,500
New Jersey					600	7,200
New York			365	4,493		
Pennsylvania	7,922	103,797	4,173	61,458	4,535	56,588
Vermont	1,884	7,800			935	11,095
Virginia	1,658	18,755	1,367	22,972	1,950	29,900
Wisconsin	100	1,000				
Other States			*a* 7,000	84,000	*a* 7,000	84,000
Total	15,158	177,472	17,555	237,523	18,294	233,823

States.	1892.		1893.	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
Alabama	375	$4,050	350	$3,000
Colorado				
Georgia	1,748	26,800	2,600	39,000
Maryland	1,000	10,000		
Massachusetts	46	418		
Missouri	1,922	28,220	555	5,413
New Jersey	175	3,600		
New York				
Pennsylvania	7,055	90,755	5,375	71,575
Vermont	544	5,731	523	5,280
Virginia	1,500	23,500		
Wisconsin				
Other States			*b* 1,744	17,560
Total	14,365	193,074	11,147	141,828

a Includes all of Maryland and estimated products of some firms in other States not reporting
b Includes Kentucky, Maryland, Massachusetts, and Virginia.

Annual production of ocher, etc., since 1884.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1884	7,000	$84,000	1890	17,555	$237,523
1885	3,950	43,575	1891	18,294	233,823
1886	6,300	91,850	1892	14,365	193,074
1887	8,000	75,000	1893	11,147	141,828
1888	10,000	120,000	1894	10,193	104,015
1889	15,158	177,472			

IMPORTS.

The following tables show the amount and value of ochers, etc., from 1867 to 1894:

Ocher, etc., imported from 1867 to 1883.

Fiscal years ended June 30—	All ground in oil.		Indian red and spanish brown.		Mineral, french, and paris green.		Other, dry, not otherwise specified.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1867	11,373	$385	....	$35,374	....	$2,083	1,430,118	$9,923
1868	6,949	333	....	11,165	....	500	3,670,093	32,102
1869	65,344	2,496	2,582,335	31,624	8,369	2,495	5,379,478	39,546
1870	149,240	6,042	3,377,944	41,607	9,618	3,444	3,935,978	32,593
1871	121,080	4,465	2,286,930	40,663	33,488	11,038	2,800,148	24,767
1872	277,617	9,225	2,810,282	38,763	41,422	10,341	5,645,343	56,680
1873	94,245	3,850	135,360	2,506	34,382	8,078	3,940,785	51,318
1874	98,176	4,623	263,389	3,772	102,876	18,153	3,212,988	35,365
1875	280,517	12,352	646,009	9,714	64,910	13,506	3,282,415	37,929
1876	63,916	3,365	2,524,989	19,555	21,222	5,385	3,962,646	47,405
1877	41,718	2,269	2,179,631	24,218	27,687	6,724	3,427,208	32,924
1878	25,674	1,591	2,314,028	23,677	67,655	14,376	3,910,947	33,260
1879	17,649	1,141	2,873,550	26,929	17,598	3,114	3,792,850	42,563
1880	91,293	4,233	3,655,920	32,726	16,154	3,269	4,602,546	52,120
1881	99,431	4,676	3,201,880	30,195	75,465	14,648	3,414,704	46,069
1882	159,281	7,915	3,789,586	34,136	18,293	2,821	5,530,204	68,106
1883 (*a*)	137,978	6,143	1,549,968	13,788	6,972	885	7,022,615	90,593

a Since 1883 classified as "dry" and "ground in oil."

Imports of ocher of all kinds from 1884 to 1894.

Years ended—	Dry.		Ground in oil.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*	
June 30, 1884	6,164,359	$63,973	108,966	$4,717	6,273,325	$68,690
1885	4,983,701	51,499	79,666	3,616	5,063,363	55,115
Dec. 31, 1886	4,939,183	53,593	112,784	6,574	5,051,967	60,167
1887	5,957,200	58,162	54,104	7,337	6,011,304	65,499
1888	6,574,608	64,123	43,142	9,690	6,617,750	73,813
1889	5,540,267	52,502	51,063	9,072	5,591,330	61,574
1890	....	....	....	....	6,471,863	71,953
1891	6,246,890	63,040	52,206	5,272	6,299,096	68,312
1892	8,044,836	97,946	49,714	5,120	8,094,550	103,066
1893	6,225,789	55,074	52,468	3,354	6,278,257	58,428
1894	4,937,738	45,276	22,387	2,100	4,960,125	47,376

Imports of umber from 1867 to 1894.

Years ended—	Quantity.	Value.	Year ended—	Quantity.	Value.
	Pounds.			*Pounds.*	
June 30, 1867	2,147,342	$15,946	June 30, 1881	1,475,835	$11,126
1868	345,173	2,750	1882	1,923,648	20,494
1869	570,771	6,159	1883	785,794	8,419
1870	708,825	6,313	1884	2,946,675	20,654
1871	470,392	7,064	1885	1,198,060	8,504
1872	1,409,822	18,203	Dec. 31, 1886	1,262,930	9,187
1873	845,601	8,414	1887	2,385,281	16,536
1874	729,864	6,200	1888	1,423,800	14,684
1875	513,811	5,596	1889	1,555,070	20,887
1876	681,199	7,527	1890	1,556,823	19,329
1877	1,101,422	10,213	1891	633,291	6,498
1878	1,038,880	8,302	1892	1,028,038	6,256
1879	986,105	6,959	1893	1,488,849	16,636
1880	1,877,645	17,271	1894	632,995	6,275

METALLIC PAINT.

The production of metallic paint increased from 19,960 short tons in 1893 to 25,375 short tons in 1894, a gain of 5,415 short tons. The industry, however, suffered from the general decline in values, and while the product was the largest in six years with one exception, the value was less than in any of them. Compared with 1893, the value shows a decrease of $12,406. The average price per ton shows a decrease from $14.89 in 1893 to $11.23 in 1894, a difference of $3.66, or about 25 per cent. The following table shows the annual product by States since 1889:

Production of metallic paint since 1889, by States.

States.	1889.		1890.		1891.	
	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Colorado	90	$2,500	1,300	$22,100	....	....
New York	3,658	63,698	5,224	72,952	7,352	$99,487
Ohio	540	11,123	637	16,341	800	14,500
Pennsylvania	8,849	128,036	8,955	145,243	9,175	134,138
Tennessee	3,057	24,237	5,386	46,088	4,000	30,000
Vermont	....	....	500	6,000	400	5,000
Wisconsin	1,832	26,700	2,125	31,035	2,343	34,375
Other States (*a*)	3,000	30,000	50	610	1,072	16,955
Total	21,026	286,294	24,177	340,369	25,142	334,455

States.	1892.		1893.		1894.	
	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Colorado	....	....	....	....	....	....
New York	5,200	$76,500	3,885	$57,500	4,787	$48,899
Ohio	879	17,090	710	5,750	1,006	13,516
Pennsylvania	10,289	176,785	8,300	143,875	8,683	119,674
Tennessee	5,000	32,000	3,000	27,500	5,510	37,870
Vermont	400	5,000	338	4,600	280	3,500
Wisconsin	2,448	33,826	2,246	29,500	3,057	41,889
Other States (*a*)	1,495	20,765	1,481	28,564	2,052	19,535
Total	25,711	362,966	19,960	297,289	25,375	284,883

a Includes Alabama, California, Delaware, Kentucky, Maryland, Missouri, New Jersey, and Virginia.

VENETIAN REDS.

The production of venetian reds in 1894 was 2,983 short tons, against 3,214 in 1893, the decrease in product being compensated for by an increase in value from $64,400 to $73,300. The statistics of production since 1890 are shown in the following table:

Production of venetian red since 1890.

Years.	Short tons.	Value.
1890	4,000	$84,100
1891	4,191	90,000
1892	4,900	106,800
1893	3,214	64,400
1894	2,983	73,300

SLATE AS A PIGMENT.

The amount of slate ground for paint in 1894 was 2,650 short tons, valued at $21,370, against 3,183 short tons, worth $24,727, in 1893, a decrease of 533 tons in amount and $3,357 in value. The annual product since 1880 has been as follows:

Amount and value of slate ground for pigment since 1880.

Years.	Short tons.	Value.	Years.	Short tons.	Value.
1880	1, 120	$10, 000	1888	2, 800	$25, 100
1881	1, 120	10, 000	1889	2, 240	20, 000
1882	2, 240	24, 000	1890	2, 240	20, 000
1883	2, 240	24, 000	1891	2, 240	20, 000
1884	2, 240	20, 000	1892	3, 787	23, 523
1885	2, 212	24. 687	1893	3, 183	24, 727
1886	3, 360	30, 000	1894	2, 650	21, 370
1887	2, 240	20, 000			

WHITE LEAD, ETC.

The production of white lead increased from 72,172 short tons in 1893 to 76,343 short tons in 1894, but the value decreased more than $1,000,000—from $7,695,130 to $6,623,071. Red lead increased from 6,122 short tons to 6,176 short tons, while the value decreased over $100,000. Litharge decreased both in amount and value. Orange mineral increased from 217 short tons, valued at $32,893, to 319 tons, worth $43,517. Zinc white decreased from 24,059 short tons to 21,443 short tons, with a decrease in value from $1,804,420 to $1,500,975. The decline in values was in reality not so great as appears. Previous to 1894 the values were based on white lead in oil. In 1894 the product includes the amount sold dry, with the value in that condition:

Production of white lead, etc., for four years.

	1891.		1892.		1893.		1894.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
White lead	78, 018	$10, 454, 029	74, 485	$8, 733, 620	72, 172	$7, 695, 130	76, 343	$6, 623, 071
Red lead	4, 607	591, 730	6. 122	757, 787	6, 122	707, 363	6, 176	601, 972
Litharge	5, 759	720, 925	5, 764	611, 726	11, 077	1, 091, 293	4, 630	412, 128
Orange mineral	330	43, 300	395	60, 170	217	32, 893	319	43, 517
Zinc white	23, 700	1, 600, 000	27, 500	2, 200, 000	24, 059	1, 804, 420	21, 443	1, 500, 975
Total	112, 414	13, 409, 984	114, 266	12, 363, 303	113, 647	11, 331, 099	108, 911	9, 181, 663

The annual production of white lead since 1884 has been as follows:

Product of white lead in the United States since 1884.

Years.	Qauntity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1884	65, 000	$6, 500, 000	1890	77, 636	$9, 382, 967
1885	60, 000	6, 300, 000	1891	78, 018	10, 454, 029
1886	60, 000	7, 200, 000	1892	74, 485	8, 733, 620
1887	70, 000	7, 560, 000	1893	72, 172	7, 695, 130
1888	84, 000	10, 080, 000	1894	76, 343	6, 623, 071
1889	80, 000	9, 600, 000			

The following table is of interest, as it shows the average yearly prices of pig lead and white lead in oil (both at New York) and the difference between the two since 1874:

Average yearly net prices, at New York, of pig lead and white lead in oil since 1874.

[Per 100 pounds.]

Years.	Pig lead in New York.	White lead in oil in New York.	Difference.	Years.	Pig lead in New York.	White lead in oil in New York.	Difference.
1874	$6.00	$11.25	$5.25	1885	$3.95	$6.00	$2.05
1875	5.95	10.50	4.55	1886	4.63	6.25	1.62
1876	6.05	10.00	3.95	1887	4.47	5.75	1.28
1877	5.43	9.00	3.57	1888	4.41	5.75	1.34
1878	3.58	7.25	3.67	1889	3.80	6.00	2.20
1879	4.18	7.00	2.82	1890	4.33	6.25	1.92
1880	5.05	7.60	2.55	1891	4.33	6.37	2.05
1881	4.80	7.25	2.45	1892	4.05	6.39	2.34
1882	4.90	7.00	2.10	1893	3.73	6.03	2.30
1883	4.32	6.88	2.56	1894	3.28	5.26	1.98
1884	3.73	5.90	2.17				

In considering the variations between the value of pig lead and white lead in oil allowance should be made for the fluctuations in the value of linseed oil, which enters largely into the manufacture of lead in oil. The fluctuations in the price of linseed oil in two years have ranged from 30 cents a gallon to 58 cents—almost double.

The following table shows the imports of white lead, red lead, litharge, and orange mineral since 1867:

Red lead, white lead, litharge, and orange mineral imported from 1867 to 1894.

Years ended—	Red lead.		White lead.		Litharge.		Orange mineral.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
June 30, 1867	926,843	$53,087	6,636,508	$430,805	230,382	$8,941		
1868	1,201,144	76,773	7,533,225	455,698	250,615	12,225		
1869	808,686	46,481	8,948,642	515,783	187,333	7,767		
1870	1,042,813	54,626	6,228,285	365,706	97,398	4,442		
1871	1,295,616	78,410	8,337,842	483,392	70,889	3,870		
1872	1,513,794	85,644	7,153,978	431,477	66,544	3,396		
1873	1,583,039	99,891	6,331,373	408,986	40,799	2,379		
1874	756,644	56,305	4,771,509	323,926	25,687	1,450		
1875	1,048,713	73,131	4,354,131	295,642	15,767	950		
1876	749,918	54,884	2,546,776	175,776	47,054	2,562		
1877	387,260	28,747	2,644,184	174,844	40,331	2,347		
1878	170,608	9,364	1,759,608	113,638	28,190	1,499		
1879	143,237	7,237	1,274,196	76,061	38,495	1,667		
1880	217,033	10,397	1,906,931	107,104	27,389	1,222		
1881	212,423	10,009	1,068,030	60,132	63,058	2,568		
1882	288,946	12,207	1,161,889	64,493	54,592	2,191		
1883	249,145	10,503	1,044,478	58,588	34,850	1,312		
1884	265,693	10,589	902,281	67,918	54,183	1,797		
1885	216,449	7,641	705,535	40,437	35,283	1,091		
Dec. 31, 1886	597,247	23,038	785,554	57,340	51,409	1,831		
1887	371,299	16,056	804,320	58,602	35,908	1,302		
1888	529,665	23,684	627,900	49,903	62,211	2,248		
1889	522,026	24,400	661,694	56,875	41,230	1,412		
1890	450,402	20,718	742,196	57,659	48,283	2,146		
1891	651,577	23,807	718,228	40,773	94,586	3,108		
1892	812,703	28,443	744,838	40,032	56,737	1,811	1,409,601	$64,133
1893	854,982	27,349	686,490	34,145	42,582	1,310	1,385,828	61,360
1894	947,873	29,064	796,480	40,939	38,595	1,110	1,386,464	58,614

BARYTES.

By Edward W. Parker.

OCCURRENCE.

Barytes, barium sulphate, or heavy spar, as it is commonly called, occurs in a number of localities in the United States, chiefly in Missouri, New Jersey, North Carolina, and Virginia. The better grades are used principally in the manufacture of pigments as a cheaper substitute for white lead. Usually it is mixed with white lead, thus lessening the cost to the consumer, and, it is claimed, not materially affecting the weight, quality, or covering properties. It is also used as a make-weight in paper manufactures, and the lower grades find a market with pork packers in the preparation of canvas covers for their products.

PRODUCTION.

The declining tendency in production which prevailed in 1893 continued during 1894, the output decreasing from 28,970 short tons in 1893 to 23,335 short tons in 1894, a decrease of 5,635 tons, or nearly 20 per cent. There was a slight recovery in the value, although that of 1894 was less than that of 1893.

The product in 1893 was entirely from Missouri and Virginia, in nearly equal proportions. In 1894 three other States furnished a portion of the output, New Jersey yielding 520 tons, North Carolina 1,200 tons, and Georgia 60 tons. The remainder of the product was about equally divided between the first-mentioned States. The value quoted is uniformly for crude barytes, which is, of course, much less than that of the material after it has been ground, floated, or otherwise prepared for commerce. The production of crude barytes in the United States since 1882 has been as follows:

Production of crude barytes from 1882 to 1894.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1882	22,400	$80,000	1889	21,460	$106,313
1883	30,240	108,000	1890	21,911	86,505
1884	28,000	100,000	1891	31,069	118,363
1885	16,800	75,000	1892	32,108	130,025
1886	11,200	50,000	1893	28,970	88,506
1887	16,800	75,000	1894	23,335	86,983
1888	22,400	110,000			

IMPORTS.

The following table shows the imports of barytes into the United States from 1867 to 1894:

Imports of barium sulphate from 1867 to 1894.

Years ended—	Manufactured.		Unmanufactured.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*	
June 30, 1867	14,968,181	$141,273		
1868	2,755,547	26,739		
1869	1,117,335	8,565		
1870	1,684,916	12,917		
1871	1,385,004	9,769		
1872	5,804,098	43,521		
1873	6,939,425	53,759		
1874	4,788,966	42,235		
1875	2,117,854	17,995		
1876	2,655,349	25,325		
1877	2,388,373	19,273		
1878	1,366,857	10,340		
1879	453,333	3,496		
1880	4,924,423	37,374		
1881	1,518,322	11,471		
1882	562,300	3,856		
1883	411,666	2,489		
Dec. 31, 1884	3,884,516	24,671	5,800,816	$8,044
1885	4,095,287	20,606	7,841,715	13,567
1886	3,476,691	18,338	6,588,872	8,862
1887	4,057,831	19,769	10,190,848	13,290
1888	3,821,842	17,135	6,504,975	9,037
1889	3,601,506	22,458	13,571,206	7,660
1890	*a* 1,563	16,453	*a* 4,815	13,133
1891	2,149	22,041	2,900	8,816
1892	1,389	15,419	2,789	7,418
1893	1,032	11,457	2,983	7,612
1894	836	10,556	1,884	5,270

a Tons since 1890.

ASBESTOS.

By Edward W. Parker.

The total production of asbestos in 1894, 325 short tons; total value, $4,463. Two distinct minerals, somewhat similar in appearance and in physical properties, but different in chemical composition and mode of occurrence, are usually considered commercially under one head—asbestos. True asbestos is a fibrous variety of hornblende and usually occurs in pockets associated with talc or soapstone. Its kindred mineral, chrysotile, is a hydrous silicate of magnesium and occurs in well-defined seams in a gangue of serpentine. The fibers of the chrysotile are from 1 to 4 inches in length and perpendicular to the direction of the seam. The composition of true asbestos is variable, the fair average being $MgCaSi_2O_6$. The composition of chrysotile is more regular—$Mg_3H_4Si_2O_9$. The one is an anhydrous magnesium calcium silicate, the other a hydrous silicate of magnesium, no lime being present. Both minerals are remarkable for their resistance to the action of heat, but differ under the action of acids. True asbestos is impervious to, while chrysotile is decomposable by the ordinary agents. The fibers of chrysotile, however, possess qualities of toughness, elasticity, and flexibility which make it more suitable for the manufacture of woven materials than asbestos, whose fibers, while usually longer than those of chrysotile, are brittle and harsh and not adapted to textile manufacture. This is particularly true of the American product. Considerable quantities, however, of domestic asbestos have been used in the manufacture of fireproof paints and as a packing material for fireproof safes and for boiler and steam-pipe covering. In these cases resistance to heat is requisite, but strength of fiber not essential.

OCCURRENCE.

True asbestos is found in many localities throughout the United States, but usually in small quantities. It occurs in many of the soapstone formations along the Appalachian range from New York to Georgia; also in considerable quantity in California, Oregon, and Washington on the Pacific Slope, and in Montana and Wyoming. For its supply of chrysotile to be used in the manufacture of textile materials this country has depended principally upon the mines of Thetford and Black Lake, in Canada, and when the importations of this material are compared with the domestic production of asbestos the latter falls into insignificance. Some chrysotile similar to the Canadian material has been found in Virginia in the vicinity of Round Hill, on the eastern slope of the Blue Ridge Mountains, and near Casper, Wyoming; but developments have not proceeded far enough in either locality to demonstrate the economic value of the deposits.

PRODUCTION.

For a number of years previous to 1894, the commercial product of domestic asbestos was obtained from California, though small amounts incidental to the quarrying of soapstone have been taken out in Pennsylvania, Maryland, Virginia, and Georgia, and also in Oregon and Wyoming, in the prosecution of the development work required by law for the maintenance of title. In 1894, however, the mines in California were closed down, and the scene of operations was transferred from the Pacific to the Atlantic Slope. Mines were opened during the year in Troup and White counties, Ga., and 325 tons of fiber were shipped from there in 1894, 75 tons from Troup and 250 tons from White County. The mine in Troup County was not fully developed, but indications are that work will be systematically pushed. The mine at Santee, in White County, was completely developed during the year and began shipping in December. The property has been equipped with a plant for treating the material and preparing it for market. It consists of two Raymond cyclone pulverizers having a capacity of 75 tons per day. The crude mineral is crushed in these pulverizers, and that which is reduced to a sufficient fineness is drawn off by a blast of air into another room where it is packed for shipment, while the coarser material is returned to the pulverizer for re-treatment.

The amount of asbestos produced in Georgia during 1894 was larger than that obtained from California in any year since 1885, but there were several years in which the value exceeded that of the product in 1894. During 1892, 64 tons of asbestus were mined in Oregon and 10 tons in Wyoming. In both cases the product was incidental to development work, and, owing to the industrial depression prevalent during 1893 and 1894, operations on these properties were suspended during these years.

The following table exhibits the annual product of asbestos since 1880, with the value:

Annual product of asbestos from 1880 to 1894.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	150	$4,312	1888	100	$3,000
1881	200	7,000	1889	30	1,800
1882	1,200	36,000	1890	71	4,560
1883	1,000	30,000	1891	66	3,960
1884	1,000	30,000	1892	104	6,416
1885	300	9,000	1893	50	2,500
1886	200	6,000	1894	325	4,463
1887	150	4,500			

Comparing the above table with that of the table of imports, which is given below, it will be seen that there is a profitable market to be supplied with domestic fiber if any be found which is equal in quality to that of the Canadian chrysotile, nearly all of the imports into the United States being from the Canadian mines.

IMPORTS.

The following table shows the value of asbestos imported since 1869:

Value of asbestos imported from 1869 to 1894.

Years ended—	Unmanufactured.	Manufactured.	Total.
June 30, 1869	....	$310	$310
1870	....	7	7
1871	....	12	12
1872	....	....	....
1873	$18	....	18
1874	152	....	152
1875	4,706	1,077	5,783
1876	5,485	396	5,881
1877	1,671	1,550	3,221
1878	3,536	372	3,908
1879	3,204	4,624	7,828
1880	9,736	....	9,736
1881	27,717	69	27,786
1882	15,235	504	15,739
1883	24,369	243	24,612
1884	48,755	1,185	49,940
Dec. 31, 1885	73,026	617	73,643
1886	134,193	932	135,125
1887	140,264	581	140,845
1888	168,584	8,126	176,710
1889	254,239	9,154	263,393
1890	252,557	5,342	257,879
1891	353,589	4,872	358,461
1892	262,433	7,209	269,642
1893	175,602	9,403	185,005
1894	240,029	15,989	256,018

CANADIAN PRODUCTION.

As the supply for the United States is drawn almost entirely from Canada, the following table of production in that country will be found of interest:

Annual product of asbestos in Canada since 1879.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Tons.			*Tons.*	
1879	300	$19.500	1888	4,404	$255,007
1880	380	24,700	1889	6,113	426,554
1881	540	35,100	1890	9,860	1,260,240
1882	810	52,650	1891	9,000	1,000,000
1883	955	68,750	1892	6,042	388,462
1884	1,141	75,079	1893	6,473	313,806
1885	2,440	142,441	1894	7,630	420,825
1886	3,458	206,251			
1887	4,619	226,976	Total	64,165	4,916,359

OTHER FOREIGN PRODUCTION.

In addition to the Canadian chrysotile, some asbestos is imported from Italy, but while the Italian material is superior to that of the United States and possesses a fiber longer than the Canadian chrysotile, it is inferior in strength and flexibility to the latter, and its use is growing less. Large deposits of asbestos are reported in Griqualand West, about 90 miles from Kimberly, South Africa. In Newfoundland is found the same formation from which the Canadian chrysotile is obtained. Mr. C. E. Willis, in a paper read before the Mining Society of Nova Scotia, describes the occurrence in Newfoundland. Mr. Willis states that the metamorphic rocks and serpentines of the eastern townships of Quebec dip under the Gulf of St. Lawrence and appear again in Port au Port, on the west coast of Newfoundland, and extend a long distance inland. Many claims have been located on the best prospects and development work is being prosecuted. There is good reason to believe that this region will prove a formidable rival to the Thetford and Black Lake properties.

MINERAL WATERS.

By A. C. Peale.

PRODUCTION.

The business depression prevalent throughout the country has apparently been felt among the mineral-spring owners, as among other business interests, although in respect to the production of mineral waters there is some inequality between the different sections of the country. An increase of production is seen in two sections, although in one of them there is a decrease in the value of the increased product as compared with 1893.

The list of spring localities for 1894 contains 27 more springs than the list of 1893, the total for 1894 being 357, as compared with 330 for the previous year. Of this number 286 have reported this year, leaving a delinquent list of 71 springs not reporting. Of the springs not reporting in 1894 nearly two-thirds gave figures in 1893. The average price per gallon this year has been about 17 cents, as compared with 18 cents for 1893 and 22½ cents for 1892.

The total number of gallons produced in 1894, including an estimate for the delinquent springs of one-half the production last reported by them, reaches 21,569,608, with a valuation of $3,741,846. Compared with the corresponding figures of 1893, this is a loss of 1,947,887 gallons and a decrease of $504,888 in the valuation of the total product. Comparing the figures presented by the springs actually reporting in the two years, we find that the 286 springs reporting in 1894 show a total of 18,972,266 gallons, which is a loss of 1,120,467 gallons from 1893. The decrease in the valuation of their product is $372,065.

In the North Atlantic States 3 springs have been dropped from the list, as the water from them is no longer on sale. Ten springs not on the list of 1893 have been added to the present list. They are as follows: In Maine, Paradise Spring and Pownal Spring; in Connecticut, Puritan Spring; in New York, D. A. Ayer Amherst Mineral Spring, Colonial Mineral Springs, Esperanza Mineral Springs, Boonville Mineral Springs, and the Old Putnam Spring of Saratoga, and in Pennsylvania, Alicia Mineral Spring and Apollo Springs. The total number of springs credited to the section is 105, as compared with 98 in 1893. Of these 83 report in 1894, the figures showing a loss of 133,664 gallons from the previous year, with a decrease of $356,484 in the valuation.

The South Atlantic States in 1894 show a total of 55 springs, a net gain of 5 from 1893, 2 springs being taken from the list and 7 having been added. The latter are the Chicora Artesian Well and Harris Lithia Spring, in South Carolina; and the following in Virginia, viz, Iron Lithia Springs, Pine Mountain Springs, Seawright Magnesian Lithia Springs, Swineford's Arsenic Lithia Springs, and the Virginia Magnesian Alkaline Springs. The decrease in the total production for the section is 432,709 gallons, the decrease in valuation being $175,593. Fifty-five springs have reported.

The North Central States report for 1894 a total of 103 springs, the section being second in this respect only to the North Atlantic States. The total number on the list for 1893 was 92. From this 5 localities have been taken and 16 have been added. The springs new to the list are: In Ohio, the Devonian Mineral Spring and the Puritas Mineral Springs; in Indiana, the Emerald Spring; in Illinois, Diamond Mineral Spring and Tivoli Mineral Spring; in Iowa, Mynster Springs; in Michigan, the Clarke Red Cross Well, Magnetic Mineral Springs, Medea Spring, Mount Clemens Pagoda Spring, and Plymouth Rock Well; in Minnesota, Indian Medical Spring and Mankato Mineral Springs; and in Wisconsin, St. John Mineral Springs and the Fountain Spring and Silurian Spring of Waukesha. In Ohio the name of the Crystal Mineral Spring of Urbana has been changed to the Purtlebaugh Mineral Springs, while the Cumberland Mineral Spring in Indiana is now known as the Greenup Mineral Spring. The number of gallons sold from 82 springs in 1894 in this section is reported as 6,914,900, a loss of 1,918,812 gallons from the figures of 1893. There is, however, a gain of $41,895 in the valuation of the product, the difference being between $1,115,322 for 1894 and $1,073,427 for 1893.

In the South Central States there is little change from 1893, so far as the total number of springs is concerned, the net gain being 1 spring. The total for 1894 is 42, two springs having been dropped and three added. The springs not on the list for 1893 are one of the Blue Lick Springs of Kentucky, and the Blancoe Springs and Sulphur Springs, in Arkansas. This section shows a gain of 1,179,854 gallons from 1893, the total number of gallons reported for 1894 being, from 37 springs, 2,319,813. There is also an increase in the value of the production amounting to $151,505.

The Western States and Territories show a net gain of 3 springs, the total for 1894 being 42. One spring has been dropped and 4 have been added to the list. The springs new to the list are: Carlile Soda and Iron Springs, of Colorado; Castilla Hot Springs, of Utah, and Ætna Springs and the Almaden Vichy Springs, in California. The name of the Coyote Soda Springs, in New Mexico, is changed to Harsch's Iron Springs. Twenty-nine of the 42 springs report their sales for 1894, showing an increased production of 184,864 gallons over that of 1893. Notwithstanding this increase, the total valuation has decreased to the extent of $33,388.

Production of mineral waters for 1894, by States and Territories.

States and Territories.	Springs reporting.	Product.	Value.
		Gallons.	
Alabama	4	12,012	$12,809
Arkansas	7	155,424	36,678
California	14	432,055	215,192
Colorado	4	302,296	18,305
Connecticut	3	35,500	4,085
Georgia	2	36,000	8,100
Illinois	10	196,454	19,154
Indiana	9	198,960	31,146
Iowa	4	24,100	2,510
Kansas	3	56,707	3,668
Kentucky	6	91,995	13,347
Maine	10	969,984	105,659
Maryland	5	119,000	15,580
Massachusetts	25	2,347,789	103,134
Michigan	13	540,550	150,282
Minnesota	3	1,292,000	104,500
Mississippi	5	166,432	42,682
Missouri	6	144,200	47,310
New Hampshire	2	1,413,100	563,220
New Mexico	2	10,000	500
New York	23	2,167,499	525,148
North Carolina	8	14,893	4,458
Ohio	11	125,450	256,000
Oregon	2	15,500	4,500
Pennsylvania	13	1,108,224	160,406
Rhode Island	3	115,000	9,125
South Carolina	3	47,700	9,515
Tennessee	3	36,000	6,100
Texas	12	1,857,950	162,220
Utah	2	25,250	7,562
Vermont	3	55,432	16,584
Virginia	30	402,827	80,715
Washington	3	38,000	5,600
West Virginia	6	27,700	4,785
Wisconsin	21	4,281,746	494,236
Other States (*a*)	6	108,537	36,582
Total	286	18,972,266	3,280,897
Estimated production of springs not reporting	71	2,677,342	460,949
Grand total	357	21,569,608	3,741,846

a These include Florida, Idaho, Nebraska, Montana, New Jersey, and South Dakota, from which but one spring reports for each State.

Production of natural mineral waters from 1883 to 1894.

Geographical division.	Springs reporting.	Gallons sold.	Value.
1883.			
North Atlantic	38	2,470,670	$282,270
South Atlantic	27	312,090	64,973
North Central	37	1,435,809	323,600
South Central	21	1,441,042	139,973
Western	6	169,812	52,787
	129	5,829,423	863,603
Estimated	60	1,700,000	256,000
Total	189	7,529,423	1,119,603
1884.			
North Atlantic	38	3,345,760	328,125
South Atlantic	27	464,718	103,191
North Central	37	2,070,533	420,515
South Central	21	1,526,817	147,112
Western	6	307,500	85,200
	129	7,715,328	1,084,143
Estimated	60	2,500,000	375,000
Total	189	10,215,328	1,459,143
1885.			
North Atlantic	51	2,527,310	192,605
South Atlantic	32	908,692	237,153
North Central	45	2,925,288	446,211
South Central	31	540,436	74,100
Western	10	509,675	86,776
	169	7,411,401	1,036,845
Estimated	55	1,737,000	276,000
Total	224	9,148,401	1,312,845
1886.			
North Atlantic	49	2,715,050	177,969
South Atlantic	38	720,397	123,517
North Central	40	2,048,914	401,861
South Central	31	822,016	58,222
Western	14	781,540	137,796
	172	7,087,917	899,365
Estimated	53	1,862,400	384,705
Total	225	8,950,317	1,284,070
1887.			
North Atlantic	40	2,571,004	213,210
South Atlantic	34	614,041	147,149
North Central	38	1,480,820	208,217
South Central	29	741,080	87,946
Western	12	1,236,324	288,737
	153	6,643,269	945,259
Estimated	62	1,616,340	316,204
Total	215	8,259,609	1,261,463
1888.			
North Atlantic	42	2,856,799	247,108
South Atlantic	32	1,689,387	493,489
North Central	38	2,002,373	325,839
South Central	19	426,410	71,215
Western	15	1,853,679	421,651
	146	8,828,648	1,559,302
Estimated	52	750,000	120,000
Total	198	9,578,648	1,679,302
1889.			
North Atlantic	60	4,166,464	$471,575
South Atlantic	47	646,239	198,032
North Central	86	6,137,776	604,238
South Central	33	500,000	43,356
Western	32	1,389,992	431,257
Total	258	12,780,471	1,748,458
1890.			
North Atlantic	55	5,043,074	1,175,512
South Atlantic	39	647,625	245,760
North Central	71	5,050,413	737,672
South Central	30	604,571	81,426
Western	25	869,504	253,578
	220	12,215,187	2,493,948
Estimated	53	1,692,231	106,802
Total	273	13,907,418	2,600,750
1891.			
North Atlantic	62	5,724,752	1,591,746
South Atlantic	41	796,439	313,443
North Central	68	8,010,556	482,082
South Central	29	629,015	106,022
Western	27	1,123,640	414,564
	227	16,284,402	2,907,857
Estimated	61	2,108,330	88,402
Total	288	18,392,732	2,996,259
1892.			
North Atlantic	65	6,853,722	1,933,416
South Atlantic	47	1,062,945	353,193
North Central	74	11,566,440	1,834,732
South Central	32	693,544	109,334
Western	24	1,261,453	594,469
	242	21,438,104	4,825,144
Estimated	41	438,500	80,826
Total	283	21,876,604	4,905,970
1893.			
North Atlantic	79	8,351,192	1,844,845
South Atlantic	49	1,092,829	304,736
North Central	78	8,833,712	1,073,427
South Central	35	1,139,959	122,331
Western	29	675,041	307,623
	270	20,092,733	3,652,962
Estimated	60	3,451,762	593,772
Total	330	23,544,495	4,246,734
1894.			
North Atlantic	83	8,217,528	1,488,361
South Atlantic	55	660,120	129,143
North Central	82	6,914,900	1,115,322
South Central	37	2,319,813	273,836
Western	29	859,905	274,235
	286	18,972,266	3,280,897
Estimated	71	2,677,342	460,949
Total	357	21,569,608	3,741,846

LIST OF COMMERCIAL SPRINGS.

ALABAMA.

There is no change in the list of springs for Alabama. One spring is delinquent for 1894, and the following report:

Bailey Springs, Bailey Springs, Lauderdale County.
Healing Springs, Healing Springs, Washington County.
Jackson White Sulphur, Jackson, Jackson County.
Wilkinson's Matchless Mineral Water, Greenville, Butler County.

ARKANSAS.

Two new springs are added to the list, and of the 7 now credited to the State all report sales for 1894:

Arkansas Lithia Springs, Hope, Hempstead County.
Blancoe Springs, near Hot Springs, Garland County.
Dovepark Springs, Dovepark, Hot Springs County.
Eureka Springs, Eureka Springs, Carroll County.
Mountain Valley Springs, Mountain Valley, Garland County.
Potash Sulphur Spring, Hot Springs, Garland County.
Sulphur Springs, Sulphur Springs, Benton County.

CALIFORNIA.

One spring is dropped from the 1 st for California and 2 are added, making the total 19; of these the following 14 report:

Ætna Springs, Lidell, Napa County.
Alhambra Mineral Spring, Martinez, Contra Costa County.
Almaden Vichy Springs, New Almaden, Santa Clara County.
Azule Natural Seltzer Water, San Jose, Santa Clara County.
California Seltzer Spring, Lytton Springs, Sonoma County.
Castalian Mineral Water, Inyo County.
El Moro Mineral Spring, El Moro, San Luis Obispo County.
Geyser Soda Spring, Lytton Springs, Sonoma County.
Napa Soda Springs, Napa Soda Springs, Napa County.
Ojai Hot Springs, Matilija, Ventura County.
Pacific Congress Springs, Saratoga, Santa Clara County.
Shasta Mineral Spring, Shasta Springs, Siskiyou County.
Tolenas Soda Spring, Fairfield, Solano County.
Tuscan Springs, Red Bluff, Tehama County.

COLORADO.

The total number of springs for 1894 is 9, 1 spring being added to the list of 1893. Of these the following 4 report:

Canyon City Vichy Springs, Canyon City, Fremont County.
Carlile Soda and Iron Springs, near Pueblo, Pueblo County.
Colorado Carlsbad Springs, Barr, Arapahoe County.
Manitou Mineral Springs, Manitou, El Paso County.

CONNECTICUT.

One new spring is included in the total of 7 springs for Connecticut, and the following 3 report sales for 1894:

Althea Spring, Waterbury, New Haven County.
Oxford Chalybeate Spring, Oxford, New Haven County.
Puritan Spring, Norwich, New London County.

FLORIDA.

But 1 spring in Florida reports sales, viz:

Magnolia Springs, Magnolia Springs, Clay County.

GEORGIA.

There is no change in the list for Georgia. Of the 3 springs only the following 2 report sales in 1894:

Bowden Lithia Springs, Lithia Springs, Douglas County.
Hughes Mineral Spring, near Rome, Floyd County.

IDAHO.

The only spring in Idaho reporting sales is:

Idanha Spring, Soda Springs, Bannock County.

ILLINOIS.

The list for Illinois has increased by the addition of 2 springs, the total being 12. Of these the following 10 report:

American Carlsbad, Nashville, Washington County.
Black Hawk Springs, Rock Island, Rock Island County.
Diamond Mineral Spring, Grant Fork, Madison County.
Glen Flora Springs, Waukegan, Lake County.
Greenup Mineral Spring, Greenup, Cumberland County.
Perry Springs, Perry Springs, Pike County.
Red Avon Mineral Springs, Avon, Fulton County.
Sailor Springs, Sailor Springs, Clay County.
Sanicula Springs, Ottawa, La Salle County.
Tivoli Spring, Chester, Randolph County.

INDIANA.

The list for Indiana is increased by 1 new spring, making the total 11. Nine of these report for 1894:

Barnard's Spring, Martinsville, Morgan County.
Emerald Spring, Indiana Mineral Springs, Warren County.
French Lick Springs, French Lick, Orange County.
Indiana Mineral Springs, Indiana Mineral Springs, Warren County.
Kickapoo Magnetic Springs, Kickapoo, Warren County.
King's Mineral Springs, Muddy Fork, Clark County.
Lodi Artesian Well, Silverwood, Fountain County.
Magnetic Mineral Springs, Terre Haute, Vigo County.
West Baden Springs, West Baden, Orange County.

IOWA.

One new spring is added, making 7 springs for the State. Of these, 4 report, viz:

Colfax Mineral Spring, Colfax, Jasper County.
Mynster Springs, Council Bluffs, Pottawattamie County.
Siloam Springs, Iowa Falls, Hardin County.
White Sulphur Spring, White Sulphur, Scott County.

KANSAS.

One spring is dropped from the list for Kansas, and of the remaining 7 only 3 report sales for 1894. They are:

Blazing's Natural Medical Spring, Manhattan, Riley County.
Geuda Mineral Springs, Geuda Springs, Cowley County.
Jewell County Lithium Spring, Montrose, Jewell County.

KENTUCKY.

One spring is added to the list, and all the springs, 6 in number, report. They are:

Anita Springs, La Grange, Oldham County.
Bedford Springs, Bedford, Trimble County.
Blue Lick Springs, Blue Lick Springs, Nicholas County.
Crab Orchard Springs, Crab Orchard, Lincoln County.
St. Patrick's Well, Louisville, Jefferson County.
Upper Blue Lick Springs, Blue Lick Springs, Nicholas County.

LOUISIANA.

No reports have been received from the State of Louisiana.

MAINE.

The total number of springs for Maine is increased by 2, making 14 in all. Of these, the following 10 report:

Cold Bowling Spring, Steep Falls, Limington, York County.
Crystal Springs, Auburn, Androscoggin County.
Keystone Spring, East Poland, Androscoggin County.
Oxford Mineral Spring, Oxford, Oxford County.
Paradise Spring, Brunswick, Cumberland County.
Poland Spring, South Poland, Androscoggin County.
Pownal Spring, New Gloucester, Cumberland County.
Underwood Springs, Falmouth Foreside, Cumberland County.
Wilson Spring, North Raymond, Cumberland County.
Windsor Mineral Spring, Lewiston, Androscoggin County.

MARYLAND.

One spring is taken from the list for Maryland, leaving 5, all of which report. They are:

Carroll Spring, Forest Glen, Montgomery County.
Chattolanee Springs, Baltimore County.
Mardela Springs, Wicomico County.
Strontia Mineral Spring, Brooklandville, Baltimore County.
Takoma Springs, Takoma, Montgomery County.

MASSACHUSETTS.

Two springs are dropped from the list for Massachusetts, leaving the total for the State at 27, of which 25 report, as follows:

Ballardville Lithia Spring, Lowell, Middlesex County.
Belmont Hill Spring, Everett, Middlesex County.
Belmont Natural Spring, Belmont, Middlesex County.
Blue Hill Silver Spring, Milton, Norfolk County.
Burnham Spring, Methuen, Essex County.
Columbia Lithia Spring, Revere, Suffolk County.
Commonwealth Mineral Spring, Waltham, Middlesex County.
Crystal Spring, Stoughton, Norfolk County.
Crystal Mineral Spring, Methuen, Essex County.
Crystal Mineral Spring, Stoneham, Middlesex County.
Diamond Spring, Lawrence, Essex County.
Electric Spring, Lynn, Essex County.
Everett Crystal Spring, Everett, Middlesex County.
Fulton Natural Spring, Medford, Middlesex County.
Goulding Spring, Whitman, Plymouth County.
Harvard Crystal Spring, Allston, Suffolk County.
Indian Spring, Brighton, Suffolk County.
Leland Mineral Spring, Lowell, Middlesex County.
Massasoit Spring, Springfield, Hampden County.
Middlesex Mountain Spring, Malden, Middlesex County.
Moose Hill Spring, Swampscott, Essex County.
Nobscot Mountain Spring, Framingham, Middlesex County.
Robbins Spring, Arlington, Middlesex County.
Sheep Rock Spring, Lowell, Middlesex County.
Simpson Spring, South Easton, Bristol County.

MICHIGAN.

Five springs new to the list for Michigan increase the total to 15. Of these the following 13 report sales for 1894:

Americanus Spring, Lansing, Ingham County.
Blue Rock, Grand Rapids, Kent County.
Clarke Red Cross Well, Big Rapids, Mecosta County.
Eastman Springs, Benton Harbor, Berrien County.
Magnetic Mineral Springs, Spring Lake, Ottawa County.
Medea Spring, Mount Clemens, Macomb County.
Moorman Well, Ypsilanti, Washtenaw County.
Mount Clemens Pagoda Spring, Mount Clemens, Macomb County.
Mount Clemens Sprudel Water, Mount Clemens, Macomb County.
Plymouth Rock Well, Plymouth, Wayne County.
Salutaris Spring, St. Clair Springs, St. Clair County.
Ypsilanti Mineral Spring, Ypsilanti, Washtenaw County.
Zauber Wasser, Hudson, Lenawee County.

MINNESOTA.

Two springs are added to the list, and all of the springs for the State, 3 in number, report sales for 1894. They are:

Indian Medical Spring, Elk River, Sherburne County.
Inglewood Spring, Minneapolis, Hennepin County.
Mankato Mineral Springs, near Mankato, Blue Earth County.

MISSISSIPPI.

There is no change in the list for Mississippi for 1894. The 5 springs credited to the State all report. They are:

Brown's Wells, Brown's Wells, Copiah County.
Castalian Springs, Durant, Holmes County.
Godbold Mineral Well, Summit, Pike County.
Robinson Mineral Spring, Madison County.
Stafford Mineral Springs, near Vosburg, Jasper County.

MISSOURI.

Two springs are taken from the list. Of the 8 remaining springs the following 6 report:

B. B. Mineral Springs, Bowling Green, Pike County.
Blue Lick Springs, Blue Lick, Saline County.
Eldorado Springs, Cedar County.
Excelsior Springs, Excelsior Springs, Clay County.
Lineville Mineral Springs, Mercer County, near Lineville, Iowa.
Randolph Springs, Randolph Springs, Randolph County.

MONTANA.

The only spring reporting from Montana is:

Lisner's Mineral Springs, Helena, Lewis and Clarke County.

NEBRASKA.

The State of Nebraska is represented on the list by 1 spring, viz:

Victoria Mineral Springs, New Helena, Custer County.

NEW HAMPSHIRE.

Three springs are credited to New Hampshire. Of these 2 report, as follows:

Londonderry Lithia Spring, Londonderry, Rockingham County.
Pack Monadnock Lithia Spring, Temple, Hillsboro County.

NEW JERSEY.

No change is noted in New Jersey. It is still represented on the list by—

Kalium Springs, Collingswood, Camden County.

NEW MEXICO.

Only 2 of New Mexico's 4 springs make a report. They are:

Harsch's Iron Springs, Coyote Canyon, Bernalillo County.
Ojo Caliente Spring, Ojo Caliente, Taos County.

NEW YORK.

Four springs are added to the list for New York, bringing the total up to 29. Of these 22 report as follows:

Avon Sulphur Spring, Avon, Livingston County.
A. D. Ayer Amherst Mineral Springs, near Williamsville, Erie County.
Boonville Mineral Springs, Boonville, Oneida County.
Cayuga Water, Cayuga, Cayuga County.
Colonial Mineral Springs, West Deer Park, Suffolk County.
Deep Rock Springs, Oswego, Oswego County.
Esperanza Mineral Springs, Lake Keuka, Yates County.
Massena Springs, Massena, St. Lawrence County.
Saratoga Springs, Saratoga County:
  Champion Spring.
  Empire Spring.
  Excelsior Spring.
  Hathone Spring.
  Old Putnam Spring.
  Royal Spring.
  Saratoga Carlsbad Spring.
  Saratoga Imperial Spring.
  Saratoga Kissingen Spring.
  Saratoga Vichy Spring.
  Saratoga Victoria Spring.
  Union Spring.
Sulphur Springs, Richfield Springs, Otsego County.
Table Rock Mineral Spring, Honeoye Falls, Monroe County.
White Sulphur Spring, Sharon Springs, Schoharie County.

NORTH CAROLINA.

There is no change in the list for North Carolina. Eight of the 10 springs report. They are:

Ashley Bromine and Arsenic Spring, Ashe County.
Barium Springs, Barium Springs, Iredell County.
Lemon Springs, Lemon Springs, Moore County.
Park Spring, Caswell County, near Danville, Va.
Panacea Springs, Warren County.
Seven Springs, Seven Springs, Wayne County.
Shaw's Healing Springs, Littleton, Halifax County.
Thompson's Bromine Arsenic Springs, Crumpler, Ashe County.

OHIO.

One spring is dropped from the list and 2 are added, so the total for the State is 12. Of these 11 report:

Crum Mineral Springs, Austintown, Mahoning County.
Crystal Rock Spring, Erie County.
Devonian Mineral Spring, Lorain, Lorain County.
Magnetic and Saline Spring, Marysville, Union County.
Musteash Spring, Erie County.
Oak Ridge Spring, Green Spring, Seneca County.
Puritas Mineral Springs, Rockport, Cuyahoga County.
Purtlebaugh Mineral Springs, Urbana, Champaign County.
Rex Mineral Spring, New Richmond, Clermont County.
Ripley Bromo-Lithia Natural Spring, Ripley, Brown County.
Sulphur Lick Springs, Anderson, Ross County.

OREGON.

Both of Oregon's springs report for 1893. They are:

Siskkiyou Spring, Soda Springs, Jackson County.
Wilhoit Springs, Wilhoit, Clackamas County.

PENNSYLVANIA.

Two springs added to the list for Pennsylvania bring the total up to 17. Thirteen report for 1894. They are:

Alicia Mineral Spring, Penfield, Clearfield County.
Apollo Springs, Pine Run, Westmoreland County.
Bedford Mineral Spring, Bedford, Bedford County.
Black Barren Mineral Spring, Pleasant Grove, Lancaster County.
Cresson Springs, Cresson, Cambria County.
Eureka Springs, Saegertown, Crawford County.
Gettysburg Katalysine Spring, Gettysburg, Adams County.
Gray Spring, Cambridgeboro, Crawford County.
Parker Mineral Spring, Gardeau, McKean County.
Pavilion Spring, Wernersville, Berks County.
Pulaski Natural Mineral Springs, Pulaski, Lawrence County.
Rush Spring, Rush, Susquehanna County.
Sizerville Magnetic Mineral Spring, Sizerville, Cameron County.

RHODE ISLAND.

The 3 springs on our list for Rhode Island all report. They are:

Gladstone Spring, Narragansett Pier, Washington County.
Holly Spring, Woonsocket, Providence County.
Ochee Mineral and Medical Springs, Johnson, Providence County.

SOUTH CAROLINA.

One spring is dropped from the list and 2 added, making the present number of springs 4. Of these 3 report as follows:

Chicks Springs, Chicks Springs, Greenville County.
Chicora Artesian Well, Chicora, Berkeley County.
Harris Lithia Spring, Waterloo, Laurens County.

SOUTH DAKOTA.

There is no change in the list for South Dakota. The 1 spring credited to the State is:

Hot Springs of South Dakota, Hot Springs, Fall River County.

TENNESSEE.

One spring is taken from the list, leaving the total 5, of which the following 3 report:

Idaho Springs, St. Bethlehem, Montgomery County.
Red Boiling Springs, Red Boiling Springs, Macon County.
Tate Epsom Springs, Tate Spring, Grainger County.

TEXAS.

There is no change from 1893 in the list of springs for Texas. Of the 13 credited to the State 12 report. They are:

Capp's Well, Longview, Gregg County.
Dalby Springs, Dalby Springs, Bowie County.
Elkhart Mineral Wells, Elkhart, Anderson County.
Georgetown Mineral Water, Georgetown, Williamson County.
Mineral Wells, Mineral Wells, Palo Pinto County.
Montvale Springs, Marshall, Harrison County.
Overall Mineral Wells, Franklin, Robertson County.
Rockdale Mineral Wells, Rockdale, Milam County.
Slack's Wells, Fayette County, near Waelder, Gonzales County.
Texas Sour Springs, Luling, Caldwell County.
Tioga Mineral Wells, Grayson County.
Wootan Wells, Wootan Wells, Robertson County.

UTAH.

One new spring appears on the list for Utah. Both of the springs now on the list report. They are:

Castilla Hot Spring, Spanish Fork Canyon, Utah County.
Wasatka Springs, Salt Lake City, Salt Lake County.

VERMONT.

One spring is dropped from the list, and of the 4 remaining 3 report as follows:

Clarendon Springs, Clarendon Springs, Rutland County.
Equinox Spring, Manchester, Bennington County.
Missisquoi Mineral Springs, Sheldon, Franklin County.

VIRGINIA.

Five springs, new to the list for 1894, increase Virginia's total to 34 springs. Of these, 30 report, as follows:

Blue Ridge Springs, Botetourt County.
Buffalo Lithia Springs, Buffalo Lithia Springs, Mecklenburg County.
Chase City Mineral Springs, Chase City, Mecklenburg County.
Cove Lithia Springs, near Wytheville, Wythe County.
Crockett Arsenic Lithia Spring, Shawsville, Montgomery County.
Farmville Lithia Springs, Cumberland County, near Farmville, Prince Edward County.
Harris Anti-Dyspeptic and Tonic Spring, Burkeville, Nottoway County.
Healing Springs, Healing Springs, Bath County.
Iron Lithia Springs, Tip Top, Tazewell County.
Jordan White Sulphur Spring, Stephenson, Frederick County.
Lake Como Lithia Spring, Henrico County.
Massanetta Springs, Harrisonburg, Rockingham County.
Nye Lithia Springs, Wytheville, Wythe County.
Osceola Springs, near Pleasant Valley, Rockingham County.
Otterburn Lithia and Magnesia Springs, Amelia Court House, Amelia County.
Paeonian Springs, Loudoun County.

Powhatan Lithia and Alum Springs, Tobaccoville, Powhatan County.
Pine Mountain Springs, Washington County.
Rawley Springs, Rawley Springs, Rockingham County.
Roanoke Red Sulphur Spring, Catawba, Roanoke County.
Rockbridge Alum Springs, Goshen Bridge, Rockbridge County.
Seawright Magnesian Lithia Spring, Staunton, Augusta County.
Seven Springs, near Glade Spring, Washington County.
Shenandoah Alum Springs, Shenandoah Alum Springs, Shenandoah County.
Steephill Ferro-phospho-magnesium Spring, North Staunton, Augusta County.
Swineford's Arsenic Lithia Springs, Osceola.
Virginia Magnesian Alkaline Springs, near Staunton, Augusta County.
Virginia Waukesha Lithia Springs, Staunton, Augusta County.
Wallawhatoola Alum Springs, near Millboro Spring, Bath County.
Wolf Trap Lithia Springs, Wolf Trap, Halifax County.

WASHINGTON.

The list for the State of Washington remains unchanged. The 3 springs of the State all report. They are:

Cascade Springs, near Cascades, Skamania County.
Medical Lake, Medical Lake, Spokane County.
Yakima Soda Spring, near North Yakima, Yakima County.

WEST VIRGINIA.

Six of West Virginia's 7 springs report sales for 1894. They are:

Borland Springs, Bull Creek, Wood County.
Capon Springs, Capon Springs, Hampshire County.
Irondale Springs, Independence, Preston County.
Salt Sulphur Springs, Salt Sulphur Springs, Monroe County.
Triplet Well, Calf Creek, Grant District, Pleasants County.
White Sulphur Springs, White Sulphur Springs, Greenbrier County.

WISCONSIN.

The number of springs for Wisconsin shows a net gain of 2, 3 springs being added to the list and 1 dropped. Of the 26 springs credited to the State 21 report. They are:

Allouez Mineral Springs, Green Bay, Brown County.
Bethania Mineral Spring, Osceola, Polk County.
Fort Crawford Springs, Prairie du Chien, Crawford County.
Great Geyser Spring, Palmyra, Jefferson County.
Lebens Wasser, Green Bay, Brown County.
Nee-Ska-Ra Mineral Spring, Wauwatosa, Milwaukee County.
Salvator Springs, Green Bay, Brown County.
Shealtiel Springs, Waupaca, Waupaca County.
Sheboygan Spring, Sheboygan, Sheboygan County.
Silver Sand Spring, Milwaukee, Milwaukee County.
Sparkling Spring, Milwaukee, Milwaukee County.
St. John Mineral Spring, Green Bay, Brown County.
Wautoma Mineral Spring, Waushara County.
Waukesha Springs, Waukesha County:
    Almanaris Springs.
    Arcadian Spring.
    Bethesda Mineral Spring.

Waukesha Springs, Waukesha County—Continued.
- Fountain Spring.
- Horeb Spring.
- Siloam Spring.
- Waukesha Hygeia Mineral Spring.
- Silurian Mineral Spring.

Summary of reports of mineral springs for 1894.

States and Territories.	Springs reporting.	Springs not reporting.	Total used commercially.	States and Territories.	Springs reporting.	Springs not reporting.	Total used commercially.
NORTH ATLANTIC STATES.				NORTH CENTRAL STATES.			
Maine	10	4	14	Ohio	11	1	12
New Hampshire	2	1	3	Indiana	9	2	11
Vermont	3	1	4	Illinois	10	2	12
Massachusetts	25	2	27	Michigan	13	2	15
Rhode Island	3	0	3	Wisconsin	21	5	26
Connecticut	3	4	7	Minnesota	3	0	3
New York	23	6	29	Iowa	4	3	7
New Jersey	1	0	1	Missouri	6	2	8
Pennsylvania	13	4	17	North Dakota	0	0	0
				South Dakota	1	0	1
SOUTH ATLANTIC STATES.				Nebraska	1	0	1
				Kansas	3	4	7
Delaware	0	0	0				
Maryland	5	0	5	WESTERN STATES AND TERRITORIES.			
District of Columbia	0	0	0				
Virginia	30	4	34				
West Virginia	6	1	7	Alaska	0	0	0
North Carolina	8	2	10	Wyoming	0	0	0
South Carolina	3	1	4	Montana	1	1	2
Georgia	2	1	3	Colorado	4	5	9
Florida	1	1	2	New Mexico	2	2	4
				Arizona	0	0	0
SOUTH CENTRAL STATES.				Utah	2	0	2
				Nevada	0	0	0
Kentucky	6	0	6	Idaho	1	0	1
Tennessee	3	2	5	Washington	3	0	3
Alabama	4	1	5	Oregon	2	0	2
Mississippi	5	0	5	California	14	5	19
Louisiana	0	1	1				
Texas	12	1	13	Totals	286	71	357
Indian Territory	0	0	0				
Arkansas	7	0	7				
Oklahoma	0	0	0				

IMPORTS AND EXPORTS.

Prior to 1884 the Treasury Department did not distinguish natural mineral waters from those that were artificial; since 1883 the distinction has been made, but the artificial waters have not been classified according to the receptacles in which they have been imported. The importation is shown in the two tables following, with a table of exports appended:

Mineral waters imported and entered for consumption in the United States, 1867 to 1883, inclusive.

Fiscal years ended June 30—	In bottles of 1 quart or less.		In bottles in excess of 1 quart.		Not in bottles.		All, not artificial.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Bottles.		*Quarts.*		*Gallons.*		*Gallons.*		
1867	370, 610	$24, 913	3, 792	$360		$137			$25, 410
1868	241, 702	18, 438	22, 819	2, 052	554	104			20, 594
1869	344, 691	25, 635	9, 739	802	1, 042	245			26, 682
1870	433, 212	30, 680	18, 025	1, 743	2, 063	508			32, 931
1871	470, 947	34, 604	2, 320	174	1, 336	141			34, 919
1872	892, 913	67, 951			639	116			68, 067
1873	35, 508	2, 326			355	75	394, 423	$98, 151	100, 552
1874	7, 238	691			95	16	199, 035	79, 789	80, 496
1875	4, 174	471			5	2	395, 956	101, 640	102, 113
1876	25, 758	1, 899					447, 646	134, 889	136, 788
1877	12, 965	1, 328				22	520, 751	167, 458	168, 808
1878	8, 229	815					883, 674	350, 912	351, 727
1879	28, 440	2, 352			3	4	798, 107	282, 153	284, 509
1880	207, 554	19, 731					927, 759	285, 798	305, 529
1881	150, 326	11, 850			55	26	1, 225, 462	383, 616	395, 492
1882	152, 277	17, 010					1, 542, 905	410, 105	427, 115
1883	88, 497	7, 054					1, 714, 085	441, 439	448, 493

Imports for years 1884 to 1894.

Years ended—	Artificial mineral waters.		Natural mineral waters.	
	Gallons.	Value.	Gallons.	Value.
June 30, 1884	29, 366	$4, 591	1, 505, 298	$362, 651
1885	7, 972	2, 157	1, 660, 072	397, 875
Dec. 31, 1886	62, 464	16, 815	1, 618, 960	354, 242
1887	13, 885	4, 851	1, 915, 511	385, 906
1888	12, 752	4, 411	1, 716, 461	341, 695
1889	36, 494	8, 771	1, 558, 968	368, 661
1890	22, 328	7, 133	2, 322, 008	433, 281
1891	26, 700	8, 700	2, 019, 833	392, 894
1892	16, 052	9, 089	2, 266, 123	497, 660
1893	6, 086	2, 992	2, 321, 081	506, 866
1894	7, 753	3, 047	1, 891, 964	417, 500

Exports of natural mineral waters, of domestic production, from the United States.

Fiscal years ending June 30—	Value.	Fiscal years ending June 31—	Value.
1875	$162	1881	$1, 029
1876	80	1882	421
1879	1, 529	1883	*a* 459
1880	1, 486		

a None reported since 1883.

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