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Mineral Resources of the United States, 1892.

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To the Director of the
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Washington, D. C., *October, 1893.*

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Washington, D. C.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
J. W. POWELL, DIRECTOR

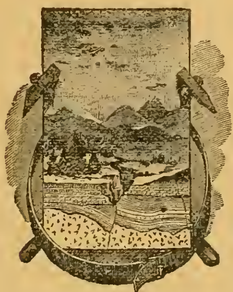
MINERAL RESOURCES

OF THE

UNITED STATES

CALENDAR YEAR
1892

DAVID T. DAY
CHIEF OF DIVISION OF MINING STATISTICS AND TECHNOLOGY



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CONTENTS.

LETTER OF TRANSMITTAL.

WASHINGTON, D. C., *September 30, 1893.*

SIR: I have the honor to transmit herewith a report which constitutes the ninth annual volume of the series "Mineral Resources of the United States." This volume bears the title "Mineral Resources of the United States, 1892." In this report the statistics of mineral production are carried forward to the close of 1892, although the accompanying descriptive matter has been brought up to the latest date possible in 1893.

The important chapters have been published in advance. In accordance with your instructions a report covering the statistics of 1893 is in active preparation.

Very respectfully, your obedient servant,

DAVID T. DAY,
Geologist in Charge.

Hon. J. W. POWELL,
Director U. S. Geological Survey.

INTRODUCTION.

This volume is intended to show the progress made in the development of the mineral resources of the United States in 1892. The statistical tables of previous years are carried forward from former reports of the series, of which this is the ninth. For general information concerning any mineral the volumes should be consulted together.

ARRANGEMENT.

As in preceding volumes the book is divided by mineral topics, which take the place of chapters. These are so arranged as to bring kindred subjects together.

UNITS.

The most customary units in the trades are used. The objection to the great diversity of units thus occasioned is acknowledged, but the system is the best one for those most interested.

ACKNOWLEDGMENTS.

This work is the result of a census conducted by the principal experts in each subject. Their names are usually given at the head of the chapters which they contribute.

Especial acknowledgments are due, first, to the producers, who, as a rule, place their confidential returns at the disposal of the Survey, and many of whom devote much valuable time to special inquiries as to the condition of trade.

The Bureau of Statistics of the Treasury Department is to be credited with all the statistics of imports and exports.

MINERAL RESOURCES OF THE UNITED STATES.

SUMMARY.

Totals.—The values given below for the various mineral products are those most commonly used in the trade. For the metals values are usually represented delivered at some prominent trade center. For the others "spot" values are taken; *i. e.*, aboard cars at the mine and in the condition in which the materials first become articles of sale. Summing these values it is seen that the total value is $685,377,383. This is the highest value the mineral products have ever aggregated. It represents a still greater aggregate of quantities, for prices ruled lower than in 1891. With the prices of 1891 the total value would have exceeded $700,000,000. The effect of low prices will be felt in reduced production in 1893, although the several items concerning the production during the first six months of 1893 do not show as great a reduction as would naturally be expected.

METALS.

Iron and steel.—The quantity of pig iron produced in 1892 was 9,157,000 long tons. This is an increase of nearly 1,000,000 tons over 1891 and almost equal to the great output of 1890. Owing to the general decline in prices, the total value, $131,161,039, was only slightly greater than for the much smaller product in 1891. The product of steel of all kinds aggregated 4,927,581 long tons. The limestone consumed as iron flux amounted to 5,172,114 long tons, valued at $3,620,480.

The production of cut nails decreased from 5,002,176 kegs in 1891 to 4,507,819 kegs in 1892, while the wire nail product increased from 4,114,385 kegs to 4,719,524 kegs, exceeding the product of cut nails over 200,000 kegs. This is the first time that the production of wire nails has been greater than that of cut nails.

In the first six months of 1893, 4,562,918 long tons of pig iron were made. The production of Bessemer pig iron in the same time was 2,374,890 long tons, the largest half-yearly production in the history of the trade. The production of Bessemer steel ingots during the first half of 1893 was 2,092,057 long tons, against 2,058,928 long tons in the first half of 1892.

Iron ore.—During 1892 the United States produced 16,296,666 long tons of iron ore, continuing to lead the world in this regard. The product consisted of 11,646,619 tons of red hematite, 2,485,101 tons of brown hematite, 1,971,965 tons of magnetite, and 192,981 tons of carbonate.

Precious metals.—The product of both gold and silver decreased slightly; gold, 1,596,375 fine ounces (troy), with a coining value of $33,000,000; silver, 55,000,000 ounces, with a coining value of $74,989,900.

Copper.—The product was 353,275,742 pounds—the greatest ever recorded in this country. It exceeded the product of 1891 by 57,465,676 pounds. In both 1891 and 1892 the value of the copper product has exceeded that of gold. Prices were lower and averaged 10.75 cents per pound for the year. This considers all grades of new copper.

Lead.—The lead product was unprecedented. It amounted to 213,262 short tons, worth at the average New York price $17,060,960. The product in 1891 was 202,406 short tons, worth $17,609,322. As in 1891, the increase was in desilverized lead. During the first six months of 1893 the gross production of lead was at an even greater rate than in 1892. For the six months it aggregated 111,926 short tons, which includes 12,230 of foreign base bullion refined in bond.

Zinc.—As with other metals, the zinc product exceeded all former years. It aggregated 87,260 short tons, against 80,337 tons in 1891. During the first six months of 1893, 45,794 short tons were produced, a slight increase over the product, 45,499 short tons, for the corresponding six months of 1892.

Quicksilver.—The product shows a marked increase due to more active work at the northern California mines. The total product was 27,993 flasks, worth in San Francisco $1,245,689, against 22,904 flasks in 1891, worth $1,036,386. Prices have not changed markedly.

Aluminum.—Production is increasing rapidly. In 1891 150,000 pounds, worth $100,000, were produced. In 1892 this increased to 259,885 pounds, worth $172,824.

Nickel and cobalt.—The nickel product from United States ores decreased from 118,498 pounds in 1891 to 92,252 pounds in 1892. This all came from the Lancaster Gap mine, Pennsylvania. The principal feature of the nickel industry is the refining of Canadian matte, by which more than one million pounds of nickel were converted into oxide and sold chiefly for making nickel steel. A small part was subsequently converted into metallic nickel.

The production of cobalt oxide amounted to 7,869 pounds compared with 7,200 pounds in 1891. The value decreased from $18,000 in 1891 to $15,738 in 1892.

Tin.—Tin was produced in California to the amount of 162,000 pounds. Besides this a considerable quantity of concentrates was collected at

Hill City, South Dakota, as the result of experiments with the new mill. The production of tin plate from July 1, 1891, to December 31, 1892, was 14,289,696 pounds, and of terne plates 30,066,239 pounds.

Antimony.—The product is gradually increasing. In 1892 150 tons of metallic antimony were produced, worth $30,000. In addition to this, 380 tons of ore, worth $26,466, were shipped to England. In 1891, 278 tons were produced, worth $47,007.

Platinum.—The product in the United States is insignificant, amounting to 80 ounces, worth $5.50 per ounce. This was produced with placer gold.

FUELS.

Coal.—The product of all kinds of coal in 1892 was 160,115,242 long tons, or 179,329,071 short tons, valued at $207,566,381. It consisted of 46,850,450 long tons, or 52,472,504 short tons of Pennsylvania anthracite coal, valued at $82,442,000, and of 113,264,792 long tons, or 126,856,567 short tons of bituminous coal, worth $125,124,381. In the latter product is included small amounts of anthracite from Colorado, New Mexico, and Virginia, and all lignite and cannel coals. The notable feature of the year was the advance in the price of Pennsylvania anthracite, which rose from $1.79 in 1891 to $1.92 in 1892. The price of bituminous coal remained about the same.

Coke.—The amount of coke produced in 1892 was 12,010,829 short tons, valued at $23,536,141. The amount of coal consumed in its production was 18,813,337 short tons, the average yield of the coal in coke being 64 per cent. The product in 1891 was 10,352,688 short tons, worth $20,393,216.

Petroleum.—The product in 1891 was the greatest since production began, *i. e.*, 54,291,980 barrels of 42 gallons each, worth $30,526,553. In 1892 this declined to 50,509,136 barrels, worth $25,901,436. The feature of 1892 was the development of the Sistersville pool in Pennsylvania and Ohio. During the first six months of 1893 the production has indicated a slightly greater decline than in 1892.

Natural gas.—The product is declining and the price is increasing. The value of the product in 1891 was $15,500,084. In 1892 this declined to $14,800,714.

MISCELLANEOUS.

Building stone.—In spite of strikes among the quarrymen in New England, the year's product was slightly greater than in 1891. The total value of all kinds of stone for structural purposes aggregated $48,706,625, against $47,294,746 in 1891. The granite amounted to $12,627,000; sandstone, $8,265,500; bluestone, $1,600,000; limestone for building purposes, $18,392,000; marble, $3,705,000; and slate, $4,117,125. In addition 65,000,000 barrels of lime were produced, valued at $40,000,000.

Feldspar.—The demand is proportional to the use of clay by the potters. In 1892 15,000 tons were produced, worth $75,000.

Flint.—This is the general term for the silica used by potters. The product amounted to 20,000 long tons, worth $80,000, ground ready for use.

Clay.—The use of domestic clays in the potteries is increasing slowly, compared to the possibilities of the known deposits. In 1892 the amount of clays utilized was 420,000 tons, valued at $1,000,000.

Cement.—Product in 1892, 8,758,621 barrels, valued at $7,152,750. Of this 8,211,181 barrels of 300 pounds each came from natural rock, and 547,440 barrels (of 400 pounds each) were artificial, or Portland cement.

Precious stones.—The finds in 1892 amounted to $299,000 in the condition in which they were first sold. This is an increase from $235,500 in 1891. The product in the future will be larger, due to more systematic mining. The opals found in Owyhee county, Idaho, have proved very valuable. Many have been sold for from $5 to $40 per carat.

Phosphate rock.—Total product, 681,571 long tons, valued at the mines at $3,296,227, of which Florida contributed 287,343 long tons, worth $1,418,418, and South Carolina 394,228 long tons, worth $1,877,-709. This is a marked gain in quantity at a significantly lower price.

Buhrstones.—Millstones are produced in New York, Pennsylvania, and Virginia to supply an irregular demand from some of the grinders of corn, paints, etc. In 1892 the product increased to a value of $23,417 from $16,587 in 1891.

Grindstones.—The Berea grit sandstones of northern Ohio furnish most of the grindstones, which were valued at $272,000 in 1892 and at $476,113 in 1891.

Whetstones.—Total value, $148,730, a slight decrease from the product of 1891. The product includes novaculite from Hot Springs, Arkansas, and other whetstones from Pike Station, New Hampshire, and French Lick, Indiana.

Corundum.—The output consisted of 321 short tons of corundum and 1,450 tons of emery, the total value of which was $181,300.

Marls.—Product, 125,000 long tons, worth $65,000, a decline from 135,000 tons in 1891.

Asphaltum.—Total product, 36,680 long tons, worth $292,375. The sources of supply are unchanged. California contributes most, in the form of bituminous rock. The decrease from 45,054 tons in 1891 is due to the diminished output in Utah.

Salt.—Product, 11,698,890 barrels (of 280 pounds), worth at the point of production $5,654,915. This is an increase from 9,987,945 tons in 1891.

Bromine.—Product, 379,480 pounds, worth $64,502, an increase from 343,000 pounds in 1891.

Sulphur.—Product from Utah and Nevada, 2,688 short tons, worth, principally for sheep dip, $80,640.

Pyrites.—Product from Virginia and Massachusetts, 122,963 short tons, worth $305,191.

Graphite.—The product is still from New York State and was valued at $87,902 in 1892, against $110,000 in 1891.

Mineral paints.—Including ocher, the iron oxides sold as "metallic paints" and small amounts of umber, sienna, Venetian reds, mineral black, and soapstone ground for pigment, the product aggregated 54,513 long tons, worth $789,263, which is more than the quantity produced in the previous year and a significant gain in value.

Included in the above is a product of 3,787 long tons of ground slate, worth $23,523, an increase from 2,000 tons in 1891.

Zinc white.—Product 27,500 short tons; value $2,200,000. This represents a steady increase in production. In the first six months of 1893 the product decreased, *i. e.*, 12,700 short tons. The price is constant.

Chrome iron ore.—The industry is depressed, as it has been for several years. Product in 1892, 1,500 long tons, worth in San Francisco $25,000.

Lithographic stone.—The known deposits in Virginia, Tennessee, Kentucky, Texas, and Arizona, are not yet marketed, partly on account of lack of transportation facilities.

Barytes.—The product from the usual sources, Missouri and Virginia, increased from 31,069 long tons in 1891 to 32,108 long tons in 1892. The total value was $118,363 in 1891 and $130,025 in 1892.

Gypsum.—The product was greater in 1892 than ever before; 256,259 short tons valued at $695,492. The product in 1891 was 208,126 long tons, worth $628,051.

Infusorial earth.—The demand is easily supplied from deposits in Maryland, Nevada and New Hampshire, from which an amount valued at $43,655 was produced in 1892. This is about the average for the past few years.

Asbestos.—The California deposit spoken of in previous reports, with small lots from Oregon and Wyoming, yielded 104 tons, worth $6,416.

Rutile.—The makers of porcelain teeth use about 200 pounds a year of this material as coloring matter. Purchases of 1891 left a surplus, so that only 100 pounds were bought in 1892. It is found principally in eastern Pennsylvania.

Fluorspar.—The product is slowly increasing, especially for use as a flux. In 1892 12,250 short tons were sold from the Rosiclare deposits in southwestern Illinois. The product was valued at $89,000.

Borax.—The product amounted in 1892 to 13,500,000 pounds, worth $900,000 in San Francisco.

Soapstone.—Product 23,208 short tons, worth $423,449. This is a considerable increase beyond the usual product, which in 1891 was 16,514 short tons, worth $243,981.

Fibrous talc from Gouveneur, New York, was produced to the amount of 41,925 short tons, worth $472,485.

Mineral waters.—The product which actually sold amounted to 21,876,604 gallons, worth $4,905,970, an increase from 18,392,732 gallons in 1891, worth $2,996,259.

Mica.—Product 75,000 pounds, worth $100,000. The industry is unchanged.

Metallic products of the United States in 1892.

Products.	Quantity.	Value.
Pig iron .... long tons..	9,157,000	$131,161,039
Silver .... troy ounces..	55,000,000	74,989,900
Gold .... do....	1,596,375	33,000,000
Copper .... pounds..	353,275,742	37,977,142
Lead .... short tons..	213,262	17,060,960
Zinc .... do....	87,260	9,027,920
Quicksilver .... flasks..	27,993	1,245,689
Nickel .... pounds..	92,252	50,739
Aluminum .... do....	259,885	172,824
Tin .... do....	162,000	32,400
Antimony .... short tons..	*a* 359	56,466
Platinum .... troy ounces..	80	440
Total value	....	304,775,519

a Includes metal contents of ore shipped to England for smelting.

Non-metallic mineral products of the United States in 1892.

Products.	Quantity.	Value.
Bituminous coal.....long tons..	113, 264, 792	$125, 124, 381
Pennsylvania anthracite.....do....	46, 850, 450	82, 442, 000
Building stone.....	.....	48, 706, 625
Petroleum.....barrels..	50, 509, 136	25, 901, 436
Lime.....do....	65, 000, 000	40, 000, 000
Natural gas.....	.....	14, 800, 714
Cement.....barrels..	8, 758, 621	7, 152, 750
Salt.....do....	11, 698, 890	5, 654, 915
Phosphate rock.....long tons..	681, 571	3, 296, 227
Limestone for iron flux.....do....	5, 172, 114	3, 620, 480
Mineral waters.....gallons sold..	21, 876, 604	4, 905, 970
Zinc white.....short tons..	27, 500	2, 200, 000
Potters' clay.....long tons..	420, 000	1, 000, 000
Mineral paints.....short tons..	50, 726	765, 740
Borax.....pounds..	13, 500, 000	900, 000
Gypsum.....short tons..	256, 259	695, 492
Grindstones.....	.....	272, 000
Fibrous talc.....short tons..	41, 925	472, 485
Pyrites.....long tons..	122, 963	305, 191
Soapstone.....short tons..	23, 208	423, 449
Manganese ore.....long tons..	13, 613	129, 586
Asphaltum.....short tons..	36, 680	292, 375
Precious stones.....	.....	299, 000
Bromine.....pounds..	379, 480	64, 502
Corundum.....short tons..	1, 771	181, 300
Barytes (crude).....do....	32, 108	130, 025
Graphite.....pounds..	.....	87, 902
Millstones.....	.....	23, 417
Novaculite.....pounds..	.....	148, 730
Marls.....short tons..	125, 000	65, 000
Flint.....long tons..	20, 000	80, 000
Fluorspar.....short tons..	12, 250	89, 000
Chromic iron ore.....long tons..	1, 500	25, 000
Infusorial earth.....short tons..	.....	43, 655
Feldspar.....long tons..	15, 000	75, 000
Mica.....pounds..	75, 000	100, 000
Ozocerite, refined.....do....	.....	.....
Cobalt oxide.....do....	7, 869	15, 738
Slate ground as a pigment.....short tons..	3, 787	23, 523
Sulphur.....do....	2, 688	80, 640
Asbestos.....do....	104	6, 416
Rutile.....pounds..	100	300
Lithographic stone.....short tons..	.....	.....
Total value.....	.....	370, 601, 864

RÉSUMÉ.

Metals.....	$304, 775, 519
Non-metallic mineral substances named in foregoing table.....	370, 601, 864
Estimated value of mineral products unspecified.....	10, 000, 000
Grand total.....	685, 377, 383

Mineral products of the United States

	Products.	1880.		1881.	
		Quantity.	Value.	Quantity.	Value.
	METALLIC.				
1	Pig iron, value at Philadelphia.......long tons..	3,375,912	$89,315,569	4,144,254	$87,029,334
2	Silver, coining value..................troy ounces..	30,320,000	39,200,000	33,077,000	43,000,000
3	Gold, coining value..........................do....	1,741,500	36,000,000	1,676,300	34,700,000
4	Copper, value at New York City.........pounds..	60,480,000	11,491,200	71,680,000	12,175,600
5	Lead, value at New York City.......short tons..	97,825	9,782,500	117,085	11,240,160
6	Zinc, value at New York City..............do....	23,239	2,277,432	26,800	2,680,000
7	Quicksilver, value at San Francisco......flasks..	59,926	1,797,780	60,851	1,764,679
8	Nickel, value at Philadelphia............pounds..	329,968	164,984	265,668	292,235
9	Aluminum, value at Pittsburg..............do....	....	....	....	....
10	Tin..do....	....	....	....	....
11	Antimony, value at San Francisco....short tons..	50	10,000	50	10,000
12	Platinum, value (crude) at San Francisco, ...troy ounces..	100	400	100	400
13	Total value of metallic products............	....	190,039,865	....	192,892,408
	NON-METALLIC (spot values).				
14	Bituminous coal.......................long tons..	38,242,641	53,443,718	48,179,475	60,224,344
15	Pennsylvania anthracite....................do....	25,580,189	42,196,678	28,500,016	64,125,036
16	Building stone..	....	18,356,055	....	20,000,000
17	Petroleum..................................barrels..	26,286,123	24,183,233	27,661,238	25,448,339
18	Lime..do....	28,000,000	19,000,000	30,000,000	20,000,000
19	Natural gas..	....	....	....	....
20	Cement....................................barrels.	2,072,943	1,852,707	2,500,000	2,000,000
21	Salt..do....	5,961,060	4,829,566	6,200,000	4,200,000
22	Phosphate rock........................long tons..	211,377	1,123,823	266,734	1,980,259
23	Limestone for iron flux......................do....	4,500,000	3,800,000	6,000,000	4,100,000
24	Mineral waters......................gallons sold..	2,000,000	500,000	3,700,000	700,000
25	Zinc white...............................short tons..	10,107	763,738	10,000	700,000
26	Potters' clay..............................long tons..	25,783	200,457	25,000	200,000
27	Mineral paints..............................do....	3,604	135,840	6,000	100,000
28	Borax......................................pounds..	3,692,443	277,233	4,046,000	304,461
29	Gypsum...................................short tons..	90,000	400,000	85,000	350,000
30	Grindstones..	....	500,000	....	500,000
31	Fibrous talc.............................short tons..	4,210	54,730	5,000	60,000
32	Pyrites...................................long tons..	2,000	5,000	10,000	60,000
33	Soapstone...............................short tons..	8,441	66,665	7,000	75,000
34	Manganese ore..........................long tons..	5,761	86,415	4,895	73,425
35	Asphaltum...............................short tons..	444	4,440	2,000	8,000
36	Precious stones..	....	100,000	....	110,000
37	Bromine.....................................pounds..	404,690	114,752	300,000	75,000
38	Corundum.................................short tons..	1,044	29,280	500	80,000
39	Barytes (crude)..........................long tons..	20,000	80,000	20,000	80,000
40	Graphite....................................pounds..	....	49,800	400,000	30,000
41	Millstones..	....	200,000	....	150,000
42	Novaculite.................................pounds..	420,000	8,000	500,000	8,580
43	Marls......................................short tons..	1,000,000	500,000	1,000,000	500,000
44	Flint.......................................long tons..	20,000	80,000	25,000	100,000
45	Flourspar................................short tons..	4,000	16,000	4,000	16,000
46	Chromic iron ore........................long tons..	2,288	27,808	2,000	30,000
47	Infusorial earth.......................short tons..	1,833	45,660	1,000	10,000
48	Feldspar...................................long tons..	12,500	60,000	14,000	70,000
49	Mica...pounds..	81,669	127,825	100,000	250,000
50	Ozocerite, refined............................do....	....	....	....	....
51	Cobalt oxide.................................do....	7,251	24,000	8,280	25,000
52	Slate ground as a pigment.............short tons..	1,000	10,000	1,000	10,000
53	Sulphur......................................do....	600	21,000	600	21,000
54	Asbestos.....................................do....	150	4,312	200	7,000
55	Rutile.......................................pounds..	100	400	200	700
56	Lithographic stone.....................short tons..	....	....	50	1,000
57	Total value of non-metallic mineral products	....	173,279,135	....	206,783,144
58	Total value of metallic products............	....	190,039,865	....	192,892,408
59	Estimated value of mineral products unspecified.	....	6,000,000	....	6,500,000
60	Grand total..............................	....	369,319,000	....	406,175,552

for the calendar years 1880 to 1891.

1882.		1883.		1884.		1885.		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
4,623,323	$106,336,429	4,595,510	$91,910,200	4,097,868	$73,761,624	4,044,425	$64,712,400	1
36,197,695	46,800,000	35,733,622	46,200,000	37,744,605	48,800,000	39,910,279	51,600,000	2
1,572,186	32,500,000	1,451,249	30,000,000	1,489,949	30,800,000	1,538,376	31,800,000	3
91,646,232	16,038,091	117,151,795	18,064,807	145,221,934	17,789,687	170,962,607	18,292,999	4
132,890	12,624,550	143,957	12,322,719	139,897	10,537,042	129,412	10,469,431	5
33,765	3,646,620	36,872	3,311,106	38,544	3,422,707	40,688	3,539,856	6
52,732	1,487,042	46,725	1,253,632	31,913	936,327	32,073	979,189	7
281,616	309,777	58,800	52,920	64,550	48,412	277,904	179,975	8
....	....	83	875	150	1,350	283	2,550	9
....	....	....	....	....	....	....	....	10
60	12,000	60	12,000	60	12,000	50	10,000	11
200	600	200	600	150	450	250	187	12
....	219,755,109	....	203,128,859	....	186,109,599	....	181,586,587	13
60,861,190	76,076,487	68,531,500	82,237,800	73,730,539	77,417,066	64,840,668	82,347,648	14
31,358,264	70,556,094	34,336,469	77,257,055	33,175,756	66,351,512	34,228,548	76,671,948	15
....	21,000,000	....	20,000,000	....	19,000,000	....	19,000,000	16
30,510,830	24,065,988	23,449,633	25,790,252	24,218,438	20,595,966	21,847,205	19,198,243	17
31,000,000	21,700,000	32,000,000	19,200,000	37,000,000	18,500,000	40,000,000	20,000,000	18
....	215,000	....	475,000	....	1,460,000	....	4,857,200	19
3,250,000	3,672,750	4,190,000	4,293,500	4,000,000	3,720,000	4,150,000	3,492,500	20
6,412,373	4,320,140	6,192.231	4,211,042	6,514,937	4,197,734	7,038,653	4,825.345	21
332.077	1,992,462	378,380	2,270,280	431,779	2,374,784	437,856	2,846,064	22
3,850,000	2,310,000	3,814,273	1,907,136	3,401,930	1,700,965	3,356,956	1,678,478	23
5,000,000	800,000	7,529,423	1,119,603	10,215,328	1,459,143	9,148,401	1,312,845	24
10,000	700,000	12,000	840,000	13,000	910,000	15,000	1,050,000	25
30,000	240,000	32,000	250,000	35,000	270,000	36,000	275,000	26
7,000	105,000	7,000	84,000	7,000	84,000	3,950	43,575	27
4,236,291	338,003	6,500,000	585,000	7,000,000	490,000	8,000,000	480,000	28
100,000	450,000	90,000	420,000	90,000	390,000	90,405	405,000	29
....	700,000	....	600,000	....	570,000	....	500,000	30
6,000	75,000	6,000	75,000	10,000	110,000	10,000	110,000	31
12,000	72,000	25,000	137,500	35,000	175,000	49,000	220,500	32
6,000	90,000	8,000	150,000	10,000	200,000	10,000	200,000	33
4,532	67,980	6,155	92,325	10,180	122,160	23,258	190,281	34
3,000	10,500	3,000	10,500	3,000	10,500	3,000	10,500	35
....	150,000	....	207,050	....	222,975	....	209,900	36
250,000	75,000	301,100	72,264	281,100	67,464	310,000	89,900	37
500	80,000	550	100,000	600	108,000	600	108,000	38
20,000	80,000	27,000	108,000	25,000	100,000	15,000	75,000	39
425,000	34,000	575,000	46,000	....	....	327,883	26,231	40
....	200,000	....	150,000	....	150,000	....	100,000	41
600,000	10,000	600,000	10,000	800,000	12,000	1,000,000	15,000	42
1,080,000	540,000	972,000	486,000	875,000	437,500	875,000	437,500	43
25,000	100,000	25,000	100,000	30,000	120,000	30,000	120,000	44
4,000	20,000	4,000	20,000	4,000	20,000	5,000	22,500	45
2,500	50,000	3,000	60,000	2,000	35,000	2,700	40,000	46
1,000	8,000	1,000	5,000	1,000	5,000	1,000	5,000	47
14,000	70,000	14,100	71,112	10,900	55,112	13,600	68,000	48
100,000	250,000	114,000	285,000	147,410	368,525	92,000	161,000	49
....	....	....	....	....	....	....	....	50
11,653	32,046	1,096	2,795	2,000	5,100	68,723	65,373	51
2,000	24,000	2,000	24,000	2,000	20,000	1,975	24,687	52
600	21,000	1,000	27,000	500	12,000	715	17,875	53
1,200	36,000	1,000	30,000	1,000	30,000	300	9,000	54
500	1,800	550	2,000	600	2,000	600	2,000	55
....	....	....	....	....	....	....	....	56
....	231,340,150	....	243,812,214	....	221,879,506	....	241,312,093	57
....	219,755,109	....	203,128,859	....	186,109,599	....	181,586,587	58
....	6,500,000	....	6,500,000	....	5,000,000	....	5,000,000	59
....	457,595,259	....	453,441,073	....	412,989,105	....	427,898,680	60

Mineral products of the United States for the

	Products.	1886.		1887.	
		Quantity.	Value.	Quantity.	Value.
	METALLIC.				
1	Pig iron, value at Philadelphia.....long tons..	5,683,329	$95,195,760	6,417,148	$121,925,800
2	Silver, coining value..............troy ounces..	39,445,312	51,000,000	41,269,240	53,350,000
3	Gold, coining value.......................do....	1,881,250	35,000,000	1,596,500	33,000,000
4	Copper, value at New York City.....pounds..	161,235,381	16,527,651	185,227,331	21,115,916
5	Lead, value at New York City....short tons..	135,629	12,667,749	160,700	14,463,000
6	Zinc, value at New York City...........do....	42,641	3,752,408	50,340	4,782,300
7	Quicksilver, value at San Francisco....flasks..	29,981	1,060,000	33,825	1,429,000
8	Nickel, value at Philadelphia.........pounds..	214,992	127,157	205,566	133,200
9	Aluminum, value at Pittsburg...........do....	3,000	27,000	18,000	59,000
10	Tin......................................do....	....	....	....	....
11	Antimony, value at San Francisco.short tons..	35	7,000	75	15,000
12	Platinum, value (crude) at San Francisco, ...troy ounces..	50	100	448	1,838
13	Total value of metallic products........	....	215,364,825	....	250,275,054
	NON-METALLIC (spot values).				
14	Bituminous coal.....................long tons..	65,810,676	78,481,056	78,470,857	98,004,656
15	Pennsylvania anthracite.................do....	34,853,077	76,119,120	37,578,747	84,552,181
16	Building stone	....	19,000,000	....	25,000,000
17	Petroleum..............................barrels..	28,064,841	19,996,313	28,278,866	18,877,094
18	Lime ....do....	42,500,000	21,250,000	46,750,000	23,375,000
19	Natural gas.......................................	....	10,012,000	....	15,817,500
20	Cement..................................barrels..	4,500,000	3,990,000	6,692,744	5,674,377
21	Salt ....do....	7,707,081	4,736,585	7,831,962	4,093,846
22	Phosphate rock ....long tons..	430,549	1,872,936	480,558	1,836,818
23	Limestone for iron flux..................do....	4,717,163	2,830,297	5,377,000	3,226,200
24	Mineral waters..................gallons sold..	8,950,317	1,284,070	8,259,609	1,261,463
25	Zinc white..........................short tons..	18,000	1,440,000	18,000	1,440,000
26	Potters' clay ....long tons..	40,000	325,000	43,000	340,000
27	Mineral paints (*a*) ....do....	15,800	285,000	20,000	310,000
28	Borax ....pounds..	9,778,290	488,915	11,000,000	550,000
29	Gypsum...........................short tons..	95,250	428,625	95,000	425,000
30	Grindstones	....	250,000	....	224,400
31	Fibrous talc......................short tons..	12,000	125,000	15,000	160,000
32	Pyrites...............................long tons..	55,000	220,000	52,000	210,000
33	Soapstone.........................short tons..	12,000	225,000	12,000	225,000
34	Manganese ore ....long tons..	30,193	277,636	34,524	333,844
35	Asphaltum.........................short tons..	3,500	14,000	4,000	16,000
36	Precious stones..................................	....	119,056	....	163,600
37	Bromine................................pounds..	428,334	141,350	199,087	61,717
38	Corundum ....short tons..	645	116,190	600	108,000
39	Barytes, crude (*a*)..................long tons..	10,000	50,000	15,000	75,000
40	Graphite ....pounds..	415,525	33,242	416,000	34,000
41	Millstones...	....	140,000	....	100,000
42	Novaculite ....pounds..	1,160,000	15,000	1,200,000	16,000
43	Marls ....short tons..	800,000	400,000	600,000	300,000
44	Flint..................................long tons..	30,000	120,000	32,000	185,000
45	Fluorspar..........................short tons..	5,000	22,000	5,000	20,000
46	Chromic iron ore ....long tons..	2,000	30,000	3,000	40,000
47	Infusorial earth ....short tons..	1,200	6,000	3,000	15,000
48	Feldspar ....long tons..	14,900	74,500	10,200	56,100
49	Mica ....pounds..	40,000	70,000	70,000	142,250
50	Ozocerite, refined ....do....	....	....	....	....
51	Cobalt oxide ....do....	35,000	36,878	18,340	18,774
52	Slate ground as a pigment.........short tons..	3,000	30,000	2,000	20,000
53	Sulphur ....do....	2,500	75,000	3,000	100,000
54	Asbestos....................................do....	200	6,000	150	4,500
55	Rutile..................................pounds..	600	2,000	1,000	3,000
56	Lithographic stone ....short tons..	40	700	....	....
57	Total value of non-metallic mineral products.	....	245,139,469	....	287,416,320
58	Total value of metallic products..........	....	215,364,825	....	250,275,054
59	Estimated value of mineral products unspecified.	....	5,000,000	....	5,000,000
60	Grand total..................................	....	465,504,294	....	542,691,374

a Short tons after 1889.

calendar years 1880 to 1891—Continued.

1888.		1889.		1890.		1891.		
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
6,489,738	$107,000,000	7,603,642	$120,000,000	9,202,703	$151,200,410	8,279,870	$128,337,985	1
45,783,632	59,195,000	51,354,851	66,396,988	54,500,000	70,464,645	58,330,000	75,416,565	2
1,604,927	33,175,000	1,590,869	32,886,744	1,588,880	32,845,000	1,604,840	33,175,000	3
231,270,662	33,833,954	231,246,214	26,907,809	265,115,133	30,848,797	295,810,076	38,455,300	4
180,555	15,924,951	182,967	16,137,689	161,754	14,266,703	202,406	17,609,322	5
55,903	5,500,855	58,860	5,791,824	63,683	6,266,407	80,337	8,033,700	6
33,250	1,413,125	26,484	1,190,500	22,926	1,203,615	22,904	1,036,386	7
204,328	127,632	252,663	151,598	223,488	134,093	118,498	71,099	8
19,000	65,000	47,468	97,335	61,281	61,281	150,000	100,000	9
....	....	....	....	....	....	125,289	25,058	10
100	20,000	115	28,000	129	40,756	278	47,007	11
500	2,000	500	2,000	600	2,500	100	500	12
....	256,257,517	....	269,590,487	....	307,334,207	....	302,307,922	13
91,106,998	101,860,529	85,383,059	94,346,809	99,392,871	110,420,801	105,268,962	117,188,400	14
41,624,611	89,020,483	40,714,721	65,879,514	41,489,858	66,383,772	45,236,992	73,944,735	15
....	25,500,000	....	42,809,706	....	47,000,000	....	47,294,746	16
27,612,025	17,947,620	35,163,513	26,963,340	45,822,672	35,365,105	54,291,980	30,526,553	17
49,087,000	24,543,500	68,474,668	33,217,015	60,000,000	35,000,000	60,000,000	35,000,000	18
....	22,629,875	....	21,097,099	....	18,742,725	....	15,500,084	19
6,503,295	5,021,139	7,000,000	5,000,000	8,000,000	6,000,000	8,222,792	6,680,951	20
8,055,881	4,374,203	8,005,565	4,195,412	8,776,991	4,752,286	9,987,945	4,716,121	21
448,567	2,018,552	550,245	2,937,776	510,499	3,213,795	587,988	3,651,150	22
5,438,000	2,719,000	6,318,000	3,159,000	5,521,622	2,760,811	5,000,000	2,300,000	23
9,578,648	1,679,302	12,780,471	1,748,458	13,907,418	2,600,750	18,392,732	2,996,259	24
20,000	1,600,000	16,970	1,357,600	....	1,600,000	....	1,600,000	25
36,750	300,000	294,344	635,578	350,000	756,000	400,000	900,000	26
24,000	380,000	32,307	463,766	45,732	661,992	47,652	658,478	27
7,589,000	455,340	8,000,000	500,000	9,500,000	617,500	13,380,000	869,700	28
110,000	550,000	267,769	764,118	182,995	574,523	208,126	628,051	29
....	281,800	....	439,587	....	450,000	....	476,113	30
20,000	210,000	23,746	244,170	41,354	389,196	53,054	493,068	31
54,331	167,658	93,705	202,119	111,836	273,745	119,320	338,880	32
15,000	250,000	12,715	231,708	13,670	252,309	16,514	243,981	33
29,198	279,571	24,197	240,559	25,684	219,050	23,416	239,129	34
53,800	331,500	51,735	171,537	40,841	190,416	45,054	242,264	35
....	139,850	....	188,807	....	118,833	....	235,300	36
307,386	95,290	418,891	125,667	387,847	104,719	343,000	54,880	37
589	91,620	2,245	105,565	1,970	89,395	2,265	90,230	38
20,000	110,000	19,161	106,313	21,911	86,505	31,069	118,363	39
400,000	33,000	....	72,662	....	77,500	....	110,000	40
....	81,000	....	35,155	....	23,720	....	16,587	41
1,500,000	18,000	5,982,000	32,980	....	69,909	1,375,000	150,000	42
300,000	150,000	139,522	63,956	153,620	69,880	135,000	67,500	43
30,000	175,000	11,113	49,137	13,000	57,400	15,000	60,000	44
6,000	30,000	9,500	45,835	8,250	55,328	10,044	78,330	45
1,500	20,000	2,000	30,000	3,599	53,985	1,372	20,580	46
1,500	7,500	3,466	23,372	2,532	50,240	....	21,988	47
8,700	50,000	6,970	39,370	8,000	45,200	10,000	50,000	48
48,000	70,000	49,500	50,000	60,000	75,000	75,000	100,000	49
43,500	3,000	50,000	2,500	350,000	26,250	50,000	7,000	50
8,491	15,782	13,955	31,092	6,788	16,291	7,200	18,000	51
2,500	25,000	2,000	20,000	2,000	20,000	2,000	20,000	52
....	....	1,150	7,850	....	....	1,200	39,600	53
100	3,000	30	1,800	71	4,560	66	3,960	54
1,000	3,000	1,000	3,000	400	1,000	300	800	55
....	....	18	243	....	....	....	....	56
....	303,241,114	....	307,640,175	....	339,270,491	....	351,741,781	57
....	256,257,517	....	269,590,487	....	307,334,207	....	302,307,922	58
....	5,000,000	....	10,000,000	....	10,000,000	....	10,000,000	59
....	564,498,631	....	587,230,662	....	656,604,698	....	664,049,703	60

THE AMERICAN IRON TRADE IN 1892.

By JAMES M. SWANK,

General Manager of the American Iron and Steel Association.

The history of the American iron trade in 1892 presents the anomaly of an active demand for most iron and steel products all through the year, accompanied by the lowest average of prices that has ever been known in this country. We made more Bessemer steel and more open-hearth steel, and, omitting rails, we rolled more iron and steel in 1892 than in any preceding year, and we made almost as much pig iron in 1892 as in 1890, the year of our greatest production of pig iron. The consumption of iron and steel in 1892 was so great that this large production was not only amply justified but it was actually necessary. And yet prices as a rule never were so low. The explanation of the low prices which prevailed is partly to be found in general causes affecting all the industries of the country, into a consideration of which we need not enter, and partly in our capacity to produce a yet larger quantity of iron and steel than was called for by the enormous consumption of the year. During the first six months of 1893 the low prices of 1892 have continued, with a distinct tendency to even lower prices. At the end of these six months there was noticeable a falling off in the demand for many leading iron and steel products, the result of the general financial disturbance, which is more pronounced now than at any time since the occurrence of the Baring panic of 1890.

Production of pig iron in 1892.—The following table shows our total production by States of all kinds of pig iron in the United States in 1892, compared with the production in 1891, in long tons. The States are arranged in the order of their prominence in 1892. Twenty-three States made pig iron in 1892, the same number as in 1891 and 1890:

The production of pig iron in the United States in 1892 compared with 1891.

States.	1891.	1892.	States.	1891.	1892.
	Long tons.	*Long tons.*		*Long tons.*	*Long tons.*
Pennsylvania	3,952,387	4,193,805	Kentucky	44,844	56,548
Ohio	1,035,013	1,221,913	Colorado	18,116	32,441
Illinois	669,202	949,450	Connecticut	21,811	17,107
Alabama	795,673	915,296	Minnesota	1,226	14,071
Virginia	295,292	342,847	Georgia	49,858	9,950
New York	315,112	310,395	Texas	18,662	8,613
Tennessee	291,738	300,081	Massachusetts	8,990	7,946
Michigan	213,145	184,421	Indiana	7,729	7,700
Wisconsin	197,160	174,961	Oregon	9,295	7,628
West Virginia	86,283	154,793	North Carolina	3,217	2,908
Maryland	123,398	99,131			
New Jersey	92,490	87,975	Total	8,279,870	9,157,000
Missouri	29,229	57,020			

Pennsylvania produced almost 46 per cent. of the total production of pig iron in 1892; Ohio, over 13 per cent.; Illinois, over 10 per cent.; and Alabama, almost 10 per cent. Every other State fell below 4 per cent. Allegheny county, Pennsylvania, made over 42 per cent. of the total production of pig iron by that State in 1892.

Of the total production of pig iron in 1892, the Bessemer pig iron produced amounted to 4,444,041 long tons, or 48.53 per cent. The States which produced Bessemer pig iron in 1891 and 1892 and the quantities which they respectively produced were as follows:

The production of Bessemer pig iron in the United States in 1891 and 1892.

States.	1891.	1892.	States.	1891.	1892.
	Long tons.	*Long tons.*		*Long tons.*	*Long tons.*
Pennsylvania	2,077,805	2,489,730	Colorado	8,430	31,416
Illinois	540,714	800,661	North Carolina	3,217	2,908
Ohio	458,978	639,183	Michigan	4,544	
New York	131,867	133,723	Alabama	625	
Maryland	111,468	88,224	Kentucky	1,172	24,357
West Virginia	84,283	154,793	Texas	1,607	
New Jersey	12,964	17,225	Minnesota	1,226	14,071
Missouri	26,632	44,950			
Wisconsin	6,658	2,800	Total	3,472,190	4,444,041

There was a great increase in the production of spiegeleisen in 1892, the production being 179,131 long tons, against 127,766 tons in 1891, 133,180 tons in 1890, and 76,628 tons in 1889.

The production of pig iron in nine southern States shows a large increase in 1892 as compared with 1891, as will be seen from the following table:

The production of pig iron in the South in 1891 and 1892.

States.	1891.	1892.	States.	1891.	1892.
	Long tons.	*Long tons.*		*Long tons.*	*Long tons.*
Alabama	795,673	915,296	Georgia	49,858	9,950
Virginia	295,292	342,847	Texas	18,662	8,613
Tennessee	291,738	300,081	North Carolina	3,217	2,908
West Virginia	86,283	154,793			
Maryland	123,398	99,131	Total	1,708,965	1,890,167
Kentucky	44,844	56,548			

The production of pig iron by nine western States, beginning with Ohio and extending to the Pacific coast, greatly increased in 1892 as compared with 1891, as the following table will show:

The production of pig iron in the West in 1891 and 1892.

States.	1891.	1892.	States.	1891.	1892.
	Long tons.	*Long tons.*		*Long tons.*	*Long tons.*
Ohio	1,035,013	1,221,913	Minnesota	1,226	14,071
Indiana	7,729	7,700	Colorado	18,116	32,441
Illinois	669,202	949,450	Oregon	9,295	7,628
Michigan	213,145	184,421			
Wisconsin	197,160	174,961	Total	2,180,115	2,649,605
Missouri	29,229	57,020			

Consumption of pig iron.—Our consumption of pig iron in the last three years is approximately shown in the following table, in long tons, the comparatively small quantity of foreign pig iron held in bonded warehouses and of domestic pig iron exported not being considered.

Comparison of pig-iron production and consumption.

Pig iron.	1890.	1891.	1892.
	Long tons.	*Long tons.*	*Long tons.*
Domestic production	9,202,703	8,279,870	9,157,000
Imported	134,955	67,179	70,125
Stocks on hand January 1	283,879	661,858	627,233
Total supply	9,621,537	9,008,907	9,854,358
Deduct stocks December 31; also warrant yard stocks	661,858	627,233	535,616
Approximate consumption	8,959,679	8,381,674	9,318,742

Production of Bessemer steel in 1892.—The production of Bessemer steel ingots and direct castings in the United States in 1892 was 4,168,435 long tons, against 3,247,417 tons in 1891, an increase of 921,018 tons, or over 28 per cent. The production in 1892 was much the largest in our history.

The following table shows the production by states of Bessemer steel in 1892 compared with 1891. The production by the Clapp-Griffiths process is included in the totals for the years mentioned, but we also add a statement of production by this process alone. The production of steel by the Robert-Bessemer works is also included in the totals.

Production of Bessemer steel in 1892 compared with 1891.

States.	1891.	1892.
	Long tons.	*Long tons.*
Pennsylvania	2,048,330	2,397,984
Illinois	605,921	879,952
Ohio	333,666	409,855
Other States	259,500	480,644
Total	3,247,417	4,168,435
Clapp-Griffiths only	65,389	74,718

In 1892 Pennsylvania made over 57 per cent. of all the Bessemer steel produced, against 63 per cent. in 1891. Illinois made over 21 per cent. in 1892, against 18 per cent. in 1891. Ohio made almost 10 per cent. in 1892, against 10 per cent in 1891.

Production of open-hearth steel in 1892.—The production of open-hearth steel ingots and direct castings in the United States in 1892 was 669,889 long tons, against 579,753 tons in 1891, an increase of 90,136 tons, or over 15 per cent. The production of 1892 was much the largest yet attained in this country.

The production of open-hearth steel in 1892 in New England, New York, and New Jersey amounted to 38,131 long tons; in Pennsylvania to 551,010 tons; in Ohio to 60,834 tons; and in the other western, Pacific, and southern States to 19,914 tons.

Production of crucible steel in 1892.—The production of crucible steel in the United States in 1892 amounted to 84,709 long tons, against 72,586 tons in 1891, an increase in 1892 of 12,123 long tons, or over 16 per cent. The production of 1892 was made in twelve states: Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Tennessee, Ohio, Indiana, Illinois, Michigan, and Missouri.

Of the total production of 84,709 long tons of crucible steel in 1892 New England contributed 3,003 tons; New York, 5,450 tons; New Jersey, 7,248 tons; Pennsylvania, 64,834 tons; the western States, 4,054 tons; and the southern States, 120 tons.

Production of miscellaneous steel in 1892.—The production of steel in the United States in 1892 by various minor processes amounted to 4,548 long tons, against 4,484 tons in 1891. Blister, puddled, and "patented" steel, including "patented" steel castings, are embraced in these figures. The miscellaneous steel produced in 1892 was made in Pennsylvania, Iowa, and California.

Total production of steel in 1892.—The production of all kinds of steel in the United States in 1892 was as follows: Bessemer steel, 4,168,435 long tons; open-hearth steel, 669,889 tons; crucible steel, 84,709 tons; all other steel, 4,548 tons: total, 4,927,581 tons, against 3,904,240 tons in 1891.

Production of rolled iron and steel in 1892.—The following table shows the total production by States of all kinds of rolled iron and steel in the United States in 1892, steel rails included, compared with the production in 1891, in long tons. Twenty-nine States rolled either iron or steel or both iron and steel in 1892:

The production of rolled iron and steel in 1892 compared with 1891.

States.	1891.	1892.	States.	1891.	1892.
	Long tons.	*Long tons.*		*Long tons.*	*Long tons.*
Maine	7,217	6,005	Texas	....	235
New Hampshire	4,955	5,100	Ohio	783,575	888,793
Massachusetts	140,169	137,882	Indiana	112,129	150,596
Rhode Island	13,203	13,328	Illinois	590,327	748,635
Connecticut	28,434	31,574	Michigan	29,934	43,887
New York	118,352	134,069	Wisconsin	67,697	90,405
New Jersey	100,651	106,816	Minnesota	4,464	5,429
Pennsylvania	3,041,254	3,302,506	Missouri	24,121	30,156
Delaware	36,446	37,213	Iowa	2,768	2,829
Maryland	33,588	114,594	Colorado	13,138	34,079
Virginia	29,245	45,616	Oregon	....	1,310
West Virginia	79,207	87,955	Wyoming	3,571	7,446
Kentucky	45,215	51,282	California	38,907	38,840
Tennessee	9,229	13,016			
Georgia	2,790	2,902	Total	5,390,963	6,165,814
Alabama	30,377	33,316			

Pennsylvania made 53.5 per cent. of the total production of rolled iron and steel in 1892 and 56.4 per cent. in 1891; Ohio made 14.4 per cent. in 1892 and 14.5 per cent. in 1891; and Illinois made 12.1 per cent. in 1892 and 10.9 per cent. in 1891. No other State produced 3 per cent. in any year.

Production of rails in 1892.—The production of all kinds of rails, including light and heavy and street and mine rails, in the United States in 1892 was 1,551,844 long tons, against 1,307,176 tons in 1891, an increase of 244,668 tons, or 18.7 per cent. The production of 1892 was composed of 1,537,588 tons of Bessemer steel rails, 3,819 tons of open-hearth steel rails, and 10,437 tons of iron rails. Of the total production of Bessemer steel rails Pennsylvania made 961,987 long tons, against 901,159 tons in 1891; Illinois, 450,553 tons, against 364,725 tons in 1891, and the remainder of the country, 125,048 tons, against 27,169 tons in 1891. Eight States made Bessemer steel rails in 1892, namely: Pennsylvania, Maryland, West Virginia, Ohio, Illinois, Wisconsin, Colorado, and California. The quantity of Bessemer steel rails made outside of Pennsylvania, Maryland, and Illinois was, however, very small. The open-hearth steel rails were nearly all made in California. The iron rails were made in Pennsylvania, Tennessee, Alabama, Ohio, Indiana, Illinois, and Colorado.

Of the total production of rails in 1892 Pennsylvania made over 62 per cent., against 69 per cent. in 1891. Illinois made over 29 per cent. in 1892, against 28 per cent. in 1891. These two States made over 91 per cent. of all the rails rolled in 1892, against over 97 per cent. in 1891.

The rails which are definitely known to have been ordered and rolled for street railways amounted in 1892 to 111,580 long tons, against 81,302 tons in 1891 and 98,529 tons in 1890, an increase in 1892 over 1891 of 30,278 tons. Nearly all street rails are now rolled from Bessemer steel.

Production of structural iron and steel in 1892.—In the following table is given the production in 1892 of all rolled iron and steel structural shapes, including beams, girders, tees, channels, and angles, but not including plates, which are largely used for structural purposes in combination with the other structural forms mentioned. Nor do the figures given include any forms of structural iron and steel which are cast.

Production of structural iron and steel in 1892.

States.	1892.	States.	1892.
	Long tons.		*Long tons.*
New England and New York	2,624	Indiana and Illinois	36,211
New Jersey	26,678	Michigan and Wisconsin	4,580
Pennsylvania	342,644	Oregon and California	7,640
Alabama and Kentucky	10,365		
Ohio	23,215	Total	453,957

Production of tin plates in 1891 and 1892.—The duty on tin plates which is provided in the tariff act of October 1, 1890, did not take effect until July 1, 1891. After that date the Treasury Department undertook the collection of the statistics of the domestic production of tin plates and terne plates, and it has published the following results for the second half of 1891 and the whole of 1892:

Production of tin plates in the United States.

Production by quarters.	Tin plates.	Terne plates.	Total.
	Pounds.	*Pounds.*	*Pounds.*
July 1, 1891, to September 30, 1891	152, 489	674, 433	826, 922
October 1, 1891, to December 31, 1891	215, 911	1, 193, 910	1, 409, 821
January 1, 1892, to March 31, 1892	1, 099, 656	2, 109, 569	3, 209, 225
April 1, 1892, to June 30, 1892	3, 071, 534	5, 129, 217	8, 200, 751
July 1, 1892, to September 30, 1892	3, 611, 367	7, 341, 358	10, 952, 725
October 1, 1892, to December 31, 1892	6, 138, 739	13, 617, 752	19, 756, 491
Total for six quarters	14, 289, 696	30, 066, 239	44, 355, 935

Production of plates and sheets in 1892.—The production of plate and sheet iron and steel in 1892, excluding nail plate, amounted to 751,460 long tons, against 678,927 tons in 1891, an increase of 72,533 tons. The following table gives the production of iron and steel plates and sheets by States, not including nail plates, in 1891 and 1892, in long tons:

Production of iron and steel plates and sheets in 1892 compared with 1891.

States.	1891.	1892.	States.	1891.	1892.
	Long tons.	*Long tons.*		*Long tons.*	*Long tons.*
New Hampshire and Massachusetts	6, 437	7, 035	Alabama	4, 323	3, 989
New York and New Jersey	9, 239	12, 179	Ohio	112, 508	139, 004
Pennsylvania	489, 947	515, 506	Indiana and Illinois	6, 053	16, 631
Delaware and Maryland	16, 548	13, 206	Michigan, Wisconsin, and Missouri	7, 682	17, 775
West Virginia and Kentucky	26, 190	26, 135	Total	678, 927	751, 460

Production of wire rods in 1892.—The production of wire rods in 1892 amounted to 627,829 long tons, against 536,607 tons in 1891, an increase of 91,222 tons. Pennsylvania made the largest quantity in 1892, with Ohio second, Massachusetts third, and Illinois fourth in production. The other States which rolled rods in 1892 were New York, New Jersey, Indiana, and Connecticut.

Our production of wire rods has increased greatly in late years. We made more tons of wire rods in 1892 than we did of Bessemer steel rails in 1879, and almost two-thirds as many tons as of Bessemer steel rails in each of the years 1884 and 1885.

Production of cut and wire nails in 1892.—Including cut spikes, but not including railroad and other spikes made from bar iron, nor machine-made horseshoe nails, our production of cut nails in 1892 was 4,507,819 kegs of 100 pounds each, against 5,002,176 kegs in 1891, a decrease of 494,357 kegs, or almost 10 per cent. The following table shows the production of iron and steel cut nails by States in 1891 and 1892, in kegs:

Production of cut nails in 1892 compared with 1891.

States.	1891.	1892.	States.	1891.	1892.
	Kegs.	*Kegs.*		*Kegs.*	*Kegs.*
Pennsylvania	1,470,613	1,521,332	California	164,000	145,000
Ohio	1,408,449	1,261,813	Virginia	107,475	96,007
West Virginia	768,648	429,243	Kentucky	248,854	247,107
Illinois	97,400	128,700	Wyoming		10,000
Massachusetts and New Jersey	353,292	297,888	Total	5,002,176	4,507,819
Indiana	383,445	370,729			

The production of wire nails in the United States in 1889 was 2,435,000 kegs; in 1890 the production increased to 3,135,911 kegs; in 1891 to 4,114,385 kegs; and in 1892 it reached the large total of 4,719,524 kegs. The following table gives the production of wire nails in the last four years, in kegs of 100 pounds:

Production of wire nails during the past four years.

Years.	New England.	New York and New Jersey	Pennsylvania.	Ohio.	Indiana and Illinois.	Other States.	Total.
	Kegs.	*Kegs.*	*Kegs.*	*Kegs.*	*Kegs.*	*Kegs.*	*Kegs.*
1889	110,000	170,000	816,000	944,000	46,000	349,000	2,435,000
1890	167,135	168,460	1,061,639	1,115,320	47,507	575,850	3,135,911
1891	193,668	128,159	1,460,252	1,659,396	381,950	290,960	4,114,385
1892	107,477	91,470	1,676,684	1,800,742	796,406	246,745	4,719,524

The "other States" referred to in the table as making wire nails in 1892 were Michigan, Missouri, California, and Washington.

It will be observed that our production of wire nails in 1892 exceeded that of cut nails. Prior to 1892 the production of cut nails had always exceeded that of wire nails.

Prices of iron and steel.—Since the beginning of 1890 the prices of all leading iron and steel products in the United States have steadily declined. The following table will show how great has been the reduction in prices during the period mentioned, the figures given representing the average monthly prices in the month of January of each year. The prices named are per long ton of 2,240 pounds, except for bar iron, beams, and nails, which are quoted by the hundred pounds and the keg respectively.

Prices of iron and steel products during the past four years.

Articles.	January.			
	1890.	1891.	1892.	1893.
Old iron T rails, at Philadelphia	$27.50	$23.50	$21.00	$18.00
No. 1 anthracite foundry pig iron, at Philadelphia	19.90	17.50	17.50	14.80
Gray forge pig iron, at Philadelphia	17.90	14.50	14.25	13.10
Gray forge pig iron, Lake ore, at Pittsburg	18.00	14.25	13.50	12.30
Bessemer pig iron, at Pittsburg	23.60	15.95	15.65	13.59
Steel rails, at mills in Pennsylvania	35.25	29.00	30.00	29.00
Best refined bar iron, from store, Philadelphia	2.20	2.00	1.85	1.80
All muck bar iron, at Pittsburg	1.90	1.80	1.70	1.59
Cut nails at Wheeling in carload lots	2.40	1.65	1.55	1.42½
Cut nails at Philadelphia, from store	2.20	1.90	1.75	1.75
Rolled beams in Pennsylvania	3.10	3.10	2.00	2.00

Since the close of January, 1893, the prices of many of the articles mentioned in the above table have still further declined.

Imports and exports of iron and steel.—The foreign value of all our imports of iron and steel in 1892, including firearms, hardware, cutlery, anvils, chains, machinery, etc., was $33,882,447, against $41,983,626 in 1891. The total foreign value of our imports of iron and steel in the twenty-two years ending with 1892 was $977,340,235.

The exports from this country to all countries of domestic iron and steel and manufactures thereof in 1892 were valued at $27,900,862, against $30,736,507 in 1891, $27,000,134 in 1890, and $23,712,814 in 1889. Our exports of iron and steel are composed chiefly of machinery, builders' hardware, sewing machines, saws, tools, locomotives, firearms, scales and balances, pig iron, steel rails, wire, car wheels, miscellaneous castings, and engines and boilers. There has been a gratifying increase in late years in our exports of iron and steel. In 1886 they amounted to only $14,865,087 in value.

Summary of the foregoing statistics.—In the following table is given a summary of the leading results presented in the foregoing tables:

The principal iron and steel products of 1892 compared with 1891.

Subjects.	1891.	1892.
Production of pig iron ....long tons..	8,279,870	9,157,000
Production of spiegeleisen, included in pig iron ....do....	127,766	179,131
Production of iron and steel wire rods ....do....	536,607	627,829
Production of plate and sheet iron and steel, except nail plate..do....	678,927	751,460
Production of tin plates and terne plates........pounds..	....	42,119,192
Production of iron and steel cut nails........kegs of 100 pounds..	5,002,176	4,507,819
Production of iron and steel wire nails........do....	4,114,385	4,719,524
Production of all rolled iron and steel, including nails and excluding rails........long tons..	4,083,787	4,613,970
Production of Bessemer steel rails........do....	1,293,053	1,537,588
Production of open-hearth steel rails ....do....	5,883	3,819
Production of iron rails........do....	8,240	10,437
Total production of rails........do....	1,307,176	1,551,844
Production of street rails, included above........do....	81,302	111,580
Production of Bessemer steel ingots ....do....	3,247,417	4,168,435
Production of open-hearth steel ingots........do....	579,753	669,889
Production of crucible steel ingots........do....	72,586	84,709
Production of miscellaneous steel........do....	4,484	4,548
Production of all kinds of crude steel........do....	3,904,240	4,927,581
Value of imports of iron and steel........	$41,983,626	$33,882,447
Value of exports of iron and steel........	$30,736,507	$27,900,862

The two great ironmaking and steelmaking countries.—We may properly close this review of the iron and steel industries of the United States in 1891 and 1892 with a statement showing the production of four leading articles of iron and steel in the United States in these two years in comparison with their production in Great Britain in the same years. The tons used are long tons.

The four leading iron and steel products of the United States compared with Great Britain.

Products.	United States.		Great Britain.	
	1891.	1892.	1891.	1892.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*
Pig iron	8, 279, 870	9, 157, 000	7, 406, 064	6, 709, 255
Bessemer steel	3, 247, 417	4, 168, 435	1, 642, 005	1, 500, 810
Open-hearth steel	579, 753	669, 889	1, 514, 538	1, 418, 830
Bessemer steel rails	1, 293, 053	1, 537, 588	662, 676	535, 836

In 1890 the United States first passed Great Britain in the production of pig iron, but in 1880 we first exceeded her production of Bessemer steel, and in 1879 we first exceeded her production of Bessemer steel rails. In the production of open-hearth steel we are still far behind Great Britain.

Production of pig iron in the United States in the first half of 1893.—The total production of pig iron in the United States in the first half of 1893 was 4,562,918 long tons, against 4,387,317 tons in the second half of 1892, an increase of 175,601 tons. The production in the first half of 1892 was, however, 4,769,683 tons. Compared with the first half of 1892, the production of the first half of 1893 shows a decrease of 206,765 tons. The production of the second half of 1893 will undoubtedly be less than that of the second half of 1892, so that the total production of 1893 will be much less than the total production of 1892. The facts affecting the general industrial condition of the country, upon which we base this forecast, are so well known that they need not be stated. It is, however, a most remarkable fact that the production of the first half of this year of great depression in the iron trade should show an increase over that of the more prosperous second half of 1892.

The production of pig iron by each of the pig-iron producing States in the three half years ending with June 30, 1893, is given in the following table; also the number of furnaces in blast at the end of each of the last two half-yearly periods:

Production of pig iron during 1892 and the first half of 1893, by half-year periods, by States, with the number of furnaces in blast.

States.	Blast furnaces.				Production. (Includes spiegeleisen.)		
	In blast Dec. 31, 1892.	June 30, 1893. In.	Out.	Total.	First half of 1892.	Second half of 1892.	First half of 1893.
					Long tons.	Long tons.	Long tons.
Massachusetts	2	2	2	4	4,178	3,768	4,119
Connecticut	5	4	4	8	9,856	7,251	7,335
New York	9	6	27	33	163,838	146,557	140,776
New Jersey	6	4	11	15	44,282	43,693	39,598
Pennsylvania	106	103	103	206	2,216,832	1,976,973	2,225,962
Maryland	3	4	7	11	49,981	49,150	89,729
Virginia	14	9	25	34	164,086	178,761	152,155
North Carolina	1	1	1	2	1,853	1,055	2,445
Georgia	1	2	4	6	3,330	6,620	16,509
Alabama	28	23	29	52	479,131	436,165	447,948
Texas	......	1	3	4	6,403	2,210	5,838
West Virginia	3	1	3	4	80,238	74,555	66,398
Kentucky	3	3	6	9	32,649	23,899	37,281
Tennessee	10	11	9	20	157,214	142,867	128,539
Ohio	34	33	32	65	651,335	570,578	594,643
Indiana	1	1	1	2	5,431	2,269	5,313
Illinois	8	5	15	20	477,961	471,489	335,771
Michigan	8	5	17	22	91,190	93,231	81,907
Wisconsin	6	4	6	10	72,156	102,805	107,855
Minnesota	......	......	1	1	13,218	853	10,373
Missouri	2	2	3	5	30,634	26,386	22,329
Colorado	2	2	1	3	10,448	21,993	37,119
Oregon	1	......	1	1	3,439	4,189	2,976
Washington	......	......	1	1	....	....	....
Total	253	226	312	538	4,769,683	4,387,317	4,562,918

An examination of this table will show what States increased their production of pig iron in the first half of 1893 as compared with the second half of 1892, and also the States which decreased their production. It will be noticed that Pennsylvania largely increased her production, and that there was a large decrease in Illinois.

The production of Bessemer pig iron in the first half of 1893 was the largest half-yearly production in our history, amounting to 2,374,890 long tons, against 2,189,696 tons in the second half of 1892, and 2,254,345 tons in the first half.

The production of spiegeleisen and ferromanganese in the first half of 1893, which is included in the statistics of total pig-iron production, was only 47,976 long tons, against 91,757 tons in the second half of 1892, and 87,374 tons in the first half.

The number of furnaces in blast on June 30, 1893, was 226, against 253 on December 31, 1892, and 256 on June 30, 1892. The number out of blast on June 30, 1893, was 312.

Production of Bessemer steel ingots and rails in the first half of 1893.—The following table shows the production of Bessemer steel ingots in the first half of 1893, compared with the first half and second half of

1892. In the figures for the periods mentioned are included the production of ingots by the Clapp-Griffiths works and the very small production of steel by the Robert-Bessemer works. We also add to the table a statement of the ingots produced by the Clapp-Griffiths works alone.

Production of Bessemer steel ingots during the first half of 1893 compared with 1892.

States.	First half 1892.	Second half 1892.	Total 1892.	First half 1893.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*
Pennsylvania	1,218,504	1,179,480	2,397,984	1,337,079
Illinois	437,067	442,885	879,952	220,059
Ohio	200,946	208,909	409,855	232,980
Other States	202,411	278,233	480,644	301,939
Total	2,058,928	2,109,507	4,168,435	2,092,057
Clapp-Griffiths	36,974	37,744	74,718	37,013

The following table shows the production of Bessemer steel rails of all weights and sections, including street rails, in the first half of 1893, compared with the first half and second half of 1892. In this statement we do not include a few thousand tons of Bessemer steel rails which were rolled from purchased blooms.

Production of Bessemer steel rails during the first half of 1893 compared with 1892.

States.	First half 1892.	Second half 1892.	Total 1892.	First half 1893.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*
Pennsylvania	474,018	411,634	885,652	429,059
Illinois	240,925	209,617	450,542	170,263
Other States	57,493	65,045	122,538	104,918
Total	772,436	686,296	1,458,732	704,240

These statistics show a remarkable uniformity in the production of both ingots and rails in the second half of 1892 and the first half of 1893. A considerable falling off in the production of both ingots and rails in the second half of 1893 is, however, inevitable.

IRON ORES.

By John Birkinbine.

In 1892, as in 1890 and 1891, the United States led the world in the production of iron ores and in the manufacture of pig iron therefrom. Of these three years, 1892 showed the greatest output of iron ore, viz., 16,296,666 long tons, against 16,036,043 long tons in 1890, and 14,591,178 tons in 1891, an increase of 260,623 tons over the product in 1890, and 1,705,488 tons more than that in 1891. In 1889, the iron ore product was 14,518,041 long tons, according to the Eleventh Census; the output of 1892, therefore, showed an increase of 1,778,625 long tons over the census year. If, as in previous years, an allowance of 1½ per cent. is made for small or scattered mines not reporting, or of which no authoritative record is obtainable, the approximate total may be given as sixteen and a half million long tons of marketable iron ore mined in 1892.

The above statistics indicate that nearly equal amounts of iron ore were mined in 1889 and 1891, and one-quarter million tons more were won in 1892 than in 1890. The law of supply and demand often encourages a small annual output following a year of large production, or *vice versa*, and it would be equitable to consider the actual increase in iron ore output as represented more closely by the average of 1889 and 1890, 15,274,042 long tons, as compared with that of 1891 and 1892, 15,443,922 long tons.

It is well to remember that these large amounts represent iron ore ready for market, in winning which considerable quantities of lean ore, ocher, sand, rock, etc., are brought to the surface and there disposed of. Thus, most of the brown hematite iron ores must be washed to separate the earth, sand, ocher, etc., often 1½ to 3 tons or more of material being required to yield 1 ton of salable ore. In the Lake Superior region large quantities of lean ore are taken out while mining the deposits of red hematite; this lean material is used either as filling in other parts of the mines, or is stocked in piles to be cobbed afterward or used as ballast in road making. A considerable portion of this waste material contains a greater percentage of iron than some of the ores mined and smelted elsewhere, but it is not sufficiently rich to stand the freight and handling charges from mines in the Lake Superior region to points of consumption, and there is at present insufficient local demand for the inferior ores. At Iron Mountain, Missouri, the lean red hematite is concentrated by hydraulicking and by jigging, and in the Marquette district of Michigan some of the ore is carefully hand-sorted. The leaner magnetites of New Jersey, New York, Pennsylvania, Michigan, and North Carolina are enriched by magnetic concentration, or by jigging to a limited extent, or roasted to reduce sulphur; from 1½ to 5 tons of material being treated to produce 1 ton of concentrated ore. The carbonate ores must be calcined for economic smelting, about 2 tons of ore resulting in 1 ton of "burnt ore."

In the year ending December 31, 1892, 163,444 tons of ore were obtained by magnetic separation, from 436,238 long tons of crude material; also 93,627 long tons of jigged ore were produced from 291,611 tons of crude material. This would show that on an average 2.67 tons of crude ore were required to produce a ton of magnetically separated ore, and 3.11 tons of lean ore to yield a ton of jigged ore. There were also 9,555 tons of hand-sorted ore marketed as such. The amount of crude ore necessary to produce one ton of concentrate does not necessarily represent the relative merits of the two methods specified, the figures being introduced merely to show the practice in concentration during 1892.

In addition to the iron ore charged into the blast furnaces, considerable quantities of mill cinder, "blue billy," franklinite residuum, etc., are employed in the mixtures, and while it is impossible to obtain the exact amounts of all the materials used, it has been practical to collect the quantity of franklinite residuum so charged, which aggregated in 1892, 31,573 long tons, at an average value of $1.17 per long ton. On the other hand, considerable quantities of iron ores are used as "fix" or fettling in rolling mills, as a flux in silver smelting, etc., and it is equitable to consider that the amount of iron ore so employed is approximately offset by the quantity of other materials which are charged into the blast furnaces.

While the year 1892 shows an increase over 1890 in the amount of iron ore produced, the total make of pig iron last year was smaller than in 1890. The ores won were not necessarily leaner in 1892 than in 1890, but the amounts of ore stocked at the mines in the Lake Superior region, and in other regions, were larger at the close than at the commencement of the year 1892. This was due partially to the fact that the production of pig iron in the last half of 1891 was much greater than in the first half, and this advance was but slightly checked in the first half of 1892, but in the latter part of last year the pig iron output was materially diminished, thus encouraging large shipments of ore in the first half of the year 1892, while the later decreased demand led to stocking the ore. The iron ore consumers were also discounting the influence which the opening of the new Mesabi range in Minnesota was expected to exert upon prices for the year 1893. A condition affecting the hard specular mines of Lake Superior was that the ores which were shipped to the furnaces in such condition as to render necessary a reduction of the larger lumps in the stockhouse were met by a decided preference for the softer and more easily handled hematites. The sale of these hard ores was thereby affected, and to overcome this, one large ore-mining company put a crusher in operation at the mines, and intends to add others to break the lumps. It is probable that other companies will follow this plan, of making their ore more salable; for in a number of cases the crushing of lumps of banded ore will recover good shipping ore from masses in which lean material preponderates sufficiently to make the whole unmerchantable; and the value of the shipping ore recovered may offset much or all of the cost of crushing the mine output.

CLASSIFICATION.

As in previous years, the iron ores produced are reported by four general divisions, which within narrow limits correspond with their commercial classification, as follows:

1. *Red hematite* comprises those ores in which the iron occurs as an anhydrous oxide, giving a red streak on a porcelain plate, the color of the ore being generally a brownish red, or red, although sometimes a dark gray, almost black. This class includes "red hematite," "fossil," or "Clinton" ores, "specular," "micaceous" ore, "slate" ore, etc., as well as some "martite," which is a pseudomorph after magnetite.

2. *Brown hematite*, which contains more water than the red hematite, is generally of a brown or yellow color, and when powdered shows a brown or brownish yellow streak on the porcelain plate. The varieties are known as "limonite," "turgite," "pipe" ore, "bog" ore, "goethite," "oolitic" ore, etc.

3. *Magnetite* comprises those ores in which iron occurs as a magnetic oxide, generally black or blue-black, or occasionally steel gray or greenish in color, and which when powdered give a black streak on a test plate, and are attracted by a magnet. In this class is included some "martite," which is mined with magnetite.

4. *Carbonate* includes those iron ores which contain an excess of carbonic acid. They are generally gray, yellow, or rather buff and brown in color, and are tested by the use of hydrochloric acid. They comprise the "black band" ores, "clay ironstones," "spathic" ores, "siderite," etc.

PRODUCTION.

The table given below shows the output of the different varieties and the total of all kinds of iron ore by States, and also the total of each kind of ore produced in the United States in the calendar year 1892. From this table it will be seen that of 16,296,666 long tons of iron ore produced, of which there is authentic record, 11,646,619 long tons, or 71.47 per cent., was red hematite, 2,485,101 long tons, or 15.25 per cent., was brown hematite; 1,971,965 long tons, or 12.10 per cent., was magnetic ore; and the remainder, 192,981 long tons, or 1.18 per cent., was carbonate ore.

Production of iron ore, by kinds, in each State and Territory during the calendar year 1892.

States.	Red hematite.	Brown hematite.	Magnetite.	Carbonate.	Totals.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Michigan	7, 228, 406	187, 306	127, 832		7, 543, 544
Alabama	1, 657, 028	655, 043			2, 312, 071
Minnesota	1, 250, 465	5, 000			1, 255, 465
Pennsylvania	163, 307	229, 700	685, 986	5, 054	1, 084, 047
New York	124, 800	53, 694	648, 564	64, 041	891, 099
Wisconsin	774, 879	15, 300			790, 179
Virginia	26, 120	711, 753	3, 154		741, 027
New Jersey	4, 348	4, 348	456, 759		465, 455
Tennessee	256, 786	149, 792			406, 578
Georgia	30, 835	154, 219			185, 054
Colorado	1, 412	124, 317	16, 040		141, 769
Missouri	114, 032	4, 462			118, 494
Ohio				95, 768	95, 768
Kentucky		43, 254		7, 269	50, 523
Massachusetts		44, 941			44, 941
Maryland		19, 322		20, 849	40, 171
Connecticut		31, 324			31, 324
North Carolina			25, 379		25, 379
Texas		22, 853	50		22, 903
New Mexico	7, 000		8, 201		15, 201
Oregon		11, 503			11, 503
Utah	2, 301	8, 800			11, 101
Montana	4, 900	2, 170			7, 070
West Virginia		6, 000			6, 000
Totals	11, 646, 619	2, 485, 101	1, 971, 965	192, 981	16, 296, 666

Compared with 1889, 1890, and 1891, the following table shows the amounts of each class of iron ore produced, also the amount of increase or decrease, and the percentage of increase or decrease in 1892 and 1891. The figures for 1889 were collected for the Eleventh Census, those for succeeding years were obtained for the division of mining statistics of the U. S. Geological Survey.

Comparative production of iron ore, by kinds, in 1889, 1890, 1891, and 1892.

Kinds of ore.	Amounts produced.				Decrease or increase in 1892 as compared with 1891.	
	1892.	1891.	1890.	1889.	Amount.	Percentage.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	
Red hematite	11, 646, 619	9, 327, 398	10, 527, 650	9, 056, 288	+2, 319, 221	+24. 86
Brown hematite	2, 485, 101	2, 757, 564	2, 559, 938	2, 523, 087	— 272, 463	— 9. 88
Magnetite	1, 971, 965	2, 317, 108	2, 570, 838	2, 506, 415	— 345, 143	—14. 89
Carbonate	192, 981	189, 108	377, 617	432, 251	+ 3, 873	+ 2. 05
Totals	16, 296, 666	14, 591, 178	16, 036, 043	14, 518, 041	+1, 705, 488	+11. 69

This shows a growing demand for red hematite iron ores at the expense of the magnetite and brown hematite varieties, but the advance in the amount of red hematite smelted is not so great as would appear from the table, as nearly all of the increased stock of ore at the close of 1892 was of the red hematite class.

The cause of the falling off in the brown hematite production was the low price of richer Lake Superior ores, and the fact that nearly all of the brown ore has to be washed, thus increasing its cost. The magnetic ores (while sometimes richer in iron) are denser, and furnace operators claim that they require more fuel and care to smelt them, therefore, other things being equal, a blast-furnace manager usually prefers the softer hematites. The mines of magnetite in New York and New Jersey are also yearly becoming deeper, and the cost of winning the ores greater, for there labor-saving devices are less generally employed than in the Lake Superior region. These eastern mines have to bear not only the competition of the western ores, but also to meet those of foreign countries, and this fact has in late years caused the closing of several of the eastern magnetic mines; the same is also true of some brown hematite mines near the seaboard. The amount of carbonate ore produced is so small that any local increase has quite a marked effect upon the total; the New York mines show an augmented output, due to the reopening of some old mines and the increased product of others. Ohio uses some of the local carbonates, but the main reliance of its large iron industry is upon hematite ores brought from the Lake Superior district.

Before presenting some statements as to the positions which each of the iron-ore producing States occupy, or discussing the characteristics of the ores won from them, attention is called to the following general facts affecting some of the larger producers:

The States of New York, New Jersey, Michigan, Wisconsin, Minnesota, Alabama, North Carolina, Georgia, and possibly Missouri mine iron ores in excess of the demands of their present active smelting capacities, while Pennsylvania, Ohio, Kentucky, West Virginia, Tennessee, and Maryland each consume more iron ore in blast furnaces than they produce. The ores from the Lake Superior districts supply the blast furnaces in Michigan, Wisconsin, Minnesota, Illinois, Indiana, most of those in Ohio, West Virginia, western Pennsylvania, and part of those in the States of New York and Kentucky and eastern Pennsylvania.

The foreign iron ores imported are chiefly used by blast furnaces in Pennsylvania and Maryland, some ores being at times supplied to New York and New Jersey furnaces. A small amount also comes to Pacific Coast ports.

The economies introduced for mining, handling, and transporting by rail and water permits the Lake Superior iron ores to meet foreign ores (which pay a duty of 75 cents per ton) within less than 100 miles of Atlantic ports at equal prices per unit of iron.

MICHIGAN.

Considering the States in the order of their precedence as producers of iron ores, Michigan appears as retaining first place with an increased output. The total iron ore mined in the State during 1892 was 7,543,544 long tons, or 46.29 per cent. of the grand total for the United States, showing an increase of 1,416,543 long tons, or 23.12 per cent. over the 1891 product of the State of 6,127,001 long tons. Of the total for the State 7,228,406 long tons, or 95.82 per cent., was red hematite, giving Michigan first rank as a producer of this class of ore, with 62.06 per cent. of the nation's red hematite total. The increase in the quantity of this character of ore over the 1891 output (5,445,371 long tons) was 1,783,035 long tons, or 32.74 per cent. The brown hematite produced was 187,306 long tons, or 2.48 per cent., of the total ore mined in the State, a decrease of 270,201 long tons, or 59.06 per cent., from the figures for 1891, giving Michigan fourth place as a producer, with 7.54 per cent. of the country's total of this character of ore. It should, however, be borne in mind that there is very little brown hematite iron ore mined in Michigan, from deposits which should be classed as brown hematite, the majority being red hematite which has been partially hydrated or weathered into brown hematite ore.

The balance of Michigan's output, 1.70 per cent. or 127,832 long tons, was magnetite, a decline of 96,291 tons, or 42.96 per cent., from the 1891 total of 224,123 tons. As a producer of magnetite the State ranked fourth, with 6.48 per cent. of the total for the United States in 1892.

While Michigan still maintains the lead as a producer of iron ores, and has made advances in production, it will be noted that the older Marquette range has not been holding its own with the Gogebic range in the western part of the State. Some of the more noted Marquette mines have decreased outputs, and others may be closed, owing to the low price of ore and competition with the softer and more cheaply mined ores of the Gogebic range in Michigan and the threatened competition from the Mesabi range in Minnesota. An interesting feature in connection with the exploitation of the Marquette range is the draining of Lake Angeline, near Ishpeming, Michigan, in order to obtain the ore which lies beneath the lake to better advantage.

Besides being the greatest contributor to the iron-ore supply, Michigan has the credit of furnishing the largest annual output from one operation. The list of mines producing 50,000 tons or over, given further on, show that 32 of the largest mines are credited to this State. The workings of what are known as the Norrie, the East and North Norrie mines, are connected, extending for a length of three-fourths of a mile, while they reach a maximum depth of 650 feet. The two properties are under one management, and are only reported separately because the royalties go to different interests. The Pabst mine is also operated conjointly with the Norrie mines, but is a separate working. The Norrie mine, first opened in 1885, has produced up to the close of the year 1892, 4,113,103 long tons. A glance down the list of large mines shows which are to be credited to Michigan.

ALABAMA.

Alabama continued in second place in 1892, with an increased output of iron ore, viz., 2,312,071 tons, or 14.19 per cent. of the total for the country, of which 1,657,028 tons, or 71.67 per cent., was red hematite and 655,043 long tons, or 28.33 per cent., brown hematite. The 1891 product was 1,986,830 long tons, showing a gain in 1892 of 325,241 long tons, or 16.37 per cent., the increase in the brown hematite being 192,996 long tons and in red hematite 132,245 long tons. Alabama holds second rank as a producer of red hematite ore, with 14.23 per cent. of the total for the United States, and second rank for brown hematite, with a percentage of 26.36 of the country's total. Alabama also has some very important producers credited to her quota, although none of her mines approach in output the largest Lake Superior operations.

MINNESOTA.

Minnesota, in order of precedence, passed both Pennsylvania and New York in 1892, occupying third place, with a total iron ore output of 1,255,465 long tons, or 7.70 per cent. of the total for the United States. With the exception of 5,000 tons of ore classed as brown hematite mined in the Mesabi range, but not shipped last year, the whole of this amount is red hematite ore, the State also ranking third as a producer of this class of ore, with 10.74 per cent. of the total for the country.

The Mesabi range.—The year 1892 chronicles the first shipment (4,245 long tons) from the new Mesabi range. Although there was a considerable amount of iron ore mined, much of it was stocked on account of lack of railroad transportation, but where this ore was mined in 1892 and reported it was included in the total. In the year 1893 it is probable that important shipments will be made, but much of the work will be in the way of developing, and the range will hardly be as important a contributor of iron ore in that year as is anticipated.

In view of the interest excited by the opening of the iron ore deposits on this range, the following data concerning the varieties of Mesabi iron ore as described by Prof. Horace V. Winchell, are taken from the Twentieth Annual Report of the Minnesota Geological Survey:

"*Magnetite.*—The ore of the eastern portion of the Mesabi probably owes its magnetic properties to the heat of the gabbro overflow upon the hematites which were deposited in the rocks at the time of their formation in oceanic waters. Where this ore is associated with the lower beds of the Taconic it is rather coarsely granular and shiny. The ore which occurs higher up in the horizon is fine grained and compact, having a high specific gravity. Individual samples of this ore show a high percentage of iron and a low contents of phosphorus and sulphur Unfortunately, it seldom occurs in beds of sufficient depth to render it valuable without concentration. It is noticeable that there is a small percentage of magnetic grains in the blue-black, soft, granular hematite of the central portion of the range. The titaniferous magnetites occur in the gabbro, and are valueless at present.

"*Brown hematite.*—This ore is found below the Glacial Drift in many test pits. It is soft, homogeneous yellow ore, and occurs in layers 6 to 20 feet in thickness. It was at first called limonite, but its high percentage of iron, as revealed by several analyses, together with the large amount of combined water, showed that it was goethite. As a rule, it is non-Bessemer. It is called "yellow ocher" by the miners and is frequently thrown out as poor ore. Its composition when absolutely pure is sesqui-oxide of iron 89.9 per cent., water 10.1 per cent., metallic iron 62.9 per cent., and the following analyses of the ore as mined show its prominent constituents:

Analyses of brown hematite from the Mesabi range, Minnesota.

	Metallic iron.	Phosphorus.	Silica.	Water.	
				Combined.	Free.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
No. 1	60.65	0.070	....	....	....
No. 2	60.65	0.105	2.09	8.04	9.86
No. 3	60.75	0.065	1.85	10.05	12.77
No. 4	60.90	0.029	4.85	....	....

"The ore may be of more value for the manufacture of mineral paints than for use in the furnace. It can be obtained cheaply and in large quantities.

"Hard masses and layers of brown hematite are found in many pits on the Mesabi. The ore is inclined to be siliceous, and rather high in phosphorus. Many cavities are lined or filled with grape and pipe limonite ore. It seems to occur in portions of the ore bodies where considerable streams of water flow through the rocks and ore continually or at certain seasons of the year. Only a small percentage of all the ore in any mine so far discovered has been shown to be of this mineral. It is perhaps the least valuable of any except the titaniferous ores on the range.

"*Red hematite.*—By far the larger part of the Mesabi ores are hematites, as the term is used by mineralogists, i. e., anhydrous sesqui-oxide of iron, whether hard or soft, crystalline, massive or earthy, red, blue, purple, brown, green or black. All varieties and all textures occur in this new range. The variation in appearance is remarkable, but the uniformity of composition is equally so. There are high and low grade ores here, as on any other range, but samples of ores of at least ten totally different microscopic characteristics, can be selected that will not vary 2 per cent. in iron contents. The best grade of hematite is the blue black, soft ore found at many of the mines. When this ore is in perfectly crystalline grains, which possess little adherence to each other, and will not "pack" in one's hand, as do the more earthy ores, the percentage of iron reaches almost absolute purity. One sample of 30 feet of this ore yielded by analysis 67.90 per cent. of iron, 1.8 per cent. of silica, and 0.016 per cent. of phosphorus. It is this exceedingly pure ore that brings up the average of Mesabi ores. Without it there are several properties which would be non-Bessemer; with it they are a good Bessemer."

Black oxide of manganese is found in hard and soft streaks in the ore of many mines on the range. As yet it has not been found in sufficient quantities to guarantee any considerable production of manganese ore or manganiferous iron ore. Mr. Winchell, however, thinks that some such ore may be produced.

Competent specialists have made estimates, which they claim to be conservative, which show that from ten to twenty large mines can be developed from present explorations. Each of these mines is reported to have 1,000,000 long tons of ore in sight as a minimum, the quantity being estimated from numerous excavations, test pits, and bore holes. Whether these estimates need modification or not, the Mesabi range promises to be a basis for the supply of large quantities of rich iron ores which can be cheaply mined; and surprise is expressed that in opening up the excellent deposits of the Vermilion range in Minnesota, the Mesabi, with its hidden wealth of ore, was crossed so many times without having its secret betrayed, for the Mesabi range lies between the city of Duluth and the Vermilion iron range.

The occurrence of some of the ores of the Mesabi range offer excellent facilities for cheap exploitation, and the use of steam shovels now handling "stripping" is to be extended to mining the ore.

Minnesota, in 1892, obtained the bulk of its ore from two operations, the Chandler mine contributing 642,449, and the Minnesota Iron Company 568,771 long tons.

PENNSYLVANIA.

Pennsylvania has fallen from third to fourth position, as to iron ore output, the product of 1,084,047 long tons, being but 6.65 per cent. of the total for the United States, showing a decrease of 188,881 tons, or 14.84 per cent. from the 1891 output of 1,272,928 long tons. This decline was in all of the varieties of iron ore except the red hematite, as will be seen from the following table, in which the amounts produced in 1889, 1890, 1891, and 1892, as well as the decrease in 1892, are shown.

Production of iron ore in Pennsylvania from 1889 to 1892.

Kinds of ore.	Amounts produced.				Decrease or increase in 1892 as compared with 1891.	
	1889.	1890.	1891.	1892.	Amount.	Per cent.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	
Magnetite	860, 916	765, 318	727, 299	685, 986	—41, 313	—5. 68
Brown hematite	496, 555	415, 779	363, 894	229, 700	—134, 194	—36. 88
Red hematite	162, 957	143, 745	162, 683	163, 307	+624	+. 38
Carbonate	39, 806	36, 780	19, 052	5, 054	—13, 998	—73. 47
Totals	1, 560, 234	1, 361, 622	1, 272, 928	1, 084, 047	—188, 881	—14. 84

Of the 1892 output 63.28 per cent. was magnetite, 21.19 per cent. brown hematite, 15.06 per cent. red hematite and 0.47 per cent. carbonate, giving the State first place as a producer of magnetite, with a credit of 34.79 per cent. of the country's total; third place in the mining of brown hematite ores, with 9.24 per cent. of the total of that class of ore, and sixth and fifth places in the red hematite and carbonate varieties, with 1.40 per cent. and 2.62 per cent. of the respective totals. Pennsylvania's position as an iron-ore producer and its first rank among the contributors of magnetite is due to the large deposit of ore in the Cornwall Ore Hills, the cheap mining of which on a large scale places this property among the great mines of the country. In 1892 the Cornwall Ore Hills supplied 634,714 long tons, and up to date over 12,000,000 tons of ore have been taken from this deposit.

NEW YORK.

New York, like Pennsylvania, produced all four classes of iron ore, and these two States were the only ones winning all the different characters of ore last year. The 1892 output was 891,099 long tons, a decline from that of 1891 (1,017,216 tons) of 126,117 tons or 12.40 per cent. This restricted product was confined to the magnetic and red hematite varieties of ore, the other two classes showing an increase. The State occupies second place as a producer of magnetic iron ore, 648,564 long tons, or 32.89 per cent. of the total for the United States, being of this character. This amount is, however, 134,165 long tons, or 17.14 per cent. less than that of 1891, when 782,729 long tons were produced. There is but a slight difference in the magnetite outputs of Pennsylvania and New York, the former now taking first place, but approximately the production of magnetic iron ore in the United States may be considered as being divided in three nearly equal parts, slightly more than one-third coming from Pennsylvania, and the balance being about equally divided between New York and other States. The red hematites, in which class New York occupies seventh place, with 1.07 per cent. of the country's total, also shows a falling off of 28,923 tons, or 18.82 per cent. from the 1891 product of 153,723 long tons. The brown hematite mines produced 53,694 tons in 1892, an increase over the 1891 total (53,152 tons) of 542 tons, or 1.02 per cent., giving the State eighth position, with 2.16

per cent. of the country's total. The carbonate ores show a decided advance from 27,612 long tons in 1891 to 64,041 tons in 1892, this gain of 36,429 long tons or 131.93 per cent. being due to the reopening of old mines and more active operations in other properties in the southeastern portion of the State near the Hudson river. One-third of all the carbonate ore produced in the United states was supplied by New York, in which class of ore the State occupied second place. New York has some important producers which have supplied and can again furnish ore much in excess of the quantity credited to them last year.

WISCONSIN.

The major portion of the iron ore won in this State came from the mines near Hurley on the Gogebic range, and those on the Menominee range in the vicinity of Florence, the total being 790,179 long tons, an advance over the 1891 figures (589,481 long tons) of 200,698 long tons, or 34.05 per cent. All of the ore mined in 1892, with the exception of 15,300 tons of brown hematite, was of the red hematite variety, in which class the State occupied fourth place, supplying 6.65 per cent. of the total for the United States. Wisconsin will probably augment the output of brown hematite in future years to supply local blast furnaces.

VIRGINIA.

Virginia ranks seventh as an iron ore producer, with 741,027 long tons, or 4.55 per cent. of the total for the United States in 1892. Of the State's total 711,753 long tons, or 96.05 per cent., was of the brown hematite variety, giving the State first place as a producer of this class of ore, with 28.64 per cent. of the total for the entire country. Of the balance, 26,120 long tons was red hematite ore and 3,154 tons magnetite.

NEW JERSEY.

New Jersey occupied eighth place, producing 465,455 long tons of iron ore or 2.86 per cent. of the country's total. Of this amount, 456,759 long tons consisted of magnetic ores, giving the State third place in this class of ore, with 23.16 per cent. of the total for the United States. The balance, 8,696 long tons, was about equally divided between the red and brown hematites. This last-mentioned ore was obtained near Buttzville, where a mixture of magnetite and red and brown hematite is mined, the percentage of magnetite, however, being greater than that of the other varieties. The State shows a decline of 60,157 long tons, or 11.45 per cent., from the 1891 output of 525,612 long tons, and but a small proportion of its productive ore mines are now active.

TENNESSEE.

According to the reports furnished this office, Tennessee shows a decrease in the amount of iron ore mined in 1892 of 137,345 long tons, or 25.25 per cent., the figures for 1892 being but 406,578 tons, as compared with 543,923 long tons won in 1891. Of the amount mined in 1892, 63.16 per cent., or 256,786 tons, was red hematite ore, and the balance, 36.84 per cent., or 149,792 tons, was brown hematite. With the abundance of red and brown hematites, there seems no especial reason, beyond a spasmodic restriction, to account for a decrease in the ore output of Tennessee. In this State, as in New Jersey, New York, Pennsylvania, Virginia, and other States, the total annual output of a certain variety of iron ore may be seriously affected by the activity of blast-furnace plants which are supplied by local mines controlled by the owners of the iron works.

OTHER STATES.

Georgia, Colorado, and Missouri were the only other States which produced over 100,000 tons of ore in 1892, their outputs being 185,054, 141,769, and 118,494 long tons respectively, giving them tenth, eleventh, and twelfth places. The major portion of Georgia's output was brown hematite ore, the remainder red hematite. Colorado's product was also nearly all of the brown hematite class, but small amounts of magnetite and red hematite ores were also won. Its iron ore output was divided among the blast furnaces and the silver smelters, the use in the latter being as a flux. Approximately 43 per cent. of the Colorado iron ores were converted into pig iron and 57 per cent. used as a flux. With the exception of a small amount of brown hematite, all of Missouri's iron ores were of the red hematite variety, the brown hematite being sold to silver smelters.

Ohio heads the list of carbonate iron ore producers with 95,768 long tons or 49.63 per cent. of the total for the entire country, this being the only class of ore which was mined. Most of the ore smelted in Ohio blast furnaces comes from the Lake Superior region.

The other States and Territories mining iron ore in 1892, were Kentucky, Massachusetts, Maryland, Connecticut, North Carolina, Texas, New Mexico, Oregon, Utah, Montana, and West Virginia.

Kentucky's contribution was mainly brown hematite ores, although some of this was weathered carbonate, classed as brown hematites, the native ores being enriched by liberal mixtures of Lake Superior iron ores.

The ore won in Massachusetts and Connecticut was of the brown hematite variety, and came chiefly from the celebrated Salisbury district.

In the eastern part of Maryland carbonate ores were obtained, while the western section contributed brown hematite ores. The large blast furnaces at Sparrow's Point, near Baltimore, however, depend upon foreign sources for their iron ore supply.

The major portion of North Carolina's output was magnetite from the Cranberry district, but some hematite, the exact amount of which could not be obtained, was won.

The brown hematite ores of Texas came from the eastern and south central portion of the State, the magnetite being a few car-load lots which were sent from the Llano district for trial in the blast furnace. While this district has good iron ores, the lack of railroad transportation and a convenient market has prevented its earlier development, but in the future it is expected to prove the source of a good supply of Bessemer iron ore.

All of the ore won in New Mexico, Montana, and Utah was used as a flux in silver smelting, and was mostly brown hematite, although magnetite and red hematite were also mined.

Oregon's brown hematite ore was used at the furnace of the Oswego Iron and Steel Company, and the output of West Virginia was also consumed in the blast furnaces of the State.

It is reported that some of the excellent iron ores of Wyoming are being exploited, and that about 5,000 tons of ore were taken out and stocked for future shipment.

VALUATION.

The value of the iron ore produced during the year 1892, as set forth in the following table, represents the average market value of the ore for the year, less freight or other transportation charges, commissions, etc.; that is, the figures give the average value of the ore (including royalty, if any) delivered on cars or other vehicles at the mine. The variation exhibited by this value in the different States is affected by the quality of the ore won, and the distance of the mines from points of consumption. This would be still more evident by a comparison of districts, of groups of mines, or of single mines, but as a rule the average value of ores is a fair indication of their yield in iron, or their relative absence of deleterious ingredients. In the West the high valuation, however, is due to the increased cost of labor.

Amount and value of iron ore produced in the calendar year 1892.

States.	Amounts produced.	Total value of ore at mine.	Average value per ton of ore at mine.
	Long tons.		
Michigan	7,543,544	$16,587,521	$2.20
Alabama	2,312,071	2,442,575	1.06
Minnesota	1,255,465	3,090,942	2.46
Pennsylvania	1,084,047	2,197,028	2.03
New York	891,099	2,379,267	2.67
Wisconsin	790,179	1,428,921	1.81
Virginia and West Virginia	747,027	1,428,801	1.91
New Jersey	465,455	1,388,875	2.98
Tennessee	406,578	505,359	1.24
Georgia and North Carolina	210,433	262,517	1.25
Colorado	141,769	587,903	4.15
Missouri	118,494	237,827	2.01
Ohio	95,768	148,288	1.55
Massachusetts and Connecticut	76,265	249,198	3.27
Kentucky	50,523	63,172	1.25
Maryland	40,171	88,691	2.21
Texas	22,903	20,890	0.91
Other States	44,875	97,121	2.16
Totals	16,296,666	33,204,896	2.04

As in the smaller producing States there are but one or two active establishments (in some cases owned by one company) they have been grouped with neighboring States so as not to publish information in regard to individual operations.

The total value of the iron ore mined in the United States in the year 1892 was $33,204,896, or $2.04 per ton. Comparing the average value per ton in 1892 ($2.04) with that of 1889 ($2.30) there is an apparent decline of 26 cents or 11.30 per cent. The following table has been taken from the Eleventh Census for the purpose of comparison, showing the amount and value of the iron ore produced in the various States and Territories in the year 1889:

Production of iron ore in 1889.

States and Territories.	Amount produced.	Total value of production.	Value per long ton.
	Long tons.		
Alabama	1,570,319	$1,511,611	$0.96
Colorado	109,136	487,433	4.47
Connecticut, Maine, and Massachusetts	88,251	265,901	3.01
Delaware and Maryland	29,380	68,240	2.32
Georgia and North Carolina	258,145	334,025	1.29
Idaho and Montana	24,072	158,974	6.60
Kentucky	77,487	135,559	1.75
Michigan	5,856,169	15,800,521	2.70
Minnesota	864,508	2,478,041	2.87
Missouri	265,718	561,041	2.11
New Jersey	415,510	1,341,543	3.23
New Mexico and Utah	36,050	70,956	1.97
New York	1,247,537	3,100,216	2.49
Ohio	254,294	532,725	2.09
Oregon and Washington	26,283	39,234	1.49
Pennsylvania	1,560,234	3,063,534	1.96
Tennessee	473,294	606,476	1.28
Texas	13,000	19,750	1.52
Virginia and West Virginia	511,255	935,290	1.83
Wisconsin	837,399	1,840,908	2.20
Total	14,518,041	33,351,978	2.30

Considering the principal States individually, it will be found that in Michigan the average value per ton in 1892 was $2.20 as against $2.70 in 1889, a decrease of 50 cents per ton, or 18.52 per cent., principally attributable to a large output and a decreased demand for ore. Alabama's average value, on the other hand, shows an advance of 10 cents per ton over the 1889 figures of 96 cents, due possibly to the increased cost of winning the ores from greater depths. Minnesota's iron ores show a fall in value from $2.87 per ton in 1889 to $2.46 in 1892, while the average value per ton of the iron ores mined in Pennsylvania advanced from $1.96 per ton in 1889 to $2.03 in 1892. New York also shows an increased value per ton, the ores produced in 1892 being worth $2.67, while those mined in 1889 were valued at but $2.49 per ton.

The three States included in the Lake Superior région, and which have to ship their ores long distances to a market, show a marked decrease in value, while those mined in two of the large iron manufacturing States, viz., Pennsylvania and Alabama, indicate a slight increase in value.

The highest average value per ton was $4.15 in Colorado, and the lowest, 91 cents in Texas. The rich ores of Minnesota, Michigan, and New York, although far removed from a market, commanded prices at the mine considerably above the average by reason of their quality.

STOCKS.

The stocks of iron ore can not be given with exactness, as in many instances the actual weight of ore is not determined until it is shipped, and the quantities in stock are necessarily estimated.

The following table shows the comparative stocks of iron ore held at the beginning and at the close of the year 1892 at the mines, but in addition to this there is considerable stock held by agents of the mining companies, and at furnaces, as much of the Lake Superior ore is handled by vessels which, owing to ice, can not travel in winter. There is also usually an accumulation of ores at receiving docks and at blast furnaces about the close of the year. Some of the States, which show small stocks of ore, supply blast furnaces practically direct from mines, and little ore is kept in stock at either mine or furnace. In others a considerable proportion of the ore mined must be stocked for shipment or held for the favorable season.

Stocks of iron ore on hand December 31, 1891 and 1892.

States.	Dec. 31, 1891.	Dec. 31, 1892.
	Long tons.	*Long tons.*
Michigan	1,153,166	1,520,477
Alabama	64,864	47,918
Minnesota	160,084	247,053
Pennsylvania	31,851	62,124
New York	204,199	244,583
Wisconsin	211,869	251,649
Virginia and West Virginia	66,190	92,984
New Jersey	64,856	72,390
Tennessee	93,204	101,027
Georgia and North Carolina	22,644	24,830
Colorado	5,580	4,200
Missouri	266,544	248,337
Ohio	51,948	60,013
Massachusetts and Connecticut	7,604	2,810
Kentucky	500	6,504
Maryland	8,500	8,000
Texas	12,793	18,103
Other States	23,883	19,529
Totals	2,450,279	3,032,531

The stock on hand at the mines at the close of 1891 represented 16.79 per cent. of the total output for the year, while the stock at the close of 1892 was equivalent to 18.61 per cent. of the total production in that year.

The total stock of ore on hand December 31, 1892, was 3,032,531 long tons, an increase over the stock on December 31, 1891 (2,450,279 tons), of 582,252 long tons, or 23.39 per cent. Michigan, as would naturally be expected, had the largest stock of ore on hand at the end of both years, while Kentucky had the smallest stock at the close of 1891, and

Massachusetts and Connecticut held the same position December 31, 1892.

As mentioned in the report for 1891, the lower lake ports act as intermediary stores between the mines of the Lake Superior region and the blast furnaces for the stocking of iron ore, and, according to the Iron Trade Review, the large stocks on hand December 1, 1891, viz., 3,508,489 long tons, had risen to 4,195,451 long tons on December 1, 1892. The following will show the receipts at the various lower lake ports during the season of 1892 and the stocks of Lake Superior ore on the docks December 1, 1892.

Receipts of iron ore at lower lake ports in season of 1892, and stocks on hand December 1, 1892.

Ports.	Receipts.	Stocks.
	Long tons.	*Long tons.*
Ashtabula	2,555,416	1,312,658
Cleveland	1,950,224	1,347,992
Fairport	866,611	610,609
Erie	645,230	401,683
Lorain	190,400	147,600
Buffalo	197,000	125,000
Toledo	139,987	71,409
Huron	65,000	45,000
Sandusky	49,736	87,500
Conneaut	1,130	None.
Totals	6,660,734	4,149,451

Conneaut, a new receiving port in Ohio, received its first shipment of iron ore last season.

While the condition of trade at the lower lake ports does not represent anything more than the status of Lake Superior ores, the important position which the mineral from that district holds to the country's total gives interest to statements concerning the stocks on hand. Outside of a few mines little ore is carried in stock, except at blast furnaces, and as the Lake Superior region last year contributed 58.69 per cent. of all the iron ore mined in the United States an approximate index of the condition of trade will appear from the following table:

Lake and rail shipments and stocks of ore on hand at close of years 1889, 1890, 1891, and 1892.

Years.	Shipments.	Stocks on hand at lake ports, December 1.
	Long tons.	*Long tons.*
1889	*a*7,390,387	*a*2,607,106
1890	*b*9,003,701	*b*3,893,487
1891	*b*7,094,981	*b*3,508,489
1892	*c*9,073,568	*c*4,149,451

a Eleventh Census. *b* Cleveland Iron Trade Review. *c* U. S. Geological Survey.

There were on docks at lower lake ports, May 1, 1892	long tons..	1,537,188
Receipts during season of 1892	do....	6,660,734
Total	do....	8,197,922
On dock at lower lake ports, December 1, 1892	do....	4,149,451
The shipments from Lake Erie docks to furnaces being in that period	do....	4,048,471

This is the largest shipment on record, the next largest for a similar period being 3,917,405 long tons in 1890. The 1891 figures were 3,831,195 tons. The difference between the total receipts of iron ore at lower lake ports and the total shipments from the Lake Superior ports will show the amount sent by water to the various blast furnaces in Michigan, Illinois, etc., and also the all-rail shipments.

Mr. Leland has prepared the following table showing the percentage of the lake shipments of iron ore received by the different ports on Lake Erie in the last ten years, the advance of some of the ports and the decline of others being plainly indicated:

Percentages of lake shipments of iron ore received at lower lake ports in the years 1883 to 1892, inclusive.

Ports.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
Ashtabula	39.6	35.3	38.7	29.6	32.1	34.1	36.8	31.7	32.4	38.4
Cleveland	42.7	49.1	39.2	45.6	35.4	25.7	26.2	28.3	25.5	29.3
Fairport	2.4	1.3	2.1	4.9	14.6	16.2	15.6	15.9	14.2	13.0
Buffalo	2.4	.5	.5	1.4	.8	6.3	5.6	8.0	8.3	2.9
Erie	6.3	6.3	8.1	4.0	6.1	6.3	5.5	7.1	7.9	9.7
Lorain	1.5	1.6	.9	4.4	3.9	5.2	5.3	4.1	5.4	2.9
Sandusky	3.5	5.8	9.5	7.0	4.7	4.1	3.5	2.5	2.1	.7
Toledo	1.6	.1	1.0	1.2	1.8	2.0	1.5	2.4	3.9	2.1
Huron	......	......	......	1.9	.6	.1	......	......	.3	1.0

TRANSPORTATION.

The bulk of the iron ore from the Lake Superior region was forwarded to its destination via steam and sailing vessels on the Great Lakes, the all-rail shipments direct to blast furnaces in 1892, according to *Iron Ore*, amounting to but 525,768 long tons. One new shipping port appeared on the list, viz., Superior, Wisconsin, from which 4,245 tons of iron ore from the Mesabi range were forwarded. Nearly one-half of the lake shipments came from the port of Escanaba, Ashland being the nearest rival, and the importance of these two places as shippers of iron ore is well shown in the following table, taken from *Iron Ore*, giving the amount of iron ore sent forward from each of the upper lake shipping ports:

Amounts of iron ore sent forward in the shipping season from the various lake ports in 1892.

	Long tons.
Escanaba, Michigan	4,012,197
Ashland, Wisconsin	2,221,241
Two Harbors, Minnesota	1,155,498
Marquette, Michigan	1,034,700
Gladstone, Michigan	115,907
Superior, Wisconsin	4,245
Total lake shipments	8,543,788
All-rail shipments	525,768
Total shipments of Lake Superior ores	(*a*)9,069,556

a The difference between these figures and those furnished to the U. S. Geological Survey, viz., 9,073,598 tons, is probably due to the variation between the actual weights and those represented by bills of lading.

Of the iron ore sent to the lower lake ports via Escanaba, 2,107,506 tons came from the mines on the Menominee range, 1,392,148 tons from the Marquette range, and 512,543 tons from the Gogebic range. All of the shipments from Ashland came from the Gogebic range, and those from Two Harbors from the Vermilion range. Gladstone quota came from the Marquette and Menominee ranges, the former contributing 50,370 tons and the latter 65,537 tons. The small amount sent from Superior was the initial shipment of iron ore from the Mesabi range of Minnesota.

It is probable that the port of Superior will show increased shipments in 1893, as this port has been built solely for the purpose of giving the needed facilities for forwarding the output of the Mesabi range.

IMPORTANT PRODUCERS.

In order to produce iron ore at low cost and meet competition from other points, it is essential that the management should employ labor-saving devices and introduce economic methods; for this purpose in a number of cases several large mines are operated under one management, thus reducing the fixed charges per ton of product. By far the larger proportion of iron ore mined in the United States is obtained from a comparatively few of the more important mines, and in the year 1892, according to the returns made for this report, 10,883,677 long tons, or 66.78 per cent. of the total output, came from the fifty-nine mines named, each of which contributed 50,000 long tons or over, and, if to this we add twelve other large mines for which permission to publish figures was not given, the aggregate will be 12,561,883 long tons, or 77.08 per cent. of the total, obtained from seventy-one mines.

In 1892 there was one mining company which produced over 1,000,000 long tons, four which produced over 500,000 tons each (and of these, three exceeded 600,000 tons), two produced over 400,000, five between 300,000 and 400,000, four between 200,000 and 300,000, twenty-two between 100,000 and 200,000, and thirty-three between 50,000 and 100,000 tons, making a total of seventy-one mines producing 50,000 tons or over in 1892.

In the table below will be found the names and the amount of iron ore mined in the year 1892 by such of the larger mining companies as expressed no objection to such publication; the balance being held confidential, are not referred to by name, but the number of these mines and their output are included in the above statement.

List of mines producing 50,000 tons or more of iron ore in 1892.

		Long tons.
Norrie, Michigan	633, 807 tons	
East and North Norrie, Michigan	369, 156 tons	
		1, 002, 963
Chapin, Michigan		655, 000
Chandler, Minnesota		642, 449
Cornwall, Pennsylvania		634, 714

List of mines producing 50,000 tons or more of iron ore in 1892—Continued.

		Long tons.
Minnesota Iron Company, Minnesota		568, 771
Lake Superior, Michigan		444, 506
Buffalo Mining Company, Michigan		387, 347
Colby & Tilden, Michigan		385, 816
Cleveland Iron Company, Michigan:		
Hard ore	90, 190	
Lake	194, 600	
Hematite	89, 700	
		374, 490
Penn Iron Mining Company, Michigan		337, 713
Aurora, Michigan		289, 966
Commonwealth, Wisconsin		271, 585
Lake Angeline, Michigan		260, 257
Ashland, Michigan		244, 000
Winthrop & Mitchell, Michigan		191, 658
Old Bed, Port Henry, New York	95, 862	
New Bed, Port Henry, New York	95, 471	
		191, 333
Aragon, Michigan		181, 107
Newport, Michigan		174, 795
Republic, Michigan		167, 213
Cliff Shafts, Michigan		159, 783
Salisbury, Michigan		147, 796
Dunn mine, Michigan		142, 454
Lady Ensley Coal, Iron and Railroad Company, Alabama		142, 402
Sloss, Nos. 1 and 2, Alabama		140, 946
Iron Belt, Wisconsin		140, 535
Champion, Michigan		127, 832
Pewabic, Michigan		125, 831
Pabst, Michigan (*a*)		123, 400
Irondale, Nos. 1, 2, and 3, Alabama		123, 123
Brotherton, Michigan		116, 723
Volunteer, Michigan		110, 700
Great Western, Michigan		108, 000
Cary and West Cary, Wisconsin		107, 589
Palms, Michigan		107, 243
Chateaugay, New York		101, 231
Inman, Tennessee		90, 876
Jackson, Michigan		86, 376
Negaunee, Michigan		85, 567
Florence, Wisconsin		84, 101
Graces Gap, Alabama		72, 000
Tilly Foster, New York		70, 039
Shelby, Alabama		70, 000
Sunday Lake, Michigan		68, 618
Longdale, Virginia		68, 537
Shafer, Michigan		65, 258
Hemlock River, Michigan		65, 000
Montreal, Wisconsin		63, 732
Clinton, New York		63, 345
Stephens, Alabama		62, 400
Richard, New Jersey		60, 972
Hudson River, New York		59, 241

a Operated in connection with Norrie mine.

List of mines producing 50,000 tons or more of iron ore in 1892—Continued.

	Long tons.
Roane Iron Company, Tennessee	57,910
Claire, Michigan	57,351
Sheridan, Michigan	51,000
Lower Wood, New Jersey	50,083
Tannehill, Alabama	50,000
West Point, Tennessee	50,000
Total for fifty-nine mines	10,883,677
Add for twelve other mines not mentioned by name	1,678,206
Total for seventy-one mines	12,561,883

The following table will show the number of mines in each State which in the year 1892 produced over 50,000 gross tons, the combined output of these mines, and the percentage of the total output of each of the States which came from these large mines.

Production of the larger iron ore mines, by States.

States.	Number of large mines.	Combined output.	Per cent. of total product of State.
Michigan	32	6,922,763	92
Alabama	16	2,036,008	88
Minnesota	2	1,211,220	96
Wisconsin	5	667,542	84
Pennsylvania	1	634,714	59
New York	7	583,387	65
Tennessee	3	198,786	49
New Jersey	3	163,926	35
Other States	2	143,537	....
Total	71	12,561,883	a 77

a Of total for United States.

Of these seventy-one mines, fifty were red hematite operations, giving a total output of 10,364,359 long tons, or 89 per cent. of the total of this class of ore; ten were producers of magnetite, yielding 1,387,273 long tons, or 70 per cent. of the total output of this variety; ten were brown hematite workings, with a total product of 751,010 long tons, or 30 per cent. of the total of this character of ore mined in the United States; the one remaining mine produced carbonate ore, its output of 59,241 tons being 31 per cent. of the nation's total of this class of ore.

From the above statement it can be seen that the average output of red hematite per mine of those producing over 50,000 long tons was 207,287 tons; of magnetite, 138,727 tons; of brown hematite, 75,101 tons, and of carbonate ore, 59,241 tons.

EXTENT OF MINING OPERATIONS.

Generally speaking, most of the brown hematite iron ores are won either from open cut or open pit workings, while the red hematites and magnetites are usually obtained from underground operations. The carbonate ores are also mostly wrought underground. There are numerous exceptions to the rule, but taken as a whole the above statement will be found to be approximately correct.

In order to obtain some idea as to the depth to which the workings were carried, inquiries were made as to the maximum depth obtained both vertically and on the slope at the different mines, and from the answers received the following table, showing the minimum and maximum depths in each State, has been prepared. Unless the details of every mine were investigated no average depth of mine could be given, nor is such essential, the table presenting an idea of the extent to which exploitations are at present carried for mining iron ore. Most of the shafts and slopes are equipped with excellent machinery for handling the ore and raising water, and the great areas of underground workings are in many cases carried on by modern power drills and illuminated by electric light.

The vertical and slope distances given refer to different operations, and in many cases the slopes enter the sides of steep hills, so that no vertical depth is recorded.

Depths of mine workings in various States in 1892.

States.	Vertically.	On slope.
Alabama	Surface workings to 200 feet	Surface workings to 1,100 feet.
Colorado	15 feet to 650 feet	None given.
Connecticut	100 feet to 140 feet	Do.
Georgia	Surface workings to 200 feet	100 feet to 400 feet.
Kentucky	Surface workings to 150 feet	None given.
Maryland	Surface workings to 80 feet	Surface workings to 350 feet.
Massachusetts	165 feet to 260 feet	285 feet to 320 feet.
Michigan	75 feet to 1,460 feet	90 feet to 1,500 feet.
Minnesota	Surface workings to 490 feet	
Missouri	60 feet to 205 feet	150 feet to 480 feet.
Montana	30 feet to 100 feet	140 feet to 200 feet.
New Jersey	80 feet to 1,200 feet	130 feet to 4,350 feet.
New York	18 feet to 985 feet	130 feet to 2,575 feet.
North Carolina	100 feet to 200 feet	100 feet.
Ohio	Surface workings to 80 feet	15 feet to 860 feet.
Pennsylvania	Surface workings to 390 feet	Surface workings to 1,080 feet.
Tennessee	Surface workings to 250 feet	150 feet to 500 feet.
Texas	Surface workings to 70 feet	Surface workings to 100 feet.
Virginia	Surface workings to 430 feet	Surface workings to 600 feet.
Wisconsin	50 feet to 630 feet	330 feet to 940 feet.
Other States	80 feet to 300 feet	89 feet to 300 feet.

There are eight mines reporting a vertical depth of 1,000 feet or over, and of these, seven are located in Michigan.

IMPORTS.

While the United States has large deposits of iron ores of all kinds widely distributed throughout the various States and Territories, still the low rates of labor in foreign countries and cheap water-transportation rates have admitted considerable quantities of iron ore into this country in spite of a specific duty of 75 cents per ton which is collected on all iron ore imported. In the year ending December 31, 1892, iron ore to the amount of 806,585 long tons, valued at $1,795,644 or $2.23 per ton, was thus imported.

All of this iron ore, however, is consumed near the ports of entry, and much of the ore entering the port of Baltimore is unloaded direct from the vessels to the blast furnace stock piles; this is also the case at one Pennsylvania furnace.

All the iron ore imported from Cuba is taken from the mines operated by American companies, as was that brought from Texada Island, in British Columbia. Until 1892 but one company was mining and shipping iron ore from Cuba, but last year a second enterprise was represented by actual shipments, and 1893 is expected to add at least one more active corporation to the list of Cuban mines.

An American company is also about to exploit an iron ore deposit in Lower California, Mexico, and ship the product into the United States.

A comparison of the average values for foreign iron ores, which are based upon the values at the ports from whence shipments are made, and the average values of iron ores in different States as stated herein, will prove of interest. Some of the values given for small shipments received at certain ports are evidently excessive, and are probably based upon other constituents of the ores, which are of greater value than the iron they contain. Eliminating these, a comparison of the value of domestic iron ores with those given for imported ores indicate a close competition, and a knowledge of the composition of the iron ores imported in considerable quantities demonstrates that such as are brought to this country are, by reason of ocean freights and specific duty, of superior quality.

The Bureau of Statistics of the Treasury Department has kindly supplied the following tables showing the amounts of iron ore imported from various foreign countries in the year ending December 31, 1892, and their values, to which have been added the years 1889, 1890, and 1891 for comparison.

Quantity and value of iron ores imported into the United States in the calendar years 1889, 1890, 1891, and 1892.

	1889.		1890.		1891.		1892.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*		*Long tons.*		*Long tons.*	
Spain	298,568	$621,481	512,933	$1,099,031	323,771	$716,920	236,957	$483,847
Cuba	243,255	535,524	351,814	778,895	257,189	720,508	307,115	618,222
French Africa and Oceanica	97,583	180,697	96,428	188,360	96,961	193,606	62,502	126,238
Italy	87,410	228,164	134,399	393,280	154,073	544,914	95,313	321,988
England	54,496	111,638	51,857	155,275	39,451	119,052	35,638	76,910
Greece	23,955	32,880	48,807	87,397	24,412	34,589	44,602	69,044
Newfoundland and Labrador	14,450	43,100	6,320	18,960				
British Columbia	13,670	27,860			588	2,189	2,749	10,141
Portugal	6,659	15,151	16,526	36,941	9,940	22,130	6,490	14,386
France	6,565	17,911	2,404	5,647	9	3,084		
Quebec, Ontario, Manitoba, and Northwest Territory	4,091	10,697	22,211	57,667	2,126	4,008	8,606	17,199
Turkey in Europe					3,850	92,571	3,346	32,818
Turkey in Asia	2,870	27,265	3,078	32,345	158	2,075		
Nova Scotia, New Brunswick, etc					35	270		
Other countries	1	24	53	320	301	605	3,267	24,851
Total	853,573	1,852,392	1,246,830	2,854,118	912,864	a2,456,521	806,585	1,795,644

a The difference between the total value in this table and that of the United States custom-house department is due to the fact that in several of the ports of entry a value was given, but the amount of iron ore was not furnished by the department, and these were therefore omitted in the total valuations.

In the table given below the imports have been arranged according to customs districts. From this table it will be seen that, as in the previous year, the major portion of the ore was received at the ports of Philadelphia and Baltimore, the percentage in 1891 and 1892 being almost identical, viz., over 95 per cent.

Distribution by customs districts of foreign iron ores imported in 1889, 1890, 1891, and 1892.

Ports.	1889.		1890.		1891.		1892.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*		*Long tons.*		*Long tons.*	
Philadelphia, Pa	525,124	$1,192,141	683,665	$1,641,654	416,846	$1,098,992	438,920	$940,783
Baltimore, Md	273,050	519,736	481,250	1,015,093	453,373	1,219,015	328,326	758,033
New York, N. Y	25,824	72,297	38,717	101,908	25,817	89,975	23,533	61,260
Perth Amboy, N. J	11,558	26,075	25,524	50,984	14,089	42,087	4,428	8,153
Boston, Mass	50	283	....	....	....	....	....	....
Total Atlantic ports	835,606	1,810,532	1,229,156	2,809,639	910,125	2,450,069	795,207	1,768,229
Oswegatchie, N. Y	....	....	....	....	1,958	3,591	8,605	17,196
Buffalo Creek, N. Y	78	198	82	185	114	342	1	3
Chicago, Ill	5	58	....	....	35	276	....	....
Detroit, Mich	18	36	....	....	44	75	....	....
Oswego, N. Y	2,309	6,353	12,617	23,446	....	....	....	....
Cuyahoga, Ohio	1,224	3,403	4,675	15,460	....	....	....	....
Total Lake ports	3,634	10,048	17,374	39,091	2,151	4,284	8,606	17,199
Puget Sound, Wash	13,670	27,860	....	....	588	2,189	2,568	9,597
Willamette, Oregon	....	....	....	....	....	....	191	544
San Francisco, Cal	61	2,525	60	5,110	....	....	....	....
San Diego, Cal	....	....	1	20	....	....	....	....
Total Pacific ports	13,731	30,385	61	5,130	588	2,189	2,759	10,141
Salevira, Tex	....	....	....	....	....	....	13	67
Pensacola, Fla	135	608	....	....	....	....	....	....
Total Gulf ports	135	608	....	....	....	....	13	67
Miscellaneous	467	819	239	258	....	....	....	....
Total imports	853,573	1,852,392	1,246,830	2,854,118	912,864	a2,456,542	896,585	a1,795,636

a The difference in the total value between this table and that published by the United States custom-house department is due to the fact that in several of the ports of entry a value was given, but the amount of iron ore imported was not furnished by the department, and these were therefore omitted in the total valuations.

Note.—In view of the international interest which the Columbian Exposition attracts, a large amount of data concerning the iron ore resources, and the quantities produced in various parts of the world, has been collected, but it was considered inadvisable to delay the publication of the statistics of domestic iron ores for the completion of the balance of the report. The data herein is therefore issued so as to be of immediate service to the producers and consumers of iron ores in the United States, and the balance of the report, treating especially of foreign iron ores, will appear as a separate monograph, and also in the complete volume of Mineral Resources of the United States, 1893.

PROGRESS OF THE PRECIOUS METAL INDUSTRY IN THE UNITED STATES SINCE 1880.

By S. F. Emmons.

A review of the conditions governing the production of gold and silver in the United States during the past decade is more difficult to make, and, at the best, necessarily more incomplete than that of any other of our mining products, for the reason that the United States Geological Survey was not allowed by Congress to include these metals in its annual investigation of the mineral resources of our country. The Bureau of the Mint, which furnishes the most reliable data as to the aggregate production of these metals, is not so organized as to be able to segregate these products by mining districts, or even by States, in a complete and accurate manner, nor to furnish such technical data as are necessary for an intelligent study of the underlying causes which have governed the variations in the product of these metals.

The reports of the Tenth and Eleventh Censuses show more or less completely the conditions of the mining industry of these metals for the respective years of which they treat, but do not include the intermediate period, nor has the latter Census attempted to continue the geological sketches of the most important mining districts which was inaugurated by the former.

While, therefore, it is manifestly impossible with the available data to give more than the most general outlines of the progress of these industries, the question as to the relative future output of gold and silver is one of such paramount importance at the present time that it seems advisable to make an attempt to trace the causes of their variation in the past decade as well as the imperfection of the data will admit.

Gold is the only important metal that is found in great measure in the native or metallic state, and comparatively free from other metallic combinations. Silver, on the other hand, is almost universally found in nature more or less intimately combined with baser metals from which it must be separated by a relatively expensive process in order to be reduced to the metallic state. Gold, again, is largely produced from placer deposits—detrital gravels and sands resulting from the disintegration of gold-bearing rocks and veins—in which atmospheric agents have concentrated and prepared it for man's use, so that it can be extracted by simple processes requiring but little technical skill or scientific training. The reduction of silver from its ores, on the other hand, requires in most cases not only the highest degree of technical and scientific knowledge and experience, but to render available any but exceptionally rich ores involves the expenditure of large capital in smelting plants, centrally situated and with easy and cheap railroad transportation to and from mining districts and coal fields.

The history of the development of unexplored regions rich in the precious metals follows with comparative regularity certain general lines. Gold is first discovered in the sands of the streams, and if these lead to rich and readily accessible placer deposits, a "boom" sets in and results in a very rapid increase in gold production, from the fact that large numbers, not necessarily expert miners, can work at them, and no great preliminary expenditure of capital is required. With the rapid exhaustion of the richer and more easily worked placers, many abandon mining altogether; others search for new fields and for the veins from which the gold has been derived, and deep mining gradually replaces placer mining. This, however, is of relatively slow development, requires outside capital, and is more dependent on transportation facilities. Production for a time falls off, and increases again with the discovery of rich mines and consequent attraction of outside capital, which itself increases transportation facilities. This increase in production is slower than that due to the discovery of virgin placers of unusual richness. The prospector, who usually gathers his knowledge of ores not from previous training but from practical experience in the field, searches first for the more readily recognizable gold ores and only as circumstances increase his knowledge for the more complicated and obscure silver-bearing ores. This progression is illustrated in the broad general features of production of the precious metals in the United States. When Whitney wrote his *Metallic Wealth of the United States*, in 1854, the financial conditions of the world were being seriously disturbed by the almost simultaneous development of the placer mines of California and Australia, which together had added at a bound $120,000,000 to the world's annual production of gold without any corresponding increase in the product of silver. At that time and for many years afterwards there was "no proper silver mine" within our territory, and it is hardly to be wondered at that he considered, in the light of the world's experience up to that time, silver to be better adapted for a standard of value than gold, since it appeared to be less susceptible to violent fluctuations in its production.

The production of the precious metals in the United States during the decade 1850–'60 was practically all gold, averaging over $50,000,000 annually, and mostly derived from placers; while of the less than $100,000 average annual product of silver the greater part came from gold alloys.

In the early part of the decade 1860–'70 the gold product fell off to $40,000,000 but increased again to $50,000,000 toward the end, the more complicated hydraulic mining replacing placer workings and vein mining becoming gradually more developed. The first great silver producer, the Comstock lode, was opened during this decade, and from this and other smaller bodies of rich silver ore, whose discovery was a more or less direct consequence of its development, the silver product increased gradually during the decade from $1,000,000 to $10,000,000. Toward the end of the decade the first great silver-ore bodies in limestone were discovered, the first smelting works in the western mountain region were established, and the first transcontinental railroad line was built, circumstances which were to have a most important and far-reaching influence upon the mining industry.

During 1870–'80 the mining industry was gradually being established on a more permanent and business-like basis through the introduction of improved methods and machinery and the increase in transportation facilities. Placer mining was almost entirely conducted on the hydraulic system, which involved a considerable investment of outside capital and the concentration of the workings into fewer hands. Prospectors were turning their attention more and more to the discovery of base-metal ores whose principal value is in silver rather than gold, and which, being more likely to develop into great bonanzas like the Comstock, were hence more attractive to capitalists. Gold mining proper settled down to a comparatively regular output, but the gold product of the country was kept up by the Comstock lode, two-fifths of whose bullion value was in gold. This remarkable deposit reached the climax of its product during the decade, contributing during five years an average of $25,000,000 to $30,000,000 annually to the precious-metal product of the country. The silver product during the decade increased steadily from $12,000,000 to $30,000,000, while that of gold fluctuated between $33,000,000 and $50,000,000.

The opening of the decade 1880–'90 witnessed the final transference of the center of activity of mining in the West from the Sierra Nevada to the Rocky mountains. The bonanzas of the Comstock lode had been exhausted, and its deeper workings were soon to be abandoned as unprofitable. The reduction in the silver product caused thereby was more than replaced by the recently discovered silver-lead deposits in limestone of the Leadville district, which, however, carried little or no gold. The ultimate importance of the discovery of these ores, and of the many similar ones since opened as a direct result of the teachings their development has afforded to the mining community, has been shown in the enormous development of the smelting industry, and the concomitant opening of coal fields and the building of railroads in every direction through the mountain region, which, in turn, have stimulated the opening of silver mines carrying mixed or low-grade ores wherever they could be found within reach of railroads.

The characteristic feature has been the increase of railroad facilities throughout the mining region and the enormous development of the smelting industry, which is thus far the highest development of technical skill applied to the extraction of the metals from their ores. It forms the final step in the progression from the rude pan washing of the placer worker, through the Little Giant and riffle-boxes of the hydraulic miner, to the more or less complicated crushing by stamps or pulverizers and subsequent amalgamation, with or without the addition of chemicals, and aided in special cases by various lixiviation processes. But, without the aid of metallurgical processes, carried on in a scientific manner and aided by large capital, the greater bulk of the ores that have been reduced within the last decade would never have been extracted from their rocky beds.

The decade has been one of great commercial prosperity in our country. Capital has been abundant, and has gone freely into new enterprises. It is only in such times that mining flourishes; for, on account of its hazardous nature, it is the last sought by capital. On the other hand, the investment of capital in railroads and smelting plants is a permanent one, which can not be withdrawn without great loss, and which therefore encourages the investment of other capital in tributary mines to make profitable that which is already invested. It is evident at a glance, therefore, that general industrial conditions have been such as to stimulate mining enterprises during the decade, especially such as require large capital.

Beside these broad general causes, there are in the physical and geological conditions of our various mining regions other causes which have influenced locally the relative production of these metals, and which, if accurately known, might aid in foretelling to a certain degree the probable future of either. In the succeeding pages the writer will endeavor to trace out these underlying causes by giving a summary statement of such general facts in each State or region as available data will afford.

In the first table is given the production of gold and silver for the several States and Territories, as furnished by the reports of the Tenth and Eleventh Censuses, respectively, which, though not absolutely correct, shows sufficiently well the aggregate increase or decrease of either during that period. In this table, on account of the geological unity of their deposits, the products of the States of Maryland, Virginia, North and South Carolina, Tennessee, and Georgia, have been grouped under the general head of Appalachian States, while the as yet comparatively unimportant products of Michigan and Texas are given together as "other States." Later, and at the end of the paragraphs treating of each of these general divisions, are given tables showing the production of each year from 1880 to and including 1892, which have been taken from the reports of the Director of the Mint. Although this segregation is based on estimates that are necessarily not entirely accurate, it gives the best available approximation. (*a*)

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a Throughout this paper figures of production are given in coinage, not in commercial values—the coinage values are $20.67 per ounce for gold and $1.2929 for silver—so that the equivalent weight can readily be calculated.

Relative production of gold and silver in 1880 and 1890 (census returns).

States.	Gold.		Silver.		Totals.	
	1880.	1890.	1880.	1890.	1880.	1890.
Alaska	$5, 951	$904, 650	$51	$11, 918	$6, 002	$916, 568
Arizona	211, 965	910, 174	2, 325, 825	2, 343, 977	2, 537, 790	3, 254, 151
California	17, 150, 941	12, 585, 722	1, 150, 887	1, 373, 807	18, 301, 828	13, 960, 529
Colorado	2. 699, 898	3, 883, 859	16, 549, 274	23, 757, 751	19, 249, 172	27, 641, 610
Dakota	3, 305, 843	3, 091, 137	70, 813	135, 331	3, 376, 656	3, 226, 468
Idaho	1, 479, 653	1, 984, 159	464, 550	4, 056, 482	1, 944, 203	6, 040, 641
Montana	1, 805, 767	3, 139, 327	2, 905, 068	17, 468, 960	4, 710, 835	20, 608, 287
Nevada	4. 888, 242	3, 506, 295	12, 430, 667	6, 072, 241	17, 318, 909	9, 578, 536
New Mexico	49, 354	815, 655	392, 337	1, 617, 578	441, 691	2, 433, 233
Oregon	1, 097, 701	964, 309	27, 793	23, 382	1, 125, 494	987, 691
Utah	291, 587	487, 666	4, 743, 087	9, 057, 014	5, 034, 674	9, 544, 680
Washington	135, 800	186, 150	1, 019	36, 801	136, 819	222, 951
Wyoming	17, 321	14, 512			17, 321	14, 512
Appalachian States	224, 341	318, 261	528	4, 688	224, 869	322, 949
Other States (*a*)		93, 868	25, 858	437, 058	25, 858	530, 926
Total	33, 379, 663	32, 886, 744	41, 110, 957	66, 396, 988	74, 490, 620	99, 283, 732

a Michigan and Texas.

Product of gold and silver in the United States from 1792.

[The estimate for 1792-1873 is by Dr. R. W. Raymond, United States Mining Commissioner, and since by the Director of the Mint.]

Years.	Total.	Gold.	Silver.
April 2, 1792-July 31, 1834	$14, 000, 000	$14, 000, 000	(*a*)
July 31, 1834-Dec. 31, 1844	7, 750. 000	7, 500, 000	$250, 000
1845	1, 058, 327	1, 008, 327	50, 000
1846	1, 189, 357	1, 139, 357	50, 000
1847	939, 085	889, 085	50, 000
1848	10, 050, 000	10, 000, 000	50, 000
1849	40, 050, 000	40, 000, 000	50, 000
1850	50, 050. 000	50, 000, 000	50, 000
1851	55, 050, 000	55, 000, 000	50, 000
1852	60, 050, 000	60, 000, 000	50, 000
1853	65, 050, 000	65, 000, 000	50, 000
1854	60, 050, 000	60, 000, 000	50, 000
1855	55, 050, 000	55, 000, 000	50, 000
1856	55, 050, 000	55, 000, 000	50, 000
1857	55, 050, 000	55, 000, 000	50, 000
1858	50, 500, 000	50, 000, 000	500, 000
1859	50, 100, 000	50, 000, 000	100, 000
1860	46, 150, 000	46, 000, 000	150, 000
1861	45, 000, 000	43, 000, 000	2, 000, 000
1862	43, 700, 000	39, 200, 000	4, 500, 000
1863	48, 500, 000	40, 000, 000	8, 500, 000
1864	57, 100, 000	46, 100. 000	11, 000, 000
1865	64, 475, 000	53, 225, 000	11, 250, 000
1866	63, 500, 000	53, 500, 000	10, 000, 000
1867	65, 225, 000	51, 725, 000	13, 500, 000
1868	60, 000, 000	48, 000, 000	12, 000, 000
1869	61, 500, 000	49, 500, 000	12, 000, 000
1870	66, 000, 000	50, 000, 000	16, 000, 000
1871	66, 500, 000	43, 500, 000	23, 000, 000
1872	64, 750, 000	36, 000, 000	28, 750, 000
1873	71, 750, 000	36. 000, 000	35, 750, 000
1874	70, 800, 000	33, 500, 000	37, 300, 000
1875	65, 100, 000	33, 400, 000	31, 700, 000
1876	78, 700, 000	39, 900, 000	38, 800, 000
1877	86, 700, 000	46, 900, 000	39, 800, 000
1878	96, 400, 000	51. 200, 000	45, 200, 000
1879	79, 700, 000	38, 900, 000	40, 800, 000
1880	75, 200, 000	36, 000, 000	39, 200, 000
1881	77, 700, 000	34, 700, 000	43, 000, 000
1882	79, 300, 000	32, 500, 000	46, 800, 000
1883	76, 200, 000	30, 000, 000	46, 200, 000
1884	79, 600, 000	30, 800, 000	48, 800, 000
1885	83, 400, 000	31, 800, 000	51, 600, 000
1886	86, 000, 000	35, 000, 000	51, 000, 000
1887	86, 350, 000	33, 000, 000	53, 350, 000
1888	92, 370, 000	35, 175, 000	59, 195, 000
1889 { mint	97, 446, 000	32, 800, 000	64, 646, 000
1889 { census	99, 282, 866	32, 886, 180	66, 396, 686
1890	103, 330, 714	32, 845, 000	70, 485, 714
1891	108, 591, 565	33, 175, 000	75, 416, 565
1892	107, 989, 900	33, 000, 000	74, 989, 900
Total	3, 086, 064, 918	1, 937, 881, 769	1, 148, 183, 179

a Insignificant.

In the tables below the product is distributed, as well as possible, among the States where it was produced.

Distribution of the gold and silver product of 1892, by States.

[Estimated by the Director of the Mint.]

States and Territories.	Gold.		Silver.		Total value.
	Fine ounces.	Value.	Fine ounces.	Coining value.	
Alaska	48,375	$1,000,000	8,000	$10,343	$1,010,343
Arizona	51,761	1,070,000	1,062,220	1,373,375	2,443,375
California	580,500	12,000,000	360,000	465,455	12,465,455
Colorado	256,387	5,300,000	24,000,000	31,030,303	36,330,303
Georgia	4,583	94,734	400	517	95,251
Idaho	83,271	1,721,364	3,164,269	4,091,176	5,812,540
Michigan	3,386	70,000	60,000	77,576	147,576
Montana	139,871	2,891,386	17,350,000	22,432,323	25,323,709
Nevada	76,021	1,571,500	2,244,000	2,901,333	4,472,833
New Mexico	45,956	950,000	1,075,000	1,389,899	2,339,899
North Carolina	3,800	78,560	9,000	11,636	90,196
Oregon	67,725	1,400,000	50,000	64,646	1,464,646
South Carolina	5,986	123,365	400	517	123,882
South Dakota	178,987	3,700,000	60,000	77,576	3,777,576
Texas	.....	.....	310,000	400,808	400,808
Utah	31,936	660,175	8,100,000	10,472,727	11,132,902
Washington	18,071	373,561	150,000	193,939	567,500
Other States *a*	500	10,336	1,000	1,293	11,629
Total	1,597,098	33,014,981	58,004,289	74,995,442	108,010,423

a Includes Alabama, Maryland, Tennessee, Vermont, Virginia, and Wyoming.

Approximate distribution in round numbers, by States and Territories, of the estimated total product of precious metals in the United States during the calendar years 1881 to 1892, inclusive.

States and Territories.	1881.			1882.		
	Gold.	Silver.	Total.	Gold.	Silver.	Total.
Alaska	$15,000		$15,000	$150,000		$150,000
Arizona	1,060,000	$7,300,000	8,360,000	1,065,000	$7,500,000	8,565,000
California	18,200,000	750,000	18,950,000	16,800,000	845,000	17,645,000
Colorado	3,300,000	17,160,000	20,460,000	3,360,000	16,500,000	19,860,000
Dakota	4,000,000	70,000	4,070,000	3,300,000	175,000	3,475,000
Georgia	125,000		125,000	250,000		250,000
Idaho	1,700,000	1,300,000	3,000,000	1,500,000	2,000,000	3,500,000
Maine		5,000	5,000			
Montana	2,330,000	2,630,000	4,960,000	2,550,000	4,370,000	6,920,000
Nevada	2,250,000	7,060,000	9,310,000	2,000,000	6,750,000	8,750,000
New Mexico	185,000	275,000	460,000	150,000	1,800,000	1,950,000
North Carolina	115,000		115,000	190,000	25,000	215,000
Oregon	1,100,000	50,000	1,150,000	830,000	35,000	865,000
South Carolina	35,000		35,000	25,000		25,000
Tennessee	5,000		5,000			
Utah	145,000	6,400,000	6,545,000	190,000	6,800,000	6,990,000
Virginia	10,000		10,000	15,000		15,000
Washington	120,000		120,000	120,000		120,000
Wyoming	5,000		5,000	5,000		5,000
Total	34,700,000	43,000,000	77,700,000	32,500,000	46,800,000	79,300,000

States and Territories.	1883.			1884.		
Alaska	$300,000		$300,000	$200,000		$200,000
Arizona	950,000	$5,200,000	6,150,000	930,000	$4,500,000	5,430,000
California	14,120,000	1,460,000	15,580,000	13,600,000	3,000,000	16,600,000
Colorado	4,100,000	17,370,000	21,470,000	4,250,000	16,000,000	20,250,000
Dakota	3,200,000	150,000	3,350,000	3,300,000	150,000	3,450,000
Georgia	199,000	1,000	200,000	137,000		137,000
Idaho	1,400,000	2,100,000	3,500,000	1,250,000	2,720,000	3,970,000
Montana	1,800,000	6,000,000	7,800,000	2,170,000	7,000,000	9,170,000
Nevada	2,520,000	5,430,000	7,950,000	3,500,000	5,600,000	9,100,000
New Mexico	280,000	2,845,000	3,125,000	300,000	3,000,000	3,300,000
North Carolina	167,000	3,000	170,000	157,000	3,500	160,500
Oregon	660,000	20,000	680,000	660,000	20,000	680,000
South Carolina	56,500	500	57,000	57,000	500	57,500
Utah	140,000	5,620,000	5,760,000	120,000	6,800,000	6,920,000
Virginia	6,000		6,000	2,000		2,000
Washington	80,000	500	80,500	85,000	1,000	86,000
Wyoming	4,000		4,000	6,000		6,000
Other	17,500		17,500	76,000	5,000	81,000
Total	30,000,000	46,200,000	76,200,000	30,800,000	48,800,000	79,600,000

States and Territories.	1885.			1886.		
Alaska	$300,000	$2,000	$302,000	$446,000	$2,000	$448,000
Arizona	880,000	3,800,000	4,680,000	1,110,000	3,400,000	4,510,000
California	12,700,000	3,500,000	15,200,000	14,725,000	1,400,000	16,125,000
Colorado	4,200,000	15,800,000	20,000,000	4,450,000	16,000,000	20,450,000
Dakota	3,200,000	100,000	3,300,000	2,700,000	425,000	3,125,000
Georgia	136,000		136,000	152,500	1,000	153,500
Idaho	1,800,000	3,500,000	5,300,000	1,800,000	3,600,000	5,400,000
Montana	3,300,000	10,060,000	13,360,000	4,425,000	12,400,000	16,825,000
Nevada	3,100,000	6,000,000	9,100,000	3,090,000	5,000,000	8,090,000
New Mexico	800,000	3,000,000	3,800,000	400,000	2,300,000	2,700,000
North Carolina	152,000	3,000	155,000	175,000	3,000	178,000
Oregon	800,000	10,000	810,000	990,900	5,000	995,000
South Carolina	43,000		43,000	37,500	500	38,000
Utah	180,000	6,750,000	6,930,000	216,000	6,500,000	6,716,000
Washington	120,000	70,000	190,000	147,000	80,000	227,000
Texas, Alabama, Tennessee, Virginia, Vermont, Michigan, and Wyoming	90,000	5,000	95,000	5,000	205,000	210,000
Total	31,801,000	51,600,000	83,401,000	34,869,000	51,321,500	86,190,500

Approximate distribution in round numbers, by States and Territories, of the estimated total product of precious metals in the United States, etc.—Continued.

States and Territories.	1887.			1888.		
	Gold.	Silver.	Total.	Gold.	Silver.	Total.
Alaska	$675, 000	$300	$675, 300	$850, 000	$3, 000	$853, 000
Arizona	830, 000	3. 800, 000	4, 630, 000	871, 500	3, 000, 000	3, 871, 500
California	13, 400, 000	1, 500, 000	14, 900, 000	12, 750, 000	1, 400, 000	14, 150, 000
Colorado	4, 000, 000	15, 000, 000	19, 000, 000	3, 758. 000	19, 000, 000	22. 758, 000
Dakota	2, 400, 000	40, 000	2, 440, 000	2, 600, 000	100, 000	2, 700, 000
Georgia	110, 000	500	110, 500	104, 000	500	104, 500
Idaho	1, 900, 000	3, 000, 000	4, 900, 000	2, 400, 000	3, 000, 000	5, 400, 000
Michigan	35, 000	26, 000	61, 000	42, 000	84, 000	126, 000
Montana	5, 230. 000	15, 500, 000	20, 730, 000	4, 200, 000	17, 000, 000	21, 200, 000
Nevada	2, 500, 000	4, 900, 000	7, 400, 000	3, 525, 000	7, 000. 000	10, 525, 000
New Mexico	500, 000	2, 300, 000	2, 800. 000	602, 000	1, 200, 000	1, 802, 000
North Carolina	225, 000	5, 000	230, 000	136, 000	3, 500	139, 500
Oregon	900. 000	10, 000	910, 000	825, 000	15, 000	840, 000
South Carolina	50, 000	500	50, 500	39, 000	200	39, 200
Utah	220, 000	7, 000, 000	7, 220, 000	290, 000	7, 000, 000	7, 290, 000
Washington	150, 000	100, 000	250, 000	145, 000	100, 000	245, 000
Texas	....	250, 000	250, 000	....	300, 000	300, 000
Alabama, Tennessee, Virginia, Vermont, Michigan, and Wyoming	22, 000	1, 000	23, 000	30, 000	500	30, 500
Total	33, 147, 000	53, 433, 300	86, 580, 300	33, 167, 500	59, 206, 700	92, 374, 200

	1889.			1890.		
Alaska	$900, 000	$10, 343	$910, 343	$762, 500	$9, 697	$772, 197
Arizona	900, 000	1, 939. 393	2, 839, 393	1, 000, 000	1, 292, 929	2, 292, 929
California	13, 000, 000	1, 034, 343	14, 034, 343	12, 500, 000	1, 163, 636	13, 663, 636
Colorado	4, 000, 000	20, 686, 868	24, 186, 868	4, 150, 000	24, 307, 070	28, 457, 070
Dakota	2, 900, 000	64, 646	2, 964, 646	3, 200, 000	129, 292	3, 329, 292
Georgia	107, 000	465	107, 465	100, 000	517	100, 517
Idaho	2, 000, 000	4, 395, 959	6, 395, 959	1, 850, 000	4, 783, 838	6, 633, 838
Michigan	70. 000	77, 575	147, 575	90, 000	71, 111	161, 111
Montana	3, 500, 000	19, 393, 939	22, 893, 939	3, 300, 000	20, 363, 636	23, 663, 636
Nevada	3, 000, 000	6, 206, 060	9, 206, 060	2, 800, 000	5, 753, 535	8, 553, 535
New Mexico	1, 000, 000	1, 461, 010	2, 461, 010	850, 000	1, 680, 808	2, 530, 808
North Carolina	145, 000	3, 878	148, 878	118, 500	7, 757	126, 257
Oregon	1, 200, 000	38, 787	1, 238, 787	1, 100, 000	96, 969	1, 196, 969
South Carolina	45, 000	232	45, 232	100, 000	517	100, 517
Utah	500, 000	9, 050, 505	9, 550, 505	680, 000	10, 343, 434	11, 023, 434
Washington	175, 000	103, 434	278, 434	204, 000	90, 505	294, 505
Texas	....	300, 000	300, 000	....	387, 878	387, 878
Alabama, Tennessee, Virginia, Vermont, and Wyoming	25, 000	1, 293	26, 293	40, 000	2, 585	42, 585
Total	32. 967, 000	64. 768, 730	97, 735, 730	32, 845, 000	70, 485. 714	103, 330, 714

	1891.			1892.		
Alaska	$900, 000	$10, 343	$910, 343	$1, 000, 000	$10, 343	$1, 010, 343
Arizona	975, 000	1, 913. 535	2, 888, 535	1, 070, 000	1, 373, 375	2, 443, 375
California	12, 600, 000	969. 697	13, 569, 697	12, 000, 000	465, 455	12, 465, 455
Colorado	4, 600, 000	27, 358, 384	31, 958. 384	5, 300, 000	31, 030, 303	36, 330, 303
South Dakota	3, 550, 000	129, 293	3, 679, 293	94, 734	517	95, 251
Georgia	80, 000	517	80, 517	1, 721, 364	4, 091, 176	5, 812, 540
Idaho	1, 680, 000	5, 216, 970	6, 896, 970	70, 000	77, 576	147, 576
Michigan	75, 000	94, 384	169, 384	2, 891, 386	22, 432, 323	25. 323, 709
Montana	2, 890, 000	21, 139. 394	24, 029, 394	1, 571, 500	2, 901, 333	4, 472, 833
Nevada	2, 050, 000	4, 551, 111	6, 601, 111	950, 000	1, 389, 899	2, 339, 899
New Mexico	905, 000	1, 713, 131	2, 618, 131	78, 560	11, 636	90, 196
North Carolina	95, 000	6. 465	101, 465	1, 400, 000	64, 646	1, 464, 646
Oregon	1, 640, 000	297, 374	1, 937, 374	123, 365	517	123, 882
South Carolina	125, 000	646	125, 646	3, 700, 000	77, 576	3, 777, 576
Utah	650, 000	11, 313, 131	11, 963, 131	....	400, 808	400, 808
Washington	335, 000	213, 334	548, 334	660, 175	10, 472, 727	11, 132, 902
Texas	....	484, 848	484, 848	373, 561	193, 939	567, 500
Alabama, Tennessee, Virginia, Vermont, and Wyoming	25, 000	4, 008	29, 008	10, 336	1, 293	11, 629
Total	33, 175, 000	75, 416, 565	108, 591, 565	33, 014, 981	74, 995, 442	108, 010, 423

Rank of the States and Territories in the production of gold and silver.

1886.

Rank.	Gold.	Rank.	Silver.	Rank.	Total.
1	California.	1	Colorado.	1	Colorado.
2	Colorado.	2	Montana.	2	Montana.
3	Montana.	3	Utah.	3	California.
4	Nevada.	4	Nevada.	4	Nevada.
5	Dakota.	5	Idaho.	5	Utah.
6	Idaho.	6	Arizona.	6	Idaho.
7	Arizona.	7	New Mexico.	7	Arizona.
8	Oregon.	8	California.	8	Dakota.
9	Alaska.	9	Dakota.	9	New Mexico.
10	New Mexico.	10	"Other."	10	Oregon.
11	Utah.	11	Washington.	11	Alaska.
12	North Carolina.	12	Oregon.	12	Washington.
13	Georgia.	13	North Carolina.	13	"Other."
14	Washington.	14	Alaska.	14	North Carolina.
15	South Carolina.	15	Georgia.	15	Georgia.
16	"Other."	16	South Carolina.	16	South Carolina.

1887.

Rank.	Gold.	Rank.	Silver.	Rank.	Total.
1	California.	1	Montana.	1	Montana.
2	Montana.	2	Colorado.	2	Colorado.
3	Colorado.	3	Utah.	3	California.
4	Nevada.	4	Nevada.	4	Nevada.
5	Dakota.	5	Arizona.	5	Utah.
6	Idaho.	6	Idaho.	6	Idaho.
7	Oregon.	7	New Mexico.	7	Arizona.
8	Arizona.	8	California.	8	New Mexico.
9	Alaska.	9	Texas.	9	Dakota.
10	New Mexico.	10	Washington.	10	Oregon.
11	North Carolina.	11	"Other."	11	Alaska.
12	Utah.	12	Dakota.	12	Washington.
13	Washington.	13	Michigan.	13	Texas.
14	Georgia.	14	Oregon.	14	North Carolina.
15	South Carolina.	15	North Carolina.	15	Georgia.
16	Michigan.	16	Georgia.	16	"Other."
17	"Other."	17	South Carolina.	17	South Carolina.
		18	Alaska.	18	Michigan.

1888.

Rank.	Gold.	Rank.	Silver.	Rank.	Total.
1	California.	1	Colorado.	1	Colorado.
2	Montana.	2	Montana.	2	Montana.
3	Colorado.	3	Nevada.	3	California.
4	Nevada.		Utah.	4	Nevada.
5	Dakota.	4	Arizona.	5	Utah.
6	Idaho.		Idaho.	6	Idaho.
7	Arizona.	5	California.	7	Arizona.
8	Alaska.	6	New Mexico.	8	Dakota.
9	Oregon.	7	Texas.	9	New Mexico.
10	New Mexico.	8	Dakota.	10	Alaska.
11	Utah.		Washington.	11	Oregon.
12	Washington.	9	Michigan.	12	Texas.
13	North Carolina.	10	Oregon.	13	Washington.
14	Georgia.	11	North Carolina.	14	North Carolina.
15	Michigan.	12	Alaska.	15	Michigan.
16	South Carolina.	13	Georgia.	16	Georgia.
17	"Other."		"Other."	17	South Carolina.
		14	South Carolina.	18	"Other."

Rank of the States and Territories in the production of gold and silver—Continued.

1889.

Rank.	Gold.	Rank.	Silver.	Rank.	Total.
1	California.	1	Colorado.	1	Colorado.
2	Colorado.	2	Montana.	2	Montana.
	Montana.	3	Utah.	3	California.
3	Nevada.	4	Nevada.	4	Utah.
4	Dakota.	5	Idaho.	5	Nevada.
5	Idaho.	6	Arizona.	6	Idaho.
6	Oregon.	7	New Mexico.	7	Dakota.
7	New Mexico.	8	California.	8	Arizona.
8	Alaska.	9	Texas.	9	New Mexico.
	Arizona.	10	Washington.	10	Oregon.
9	Utah.	11	Michigan.	11	Alaska.
10	Washington.	12	Dakota.	12	Texas.
11	North Carolina.	13	Oregon.	13	Washington.
12	Georgia.	14	Alaska.	14	North Carliona.
13	Michigan.	15	North Carolina.	15	Michigan.
14	South Carolina.	16	"Other."	16	Georgia.
15	"Other."	17	Georgia.	17	South Carolina.
		18	South Carolina.	18	"Other."

1890.

Rank.	Gold.	Rank.	Silver.	Rank.	Total.
1	California.	1	Colorado.	1	Colorado.
2	Colorado.	2	Montana.	2	Montana.
3	Montana.	3	Utah.	3	California,
4	Dakota.	4	Nevada.	4	Utah.
5	Nevada.	5	Idaho.	5	Nevada.
6	Idaho.	6	New Mexico.	6	Idaho.
7	Oregon.	7	Arizona.	7	Dakota.
8	Arizona.	8	California.	8	New Mexico.
9	New Mexico.	9	Texas.	9	Arizona.
10	Alaska.	10	Dakota.	10	Oregon.
11	Utah.	11	Oregon.	11	Alaska.
12	Washington.	12	Washington.	12	Texas.
13	North Carolina.	13	Michigan.	13	Washington.
14	South Carolina.	14	Alaska.	14	Michigan.
	Georgia.	15	North Carolina.	15	North Carolina.
15	Michigan.	16	"Other."	16	Georgia.
16	"Other."	17	Georgia.		South Carolina.
			South Carolina.	17	"Other."

1891.

Rank.	Gold.	Rank.	Silver.	Rank.	Total.
1	California.	1	Colorado.	1	Colorado.
2	Colorado.	2	Montana.	2	Montana.
3	South Dakota.	3	Utah.	3	California.
4	Montana.	4	Idaho.	4	Utah.
5	Nevada.	5	Nevada.	5	Idaho.
6	Idaho.	6	Arizona.	6	Nevada.
7	Oregon.	7	New Mexico.	7	South Dakota.
8	Arizona.	8	California.	8	Arizona.
9	New Mexico.	9	Texas.	9	New Mexico.
10	Alaska.	10	Oregon.	10	Oregon.
11	Utah.	11	Washington.	11	Alaska.
12	Washington.	12	South Dakota.	12	Washington.
13	South Carolina.	13	Michigan.	13	Texas.
14	North Carolina.	14	Alaska.	14	Michigan.
15	Georgia.	15	North Carolina.	15	South Carolina.
16	Michigan.	16	"Other."	16	North Carolina.
17	"Other."	17	South Carolina.	17	Georgia.
		18	Georgia.	18	"Other."

Rank of the States and Territories in the production of gold and silver— Continued.

1892.

Rank.	Gold.	Rank.	Silver.	Rank.	Total.
1	California.	1	Colorado.	1	Colorado.
2	Colorado.	2	Montana.	2	Montana.
3	South Dakota.	3	Utah.	3	California.
4	Montana.	4	Idaho.	4	Utah.
5	Idaho.	5	Nevada.	5	Idaho.
6	Nevada.	6	New Mexico.	6	Nevada.
7	Oregon.	7	Arizona.	7	South Dakota.
8	Arizona.	8	California.	8	Arizona.
9	Alaska.	9	Texas.	9	New Mexico.
10	New Mexico.	10	Washington.	10	Oregon.
11	Utah.	11	South Dakota.	11	Alaska.
12	Washington.	12	Michigan.	12	Washington.
13	South Carolina.	13	Oregon.	13	Texas.
14	Georgia.	14	North Carolina.	14	Michigan.
15	North Carolina.	15	Alaska.	15	South Carolina.
16	Michigan.	16	Georgia.	16	Georgia.
		17	South Carolina.	17	North Carolina.

ALASKA.

The general trend of the mountain systems of the west coast of our continent runs more to the west of north than does that of the coast line itself; hence, from Washington northward through British Columbia to southern Alaska, an ever-increasing portion of these mountains have in part run out into the ocean, and form the remarkably continuous chain of islands which lend so much scenic beauty to the Alaskan coast. What little is known of their geological history points to a considerable analogy with that of the western slope of the Sierra Nevada, viz., an uplift in post-Jurassic or early Cretaceous times, followed by a deposition, in comparatively shallow waters, of later Cretaceous and Tertiary beds, with local development of important coals and frequent exhibitions of eruptive energy continued down to comparatively recent geological time.

As to the Alaskan peninsula proper, beyond Mount Saint Elias, where the coast line takes a trend due west and then southwest, still less is known geologically, for explorations have been confined to the immediate banks of the Yukon river, which is either so far north or so far in the interior as to be beyond the beneficent influence of the Japanese gulf stream, which alone renders the immediate coast line of southern Alaska inhabitable during the colder part of the year. It is known that the coal-bearing Laramie rocks extend far northward toward the Arctic circle in the interior, and that the cross chain of the Aleutian islands, which extends southwestward from the point of the peninsula, is eruptive and probably of recent origin: but while it may be considered probable that geological representatives of the older rocks, which form the mountain chains further south, extend into the peninsula, the determination of this fact is not of much evident importance to the mining industry, since climatic conditions would appear to be such as to preclude extended mining operations there. It is the island belt and the immediate shores of the mainland in southern Alaska, with its comparatively mild climate and easy water transportation over inclosed waters, that offer the best opportunities for the systematic development of the mineral wealth that geological conditions show must exist in the region. The development of this wealth may be said to have commenced with the decade, and the first steps were taken by the placer miners with their gold pans, washing the sands of the streams and the débris from the hillsides. They did not confine themselves in their explorations to the coast belt, but crossed the mountains to the waters flowing into the Yukon river. Here gravels rich enough to pay under primitive methods have been found, and from the Yukon district, on Forty-mile creek, over a quarter of a million dollars worth of gold is said to have been obtained without the use of mercury. It is quite impossible to determine with any accuracy the amount of gold actually produced by such workings, on account of the number of individual miners who carry away and sell the gold dust they obtain; hence, the figures given below may be taken as considerably below the actual amount extracted. It seems doubtful, however, whether this interior country, where, owing to the severity of the climate, it is possible to work less than a third of the year, and the expense of transporting supplies over the mountains is very great, will ever become the scene of systematic mining.

In the coast belt, however, explorations consequent upon placer mining have already led to vein mining. One important mine, the Treadwell, upon Douglass island, in latitude 58°, produces, however, two-thirds of the estimated output of the Territory. It is a quartz vein 400 feet in width, carrying free gold and auriferous pyrites, which outcrops on a steep hillside running down to the sea shore. The ore is of such very low grade that were it not for the peculiarly advantageous situation of the mine, which reduces cost to a minimum, it could hardly be worked at a profit. As it is, however, good management and an intelligent expenditure of capital have developed a large paying mine, which has produced during the past four years an annual average of nearly three-quarters of a million of gold and has had a most beneficial effect in stimulating systematic mining in the region. The mineral belt as thus far developed has a longitudinal extent of about 100 miles in a northwestern and southeastern direction, but is said to be only a few miles wide, and, even should it prove to be geologically wider, climatic conditions will probably confine the area of profitable working to the immediate proximity of the ocean. The general geological conditions that prevail in this belt, as far as known, show a close resemblance to the gold belt of California; like the latter the values are principally in gold, which is accompanied in certain parts of the region by silver, galena, and copper ores. It is probable, however, that in this colder region the limit in depth of free gold or oxidized ores will be sooner reached, and the miner be brought to face the problem of profitably treating auriferous sulphurets, which has so often proved an insurmountable obstacle to the continued development of gold mines. This obstacle has, however, already been successfully overcome in the Treadwell mine by the adaptation of the chlorination process.

The annual product of the Territory, which is given as exclusively gold (the silver product being comparatively insignificant) shows a steady increase during the decade. This increase is remarkable rather for its regularity than its amount and is hence of more favorable import for the permanency of the development of the mineral resources than would be one subject to violent fluctuations, for while the discovery of exceptionally rich ore bodies undoubtedly causes a rapid development of the district in which they occur, the reaction which follows the inevitable exhaustion of such bodies may more than counteract the good effect which they have had, so far as its permanent prosperity is concerned.

Production of gold in Alaska since 1880.

Years.	Value.	Years.	Value.
1880	$5,951	1887	$675,000
1881	15,000	1888	850,000
1882	150,000	1889	900,000
1883	300,000	1890	762,000
1884	200,000	1891	900,000
1885	300,000	1892	1,000,000
1886	446,000		

ARIZONA.

But little is known with certainty about the geological relations of the ore deposits of Arizona, no systematic geological studies yet having been made of the Territory as a whole, nor of any of its rich mining districts. As its name indicates it is a generally arid region, the aridity increasing from the east, westward and southward, the western part of the Territory, though traversed by the Colorado river, having the desert features that characterize the greater part of Nevada.

The northeastern portion forms part of the Colorado plateau, about one-third of which is included within the boundaries of Arizona. It is an elevated region supporting some forest growth, and as contrasted with the rest of the Territory is fairly well watered. To the southwest of the plateau region are a series of narrow isolated ranges separated by broad arid valleys, similar to the basin ranges of Nevada, with which, by their general northwesterly trend, they are connected. They are made up generally of Paleozoic strata resting on a basement of crystalline rocks, and traversed to a greater or less extent by eruptives. The intervening valleys in general increase in width to the southwest, approach more and more to sea level, and Paleozoic strata disappear, the rocks being mainly granites and schists. Coal-bearing rocks appear to be entirely wanting. Under such physical conditions mining and pastoral pursuits are the only self-supporting industries. Two transcontinental railway lines cross the Territory from east to west, but have few branches, the greater part of the region not being able to support anything more than the sparsest population.

Detrital material is accumulated in very considerable quantities in some of the valleys, especially in the central part of the Territory. Many of them contain considerable amounts of free gold, but the scarcity of water in most cases forms an insurmountable obstacle to their development. Some attempts are said to have been made to utilize the water of the Colorado river in working neighboring placer gravels, but with what success is not reported.

The product of the Territory may be, therefore, assumed to come almost exclusively from deep mines. The statistics of production show a fairly steady annual output of gold amounting to about a million of dollars in value, while the product of silver has decreased with remarkable regularity from over seven millions at the beginning of the decade to about a million and a quarter at its close. The most important silver-producing region has been the Tombstone district, in the southeastern part of the Territory, where silver-lead deposits in limestone, associated with eruptive rocks, commenced producing early in the decade. The product of the county (Cochise) in which these mines occur is said in 1882 to have been as much as $600,000 in gold and over $5,000,000 in silver, and in 1892 to have fallen off to about a tenth of these amounts, respectively.

Silver-lead deposits have been developed in other parts of the Territory to a certain extent, and do not appear to have been entirely confined to limestones, which may account for their relatively small and uncertain production, for it is in these rocks that the immense bodies of lead and silver ores yielding annual products of several millions in value are usually found.

Arizona undoubtedly possesses great mineral wealth and abundant stores of precious-metal ores, but in the absence of any definite geological knowledge with regard to them it is impossible to intelligently account for the decrease in the product. Probably the want of such knowledge has been a factor in this decrease, since capital is with difficulty induced to invest in the unknown. Other probable causes are to be found in the physical character of the region, a want of abundant and cheap transportation facilities, and the absence of local supplies of coal, all of which render the cost of mining and of reduction of the ores relatively high, so that only exceptionally rich ores yield a profit to the miner, and such ores are generally in small amount and rapidly exhausted. An abundant supply of low-grade ores is the surest basis on which a permanent mining industry can be found. With a falling price of silver the outlook for precious-metal production in the Territory must therefore be considered most unpromising, for successful gold mining is, as a rule, even more dependent on low costs than silver mining.

Production of gold and silver in Arizona, since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$211,965	$2,325,825	1887	830,000	$3,800,000
1881	1,060,000	7,200,000	1888	871,500	3,000,000
1882	1,063,000	7,500,000	1889	900,000	1,939,393
1883	950,000	5,200,000	1890	1,000,000	1,292,929
1884	930,000	4,500,000	1891	975,000	1,913,535
1885	880,000	3,800,000	1892	1,070,000	1,373,375
1886	1,110,000	3,400,000			

CALIFORNIA.

Although the yield of the gold deposits of California has from various causes greatly fallen off during the decade, this State still holds the first rank as a gold producer. The original source of the gold of California is found in the quartz veins occurring in a highly metamorphosed series of rocks, of both sedimentary and eruptive origin, steeply upturned against the west flank of the great granite bodies of the Sierra Nevada, and generally known as the gold belt or auriferous slates. By their great alteration the fossil casts of the sedimentary series have been so largely obliterated that their exact geological age has been almost impossible to determine. The first recognizable fossils found in them were considered to be of Jurassic age, but more detailed studies of later years have extended the possible age of the gold-bearing sedimentary rocks downward into the Paleozoic and upward into the Lower Cretaceous. The eruptive rocks are intrusive diorites and diabases, in some cases altered into serpentine. Resting unconformably upon the auriferous slates along the foothills are beds of later Cretaceous age which contain no original deposits of gold.

For something over 100 miles northward from what was originally considered as the southern limit of the gold belt proper, the quartz veins follow the apparent strike of the slates in a north and south direction, parallel with the general trend of the range, and form a regular and definite line, which is known as the Mother lode. These veins are generally in the sedimentary rocks, sometimes at the contact of intrusive bodies. Their principal metallic constituents are free gold and auriferous pyrites, with insignificant amounts of other metals. The above-mentioned characteristics hold good for a majority of the veins in the gold belt, but there are many variations from them, especially in the middle region from whose disintegration the richest placers were derived. The veins sometimes trend east and west and are entirely inclosed in eruptive rocks, in which case their mineral constituents are more varied and include some silver and base metal ores. In other cases they show a tendency to follow in the sedimentary beds a direction parallel with the contact of inclosed eruptive bodies, and again cross from the former into the latter. A certain belt of diabase is characterized by the occurrence of copper ores.

The auriferous slates were at first supposed to be confined to the Sierra Nevada proper, which terminates on the north in the geological break made by the lava flows surrounding the extinct volcanoes of Lassens peak and Mount Shasta, and at the south is cut off topographically by the Mojave desert. Their geological representatives have since been traced to the northern boundary of the State and into western Oregon, and their continuation beyond the desert is found in the mountains of southern California and extends across the boundary into Lower California along the eastern side of the peninsula.

It was in the middle region of the western slope of the Sierra Nevada that the original discovery of placer deposits was made, and this region has since continued to be the greatest producer of gold. Here the topographical conditions were peculiarly favorable to the concentration of gravel and detrital material resulting from the disintegration of gold-bearing rocks into bodies that could readily be worked by the aid of abundant water. The high range of the Sierra, with its remarkably long western slope, 50 miles in extent, condenses the moisture-laden currents coming from the Pacific into large and rapid streams, which become violent torrents during certain seasons. The great diurnal variation of temperature is moreover a powerful disintegrating agent. Under these conditions unusually large amounts of detrital matter are carried down by the modern streams, and in their long courses a very considerable concentration of the heavy sands rich in free gold takes place. These conditions must have prevailed to a considerable extent in an earlier geological period, for not only are rich gravels found along the beds of modern streams, but the beds of ancient and now abandoned rivers, crossing the modern ones at a considerable angle, are found to be filled with gold-bearing gravels. These ancient gravels have been in part protected from erosion by flows of lava, which constitute the many table mountains of the region, and in part remain as gravel ridges between the beds of the modern streams.

The rapid descent and considerable volume of the modern streams are more especially favorable to a system of mining which originated here when the richer modern placers were so far exhausted that it was no longer profitable to work them by former primitive methods. This is known as hydraulic mining, and consists in directing an artificial stream through a large nozzle and under the pressure of a high column of water upon a gravel bank and washing it bodily into sluice boxes, in which the gold is in part automatically caught by mercury properly disposed to come into contact with it. Under this system it has been possible to work over whole mountains of débris and extract at a profit the gold from gravel that contains only a few cents worth per cubic yard. Where, owing to the lava covering and the compacted nature of the gravel, this process is not practicable, drift mining has been resorted to, and tunnels have been run to reach the beds of the ancient streams and extract the richer concentration of gravel in the hollows of these beds. All these methods, properly classed as placer mining, since they work only upon detrital material, have kept up the proportion of gold produced from placers in spite of the rapid exhaustion of the richer concentrations in the lower parts of the stream beds. In 1880, according to census returns, about half of the total gold product of the State, which was over seventeen millions of dollars, was derived from placer mines and half from deep mines or original deposits. Later returns do not segregate the product of placer from that of deep mines, but it is safe to assume that the decrease in the gold product during the decade to an average of $12,000,000 to $13,000,000 has been largely due to a decrease in hydraulic mining. The farmers had long been complaining of the damage to their arable land resulting from the sands and gravel spread out over them by hydraulic mining, and, as a result of litigation in the early part of the decade, a law was passed entirely prohibiting this form of mining on navigable streams. As a result of this the greater part of the hydraulic mining in the State was stopped, and drift mining, on account of its expense, could not adequately fill its place. Costly ditches and hydraulic plants were thereby rendered practically valueless and capital was discouraged from investing in this form of mining, which necessarily involves a very large preliminary expenditure of money before any returns can be expected. In 1892 Congress passed a law providing for the appointment of a commission under whose supervision impounding dams and other means of taking care of the débris might be constructed, which it was expected would result in the resumption of work by a considerable portion of existing hydraulic mines. The statistics of production have not yet shown any beneficial result from this action, which, however, would necessarily be slow on account of the well-known timidity of capital in regard to mining enterprises, especially where any permanent effects of legislation must be depended upon. It may reasonably be looked for in time, however, when confidence in the efficiency of this measure is created, and especially as a result of the fall in the price of silver, which will naturally direct investments into gold rather than silver mining. Deep or vein mining has apparently been fairly permanent in its production. Where one mine runs out of good ore another runs into it. The increase in expense as the mine grows deeper is more or less offset in reduction in cost of treatment, as mechanical and chemical processes of concentration result in the extraction of an increasing percentage of the gold contained, especially in sulphuret ores.

In those portions of the gold belt beyond the immediate slopes of the Sierra Nevada, both north and south, topographical conditions have not been, as a rule, so favorable to the formation of large areas of placer ground. This incentive to the rapid development of a gold region being wanting, the progress of gold mining has necessarily been slow, although it is known that valuable gold ores exist in the rocks. A commencement has been made, however, and when existing mines have proved themselves successful others will be opened. The advance will undoubtedly be more rapid when systematic surveys are completed which shall give authoritative information as to the existing geological conditions.

The silver product of the State of California, as shown by the table below, is small and very variable. A portion of it is produced in the gold belt proper as a by-product in gold-mining and in part as an actual alloy with the gold. The greater portion produced during the decade has, however, been derived from Mono, Inyo, and San Bernardino counties, in the eastern part of the State, from deposits whose geological relations ally them rather with Nevada or Great Basin methods of occurrence than with those of California. They consist of rich silver minerals occurring in recent eruptives or in limestones, and are confined to a comparatively few localities. Unless some such great vein as the Comstock should be discovered, which is hardly likely, it is not probable that the silver output of California in the immediate future will be considerable or permanent. In that of gold, however, it is reasonable to look for a steady and permanent, though perhaps not very rapid, increase.

Production of gold and silver in California since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$17,150,941	$1,150,887	1887	$13,400,000	$1,500,000
1881	18,200,000	750,000	1888	12,750,000	1,400,000
1882	16,800,000	845,000	1889	13,000,000	1,034,313
1883	14,120,000	1,460,000	1890	12,500,000	1,163,636
1884	13,600,000	3,000,000	1891	12,600,000	969,697
1885	12,700,000	3,500,000	1892	12,000,000	465,455
1886	14,725,000	1,400,000			

COLORADO.

Colorado is a region exceptionally well adapted, both physically and geologically, to become the scene of a great and permanent mining industry. The great mass and elevation of its mountains produce a relatively abundant precipitation, and the waters of its numerous mountain streams furnish the means for rendering a large portion of its valley and plain area rich agricultural regions capable of supporting a considerable population. Extensive and valuable coals are found in almost every portion of the State, and railroads have sent their ramifications in every direction, not only through the valleys, but over the tops of high mountain ranges, wherever there was promise of the founding of a permanent industry.

The geological structure of its numerous high mountain ranges, showing, as it does, the results of repeated and powerful orographic movements accompanied by plentiful outbursts of eruptive rocks, indicates conditions peculiarly favorable to the concentration of metallic minerals into ore deposits. Its mineral resources are varied and abundant, and by no means confined to the precious metals; yet in the thirty-three years that have elapsed since their discovery it has produced about one hundred and five millions of gold and three hundred millions of silver. In contrast to that of California, the development of its mining industry has been comparatively slow, and of the above-mentioned amounts nearly one-half the gold and five-sixths of the silver has been produced in the last thirteen years.

As in other regions, it was the discovery of placer gold that first attracted the miner—in 1859-'60—to what was then a comparatively unknown region. As to what was the annual product of these early years estimates vary widely and nothing is certainly known. The vein mining, which followed the exhaustion of the richer placers, was conducted under a disadvantage, for most of the ores contained a great many other metallic minerals besides gold and silver—hence constituting what is called base metal ores—and could not be reduced by the simpler process of amalgamation.

It is in the older crystalline and eruptive rocks which were the first to be prospected that the gold-bearing ores are mainly found, whereas the great bonanzas of silver-bearing ores have been found in Paleozoic limestones, and it was not until the discovery of the latter ores at Leadville in 1878-'79 that their value was recognized and prospectors paid more attention to their surface indications, which before had been considered valueless.

Smelting plants were necessary for the reduction of these ores, and it is their great increase that has been the most important factor in the rapid increase in the mining industry of Colorado since 1880. To those established in the immediate vicinity of the mines have been added great central plants at Denver and Pueblo as well as in Eastern cities, which, owing to their proximity to coal fields and to their ability to receive ores by rail from every part of the State, and even from other States, can work more cheaply and to greater advantage. The cost of smelting has thus been reduced as much as 50 per cent. during the decade. This has reacted favorably on the development of mines, since by the ready market thus afforded for their product a great many mines have been opened and worked the ores of which could not otherwise have been reduced at a profit. The effect of this industrial development has been most marked in the silver product, since the greater part of the silver ores must be reduced by smelting, whereas gold ores are more generally treated by amalgamation. The effect upon the production of gold has also been beneficial, since there are ores carrying gold, such as the telluride ores of Boulder county and the concentrates from the tailings of gold mills, from which the gold can only be extracted at a profit by mixing with other ores in the larger smelting works. Of late years, moreover, numerous wet processes for the extraction of gold from complicated ores have been successfully introduced in various parts of the State.

In considering the geological distribution of the precious-metal bearing ores the following broad general features may be recognized. The mountain masses of Colorado are divided in a general way into two north and south uplifts—the Colorado or Front range, and the complex of ranges forming the Sawatch uplift—with a third uplift, the San Juan group, at the south, whose greatest extension is east and west rather than north and south.

The two first named uplifts consist of a nucleus of Archean or ancient crystalline rocks surrounded by a varying fringe of upturned Paleozoic and Mesozoic sediments, the whole cut through by dikes and intrusive sheets of eruptive rocks. The Paleozoic rocks are mostly limestones and quartzites; the Mesozoic rocks, sandstones and clay shales. Here the bulk of the silver-bearing ores are found in the Paleozoic limestones, while the crystalline rocks afford both gold and silver ores, and the Mesozoic rocks contain but few workable deposits. The precious-metal deposits are invariably found in more or less intimate association with the eruptive rocks, and in a few cases gold-bearing ores are found within the latter and also in the Mesozoic shales immediately adjoining them.

The San Juan group is made of a similar series of rocks, but differently distributed, eruptive rocks forming the greater part of the surface exposures and the sedimentary and ancient crystalline rock masses being so broken up that the nucleal structure is no longer apparent. The greater part of the precious-metal ores are found in the eruptive masses, being generally mixed ores carrying values in gold, silver, and other metals, but important deposits are found whose values are almost exclusively gold or silver. Precious-metal deposits are also found in the occasional exposures of Paleozoic limestones, and to a limited extent in the fringing Mesozoic sandstones.

In the Colorado or Front range the Paleozoic rocks which surround the Archean nucleus are mostly buried beneath the later Mesozoic sediments; consequently it is in the crystalline rocks and the associated eruptive masses that the principal precious-metal deposits have been found. The bulk of the product comes from the mining districts of Boulder, Clear Creek, and Gilpin counties. The ores of the former are rather unusual in that they consist largely of tellurides. Its product is relatively small, being less than half a million annually, and three-fourths of its value is in gold. Clear Creek produces mixed base-metal ores, less than a third of whose precious-metal values is in gold. In Gilpin county, which is the oldest mining district in the State, the ores are mainly pyrites and of the precious-metal values 80 to 90 per cent. is gold. It has produced since 1860 about fifty-four millions of the precious metals. The combined annual product of these three districts has varied from four to a little over five millions of the two metals, having reached the larger amount at the beginning and again at the end of the decade. The proportion of either metal in the total product has also varied from year to year, as it comes from a very great number of separate mines which have thin vertical veins, whose individual product is necessarily variable according as they are in bonanza or barren ground and with the depth and consequent increase in cost of extraction of the ore. Nevertheless, for the whole period the proportion of the metals has been about equal, and though no great increase in product of the region has been shown, the fact that costs of production have been so greatly reduced that mines formerly abandoned as unprofitable are being reopened assures a fair permanence. Since the close of the decade new discoveries of gold ore in eruptive rocks have been made in the Cripple Creek district at the southern end of the Front range, of whose geological relations little is yet definitely known. The annual product is said to have already reached over half a million, and to bid fair to increase rapidly. Under this influence the proportion that the gold product of this region bears to that of the State, which had fallen from two-thirds at the commencement of the decade to less than one-half at its close, has already increased, and may resume its old importance. The silver product of this range is of far less relative importance amounting to only about 12 per cent. of the total product of the State during the last thirteen years.

At the present day the Sawatch uplift is broken into several more or less distinct ranges, of which the present Sawatch range, made up as it is of Archean rocks, constitutes the original nucleus. A certain number of veins carrying base metal ores with values in gold as well as silver occur in these rocks, but their output has been insignificant compared with that derived from the overlying Paleozoic limestones which rest upon the outer edges of this central mass. Deposits in limestone, as a rule, yield a much greater and more rapidly developed product than those in so-called true fissure veins, not only because of their greater lateral extension, but because, as the limestones lie generally in a slightly inclined position, a greater bulk of ore is comparatively near the surface. These silver-bearing limestone deposits around the Sawatch uplift have yielded in the last thirteen years over $180,000,000, or 70 per cent. of the total silver product of the State.

The Leadville deposits in the Mosquito range on the east side of the Sawatch, which were the first discovered, have thus far proved the greatest. They have yielded, up to the commencement of this year, about $135,000,000 of silver and $4,500,000 of gold. The principal values are derived from sulphides of lead and iron and zinc and their decomposition products, in the order named. But very little gold, and that locally, is derived from the limestone deposits proper, a considerable proportion of the yield given above coming from ores extracted from the eruptive and crystalline rocks in the vicinity. It is somewhat singular that though the gold placers, discovered at this point as early as 1860, are said to have yielded $10,000,000 from a single, narrow gulch in a year or two, only one or two important gold deposits in place have thus far been found in the vicinity. It is not unlikely that more careful exploration may reveal others. Here, as in most ore deposits in limestone, the oxidized portions were much richer than the unaltered sulphides in depth. Hence, though enormous bodies of the latter have been found as exploration progressed in depth, with an ever-increasing output in bulk of ore the silver yield has steadily fallen off since the fourth year of the decade, the discovery of hitherto unopened bodies of rich oxidized ores in later years having been neutralized by the fall in the price of silver. Deep mining is relatively expensive owing to the large amount of water found, and unless some method is devised of treating the large bodies of low-grade base ores at a profit the yield of the district is likely to decrease much more with a continuation of the low price of silver, in spite of the great amount of capital invested there in smelting and hoisting plants.

The Aspen district, on the opposite slope of the Sawatch uplift, is the next important deposit of silver-bearing ores in limestone. The wealth and extent of its ore bodies were not suspected until the middle of the decade, and, even after two competing railroads had been built to it across the mountains, its production was delayed by litigation, so that it sprung suddenly from $800,000 in 1887 to $7,000,000 in 1888; its estimated yield up to 1893 already amounts to $44,000,000, which is practically all silver. In one mine, the Mollie Gibson, an ore body of unprecedented richness has been found, from which carload lots worth from $40,000 to $60,000 are not infrequently shipped. The geological structure of the region is not yet as well understood as that of Leadville; the same obstacle of excessive water in deep mines is met with; the ores, though richer, carry less lead, hence cost relatively more to smelt, and though the mine owners have shown unusual enterprise in the introduction of electricity as a motive power for mining machinery, as well as for lighting, and in introducing improved processes of reduction, the production of the district is likely to be seriously curtailed by a further drop in the price of silver.

Other valuable deposits in limestone around the Sawatch uplift have been developed, but none comparable in the extent of their ore development with the two above mentioned. The most important have been those of the Ten Mile and Red Cliff mining districts on the north slope, the product of the latter of which is about one-third to two-fifths gold, derived from deposits in Cambrian quartzites; and on the southeast and southwest slopes individual mines have found large bodies of silver-bearing lead ores. The total precious-metal product of such districts is an unimportant factor industrially as compared with that of the great concentrations of the Leadville and Aspen districts, and is much more susceptible to fluctuation from decrease in the value of the product since they do not have such large amounts of capital invested in plant that they must be worked in order to get some return from the investment.

The San Juan region as a whole has yielded in the thirteen years under consideration about 12 per cent. of the silver product of the State, and in the last few years of this period over one-quarter of the gold product. Its total product of precious metals has increased rapidly and steadily during the decade from a little over $250,000 in 1880 to $7,500,000 in 1890. The central and earliest developed portion of the San Juan is the most Alpine of all Colorado, and many of the important mines are situated high up in the mountains, at altitudes of 12,000 to 13,000 feet, so that in spite of the strength of the veins and the remarkable richness of the ores, it was not until a large amount of capital had been invested in roads, tunnels, and railroads that they could become large producers. These deposits are mostly vertical veins in eruptive rocks, and carry considerable values in gold as well as silver. Rich placers have been found also in recent years in the valleys of the streams flowing westward from these mountain masses. The gold product of the region which was only about $250,000 to $500,000 during the decade jumped to $1,250,000 for the last three years. Rich gold deposits in eruptive rocks in the eastern portion of the San Juan mountains were being worked at the commencement of the decade, but no reliable estimates were obtained as to the product of the district. It appears to have been quite small during most of the decade, but a slight increase is noted in 1892. Besides the veins in eruptive rocks silver-lead ores are found in Paleozoic limestones. The most important producers are those in the southwestern portion, around Rico, which, in the last three years, since railroad connections have been established, have contributed $3,750,000 in silver. Since the close of the decade remarkably rich deposits in eruptive rocks have been discovered in the Creede district on the eastern borders of the San Juan uplift, which is credited by the mint authorities with a product of $3,500,000 of silver in 1892, other estimates giving even a larger amount. Little is yet known of the geological relations of these deposits, but they seem to give promise of becoming important producers in the future.

While the region as a whole is without doubt very rich in mineral resources, its extremely rugged character makes the cost of mining relatively high and necessitates the investment of considerable capital in plant and transportation facilities, and unless some remarkably large concentration of deposits, comparable to those of Leadville, Aspen, or Butte, be discovered the development of the silver ores of the region will probably be seriously impeded by the fall in the price of this metal. On the other hand, the considerable portion of the deposits which carry a good part of their values in gold can probably still be worked at a profit, and of those which are exclusively gold-bearing, and which are hence less dependent on transportation facilities than mixed ores, the known deposits will be more actively developed, and new ones will probably be discovered.

The silver product of the three regions above named forms over 94 per cent. of the total product of the State, which therefore they practically regulate. In gold their proportion is smaller, being from 63 to 85 per cent. of the whole. Some of the balance is placer gold, but how much it is impossible to determine. There are many extensive and valuable placer deposits in Colorado, but relatively little attention has been given to them. In 1880 their product was only 3.77 per cent. of the gold product of the State. While they are relatively less important than those of Montana or California, their product can doubtless be very considerably increased, with a profit to the owners.

In considering the product of the entire State as given in the table below it will be seen that there has been an increase in the product of each of the precious metals during the decade, and that the rate of increase has been much higher since its close. For silver there was a decrease about the middle of the decade, due to the falling off in the Leadville product. This was replaced during the latter part of the decade by the rapid increase in Aspen's production, to which has been added since its close that of the new district of Creede, in either case, although primarily resulting from the discovery of large bodies of very rich ore, yet largely dependent upon the advent of railroads. The increase in the gold product in the last years is doubtless largely due to the product of the new Cripple Creek district, which the railroad has not yet reached. While the present decade may, therefore, see a considerable decrease in the silver product of the State, it is likely to be in a measure offset by an increase in its gold product.

Production of gold and silver in Colorado since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$3,200,000	$17,000,000	1887	$4,000,000	$15,000,000
1881	3,300,000	17,160,000	1888	3,758,000	19,000,000
1882	3,360,000	16,500,000	1889	4,000,000	20,686,868
1883	4,100,000	17,370,000	1890	4,150,000	24,307,070
1884	4,250,000	16,000,000	1891	4,600,000	27,358,384
1885	4,200,000	15,800,000	1892	5,300,000	31,030,303
1886	4,450,000	16,000,000			

DAKOTA.

The precious metal product of South Dakota is entirely derived from the isolated mountain group on its western boundary, known as the Black Hills. This group, which is in the form of an ellipse about 100 by 50 miles in dimensions, is a most interesting and typical example of the structure known in geology as a quaquaversal uplift, or one in which the strata dip away in every direction from a central nucleus. The central nucleus in this case consists of metamorphic slates and granites of Huronian age. The sedimentary strata, which rest upon and wrap around its edges like the leaves of an onion, are successively Cambrian sandstones, Carboniferous limestones, and a series of sandstones and shales of

Mesozoic age. The uppermost of the latter series is the coal-bearing Laramie Cretaceous.

The precious metal product is derived from the older rocks, which are, in places, cut by dikes and intrusive bodies of later eruptives. Although, as is generally the case, it was the placer gold that first attracted miners to the region in 1875, these deposits are not very extensive, and the gold derived from them forms an inconsiderable portion of the gold product of the State, having averaged in round numbers about $50,000 in the early part of the decade and $30,000 per annum in the last few years, or less than one-twentieth of the total gold product.

It is deep mining in large and easily-worked bodies of extremely low-grade ore that has been the characteristic feature of the mining industry of the region, and has placed it on an unusually permanent basis. Four large mines, now controlled by a single company, have in the last eight years contributed more than $20,000,000, or over five-sixths of the total of about $24,000,000 of gold produced in the region. Their deposits occur in the crystalline schists at the northern end of the range, in immense bodies sometimes 400 feet wide. The ore is a free-milling gold ore, easily crushed, and practically free from other metallic combinations except a small amount of iron pyrite, so that, though its average yield is said to be from $2 to $4 per ton, owing to the large quantity treated, it can be worked at a profit, and the mines have paid about six million dollars in dividends to their owners. Although no ore bodies are inexhaustible and one mine of the group has already ceased producing, so that the product from these mines will necessarily decrease in time, they have proved unusually permanent and the industry established by them has encouraged the building of railroads, which furnish fuel and other necessary facilities for cheap mining; hence it is reasonable to expect that the development of other bodies will gradually replace the falling off in their product. Four competing railroads now reach the region, where none existed at the commencement of the decade.

Gold-bearing ores also occur in the Potsdam or Cambrian sandstone. The most interesting, from a scientific point of view, are the cement or conglomerate ores at its base, which are considered to be old placers formed on the shores of the Cambrian ocean from the disintegration of the rocks of the original Huronian island, but since hardened, so that the ore is crushed and milled, and its product is classed with that of deep mines. Complicated base-metal ores, rich in gold, also occur in these sandstones, and at the end of the decade had begun to be mined on a considerable scale, the more complicated smelting or lixiviation processes necessary for the treatment of such ores having been rendered practicable by the supply of cheap fuel brought in by the railroads.

Of the silver product of the State a small but regular amount is derived from the gold bullion of the gold belt mines, about 1½ per cent.

of whose value is in silver. Besides the base metal mines which contain silver as well as gold, argentiferous galena ores are also found in the Potsdam sandstone, but the main silver product has been derived from contact deposits in the Carboniferous limestones in association with eruptive rocks, and it is to variations in the productiveness of these mines probably that the fluctuating character of the silver product as a whole is mainly due.

The gold product, which showed a steady decrease during the first part of the decade, increased as steadily during the latter part and had already reached its former level. Whether it continues this increase as a whole is mainly dependent on the gold belt mines, but a fair increase in the product of outside mines may be looked for. The product of silver will probably continue to be small and uncertain.

Production of gold and silver in South Dakota since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$3,305,843	$70,813	1887	2,400,000	540,000
1881	4,000,000	70,000	1888	2,600,000	100,000
1882	3,300,000	175,000	1889	2,900,000	64,646
1883	3,200,000	150,000	1890	3,200,000	129,292
1884	3,300,000	150,000	1891	3,550,000	129,293
1885	3,200,000	100,000	1892	3,700,000	77,576
1886	2,700,000	425,000			

IDAHO.

The State of Idaho in different portions partakes of the physical and geological characteristics of adjoining States. North of the great lava flows of the Snake Plains it is a mountainous region with high, well-watered valleys, similar physically and geologically to the adjoining region of western Montana. South and southwest of the Snake River valley it incloses part of the great basin region of Utah and Nevada.

In the larger valleys of the northern portion are considerable accumulations of gold-bearing gravels, many of which are so situated that they could not have been deposited by present streams, and bear considerable resemblance to the older placer deposits of California. The immediate valley of the Snake river also contains gravel bars rich in placer gold brought down from its headwaters in the Rocky mountains. It is, however, in so fine a state of division that great difficulty is found in saving it by the ordinary processes. The mountains of the northern portion contain both silver-lead and gold ores, which occur both in granites and sedimentary rocks of Paleozoic age. The former class of ores has received the most attention on account of the demand by large smelters for ore of this character, which it has consequently been possible to mine at a profit in spite of the fall in the price of silver. The most important new development during the decade has been that of the Cœur d'Alène region in the northern part of the State. Its ores though comparatively low in silver are rich in lead, and hence sought after by the smelters. From 1886 to 1891, inclusive, this district is reported to have produced about seven millions (coining value) in silver, and a somewhat larger value in lead. With the stimulus to gold mining that may be looked for as a result of the fall in the price of silver it is probable that more attention will be given to the development of the gold veins of the northern region, many of which are probably valuable and will yield good returns under good management. Already outside capital has been invested in considerable amount during recent years for the purpose of working the larger placers by the hydraulic process, but the returns from such investments are necessarily slow, and in the absence of statistics as to the relative proportion of gold derived from deep and from placer mines in the total product of the State, it is impossible to determine how much influence they have already had upon the product.

In the granites and eruptive rocks of the southwestern portion of the State extraordinarily rich deposits of high grade silver minerals were early discovered and worked; and many of the mines have been since abandoned, apparently in large measure on account of financial complications. These ores are in many respects similar to the rich silver ores which are characteristic of the western Nevada belt. During the decade new discoveries of similar ores have been made in the region, and already the Delamar mines have become large and important producers of silver.

The available statistics of the production of the precious metals during the decade show a slight increase in the gold product with small but not important fluctuations in its amount which may be taken in round numbers at about two millions for the latter half. At least one-half of this product may be estimated to have been derived from placer mines. According to the reports of the Tenth Census the placer mines of Idaho ranked next in importance to those of Montana and California, and what is known of their geological relations give promise of a permanence in their product comparable to a certain extent to those of the latter State.

The silver industry on the other hand has shown a rapid and comparatively regular development, the product of this metal having increased from less than half a million in 1880 to more than four millions in 1889–'90. This development has been materially aided by the building of branch railroads from the transcontinental lines to some of the more important mining centers. This fact and the demand for its ores by the smelters lends a character of permanence to this industry that is wanting in some other regions.

It may be assumed, therefore, that with a continuance of the present low price of silver, although the production of that metal in the State will probably decrease, the amount of decrease will be less than for many other silver-producing regions, and that when conditions have so adjusted themselves as to assure comparative permanency in the price of silver the mining industry will adapt itself to those conditions and the production of silver become comparatively regular. In the production of gold a fairly regular though probably not rapid increase may be looked for.

Production of gold and silver in Idaho since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$1,479.653	$464,550	1887	1,900,000	3,000,000
1881	1,700,000	1,300,000	1888	2,400,000	3,000,000
1882	1,500,000	2,000,000	1889	2,000,000	4,395,959
1883	1,400,000	2,100,000	1890	1,850,000	4,783,838
1884	1,250,000	2,720,000	1891	1,680,000	5,216,970
1885	1,800,000	3,500,000	1892	1,721,364	4,091,083
1886	1,800,000	3,600,000			

MONTANA.

The precious metal product of Montana has been mainly derived from the granites, Paleozoic limestones, and sandstones and associated eruptives which make up the mountains of its western portion, although the coal beds contained in the Mesozoic strata which underlie the broader valleys and plains in the eastern portion has played an important part in the development of the mining industry of the State.

The mountainous portion of the State has many broad valleys that are characterized by unusually large accumulations of detrital material, many of which have been proved to be highly auriferous. Geological examinations have not yet determined the age of all these gravels, but while a large proportion are undoubtedly recent, it is likely that some may be proved to be of more ancient formation. Their extent and richness have given to Montana a rank next to California in the production of placer gold, and made it during the first two decades of its existence essentially a gold-producing State. During the decade 1880 to 1890 conditions have radically changed. Its silver production has enormously increased, while the gold product, though fluctuating somewhat from year to year, has shown a considerable decrease from the production of earlier years.

In 1880 the gold derived from placers constituted nearly two-thirds of the total gold product of the State; in 1884 this proportion was reduced to little over two-fifths. There are no statistics as to the proportion in later years, but it is known in a general way that placer mining was much retarded by lack of water, and as the gold product as a whole has increased it is evident that there has been a still greater increase in the proportion of gold derived from deep mines. A considerable portion of this gold is known to have been derived from ores carrying both gold and silver; the Drumlummon mine, for instance, whose ores had over three-fifths their value in gold, have contributed about five millions to the gold product of the decade, but there are mines which have been worked for gold alone, and their number will probably be increased in the future.

To the enormous development of the silver production of the State during the decade, besides the discovery of rich deposits of unusual magnitude, other causes have contributed which have been hardly less important factors in establishing the mining industry on a permanent basis. The first of these has been the rapid development of railroads during this time, so that now the State is traversed by the lines of three large systems, two of which are transcontinental and the third is likely to become so shortly. Not only have the ores of the State been thus brought within reach of outside smelters, but the building within the State of smelting plants and of amalgamation plants of complicated nature requiring a large supply of fuel has been rendered practicable and actually brought about through this agency.

The most important producer of silver has been the mining district of Butte, whose development followed closely on the heels of that of Leadville in Colorado, which it soon rivaled in the magnitude of its product of this metal. Here the analogy ceases, however. The silver ores of Butte contain but little lead, and are mostly reduced by the amalgamation process combined with previous roasting and chlorination, there being only a single smelter which treats them, and this in connection with copper instead of lead. The ores are obtained from a series of strong and large vertical fissures in granite in the vicinity of a recent eruption of rhyolite. While at first silver was the principal product, it has of late years been overshadowed in value by the copper product, coming from a similarly situated and parallel but distinct series of veins which carry but little silver. The total precious-metal product of the district is estimated at about $92,000,000, of which nearly 7 per cent. in value is gold. The silver product reached its climax within the decade, and at its close had already begun to decline. This decline resulted not so much from exhaustion of the ore bodies as from the high cost of reduction, which, when combined with increased cost of mining at depths of a thousand feet or more, soon made the cost of production equal to the declining price of silver. In consequence most of the larger silver mines of the district are at present practically closed.

Outside of this district several unusually large and rich silver-bearing deposits have been developed during the decade, the most important of which is that upon which the Granite Mountain and Bi-Metallic mines have been located, also a strong vertical fissure in granite. The former alone has produced over $14,000,000, mostly in silver, during the decade. The Drumlummon is another important deposit, which has produced over $7,000,000 during the decade, of which less than half the value was in silver. Important deposits of argentiferous galena ores in limestone are also found, but their production is so far less important than the similar class of deposits in Colorado. Mining development in this State has progressed more rapidly than scientific investigation, and the geological conditions of a great number of its deposits are yet unknown.

The silver product, as shown by statistics, has increased steadily up to the end of 1892, thus proving a considerable increase in the product of districts and mines other than those mentioned above, which at the present time are either closed or working with a greatly reduced force. While, therefore, a very considerable falling off in the silver production of the State is to be looked for, it is not likely to cease altogether under any probable reduction in the price of that metal. Nor, on the other hand, is a moderate rise in that price liable to result in any great immediate increase, for most of the largest known ore bodies have been worked out to such a depth that the starting up of work again means a preliminary expenditure too large to be undertaken without the fair certainty of a permanent price for the product.

The gold output, on the other hand, is liable to increase. Under favorable conditions placer mining will be resumed. A considerable portion of the State is not yet thoroughly explored for ore deposits, and gold-bearing ores will be more sought than formerly, while of already opened deposits work on those that carry considerable values in gold as well as in silver will naturally be continued rather than on those whose values are in silver alone.

Production of gold and silver in Montana since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$1,805,767	$2,905,068	1887	$5,230,000	$15,500,000
1881	2,330,000	2,630,000	1888	4,200,000	17,000,000
1882	2,550,000	4,370,000	1889	3,500,000	19,393,939
1883	1,800,000	6,000,000	1890	3,300,000	20,363,636
1884	2,170,000	7,000,000	1891	2,890,000	21,139,394
1885	3,300,000	10,060,000	1892	2,891,386	22,432,323
1886	4,425,000	12,400,000			

NEVADA.

The State of Nevada has peculiar physical conditions, characteristic of the so-called Great Basin region which extends beyond its boundaries into western Arizona, southeastern California, western Utah, and portions of Idaho and eastern Oregon. These are a very arid climate, a scarcity of running water, and no exterior drainage, except in the portion traversed by the Colorado river, which, however, does but little to relieve it of its desert character. In such a region agriculture is necessarily so limited in its development as to be unable to constitute a self-supporting industry, and, since the inhabitants must necessarily be dependent on mining or pastoral industries, it will always be sparsely populated. It suffers under the further disadvantage of containing on economically valuable coal beds. Under these circumstances it can hardly expect to have the net work of railroads whose permanence is dependent upon a local population, and which do so much to reduce the cost of working ores in more favored regions; and for mining as an industry to flourish in such a region it is requisite that it should have either exceptionally rich ores or remarkably large concentrations of ore in a limited district. Under such conditions even, the industry is necessarily liable to frequent fluctuations in its product, and such, as statistics show, has been the case with Nevada.

Placer deposits like those found in California, are necessarily wanting in Nevada owing to the absence of large running streams. Its surface is a series of broad valleys separated by narrow and isolated mountain ranges. These valleys have considerable accumulations of detrital material, which is spread out in long gentle slopes from the foothills of the mountains to the middle of the respective valleys. This material is the result of subærial erosion, and, though metallic minerals are undoubtedly disseminated through the gravel, it would hardly be expected that they would be found to any great extent concentrated into workable deposits. Even if they were so concentrated, it is only under exceptional conditions, as for instance in the southeastern part of the State, that a sufficient supply of mining water could be obtained to work them.

Its mountains are made up of sedimentary rocks ranging in age from the Jurassic back to Cambrian, and of a great abundance and variety of crystalline and eruptive rocks, whose geological conditions have been extremely favorable to the concentration of the precious metals into ore deposits. The greater part of the ores thus far developed have been, especially in the western part of the State, high grade silver minerals, relatively rich in gold, the amount of base metals associated with them seeming to be in larger proportion in the eastern part of the State.

As its development proceeded from west to east, and ores were naturally developed in proportion to their adaptability to amalgamation processes which were first perfected in the West, rather than to smelting, which alone is capable of treating profitably complicated base metal ores, the actual developments may represent rather the result of these conditions than of the relative proportions in which the metals exist in the rocks. Both classes of ore contain a relatively large proportion of gold, while of gold ores proper, that is, those which contain no appreciable values in other metals, the amount discovered has been very limited, and, so far as known, confined to the western borders of the State.

The production of the Comstock lode, which is a fault fissure in eruptive rocks, that has been worked on a length of nearly four miles and to a depth of 3,000 feet, has hitherto overshadowed that of all other mines in the State, having reached in 1892 a total of $350,000,-

000 in silver and gold in the approximate proportion of 6 to 4. Owing to the great expense of working and the exhaustion of its great bonanzas, its lower workings were abandoned at the close of the last decade, and its production during the present decade has been little more than an eighth of what it was during the previous one. In spite of this greatly reduced production its proportion of the total product of the State has been nearly two-fifths of the silver and over three-fifths of the gold. Its lowest years were 1881 and 1882, but, although in 1891 and 1892 its product was more than double that of the two former years, inasmuch as this product must have been derived from ground that had been already worked over, it can not be expected to continue this rate of production for many years longer, especially with the reduced price of silver.

The Eureka district, in the central portion of the State, which has been the largest producer next to the Comstock, gets its ores, which are largely argentiferous galenas and their decomposition products, from the Silurian limestones. They have to be reduced by smelting, which is rendered expensive by the high cost of fuel, and the district consequently has been among the first to be adversely influenced by the reduced price of silver. The output of precious metals has fallen off from $1,250,000 in 1887 to $630,000 in 1892. The most important mines have stopped all new work, and with a continuation of the present low price of silver the production of the district will probably be reduced to an insignificant amount. The ores carry one-third of their value in gold, and the amount of this metal produced by them during the decade, combined with that derived from Comstock ores, make up all but about $2,000,000 out of the $25,000,000 of gold reported during this period for the entire State. If these two sources of supply of the precious metals become exhausted or cease to produce, the additional stimulus which may be given to the search after and development of gold deposits can hardly be expected to afford any adequate compensation for the loss to our gold product which will result therefrom.

Of the numerous smaller mining districts scattered through various portions of the State, it can only be said that, owing to the high cost of working consequent upon the physical conditions described above, their product has been subject to considerable fluctuations during the decade, and their development as a rule can hardly be said to have become established upon a permanent basis. With a reduced price of silver it is probable that many of them, especially those in the southern and eastern part of the State, which have rich silver-bearing ores in limestone, will be abandoned. The Pioche district, which, prior to 1880, had produced nearly $20,000,000 from its rich silver-bearing lead ores in limestones and quartzites, has lain idle during the entire decade for the reason that its ores can no longer be profitably worked except by smelting, and this is not possible until the district is reached by a railroad. Those in eruptive and more siliceous rocks along the northern and western borders may be kept alive by turning their attention to the development of the gold ores which are likely to be found in these regions, but the mining industry of the State, taken as a whole, is liable to be most disastrously affected by a permanent reduction in the price of silver.

Production of gold and silver in Nevada since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$4,888,242	$12,430,667	1887	$2,500,000	$4,900,000
1881	2,250,000	7,060,000	1888	3,525,000	7,000,000
1882	2,000,000	6,750,000	1889	3,000,000	6,206,060
1883	2,520,000	5,430,000	1890	2,800,000	5,753,535
1884	3,500,000	5,600,000	1891	2,050,000	4,551,111
1885	3,100,000	6,000,000	1892	1,571,500	2,901,333
1886	3,090,000	5,000,000			

NEW MEXICO.

In climate and physical conditions New Mexico has a general resemblance to Arizona, but it has a great advantage over the latter Territory in the occurrence of coal-bearing rocks within its borders upon whose existence has largely depended the development of railroads, smelting plants, and other factors that favor the establishment of the mining industry on a permanent basis. Of its geological structure only the most general features are known. The basin ranges extend across the southwestern portion, having, as in Arizona, a general northwest trend and made up of Paleozoic beds resting on crystalline rocks, both of which are traversed by eruptives. The southern end of the Rocky Mountains project across the northern boundary of the Territory, while through the middle portion run isolated ranges with a north and south trend, similar in geological and physical structure to the basin ranges; these become less frequent east of the valley of the Rio Grande and finally disappear in the plain region of northern Texas. In the angle between the northwesterly and northward trending ranges, in the northwestern portion of the Territory, is included a portion of the Colorado plateau which terminates to the southward in a large area of recent lava flows.

The precious metal product of the Territory has been almost exclusively derived from the mountain ranges. Placers have been worked to a certain extent in the valleys of the southwestern part of the Territory, but their output is not known. Rich placer ground is known to exist on the débris slopes of the broad arid valleys to the south of the Rocky Mountains, but they can not be worked without the expenditure of considerable capital in water ditches, and litigation is said to have hitherto stood in the way of their development.

The northwest trending ranges in the western and southwestern portion of the Territory have been the earliest and most permanent producers. Their ores are mostly silver-bearing but carry some gold, and gold ores, reducible by amalgamation, have also been developed. A most favorable indication for mining in this region has been the experience that some base metal ores have greatly increased in gold value below the oxidized zone and been successfully reduced after concentration.

A north and south belt along the west side of the Rio Grande Valley, which reached its climax of development about the middle of the decade, has been the most important factor in the silver production of the Territory. The ores are argentiferous galenas and their decomposition products, occurring in Carboniferous limestones; and their development has been stimulated by the proximity of railroads and the establishment of smelting plants. The fall in the price of silver, which came at a time when the richest ore bodies had mostly been worked out, had a most disastrous effect on the silver production of this belt whose influence is seen in the steady decrease in the product of the metal for the Territory during the last half of the decade. In one portion of this belt is a district in which gold is the chief product, and in which the stimulus given to the development of such ores by the fall in the price of silver has already had the effect of doubling its product.

In the mountains to the east of the Rio Grande valley are several mining distiets whose chief product is gold. In spite of the difficulties with which they have to contend in transporting supplies from the railroad 100 miles over a desert country, their product has rapidly increased during the last half of the decade, $55,000 being reported for 1886 and $256,000 in 1892.

It seems rather singular that but little active mining appears to be going on in the high mountains of the Rocky Mountain system near the northern boundary of the Territory, in which from general geological indications it would be expected that rich ore bodies might be found. This may be possibly due to the fact that a very considerable portion of this area is included in old Spanish grants, since confirmed to individual owners, and in which the discovery and location of ore bodies is not as attractive to the prospector as under the mining laws of the United States.

In considering the Territory as a whole it will be seen by reference to the table that the increase of the gold product during the decade has been steady and continuous, and a further and possibly greater increase may reasonably be looked for in the coming decade.

While the silver product, however, shows a considerable increase between the commencement and end of the decade, the falling off in the latter half has been about 50 per cent., or at the average rate of about a quarter of a million per annum. Under existing financial conditions a still further decrease may be looked for, but the entire silver product is not likely to cease since, although silver mining *per se* may no longer be profitable, a certain amount will naturally be produced as a by-product in the reduction of other ores required by smelters.

Production of gold and silver in New Mexico since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$49,354	$372,337	1887	500,000	2,300,000
1881	185,000	275,000	1888	602,000	1,200,000
1882	150,000	1,800,000	1889	1,000,000	1,461,010
1883	280,000	2,845,000	1890	850,000	1,680,808
1884	300,000	3,000,000	1891	905,000	1,713,131
1885	800,000	3,000,000	1892	950,000	1,075,000
1886	400,000	2,300,000			

OREGON.

In physical and climatic conditions the State of Oregon is divided by the Cascade range into two distinct and strongly contrasted portions. Western Oregon is a rugged and mountainous belt having a very moist climate. Eastern Oregon, which occupies two-thirds of the area of the State, is mostly broad desert valleys with a few mountain ranges toward the eastern border, and has the dry climate peculiar to the interior of the Rocky Mountain region. Of the geology of the State only a few broad general features are known. The rugged region of western Oregon contains representatives of the auriferous slates of the Sierra Nevada, and is supposed to form the geological continuation of that range. The higher portion of the Cascade range is formed of recent lavas, which spread out in places to a considerable distance over the horizontal tertiary beds that fill the broad plains and valleys at its eastern base. The most important mountain range of eastern Oregon, the Blue mountains, is reported to contain Triassic and Jurassic limestones, like corresponding ranges in western Nevada, while granites and metamorphic rocks form the basement complex, underlying all more recent sediments.

The precious metal output of the State is mainly in gold, silver having been produced in comparatively insignificant amount, except at the close of the decade when several important silver mines were opened in the eastern portion of the State, but which have since been closed down.

The gold placers of western Oregon are from the configuration of the country necessarily much smaller than those of California, yet in earlier times they afforded the major part of the gold product of the State. They are still worked on a small scale by individual miners, largely Chinese, and to some extent by hydraulic mining. An interesting variety of placer mine is afforded by the beach sands which result from the disintegration of the gold-bearing rocks along the Oregon coast. A small amount of placer gold is derived from them, but as a rule they are not sufficiently rich to yield much profit. At the commencement of the decade the product of western Oregon was nearly two-fifths that of the entire State, but in 1890 its product had decreased to half of what it was in 1880, and formed only one-fifth of the State's product. In the former period this product was practically all derived from placer mines, but since then there has been a small but increasing product from vein mining, though what proportion it bears to the entire product is unknown.

In eastern Oregon deep mining had already assumed considerable importance at the commencement of the decade, having yielded nearly one-third of the entire gold product of that portion of the State, while the other two-thirds came from placers. Although the returns of later years are not segregated, it may be assumed that the proportion derived from deep mining has increased, since the product of the entire region has so much increased as to replace the decrease in the production of western Oregon. The greater part of the product of eastern Oregon comes from mines along the eastern edge of the State, the yield of those scattered through the interior having been comparatively insignificant. Although the census figures show an apparent slight falling off in 1890 as compared with 1880, those of the Director of the Mint show an increase and a still greater one in the two succeeding years. A gold yield that depends on placer mining is necessarily subject to fluctuations due to failure or abundance of water supply, and no great permanence can be assured for Oregon's gold yield until it is derived in greater degree from deep mining.

Production of gold and silver in Oregon since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$1,097,701	$27,793	1887	$900,000	$10,000
1881	1,100,000	50,000	1888	825,000	15,000
1882	830,000	35,000	1889	1,200,000	38,787
1883	660,000	20,000	1890	1,100,000	96,969
1884	660,000	20,000	1891	1,640,000	297,374
1885	800,000	10,000	1892	1,400,000	64,646
1886	990,000	5,000			

UTAH.

The generally north and south trend of the Wasatch uplift divides the Territory of Utah into two parts, sharply contrasted geologically as well as topographically, though both possess the generally arid climate of the interior basin of the Cordilleran system. To the east is the plateau country, a region mainly occupied by extensive table-lands with narrow, tortuous valleys in whose bottoms run small streams tributary to the Colorado river that receive their waters from the bordering mountain ranges. The surface of the region is mostly covered by flat-lying beds of Mesozoic and Tertiary age.

On the west of this line is the Basin range province, a region of isolated mountain ranges, separated by broad desert valleys, with no external drainage. In some of these valleys are still found lakes, the partly desiccated relics of larger bodies, whose waters are for the most part so strongly charged with mineral matter as to be unserviceable to man. The mountain ranges are made up of upturned sedimentary strata of Paleozoic age, of older crystalline rocks, and of more recent eruptives; the desert valleys are covered by gravels and clays of Quaternary or recent formation.

At its northern end the Wasatch uplift develops into a broad, high mountain mass which sends down the streams that, under the beneficent irrigation system of the Mormons, have converted the desert valleys into fruitful farming lands.

This is the only part of the Territory that is capable of supporting an abundant population, and is hence necessarily its industrial center. Mining in Utah, which was discouraged by the Mormon church, has only flourished during the last two decades. During the last decade, with the increase in railroad facilities, the development of the coal beds in the plateau region, and the establishment of several smelting works in Salt Lake valley, the output of the precious metals has more than doubled, and in 1891 had reached a total of over $12,000,000.

The Wasatch mountains in which the valuable ore deposits were first discovered still contain the most productive mines, the yield of a single district, and practically of one great vein, furnishing nearly one-half of the total product of this Territory. The ore bodies in limestone, which created the first mining excitement, have yielded but little during the past decade. The product of the great Ontario-Daly vein, which is in Carboniferous quartzites associated with eruptive dikes, has reached twenty-seven millions. Its ores, which are mixed base metal ores, are reduced by amalgamation and lixiviation, and the regularity of its product and of the dividends paid from it have been most remarkable. At its present great depth, owing to excessive flow of water, the cost of mining has increased considerably, but will be reduced upon the completion of the deep-drainage tunnel, which has been driven during the past few years. It is probable that the mine can be worked at a profit with even greater reduction in the price of silver. The bullion produced from the mines of the district carries over 1 per cent. of its value in gold.

The first of the desert ranges west of the Wasatch, the Oquirrh mountains, has rich silver ores and argentiferous galenas, in Paleozoic limestones and quartzites, respectively, which have yielded nearly a million annually during the decade. Although the very rich bodies first discovered are mostly exhausted, the product of the region as a whole has maintained a fairly even grade during the decade, as it has good railroad facilities and a considerable proportion of its ores are smelted. Gold forms a relatively high percentage of its product, being estimated at about 6 per cent. of the value of the total yield. There are large bodies of low-grade siliceous ores rather difficult to reduce, which can only be worked at a profit where cheap and effective methods of treatment have been devised. The output of this district, which is the third in importance in the Territory, is seriously affected by a low price of silver, though the mines producing ores rich enough in lead or copper to command good prices from the smelters will be the last to be abandoned.

The Tintic district, in one of the desert mountain ranges forming a southern continuation of the Oquirrh uplift, has been the second largest producer during the decade, its annual output varying from $1,000,000 to nearly $5,000,000. The ores are found in Paleozoic limestone, and carry values in silver, gold, and copper, with comparatively little lead, the gold yield averaging about 3½ per cent. of the total value. They occur in immense bodies, and when profitably worked yield large returns, but are difficult of reduction under ordinary methods. The better grades are shipped to the copper-silver smelters in Colorado. Branch lines have been built to the district by two competing railroad systems during the decade. Nevertheless, the character of the ores is such that the yield is extremely sensitive to fluctuations in the price of silver. It reached its maximum in 1890, and has since been falling off. With enterprise and intelligent management, it would seem, however, that in virtue of their contents in copper and gold, a considerable proportion of the product might be kept up even with an excessively low price for silver.

In the San Francisco range in the southwestern part of the Territory large bodies of relatively pure silver-lead ores have been found, mostly in Paleozoic limestones in association with eruptive rocks, and to a certain extent within the eruptive bodies. The most important mine is the Horn Silver, which has yielded in all over ten million dollars in silver, with an insignificant percentage of gold. Narrow gauge railway connection was made with the district at the commencement of the decade, and the ores have been sent East to be smelted. For three years, about the middle of the decade, work in the Horn Silver mine practically ceased, and the product of the district was very small, but with the resumption of work in this mine it has increased again to an annual average of over half a million. This product will naturally be dependent on the price of silver, but, though at somewhat of a disadvantage on account of its distance from industrial centers, its ore may be worked to a profit on account of their lead contents even with a low price for the precious metal.

In the extreme southwestern corner of the Territory, in a band of Mesozoic sandstones known as Silver reef, is an occurrence of silver ore of rather unusual geological character. The ore occurs rather as an impregnation of the sandstone than in well-defined ore bodies. Although of rather low grade, it has been possible to mine and mill it at a profit in spite of its distance from railroad communications, owing to the purity of the mineral and the ease with which it is crushed. The total product of the district is said to have been over $6,000,000. Its annual product during the early part of the decade was about $450,000, but it has now fallen off to less than $50,000, and is no longer of much economic importance.

Mines have been opened in various other parts of the Territory but no districts have reached the point where they can be considered as permanent producers. Considerable interest has been displayed of late years in a newly discovered district on the edge of the desert near the western boundary of the Territory known as the Deep Creek district. The ore occurs in Paleozoic limestones, is mainly silver bearing, but carries some gold. From $100,000 to $200,000 has been produced during the past two years, but no permanence can be looked for until railway communication is established. In the pleateau region in the extreme southeastern portion of the Territory adjoining Colorado, to which it belongs geologically, gold-bearing placers on the Rio San Juan and near the Henry mountains have been discovered in late years, but too little is yet known of the geological relations to form an opinion as to whether they are liable to lead to the establishment of permanent mining districts.

In conclusion it may be said that, while the Territory is undoubtedly possessed of great wealth of the precious metals, much of which is as yet undiscovered, from the fact that the principal values of its ores are in silver, production is likely to be seriously curtailed by a permanent decrease in the price of that metal. The development of the unexplored parts, which is rendered difficult by their desert character and the want of knowledge of their geological structure, will be further discouraged by a decrease in the prosperity of those already developed.

Production of gold and silver in Utah since 1880.

Year.	Gold.	Silver.	Year.	Gold.	Silver.
1880	$205,747	$3,068,614	1887	$220,000	$7,000,000
1881	145,000	6,400,000	1888	290,000	7,000,000
1882	190,000	6,800,000	1889	500,000	9,050,505
1883	140,000	5,620,000	1890	680,000	10,343,434
1884	120,000	6,800,000	1891	650,000	11,313,131
1885	180,000	6,750,000	1892	660,175	10,472,727
1886	216,000	6,500,000			

WASHINGTON.

The climatic and physical conditions of the State of Washington closely resemble those of Oregon, it being divided by the Cascade mountains into a humid coast belt on the west and a dry interior region on the east. A large plain area occupies the central portion of the interior or eastern division, which is surrounded by mountains that extend into it from adjoining regions. Of the geology of the State even less is known than with regard to that of Oregon. The western belt contains valuable coal beds, which have received considerable development during the decade owing to the demands made upon them by railroads and steamers, but no output of precious metals has been reported for this portion of the State. The Cascade range proper, which is largely made up of recent lava flows, has also yielded no ore bodies, but in its outlying eastern spurs rich gold ore bodies are said to have been found in eruptive rocks, which are probably of more ancient date than the lavas. The gold product of the State, though showing a creditable increase during the decade, is still very small and largely derived from small placer mines, the working of which is rendered easy by the abundant water supply afforded by the many considerable rivers and streams throughout the State. Deep mining was apparently only taken up toward the close of the decade and up to the present time its principal development has been in the northern and eastern portion of the State, in deposits that yield mixed ores carrying values in silver and gold, or silver alone.

The eastern slopes of the Cascade range have yielded gold alone, and the northern slopes of the Blue mountains of Oregon both gold and silver. The entire silver product of the State has been inconsiderable, being not more than half that of gold, and has already fallen off very sensibly with the drop in the price of silver. It is from the development of gold vein-mining that a permanent increase in the mining industry of the State is to be looked for, and what little is known renders it fairly probable that such mining may prove profitable in the future.

Production of gold and silver in Washington since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$135,800	$1,019	1887	$150,000	$100,000
1881	120,000	....	1888	145,000	100,000
1882	120,000	....	1889	175,000	103,434
1883	80,000	500	1890	204,000	90,505
1884	85,000	1,000	1891	335,000	213,334
1885	120,000	70,000	1892	373,561	193,939
1886	147,000	80,000			

WYOMING.

The precious metal production of Wyoming has thus far been too insignificant to be taken into account. The eastern and middle portions of the State, which were the first to be settled, are great plains of flat-lying Cretaceous and Tertiary rocks, where metal-bearing deposits would not be looked for and which are preeminently adapted for pasturing cattle. The principal industry of the State has, therefore, been pastoral and the mining element in its population extremely limited; it is to this fact rather than to want of natural resources in minerals that the relative backwardness of its mining development is due. The coals which underlie a great part of its plain areas have been developed only so far as meet the wants of the railroads which traverse its territory. Besides this great source of industrial wealth it possesses valuable stores of petroleum and alkaline salts, all of which form the most substantial foundation upon which to found a permanent mining industry. Within its boundaries, moreover, are large mountain areas which there is every reason to believe will prove rich in the deposits of the useful metals when the discovery and the development of some mining district shall have given the necessary guide and impetus to the work of the prospector, so that they will be thoroughly explored.

Across the southern boundary of the State projects the northern end of the Colorado mountain uplifts in which there has already been a fitful development of precious metal deposits. A few deposits have also been opened in the low east and west ridges running through the middle of the State; but it is to the great mountain area occupying the northwestern corner and covering nearly a third of the surface of the State, which is still practically a *terra incognita*, that one naturally looks for the next important development of precious metals.

At the southwestern extremity of the great Wind River range gold placers have been worked in a small way for many years, and it is from them that the small but relatively steady gold product mainly comes. From what is known of the geological structure of this great range it appears to possess the elements that would favor the concentration of metallic minerals into economically valuable deposits, and it is reasonable to expect that intelligent and thorough prospecting, especially if supported by a fair amount of capital, would result in their discovery. The Big Horn mountains, lying due west of the Black Hills of Dakota which have proved so fruitful a source of gold, are said to resemble the latter in geological structure, and if this is true it might reasonably be expected that an analagous concentration of metallic minerals might be found in them. It is impossible to forecast the probable mineral wealth of a region without some general knowledge of its geological structure, and even this is wanting for the greater part of the mountain areas of Wyoming. Preliminary geological surveys of this comparatively unknown region would be a most valuable preparation for the work of the prospector, and are indispensable for the capitalist. Under systematic and intelligent development, Wyoming, lying as it does between the important precious metal areas of Montana and Dakota, might rival them in time in the value of its gold product, especially in view of the advantage it possesses in its physical structure and already established railroad connections.

THE APPALACHIAN STATES.

Although the existence of gold in the rocks of the Appalachian range was known soon after the discovery of our continent, and the gold-bearing deposits have been mined sporadically since colonial times, less is definitely known with regard to the geology of the rocks in which they occur or the relations of the deposits themselves than of any other gold-bearing deposits within the United States. It is probable that to this ignorance, combined with a want of technical knowledge on the part of most of those who have attempted to mine them, may in great measure be attributed the many financial disasters that have brought gold mining in this region into disrepute.

They occur along a fairly well-defined belt running northeast and southwest, the strike of the principal geological features of the mountains, in a series of highly metamorphic rocks belonging to one of the as yet undifferentiated pre-Cambrian series which until within a comparatively few years were indiscriminately classed as Archean. The ores are found in quartz veins and impregnating the adjoining altered country rock, often in the vicinity of eruptive dikes. The veins as a rule are of rather moderate dimensions as compared with the great quartz lodes of California, but they are often more abundant within a given area, and, within the zone of oxidation, portions of them have proved exceptionally rich in free gold. The configuration and physical character of the country is not such as to favor the accumulation of large bodies of placer gravel, yet occurring as they do in the unglaciated region, the surface material in the vicinity of outcrops of veins, as a result of secular disintegration, is sometimes rich enough to be worked profitably as a placer deposit. When the limits of the zone of oxidation have been reached the sulphuret ores are generally found to be of too low grade to be profitably amalgamated, and this treatment is sometimes further complicated by their association with tellurium; hence mining has in many cases been abandoned while the workings were still comparatively shallow, and the impression has got abroad that gold does not continue in depth.

One of the first essentials for the systematic development of the resources of the belt is a cheap and practical process for the extraction of the gold from the sulphuret ores, and one seems to have been discovered which solves this problem for the ores of the southern portion of the belt.

As shown by the tables of production given below, the precious metal product of the belt is practically all gold, although a few thousand ounces of silver have been produced of late years in the smelting of lead-zinc ores mined in North Carolina. Systematic gold mining can be said to have only been carried on in North and South Carolina and Georgia, the gold product of the other States mentioned having been produced by petty mining and by a few attempts at development in Maryland and Virginia, which have not yet reached the stage of permanent mining. Of the product of the first three States mentioned, which in favorable years has reached nearly half a million dollars, a certain proportion has been derived from placer mines, but the greater part from veins not yet worked below the zone of oxidation; the product has, hence, been subject to fluctuation. The product of mining in South Carolina, although its aggregate product is less than either of the other two States, is of greater importance to the development of mining industry, as in late years it shows a steady increase resulting from the successful working of sulphuret ores by a comparatively simple process of chlorination, which differs from the many patent processes that have been the curse of the region in that it has been evolved from practical experiment on the ores of one of the working mines, and does not claim to be able to extract more gold from any ore than can be shown to exist in it by assay. This process has already been successfully applied to the ores of other mines in this State, and is about to be used in those of the neighboring States. It is probable that when the geology of the belt becomes better known, and mining gradually falls into the hands of those who possess not only capital but also sufficient practical knowledge of the business of mining to be satisfied with reasonable profits, and who will carry it on in a systematic way and according to scientific rather than charlatan methods, the gold product of this belt will gradually become an important contributor to the nation's wealth.

Production of gold and silver in the Appalachian States since 1880.

Years.	Maryland.	Virginia.	North Carolina.	South Carolina.	Georgia.	Alabama.	Tennessee.	Total.
1880	$2,250	$11,500	$95,000	$15,000	$120,000	$1,000	$1,500	$244,250
1881	500	10,000	115,000	40,000	125,000	1,000	1,750	293,250
1882	1,000	15,000	215,000	25,000	250,000	3,500	250	509,750
1883	500	7,000	170,000	57,000	200,000	6,000	750	441,250
1884	500	2,500	160,500	57,500	137,000	5,000	300	363,500
1885	2,000	3,500	155,000	43,000	136,000	6,000	300	345,800
1886	1,000	4,000	178,000	38,000	153,500	4,000	500	379,000
1887	500	14,600	230,000	50,500	110,500	2,500	500	409,100
1888	3,500	7,500	139,500	39,200	104,500	5,600	1,100	300,900
1889	3,500	4,113	150,174	47,085	108,069	2,639	750	316,330
1890	16,962	6,496	126,397	100,294	101,318	2,170	1,001	354,638
1891	11,264	6,699	101,477	130,149	80,622	2,245	519	332,975
1892	1,000	5,002	90,196	123,881	95,251	2,419	1,006	318,755
Total	42,476	97,910	1,926,244	766,609	1,721,760	44,073	10,226	4,609,298

OTHER STATES.

Of the production assigned in the first table to "other States," the greater part of the silver comes from the western counties of Texas, adjoining the Rio Grande river, where the mountain ranges of Mexico, composed largely of Paleozoic limestones, extend across the international boundary. But little is authentically known of the geological relations of these deposits. Some are said to be free milling—that is, comparatively free from the base metals; others to be associated with copper, and bought by copper-silver smelters. Their development has increased rapidly of late years, but will probably be set back by the fall in the price of silver.

The balance of the "other State" production comes from Michigan, which for a long time has produced a small amount of silver, and lately has added a nearly equal value of gold to its product. Even less is known of the geological relations of the deposits from which the metals have been obtained in this State. In a general way it is assumed that they occur in the same series of rocks as do the great iron bodies which constitute its principal mineral wealth, and it is fair to assume that if more attention were given to the exploration for precious metals in this region the product of the State might assume considerable importance.

CONCLUSIONS.

In reviewing the production of the whole country for the period under consideration, it is to be remarked that the gold product has remained fairly steady while the silver product has nearly doubled. The average gold product of the country since 1873, as shown by available statistics, has been about $33,000,000 per annum, except during the years when the Comstock mines were in bonanza, to the abnormal yield of which, it is fair to assume, the increased product during the years 1876–1880 was due. The falling off during the first half of the last decade was due to the restriction of hydraulic mining, which in the later years has been replaced by the normal increase from deep mines. It is probable that the increase for 1892 over former years is greater than present statistics show. On the whole, the gold industry may be said to be in a normal and healthy state, ready for a permanent though not necessarily rapid increase, as more capital is intelligently directed to its development.

The increase in the silver product has been phenomenal, especially when it is considered that the yield of the Comstock lode, which during the previous decade constituted about half the total product of the country, has become practically an insignificant factor, and that the average price of the metal itself has steadily fallen during the period, except for the few months immediately succeeding the passage of the Sherman Act; the average price for 1892 having been about 25 per cent. less than that of 1880.

The prime factors in this increase have been the discovery and developement of great ore bodies in limestone, such as those of Leadville and Aspen, the ores of which must be reduced by smelting. This has resulted in the building up of the great smelting industry in the West and, in consequence, of an immense increase of railroad facilities, which in turn have encouraged the investment of capital in other mining enterprises. The development of the great veins of Utah, Montana, and the San Juan region, although they produce ores not necessarily reduced by smelting, is nevertheless dependent on railroad facilities which the smelting industry has been the most important factor in developing. In other words, the increase in the silver industry has been due mainly to favorable industrial conditions. If capital had not been invested in railroads and reduction plants, mining would have been confined to the richer ores near the surface, and would probably have been abandoned when these were exhausted; for it has been handicapped during the entire period by the abnormal figures at which the miners' unions have been able to keep the rate of wages, while they have been reduced in almost every other branch of industry.

That the industry as a whole has progressed in spite of a continuous fall in the value of the product has been mainly due to the fact that the larger reduction works, under the spur of the necessity of rendering the large capital invested in their plants productive, have displayed ingenuity and economy in improving their processes and in reducing the cost of fuel and other materials, so as to leave them still a margin of profit. The smaller profit is offset in the case of the larger smelters by the greater number of tons treated, and also by the utilization of other products besides the precious metals, such as lead and copper. As long, therefore, as these larger smelters can obtain even a very small profit, silver mining will be continued in the larger mines and in those whose ore is exceptionally high grade, while the smaller and less favorably situated mines will gradually be abandoned. It is to be assumed, moreover, that self-interest will induce the miners to consent to a reduction in wages when it becomes a question of that or nothing, and thus a still longer lease of life will be given to some established mines in the face of a continuous reduction in the price of silver; but when this price shall have fallen so far, without a counterbalancing rise in the price of lead and copper, that the larger smelting works are obliged to close, silver mining will be abandoned throughout the greater part of the western region. This exigency is not, however, likely to occur while the price fluctuates, as it has done during the past year, between 70 and 80 cents per ounce.

Assuming that silver continues at about these prices, it is probable that the greater part of the silver product of the country will come from Colorado, Montana, Utah, Idaho, Nevada, New Mexico, and Arizona, in the order named, and will gradually be reduced to between thirty and forty millions annually.

The annual gold product, on the other hand, is likely to see a steady increase to $40,000,000, and perhaps beyond, and its principal producers will be the following States and Territories, also in the order named: California, Colorado, Dakota, Montana, Idaho, Oregon, Alaska, Arizona, with a great deal of uncertainty as to the relative rank of the smaller producers.

An industry is of value to the country at large in proportion to its permanence and absence from violent fluctuations, and the silver mining industry has been in this sense of great value. The large amount of capital invested in extensive plants and tributary railroads has given profitable employment to great numbers of people, and assured greater permanence than the many small gold mines and gold-reducing plants.

Its destruction would therefore constitute a serious loss to the nation's industry. It may fairly be doubted, however, whether the course followed by the friends of this industry has been the wisest that could have been pursued, and it seems probable that if no attempt had been made to sustain the price of the metal by legislation, but it had been left to follow the natural course of trade, under the laws of supply and demand which govern the production of other commodities, it would to-day be in a more healthy condition. While its growth and increase of product would have been less rapid, those engaged in it would have been better able to forecast the future course of the price of silver, and would have regulated their investments accordingly.

In regard to the question of a gold or silver standard of value for coinage, it may be argued that a double standard is theoretically impossible, especially for metals whose relative production varies so greatly as has that of silver and gold, both of which have other and varying uses in the arts besides those of coinage. From a purely theoretical point of view the ideal standard would be a metal which is useless for any other purpose than for coinage. The world's experience has, however, failed to find such a metal, though some have been tried.

It is about thirty years since the sudden increase in the world's supply of gold so disturbed monetary conditions as to lead to the advocacy by some wise and long-sighted men of the establishment of silver as the sole standard of value for coinage. That sudden increase was, however, due to a cause that is not likely to occur again in the world's history, viz., the simultaneous discovery in virgin territories on two continents of enormously rich placer deposits.

The recent overproduction of silver, relatively to that of gold, which has led to an attempt to establish the world's coinage on a purely gold standard, is, however, the result of a normal and, for the most part, healthy development of industrial conditions over a long series of years.

That these conditions are at present abnormally disturbed, and that those engaged in the silver industry find themselves in danger of great pecuniary loss, is apparently due, in large measure, to effects produced upon the price of the metal by legislative action. If the natural law of supply and demand be allowed to act freely, and if no attempt be made to control by legislative enactment the ratio between gold and silver, the variations will be less violent and less injurious to the industrial interests based upon silver mining.

If we examine the broader field of the world's production of the precious metals during the period under consideration, bearing in mind the necessary imperfection of statistics, since returns from many countries, such as China and some of the South American States, are at times entirely wanting, we find the annual output of gold fairly regular from 1880 to 1887 at a little over \$100,000,000. From 1887 to 1892 (full returns for the latter not being obtainable) there has been a gradual increase to \$125,000,000. The greater part of this product has come from the United States, Australia, and Russia, in the order named, during the first term of years, and in the second term Africa has gradually risen to a nearly equal rank with Russia, while the latter's product has slightly increased.

The world's product of silver for the five years from 1880 to 1884 was on the average about equal in coinage value to that of gold. From 1885 to 1891 it has steadily increased, reaching $185,000,000 in the latter year. The principal silver-producing regions have been the United States, Mexico, and South America, in the order named, to which have been added Australia in the second period, the product of which, mainly coming from the Broken Hill mines, has increased from $1,000,000 in 1885 to $13,000,000 in 1891.

The extent and causes of the increase in the silver production of the United States have already been considered. That of Mexico has increased from similar causes, viz., the increase of railroad facilities, the improvement in reduction processes, and the investment of foreign capital, largely American. Her increase, though less in actual amount, has been greater in percentage, being over 100 per cent. during the period.

The silver product of South America is rather uncertain, owing to incomplete statistics. Its aggregate amount is apparently less than that of Mexico, but exactly how much can not be definitely ascertained. The industry has not yet reached the permanent stage which results from good railroad facilities and settled political and industrial conditions. When that stage is reached, its known wealth in minerals promises a rapid increase in production, but there is no prospect of it in the near future.

In Australia the product of the Broken Hill mines is already on the downward course, and the fall in the price of silver is likely to reduce the yield of that country as a whole to the insignificant amount of earlier years.

It still remains to consider what is likely to be the product of the precious metals throughout the world during the balance of the present decade from the point of view of the geologist and miner, as contrasted with that of the legislator and financier. From this point of view the most uncertain regions are Asia and Africa for gold, Australia and South America for silver.

The gold product of the United States is likely to show, as has already been stated, a moderate and steady increase. That of Australia is at any rate not likely to decline. In Asiatic Russia, which is said to have shown an increase of 9 to 16 per cent. in late years, the product is likely to increase still more with the progress of the trans-Siberian railway now building. This region undoubtedly possesses great mineral wealth, and the gold deposits, whether placers or deep mines, are likely to be the first developed. The most important increase in the gold production will, however, come from South Africa, and what is still more important, this increase will be of a more gradual and permanent character than that derived from California and Australia thirty years since, inasmuch as it will come from deep mines and not from placers. The greater part of the present production is obtained from a conglomerate belt, not unlike in its geological relations to the conglomerate belt from which the copper of the famous Calumet and Hecla mine is derived, and which is considered by some observers to be an old placer deposit like that of the Black Hills of Dakota. Recent borings have proved that this African conglomerate belt continues to be rich in gold at a depth of between 2,000 and 3,000 feet, thus assuring the permanence of its production for many years to come, and justifying the expenditure of capital in its development to an extent that may make its annual product very large. It is, therefore, quite fair to assume as a reasonable probability that the gold production of the world may increase to $150,000,000 within a few years, and possibly to $200,000,000 before the close of the decade.

Silver, which has the disadvantage in respect to gold of being too bulky for actual use as a medium of exchange in large sums, besides being in other respects naturally an inferior metal, is practically valued on a gold standard in all matters of international exchange, whatever value may be given to it within the borders of an individual nation by legislative agreement. The reduction of silver from its ores, as has already been stated, being so complicated a process, silver mining is far more dependent on favorable industrial conditions than gold, and its future development is hence dependent on its gold price. That there still exist, if not in the United States which is probably the most thoroughly prospected country, at least in some part of the world, great bonanzas of silver, comparable in value to the famous Comstock lode, is not to be doubted; but with a low price of the metal they will be less diligently sought after, and even if discovered capital will be more reluctant to invest in them.

If no attempt be made to control by legislative action the commercial course of silver as a metal, its production will doubtless be governed by the same conditions that have applied to copper in the past twenty years, a metal with which it presents many analogies, both in geological relations and physical characteristics. When the production of copper became greater than the ordinary demands of commerce, its price decreased until only a few of the larger and more favorably situated mines could produce it at a profit. These mines were not necessarily the richest; on the contrary, the greatest producers have been mines possessing ores of very low grade, in large quantities, and so favorably situated that they could be worked very cheaply. When the production had fallen into the hands of a few companies, an agreement was entered into by a majority to keep the price up by restricting the production. In spite of its great power and strong financial backing this agreement could not be maintained, and the price has fallen from 25 to 50 per cent. within the last twenty years. It might have fallen still lower had it not been for an increased demand for the metal consequent upon its extended use in electrical appliances. Although the consumption of this metal in the United States has increased fivefold since 1880, even some of the larger and more favorably situated mines find it advisable to close down from time to time and await a rise in the price; while many small mines, less favorably situated in regard to transportation facilities, have permanently given up the struggle for existence. In the long run, therefore, it is evident the supply of copper must be controlled by the demand, and no certain increase in the price can be looked for until the latter exceeds the former.

With silver there is less chance for the restriction of production, and the creation thereby of an artificial rise in the price of the metal, for the reason that the producing mines are much more numerous and their ownership less likely to fall into the hands of a few individuals or corporations. If, then, the production of this metal be not affected by legislative action or international agreement, it will be more subject to the law of supply and demand than copper. Among producers the law of the survival of the fittest will prevail, and the fitness will be determined by industrial conditions quite as far as by natural supply of ore. There will always be a certain proportion of silver-producing mines standing upon the border land between working at a profit or at a loss. Such mines will close down with a fall in the price of silver below a certain limit, and start up again when its rise above this limit seems to have assumed a reasonable permanence, the limit being dependent on the industrial conditions that prevail in different localities.

Under existing conditions, as already shown, it is probable that the silver production of the United States will show a considerable decrease in the next few years. Probably that of Mexico and South America will be similarly affected, but possibly to a less degree, as their ores are relatively richer, and their mining industry is established on different industrial conditions and somewhat influenced by varying political complications. The product of Australia, as already shown, has already experienced a decrease likely to be permanent under present conditions.

It is therefore reasonable to look for a very decided decrease in the world's production of silver, probably to $150,000,000, or even less if the expected increase in the gold product does not occur. In any event it is only a question of time, and probably not of very long time, when the relative production of the two metals will be about equal, as it was at the commencement of the decade. When in the downward course of the one metal and the upward course of the other the line has been crossed, and the relation between the production of the two metals shall be the reverse of that which now prevails, a decided rise in the price of silver may be looked for, which will render the mines upon the border land again productive, and restore prosperity to the silver industry as a whole.

COPPER.

By C. Kirchhoff.

The year 1892 has not been characterized by any events which have affected in a sensational manner the production of copper in the United States or in the world. No startling discoveries of new deposits have been made, nor is there any record of the opening out of exceptionally rich bodies in any of the older mines. The year has been one of quiet development and improvement, during which, in this country, there have been additions to equipment which promise to have a twofold effect. They will cheapen the cost of extracting the metal in the ore, and will bring about what has long been foreseen, a change in the character of the material exported. In the early development of the Butte district, its shipments to Europe were made in the form of ore. Then the establishment of local smelting plants led to exports of matte. Now, the extension of refining facilities near the mines, and on the Atlantic seaboard, will bring about increasing shipments abroad of refined copper and declining exports in the shape of matte. The growth in the electrolytic separation of copper is being felt also in another direction, in which its influence has been long foreseen. It is robbing Lake Superior copper of its supremacy as a material for certain purposes and is depriving it of a large share of the advantage it long possessed of commanding a higher price.

In spite of the arrangement entered into by the leading copper producers of the world, the output of the metal has increased. The international arrangement allotted maximum product to the different mines, which was so liberal that nearly all of them ran to full capacity without reaching their quota. The true value of the agreement is supposed to lie rather in the interchange of reliable information as to output and shipments than in a restriction of supplies.

DOMESTIC PRODUCTION.

The following table, showing the growth in the production of copper in the United States, is compiled, as far as the years previous to 1882 are concerned, from the best data available. Since that year the statistics are those collected by this office, with the exception of the year

1889, when the figures were gathered by the Census Office. It should be stated that the yield of copper from imported ores and of pyrites is not here included.

Production of copper in the United States from 1845 to 1892, inclusive.

Years.	Total production.	Lake Superior.	Calumet and Hecla.	Percentage of Lake Superior of total product.	Years.	Total production.	Lake Superior.	Calumet and Hecla.	Percentage of Lake Superior of total product.
	Long tons.	*Long tons.*	*Long tons.*			*Long tons.*	*Long tons.*	*Long tons.*	
1845	100	12	....	12.0	1869	12,500	11,886	5,497	95.1
1846	150	26	....	17.3	1870	12,600	10,992	6,277	87.2
1847	300	213	....	71.0	1871	13,000	11,942	7,242	91.9
1848	500	461	....	92.2	1872	12,500	10,961	7,215	87.7
1849	700	672	....	96.0	1873	15,500	13,433	8,414	86.7
1850	650	572	....	88.0	1874	17,500	15,327	8,984	87.6
1851	900	779	....	86.6	1875	18,000	16,089	9,586	89.4
1852	1,100	792	....	72.0	1876	19,000	17,085	9,683	89.9
1853	2,000	1,297	....	64.9	1877	21,000	17,422	10,075	83.0
1854	2,250	1,819	....	80.8	1878	21,500	17,719	11,272	82.4
1855	3,000	2,593	....	86.4	1879	23,000	19,129	11,728	83.2
1856	4,000	3,666	....	91.7	1880	27,000	22,204	14,140	82.2
1857	4,800	4,255	....	88.6	1881	32,000	24,363	14,000	76.1
1858	5,500	4,088	....	74.3	1882	40,467	25,439	14,309	62.9
1859	6,300	3,985	....	63.3	1883	51,574	26,653	14,788	51.6
1860	7,200	5,388	....	74.8	1884	64,708	30,961	18,069	47.8
1861	7,500	6,713	....	89.5	1885	74,052	32,209	21,093	43.5
1862	9,000	6,065	....	67.4	1886	70,430	36,124	22,553	51.3
1863	8,500	5,797	....	68.2	1887	81,017	33,941	20,543	41.9
1864	8,000	5,576	....	69.7	1888	101,054	38,604	22,453	38.2
1865	8,500	6,410	....	75.4	1889	101,239	39,364	21,727	38.7
1866	8,900	6,138	....	69.0	1890	115,966	45,273	26,727	38.9
1867	10,000	7,824	603	78.2	1891	126,839	50,992	....	40.2
1868	11,600	9,346	2,276	80.6	1892	154,018	54,999	....	35.7

In detail the production of copper territorially distributed has been as follows since 1883:

Total copper production in the United States, 1883 to 1892, inclusive.

Sources.	1883.	1884.	1885.	1886.	1887.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Lake Superior	59,702,404	69,353,202	72,147,889	80,918,460	76,028,697
Arizona	23,874,963	26,734,345	22,706,366	15,657,035	17,720,462
Montana	24,664,346	43,093,054	67,797,864	57,611,621	78,699,677
New Mexico	823,511	59,450	79,839	558,385	283,664
California	1,600,862	876,166	469,028	430,210	1,600,000
Utah	341,885	265,526	126,199	500,000	2,500,000
Colorado	1,152,652	2,013,125	1,146,460	409,306	2,012,027
Wyoming	962,468	....	....	....	....
Nevada	288,077	100,000	8,871	50,000	....
Idaho	....	46,667	40,381	....	....
Missouri	260,306	230,000	....	....	....
Maine and New Hampshire	212,124	249,018	211,602	315,719	200,000
Vermont	400,000	655,405			
Southern States	395,175	317,711	40,199	29,811	....
Middle States	64,400	2,114	190,641	....	....
Lead desilverizers, etc	782,880	950,870	910,144	1,282,496	2,432,804
Total domestic copper	115,526,053	144,946,653	165,875,483	157,763,043	181,477,331
From imported pyrites and ores	1,625,742	2,858,754	5,086,841	4,500,000	3,750,000
Total (including copper from imported pyrites)	117,151,795	147,805,407	170,962,324	162,263,043	185,227,331

Total copper production in the United States, etc.—Continued.

Sources.	1888.	1889.	1890.	1891.	1892.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Lake Superior	86, 472, 034	88. 175, 675	101, 410, 277	114, 222, 709	123, 198, 460
Arizona	31, 797, 300	31, 586, 185	34, 796, 689	39, 873, 279	38, 436, 099
Montana	97, 897, 968	98, 222, 444	112, 980, 896	112, 063, 320	163, 206, 128
New Mexico	1. 631, 271	3, 686, 137	850, 034	1, 233, 197	1, 188, 796
California	1, 570, 021	151, 505	23, 347	3, 397, 405	2, 980, 944
Utah	2, 131, 047	65, 467	1, 006, 636	1, 562, 098	2, 209, 428
Colorado, including copper smelters (*a*)	1, 621, 100	1, 170, 053	3, 585, 691	6, 336, 878	7, 593. 674
Wyoming	232, 819	100, 000			
Nevada	50, 000	26, 420	....	....	....
Idaho	50, 000	156, 490	87, 243	146, 825	226, 000
Missouri	....	....	....	....	....
Maine and New Hampshire } Vermont }	271, 631	72, 000 }	378, 840	296, 463	467, 448
Southern States	18, 201	18, 144 }			
Middle States	....	.... }			
Lead desilverizers, etc	2, 618, 074	3, 345, 442	4, 643, 439	4, 989, 590	5, 491, 702
Total domestic copper	226, 361, 466	226, 775, 962	259, 763, 092	284, 119, 764	344, 998, 679
From imported pyrites and ores	4, 909, 156	5, 190, 252	6, 017, 041	11. 690, 312	8, 277, 063
Total (including copper from imported pyrites)	231, 270, 622	231, 966, 214	265, 780, 133	295, 810, 076	353, 275, 742

a Copper smelters in Colorado, purchasing argentiferous copper ores and mattes in the open market, sources not known. The quantity of Montana matte which goes to one of these works has been deducted.

The available supply of copper for the domestic markets may be computed as follows:

Supply of copper, 1891 and 1892.

	1891.	1892.
	Pounds.	*Pounds.*
Production of domestic copper	284, 119, 764	344, 998, 679
Imported ores and pyrites	11, 690, 312	8, 277, 063
Imports of pigs, bars, ingots, and old copper	3, 154, 557	1, 552, 515
Total	298, 964, 633	354, 828, 257
Exports:		
Ingots and bars	69, 279, 024	30, 515, 736
Estimated fine copper contents of matte	50, 000, 000	66, 000, 000
Reëxports copper in foreign ore	2, 082, 708	707, 739
Reëxports foreign pig, bars, and old copper	534, 949	1, 274, 410
Total	121, 896, 681	98, 497, 885
Available supply	177, 067, 952	256, 330, 372

An important error has been discovered in the export statistics. It appears that for a number of years the collector of customs of one of the most important ports has been reporting ore and matte in net tons of 2,000 pounds, although the returns are made under a printed class which expressly gives instructions to return it in gross tons of 2,240 pounds. The published figures showing the exports of copper ore and matte to have been 50,495 gross tons in 1892 is, therefore, incorrect. It should be 47,152 gross tons. The estimate of the fine copper contents has been made on that figure.

Reports of stocks of copper from the producers and the majority of smelters, with the exception of the Calumet and Hecla, the Anaconda and the Quincy mining companies, show a decline from 41,580,179 pounds on the 1st of January, 1892, to 38,616,022 pounds on the 1st of January, 1893.

On the face of it, the statement of the available supply exclusive of stocks, printed above, appears very unfavorable to the producers, since it shows that in 1892 there was an increase of nearly 80,000,000 pounds over the preceding year. With such a growth in the quantity of copper to be sold in the domestic markets, the claims of the large producers that they have been bringing the supply within reasonable limits would seem absurd. Still, a closer examination puts a somewhat different aspect on the matter.

It was only in July that the international agreement went into effect. So far as the American mines are concerned, it really does not materially reduce the production of the individual mines, excepting a few. Practically, it only provides that they shall not greatly increase their capacity. No official data are available for the production of copper during the first half of 1892. Still, a close estimate shows that it amounted then to about 193,000,000 pounds, while the second half may be credited with 152,000,000 pounds. A very large part of this reduction in output is due to the closing down of the Anaconda for about three months. Since this mine is credited in the copper trade with having made an average of over 10,000,000 pounds per month in the first half of 1892, it is probably responsible for 25,000,000 pounds out of the 41,000,000 pounds reduction in production during the second half of 1892.

Since the establishment of the arrangement between the European and American companies careful monthly statistics have been compiled, the American statistician being Mr. John Stanton, of New York. The European companies include the principal producers of the Peninsula, Germany, the Cape, Australia, Venezuela, and Mexico. According to the returns thus collected, the monthly production of copper in the United States since July, 1892, has been as follows, the first column giving the aggregate returns from the reporting mines, which include the principal Lake, Montana, and Arizona producers; the second, being the metals from pyrites and from a number of smaller outside sources, being estimated:

American product.

Years and months.	Reporting mines.	Outside sources.	Total.
1892.	*Long tons.*	*Long tons.*	*Long tons.*
July	9,294	924	10,218
August	10,807	870	11,677
September	9,710	994	10,704
October	9,668	1,289	10,957
November	9,888	1,036	10,924
December	9,872	1,174	11,046
Total	59,239	6,287	65,526
1893.			
January	9,187	989	10,176
February	8,213	1,042	9,245
March	9,065	1,321	10,386
April	11,775	1,042	12,817
May	12,706	1,042	13,748
June	11,524	1,042	12,566
July	11,049	1,042	12,091
August	11,745	1,042	12,787
September	11,750	1,042	12,792

The product of the foreign reporting mines was as follows:

Foreign reporting mines.

	Long tons.
1892.	
July	6,358
August	6,888
September	5,478
October	6,476
November	6,789
December	7,666
Total	39,655
1893.	
January	5,736
February	6,762
March	6,896
April	6,913
May	6,806
June	7,935
July	6,095
August	7,057
September	6,303

The exports of fine copper from the United States were as follows:

United States exports.

	Long tons.
1892.	
July	3,450
August	1,545
September	1,458
October	3,141
November	3,897
December	4,486
Total	17,980
1893.	
January	3,171
February	1,815
March	2,334
April	3,450
May	4,482
June	5,109
July	7,181
August	9,127
September	16,131

The following is, in detail, the output of the Lake Superior mines, as reported by the companies from 1884 to 1890:

Production of Lake Superior copper mines, 1884 to 1890.

Mines.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Calumet and Hecla	40, 473, 585	47, 247, 990	50, 518, 222	46, 016, 123	50, 295, 720	48, 668, 296	59, 868, 106
Quincy	5, 650, 436	5, 848, 530	5, 888, 517	5, 603, 691	6, 367, 809	6, 405, 686	8, 064, 253
Osceola	4, 247, 630	1, 945, 208	3, 560, 786	3, 574, 972	4, 134, 320	4, 534, 127	5, 294, 792
Franklin	3, 748, 652	4, 007, 105	4, 264, 297	3, 915, 838	3, 655, 751	4, 346, 062	5, 638, 112
Allouez	1, 928, 174	2, 170, 476	1, 725, 463	885, 010	314, 198	1, 762, 816	1, 407, 828
Atlantic	3, 163, 585	3, 582, 633	3, 503, 670	3, 641, 865	3, 974, 972	3, 698, 837	3, 619, 972
Pewabic	227, 834	....	....	....	....	....	....
Central	1, 446, 747	2, 157, 408	2, 512, 886	2, 199, 133	1, 817, 023	1, 270, 592	1, 413, 391
Grand Portage	255, 860	....	....	....	....	....	....
Conglomerate	1, 198, 691	....	....	....	....	....	....
Mass	481, 396	363, 500	247, 179	....	....	58, 349	62, 187
Copper Falls	891. 168	1, 150, 538	1, 378, 679	719, 150	1, 199, 950	1, 440, 000	1, 330, 000
Phœnix	631, 004	344, 355	1, 101, 804	11, 000	....	....	....
Hancock	562, 636	203, 037	150, 000	....	....	....	....
Huron	1, 927, 660	2, 271, 163	1, 992, 695	1, 881, 760	2, 370. 857	2, 219, 473	1, 736, 777
Ridge	74, 030	63, 390	158, 272	84, 902	50, 924	28, 000	21, 569
St. Clair	139, 407	....	....	....	....	....	....
Cliff	28, 225	....	22, 342	....	....	....	....
Wolverine	751, 763	328, 610	3, 125	2, 300	....	....	....
Nonesuch	23, 867	28, 484	....	....	....	....	....
Isle Royale	16, 074	....	....	....	....	....	....
National	87, 368	162, 252	184, 706	25, 187	....	454, 134	123, 879
Minnesota	1, 144	12, 608	....	....	....	....	....
Belt	130, 851	27, 433	7, 300	....	....	....	....
Sheldon and Columbia	9, 828	....	....	....	....	....	....
Adventure	4, 333	4, 000	1, 000	....	....	692	15, 485
Peninsula	1, 225, 981	....	....	....	....	736, 507	1, 108, 660
Tamarack	....	181, 669	3, 646, 517	7, 396, 529	11, 411, 325	10. 605, 451	10, 106, 741
Ogima	1, 106	12, 000	....	....	....	....	....
Kearsarge	....	....	....	21, 237	829, 185	1, 918, 849	1, 598, 525
Evergreen Bluff	954	1, 500	1, 000	....	....	21, 580	....
Ash Bed	1, 517	....	....	....	....	....	....
Sundry companies—tributers	21, 696	34, 000	50, 000	50, 000	50, 000	6, 224	....
Total	69, 353, 202	72, 147, 889	80, 918, 460	76, 028, 697	86, 472, 034	88, 175, 675	101, 410, 277

The permission to publish the report of the Calumet and Hecla Company for the years 1891 and 1892 has not been given. The following table, therefore, records only the output of the other leading producers in that district:

Production of Lake Superior copper mines in 1891 and 1892.

	1891.	1892.
	Pounds.	*Pounds.*
Tamarack	16, 161, 312	16, 426, 633
Quincy	10, 542. 519	11, 103, 926
Osceola	6, 543, 358	7. 098, 656
Franklin	4, 319, 840	3, 769, 605
Atlantic	3, 653, 671	3, 703, 875
Kearsarge	1, 727, 390	1, 467, 758
Peninsular	1, 599, 670	973, 217
Copper Falls	1, 427, 000	1, 350, 000
Huron	1, 257, 059	461, 499
Allouez	1, 241, 423	546, 530
Central	1, 237, 500	1, 625, 982
Centennial	531, 983	106, 801

The Calumet and Hecla Company considerably increased its product during 1892, while the Tamarack has not materially added to its previous record, The additions to the Quincy stamp mill were completed during 1892, No. 4 stamp going into service in October, while No. 5 was ready in December. The company has also entered into a contract for a new smelting works. During 1892 there were mined 349,400 tons of rock, 327,849 tons being hoisted and 323,051 tons stamped, yielding 8,639,670 pounds of stamp mineral. In addition thereto there was obtained 4,982,145 pounds of masses, making the total mineral 13,621,815 pounds, which yielded 11,103,926 pounds of refined copper. The receipts were $1,250,894.88 for copper and $2,263.35 for silver, while the expenditures were $588,008.01 at the mine, $218,841.20 for construction, and $166,675.17 for smelting, transportation, and other expenses, a total of $973,524.38, which would show a cost, laid down sold at New York, including construction, of 8.77 cents per pound. The profit was $296,195.25, out of which there was paid in dividends $350,000, leaving a balance of assets of $653,210.79. The effect upon the output of the Quincy mine through the increased equipment provided, is clearly shown in the following figures, covering the years 1889, 1890, 1891, and 1892:

Operations of the Quincy copper mine, Lake Superior.

	1889.	1890.	1891.	1892.
Rock mined ....tons..	167,077	187,244	276,336	349,400
Rock hoisted ....do....	123,998	168,017	269,817	327,849
Rock stamped ....do....	117,875	165,140	263,678	323,051
Product of stamp mineral...pounds..	6,641,785	7,262,485	8,649,585	8,639,670
Product of masses..................do....	1,178.225	2,740,365	4,177,490	4,982,145
Total refined copper ....do....	6,405,686	8,064,253	10,542,519	11,103,926
Earnings	$182,601.14	$596,677.60	$414,970.39	$293,195.25

The Osceola has had a good year, hoisting 277,758 tons of stamp rock and stamping 247,575 tons, which yielded 7,590,125 pounds of mineral, in addition to which 670,267 pounds of barrel and mass copper was obtained, making a total of 8,260,392 pounds. At 85.94 per cent. fine copper this yielded 7,098,656 pounds of ingot. The cost per ton of rock hoisted was $1.84, and per ton of rock stamped, which yielded 1.435 per cent of fine copper, was $2.07. The stamping and washing cost 37.8 cents per ton. The outlays at the mine per pound of fine copper figured at 7.20 cents, the cost of smelting, freight, and all expenses of handling the copper, was 1.54 cents, while the cost of construction was 0.38 cents, making the total cost of the fine copper laid down in New York sold, inclusive of construction, 9.12 cents. The net income for the year was $188,229.55, out of which dividends aggregating $150,000 were paid, carrying the total to date to $1,747,500. The cost in 1892 compared as follows with previous years:

Cost of refined copper at the Osceola mine.

	1890.	1891.	1892.
Mining cost per ton of stamp rock	$2.39	$2.13	$2.07
Cost of refined copper at mine	8.31	7.63	7.20
Cost of smelting, transportation, and handling	1.51	1.64	1.54
Cost for construction	1.42	0.84	0.38
Total cost per pound	11.24	10.11	9.12

The destruction by fire of the rock house at No. 1 shaft of the Kearsarge had an adverse effect upon its operations by increasing its cost and lowering its receipts. There were sent to the mill 60,986 tons of rock, 18,956 tons having been discarded. The stamp rock afforded 1,732,380 pounds of mineral, and there were obtained 15,256 pounds of barrel and mass copper, making a total of 1,747,636 pounds, which yielded, at 83.99 per cent., 1,467,758 pounds of ingot. The copper realized an average price of 11.45 cents, while the total cost was 12.22 cents. This included 9.50 cents for running expenses at the mine, 1.95 cents for smelting, freight, etc., and 0.77 cents for construction. This compares as follows with previous years:

Cost of fine copper at the Kearsarge mine.

	1889.	1890.	1891.	1892.
	Cents.	*Cents.*	*Cents.*	*Cents.*
Cost per pound at mine	7.27	8.64	8.84	9.50
Cost per pound, smelting, freight, etc	1.94	1.83	1.65	1.95
Total excluding construction	9.21	10.47	10.49	11.45
Cost of construction	0.31	0.21	1.03	0.77
Total cost, sold	9.52	10.68	11.52	12.22

The Atlantic Mining Company has realized a further reduction in its extremely low cost of production, the following table showing the comparison with previous years:

Cost of copper at the Atlantic mine per ton of rock treated.

Items of cost.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Mining, selecting, breaking, and all surface expenses, including taxes	78.62	80.88	87.23	83.73	87.87	104.14	95.29	83.98
Transportation to mill	4.80	3.48	3.80	3.47	3.88	3.46	3.86	3.33
Stamping and separating	30.36	26.53	27.31	26.89	27.78	27.78	25.82	25.09
Freight, smelting, marketing, and New York expenses	25.45	24.25	23.07	21.42	20.22	20.37	18.47	17.67
Total working expenses	139.23	135.14	141.41	135.51	129.75	155.75	143.44	130.07
Total expenditures	143.60	138.01	145.22	142.82	153.27	166.70	154.51	133.51
Net profit	22.05	15.29	30.53	54 36	6.23	27.71	0.16	....
Yield of copper per cent	0.743	0.709	0.712	0.667	0.663	0.650	0.615	0.615

During the year there were stamped 300,900 tons of rock, which produced 5,028,560 pounds of mineral, yielding 3,703,875 pounds of ingot, so that the average was 0.615 per cent. The income was $444,124.39, while the outlays, a total of $391,369.44, included $338,199.06 for working expenses at the mine, $9,329.22 for freight, and $33,577.80 for smelting. The net gain during the year was $42,681.01, which carried the surplus at the end of the year to $295,515.70. No dividend was declared, because there will be heavy outlays in the construction of a new mill and railroad to it.

The Central Company produced 1,625,982 pounds of ingot from 2,072,970 pounds of mineral. Since it is the most prominent of the mass mines, which were once great, it may be interesting to note that it yielded 331 masses of copper, 306,530 pounds, and 377,950 pounds of barrel copper. The working expenses at the mine were $156,760.54, and smelting, freight, and handling expenses aggregated $28,616.98. The mining profit was $10,279.67. As yet no promising developments have been made below the "slide" which displaced the vein.

The Franklin has done considerable development work with some success in the upper levels. During 1892 there was hoisted 153,509 tons, of which 123,236 tons was stamped, yielding 1.529 per cent. of refined copper. The product of mineral was 4,571,491 pounds, which, at 82·457 per cent., gave 3,769,605 pounds of refined copper. Including construction account, the running expenses at the mine were $294,434.67, while the other outlays were $53,974.62, a total of $348,409.29, which would indicate a cost of production of 9·25 cents per pound, laid down, sold in New York. The receipts were $446,594.02, leaving a profit of $98,184.73, out of which a dividend of $80,000 has been paid.

The Allouez Company stopped work on the 15th of April, being unable to work its lode profitably with copper below 12½ cents per pound. During the time when it was working it produced 546,530 pounds. Explorations with the diamond drill on the different lodes coursing through the property have failed to develop anything of value thus far.

MONTANA.

The principal mine of the Butte district, the Anaconda, attained the unparalleled record for a single company of producing 100,000,000 pounds of copper in one year, and this was achieved although mines and works were idle during a part of the year. The capacity for production of the great plants of the company was demonstrated by the attainment of a record of close to 14,000,000 pounds in one month at a time when a part of the smelting works was undergoing reconstruction.

The Boston and Montana Company succeeded in getting its Great Falls plant into operation, and is about to extend its electrolytic department to treat the material from the Butte and Boston Company, an allied interest.

One producer has been added to the list in the Montana Ore Purchasing Company, which shipped considerable material to eastern refiners, and has since built a smelting plant.

The development of the copper production of Montana is shown in the following table:

Montana's proportion of the copper product.

Years.	United States.	Montana.	Montana.	Lake Superior.
	Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
1882	90,646,232	9,058,284	....	....
1883	115,526,053	24,664,346	21.4	50.1
1884	144,946,635	43,098,054	29.7	48.4
1885	165,875,483	67,797,864	40.9	43.5
1886	156,763,043	57,611,621	36.6	50.1
1887	181,477,331	78,699,677	43.4	41.7
1888	226,361,466	97,897,968	43.3	38.2
1889	226,055,962	98,222,444	43.5	38.7
1890	259,098,092	112,980,896	43.6	38.9
1891	284,119,764	112,063,320	39.4	40.2
1892	345,121,280	163,206,128	47.3	....

ARIZONA.

While the largest mine, the Copper Queen, somewhat reduced its production, the Detroit fell off considerably, and the Buffalo dropped out of the list entirely; the United Verde, the Old Dominion, and the Holbrook and Cave increased their output. There are no indications that the copper product of Arizona will be materially added to during the current year.

In other parts of the United States no developments have been made during 1892 which promise to affect the supply notably during 1893.

IMPORTS.

The imports of fine copper contained in ores, and of regulus and black copper, and of ingot copper, old copper, plates not rolled, rolled plates, sheathing metal, and manufactures not otherwise specified, and of brass are given in the following tables:

Fine copper contained in ores, and regulus and black copper imported and entered for consumption in the United States, 1867 to 1892, inclusive.

Years ending—	Fine copper contained in ores.		Regulus and black copper. (a)		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
June 30, 1867	....	$936,271	....	....	$936,271
1868	3,496,994	197,203	....	....	197,203
1869	24,960,604	448,487	....	....	448,487
1870	1,936,875	134,736	....	....	134,736
1871	411,315	42,453	499	$60	42,513
1872	584,878	69,017	4,247	1,083	70,100
1873	702,086	80,132	1,444,239	279,631	359,763
1874	606,266	70,633	28,880	5,397	76,030
1875	1,337,104	161,903	12,518	2,076	163,979
1876	538,972	68,922	8,584	1,613	70,535
1877	76,637	9,756	1,874	260	10,016
1878	87,039	11,785	....	....	11,785
1879	51,959	6,199	....	....	6,199
1880	1,165,283	173,712	2,201,394	337,163	510,875
1881	1,077,217	124,477	402,640	51,633	176,110
1882	1,473,109	147,416	224,052	30,013	177,429
1883	1,115,386	113,349	....	....	113,349
1884	2,204,070	219,957	2,036	204	220,161
1885	3,665,739	343,793	285,322	20,807	364,600
Dec. 31, 1886	4,530,400	341,558	1,960	98	341,656
1887	3,886,192	194,785	27,650	1,366	196,151
1888	4,850,812	381,477	4,971	324	381,801
1889	3,772,838	274,649	60,525	4,244	278,893
1890	3,448,237	241,732	221,838	15,688	257,420
1891	8,931,554	774,057	2,403,919	214,877	988,934
1892	7,669,978	453,474	303,087	17,390	470,864

a Not enumerated until 1871.

Copper imported and entered for consumption in the United States, 1867 to 1892, inclusive.

Years ending—	Bars, ingots, and pigs.		Old, fit only for remanufacture.		Old, taken from bottoms of American ships abroad. (*a*)		Plates not rolled.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
June 30, 1867	1,635,953	$287,831	569,732	$81,930	....	....	....	....
1868	61,394	6,935	318,705	42,652	....	....	....	....
1869	13,212	2,143	290,780	34,820	....	....	....	....
1870	5,157	418	255,386	31,931	....	....	....	....
1871	3,316	491	369,634	45,672	....	....	430	$129
1872	2,638,589	578,965	1,144,142	178,536	....	....	148,192	33,770
1873	9,697,608	1,984,122	1,413,040	255,711	32,307	$4,913	550,431	97,888
1874	713,935	134,326	733,326	137,087	9,500	930	....	....
1875	58,475	10,741	396,320	55,564	11,636	1.124	8	4
1876	5,281	788	239,987	35,545	10,304	1,981	5,467	600
1877	230	30	219,443	28,608	41,482	5,136	....	....
1878	1	1	198,749	25,585	....	6,004	....	....
1879	2,515	352	112,642	11,997	11,000	1,107	27,074	4,496
1880	1,242,103	206,121	695,255	91,234	....	....	120	11
1881	219,802	36,168	541,074	63,383	14,680	1,504	29	3
1882	6,200	836	508,901	59,629	16.075	1,629	....	....
1883	....	....	330,495	36.166	9,415	666	....	....
1884	(*b*)542	107	149,701	12.099	....	554	....	....
1885	914	172	81,312	6,658	....	1.160	....	....
Dec. 31, 1886	276	37	37,149	2,407	....	581	....	....
1887	212	22	39,957	2.374	....	129	....	....
1888	1.787	299	37,620	2,535	....	....	....	....
1889	3,160	522	19,912	1,176	....	....	....	....
1890	5,189	859	284,789	26,473	....	....	....	....
1891	2,556	389	134,407	9,685	....	....	....	....
1892	22,097	2,588	71,485	6,114	....	....	....	....

a Not enumerated until 1873. *b* Includes "plates not rolled" since 1884.

Copper imported and entered for consumption in the United States, 1867 to 1892—Cont'd.

Years ending—	Plates rolled, sheets, pipes, etc.		Sheathing metal, in part copper. (*a*)		Manufactures not otherwise specified.	Total value.
	Quantity.	Value.	Quantity.	Value.	Value.	
	Pounds.		*Pounds.*			
June 30, 1867	....	$1,101	220,889	$37,717	$15,986	$424,565
1868	....	1	101,488	18,852	21,492	89,932
1869	....	39	43,660	6,592	43.212	86.806
1870	....	2.039	....	....	485,220	519,608
1871	....	7,487	....	....	668,894	722,673
1872	....	18,895	....	....	1,007,744	1,817,910
1873	....	4,514	....	....	869,281	3,216,429
1874	....	27	282,406	50,174	125,708	448,252
1875	....	617	136,055	28,650	35,572	127,272
1876	....	326	18,014	2,903	29,806	71,949
1877	....	203	110	22	41,762	75,761
1878	....	1,201	647	55	35,473	68,319
1879	....	786	300	20	39,277	58,035
1880	....	4,134	6,044	693	130,329	432,522
1881	....	82	39,520	4,669	284,509	390,318
1882	5,855	1,551	....	....	77,727	141,372
1883	2,842	379	6,791	1,047	40,343	78,601
1884	6,529	2,330	19,637	926	55,274	71,290
1885	470	120	86,619	9,894	61,023	79,027
Dec. 31, 1886	3,770	339	21,573	1,017	31,871	37,155
1887	37,925	5,493	18,189	1,867	37,289	47,174
1888	5,208	737	23.622	2,696	14,567	20,834
1889	13,848	2,082	23,520	2,572	23,430	19,782
1890	4,209	917	37,458	4,467	24,752	57,468
1891	122,219	23,291	228,486	29,112	12,926	65,329
1892	1.788	600	417,134	51.380	49,764	101,744

a Does not include copper sheathing in 1867, 1868, and 1869.

Brass imported and entered for consumption in the United States, 1867 to 1892, inclusive.

Years ending—	Bars and pigs.		Old, fit only for remanufacture.		Not otherwise provided for.	Total value.
	Quantity.	Value.	Quantity.	Value.	Value.	
	Pounds.		*Pounds.*			
June 30, 1867	....	$3,099	....	$26,468	$170,873	$200,440
1868	31,104	2,071	120,913	11,699	181,114	194,884
1869	33,179	2,457	131,640	10,838	198,310	211,605
1870	54,168	3,791	98,825	6,918	49,845	60,554
1871	28,453	2,803	438,085	37,922	13,659	54,384
1872	17,963	1,664	829,964	73,098	23,738	98,500
1873	56,656	7,147	699,478	71,494	114,767	193,408
1875	253	19	682,151	64,848	350,266	415,133
1874	370,273	38,867	124,285	12,786	273,873	325,526
1876	....	....	618,191	54,771	232,870	287,641
1877	....	....	689,633	59,402	207,642	267,044
1878	....	....	713,171	57,551	205,209	262,760
1879	950	49	485,354	32,278	232,030	264,357
1880	....	....	958,590	75,093	339,131	414,224
1881	85,370	11,202	1,615,402	151,541	331,506	494,249
1882	30,769	3,168	2,954,148	263,891	400,477	667,536
1883	6,380	559	1,015,345	84,786	485,321	570,666
1884	1,611	445	508,923	40,766	429,224	470,435
1885	2,305	532	166,317	15,717	400,175	416,424
Dec. 31, 1886	6,705	295	143,121	30,517	374,364	405,176
1887	2,332	562	189,157	30,158	331,800	362,520
1888	....	....	257,748	40,373	156,738	197,111
1889	7,667	1,093	188,467	37,293	140,193	178,579
1890	7,905	1,261	285,089	38,938	175,684	215,883
1891	23,113	3,325	407,201	50,617	244,660	298,602
1892	6,736	1,015	400,102	57,754	178,262	237,031

EXPORTS.

The exports of copper in the form of ore (including matte), ingot copper, and manufactured copper for a series of years have been as follows:

Copper and copper ore of domestic production exported from the United States, 1864 to 1892, inclusive.

[Cwts. are long hundred weights of 112 pounds.]

Years ending—	Ore.		Pigs, bars, sheets, and old.		Manufactured.	Total value.
	Quantity.	Value.	Quantities.	Value.	Value.	
	Cwts.		*Pounds.*			
June 30, 1864	109,581	$181,298	102,831	$43,229	$208,043	$432,570
1865	225,197	553,124	1,572,382	709,106	282,640	1,544,870
1866	215,080	792,450	123,444	33,553	110,208	936,211
1867	87,731	317,791	(*a*)4,637,867	303,048	171,062	791,901
1868	92,612	442,921	1,358,896	327,287	152,201	922,409
1869	121,418	237,424	1,134,360	233,932	121,342	592,698
1870	(*a*)19,198	537,505	2,214,658	385,815	118,926	1,042,246
1871	(*a*)54,445	727,213	581,650	133,020	55,198	915,431
1872	35,564	101,752	267,868	64,844	121,139	287,735
1873	45,252	170,365	38,958	10,423	78,288	259,076
1874	13,326	110,450	503,160	123,457	233,301	467,208
1875	(*a*)51,305	729,578	5,123,470	1,042,536	43,152	1,815,266
1876	15,304	84,471	14,304,160	3,098,395	343,544	3,526,410
1877	21,432	109,451	13,461,553	2,718,213	195,730	3,023,394
1878	32,947	169,020	11,297,876	2,102,455	217,446	2,488,921
1879	23,070	102,152	17,200,739	2,751,153	79,900	2,933,205
1880	21,623	55,763	4,206,258	667,242	126,213	849,216
1881	9,958	51,499	4,865,407	786,860	38,036	876,395
1882	25,936	89,515	3,340,531	565,295	93,646	748,456
1883	112,923	943,771	8,221,363	1,293,947	110,286	2,348,004
1884	386,140	2,930,895	17,044,760	2,527,829	137,135	5,595,859
1885	432,300	4,739,601	44,731,858	5,339,887	107,536	10,187,024
Dec. 31, 1886	417,520	2,341,164	19,553,421	1,968,772	76,386	4,386,322
1887	501,280	2,774,464	12,471,393	1,247,928	92,064	4,114,456
1888	794,960	6,779,294	31,706,527	4,906,805	211,141	11,897,240
1889	818,500	8,226,206	16,813,410	1,896,752	86,764	10,209,722
1890	431,411	4,413,067	10,971,899	1,365,379	139,949	5,918,395
1891	672,120	6,565,620	69,279,024	8,844,304	293,619	15,703,543
1892	(*b*)943,040	6,479,758	30,515,736	3,438,048	245,064	10,162,870

a Evidently errors in quantities. *b* Corrected figures.

THE COPPER MARKETS.

The following table summarizes the highest and lowest prices obtained for Lake copper monthly in the New York markets from 1860 to 1892, both inclusive.

Highest and lowest prices of Lake Superior ingot copper, by months, from 1860 to 1892.

[Cents per pound.]

Years.	January.		February.		March.		April.		May.		June.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1860	24	23½	24	23¾	23¾	23	23½	23	23¼	22½	22¾	21¾
1861	20	19	19½	19	19¾	19¼	19¾	19	19¾	19¼	19	18
1862	28	27	28	25	25	23	23	21½	21½	20¾	23	20¾
1863	35	31	37	35	37	31	31	30	30½	30	30½	30
1864	41¼	39	42	41¼	42½	41½	44	42½	44	43	49	44
1865	50½	46	46	44	44½	34	35	34	34	30	30½	28½
1866	42	38	38	35½	35½	29½	30	28½	31	29	33	31
1867	29¼	27	27¾	27½	27½	24	24½	23½	24¼	24	24½	24
1868	23½	21½	24	22½	24	23¼	24¼	23¼	24¼	24	24	23⅛
1869	26¼	23¾	27	26	26¾	24	24	23¼	24¼	23¾	23¾	22
1870	22	21⅛	21¼	20⅞	20¾	19	19¾	19¼	19½	19	20⅝	19
1871	22⅞	22	22⅜	21⅞	22	21½	21¾	21¼	21¾	21⅜	21½	21¼
1872	28½	27⅛	28⅜	28¼	30½	28⅜	44	30½	42	36	34¾	33
1873	35	32½	35	34	35	34½	34½	33½	33½	32	31½	29⅛
1874	25	24½	25	24⅓	24¾	24	25	24¾	25	24½	24¾	24¼
1875	23½	21½	22¾	21¾	21¾	21½	21¾	21½	23¼	22⅝	23	23
1876	23¼	23	22⅞	22½	22¼	22	22⅝	22	22⅛	21	21	19¼
1877	19½	19	20½	19½	19¼	19	19½	19¼	19¼	19	19⅜	19
1878	17⅝	17¼	17½	17⅛	17⅛	16⅞	17	16⅞	16¾	16¼	16⅜	16¼
1879	16	15½	15½	15½	15¾	15¾	16	15¾	16¼	16	16¼	16⅛
1880	25	21⅜	24½	24	24	22¾	22½	24	21	18	18½	17⅞
1881	19⅜	19⅛	19⅜	19⅛	19⅜	19	19	18¾	18⅞	18¼	18¼	16⅜
1882	20⅜	20¼	20	19	19¼	18⅞	18⅞	17⅞	18¼	18	18¼	18
1883	18⅛	18	17⅞	17¾	17⅝	17⅛	16	15¾	16	15⅞	15⅞	15
1884	15	14⅞	15	14⅞	15	14⅞	15	14½	14¼	14⅛	14¼	14
1885	11½	10⅜	11⅛	10⅕	11⅛	10⅖	11¼	$10\frac{1}{10}$	11½	9⅘	11½	11
1886	11⅝	11⅜	11⅝	11⅜	11½	11⅜	11½	11⅜	11⅛	10	10⅛	10
1887	12	11⅛	11⅛	10½	10½	10⅜	10⅕	10	10	$9\frac{19}{20}$	10¼	10
1888	$17\frac{4}{10}$	$15\frac{17}{20}$	$16\frac{6}{10}$	16	$16\frac{7}{20}$	$15\frac{9}{20}$	$16\frac{9}{10}$	16	16¾	$16\frac{3}{10}$	$16\frac{13}{20}$	$16\frac{9}{20}$
1889	17½	16½	16¾	16½	15¾	15	16	15½	12⅛	12	12¼	12
1890	14½	14¼	14¼	14¼	14¼	14	14½	14¼	15¼	14⅝	16¾	15¼
1891	15	14⅝	14⅞	14¼	14¼	13⅝	13¾	13½	13¾	12¾	13	12⅞
1892	11	10¾	10¾	10½	12	10¾	12	11¾	12¼	12	11⅞	11⅓

Highest and lowest prices of Lake Superior ingot copper, etc.—Continued.

Years.	July.		August.		September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1860	21 3/4	21 1/2	21 1/2	21 1/2	22	21 1/4	22	21 1/2	21 1/2	20 1/4	20 1/4	19 3/4
1861	18	17 1/2	19	17 3/4	20 1/4	19	20 1/4	20	22 1/2	20 1/4	27	22 1/2
1862	24 1/2	22 1/2	24 1/2	24	27	24 1/4	32 7/8	27	32 7/8	30 1/2	31 1/2	30 1/2
1863	32	29	31	29	32 1/4	31	34 1/4	32 1/4	38 1/2	34 1/2	38 3/4	38 1/2
1864	55	49	52 1/2	50	52 1/2	47 1/2	48	47	49	47	50	48 1/2
1865	30 1/4	28	32	30 1/2	32 3/4	31 1/2	33	32 1/2	45 1/2	33	45 1/2	39 1/4
1866	33 1/2	31	31	30	31 1/2	30 3/4	31	30 3/4	30 3/4	26 1/2	29	26 1/2
1867	26	24	26 1/4	25 3/4	27 1/4	26 1/4	26 3/4	22 3/4	23	22 3/4	23	21 1/2
1868	24 1/2	23 1/8	24 1/4	24	24	23 3/4	24	23	24	22 1/2	24 1/2	23 3/4
1869	22 1/4	21 7/8	23 1/8	21 7/8	23	22	22 3/4	22	22 1/2	22	22	21 1/2
1870	20 1/2	20 3/8	21 3/8	20 1/8	21 1/2	20 3/4	21 3/4	21 1/2	23 3/8	21 3/4	22 5/8	22 1/4
1871	22 1/4	21 5/8	23	22 3/8	23 7/8	22 7/8	23 7/8	23 1/4	24 1/4	23 1/4	27	24 1/2
1872	34	33	35	32 1/2	35 1/4	33	34 3/4	31 1/4	32 1/4	30 3/4	32 1/2	30 1/2
1873	29	26 5/8	27 1/2	27	27	25 1/2	25 1/2	24	24	21	25	23
1874	24 1/4	20	21	19	21 1/4	21	22 1/4	21 1/4	23 3/4	22 1/4	23 1/4	23 1/4
1875	23	22 5/8	23 3/8	23	23 7/8	23 1/8	23 1/4	23	23 1/4	23	23 3/8	23 3/8
1876	20	19 1/2	19 1/2	18 3/4	21	18 3/4	21 1/4	20 1/2	20 1/2	20	20	19 5/8
1877	19 1/4	19	19	17 7/8	18 1/2	17 7/8	18	17 3/4	17 3/4	17 5/8	17 3/4	17 1/2
1878	16 1/4	16	16	16	16 1/4	16	16	15 1/2	15 7/8	15 1/2	16	15 7/8
1879	16 1/8	16	16 3/8	16	17	16 1/4	21 1/2	18	21 3/4	21	21 1/2	21
1880	18 7/8	18 1/2	19 1/8	19	18 7/8	18 3/4	18 7/8	18 3/4	18 7/8	18 3/4	19 1/8	18 7/8
1881	16 1/2	16	16 5/8	16 3/8	18 1/8	16 3/4	18 3/8	18	19	18 1/8	20 3/8	19 1/4
1882	18 1/4	18 1/8	18 1/4	18 1/8	18 1/4	18	18 1/4	18	18 1/8	18	18	17 7/8
1883	15 1/8	15	15	15	15 1/4	15 1/8	15 1/4	15 1/8	15	14 7/8	15	14 7/8
1884	14 1/8	13 7/8	14	13 7/8	13 1/8	13	13 1/8	12 7/8	13	12 1/2	12 1/8	11
1885	11 1/4	10 7/8	11 1/4	11	11 1/2	10 19/20	11 1/3	10 1/5	11 1/8	10 4/5	11 1/2	11 1/10
1886	10 1/8	10	10 1/4	10	11 1/8	10 1/4	11 3/4	11 1/8	12	11 3/4	12 1/8	11 7/8
1887	10 3/4	10 1/8	10 3/4	10 3/5	11	10 5/8	12 3/20	10 3/10	14 19/20	11 11/20	17 3/4	14 19/20
1888	16 9/10	16 13/20	17	16 3/5	17 7/10	16 9/10	17 3/5	17 7/20	17 3/5	17 1/4	17 9/20	17 1/10
1889	12	12	12	12	12	11	11	11	13 1/4	11 1/4	14 1/2	14
1890	17 1/4	16 1/2	17 1/4	17	17	17	16 7/8	16 3/4	16 3/4	16 3/4	16	15
1891	12 7/8	12 1/2	12 3/8	12	12 1/2	12 1/8	12 3/8	11 3/8	11 1/2	11	11 1/8	10 1/4
1892	11 3/4	11 1/4	11 3/4	11 6/10	11 6/10	11 1/10	11 3/4	11 1/10	12	11 3/4	12 3/8	12 1/4

The prices actually realized differ of course from the averages of these quotations. For a number of years they are recorded in the following table, the quantities sold being added.

Prices realized for lake copper in 1888, 1889, 1890, 1891, and 1892.

Mines.	1888.		1889.	
	Sales.	Average price.	Sales.	Average price.
	Pounds.	*Cents.*	*Pounds.*	*Cents.*
Alloues	314, 198	13. 71	1, 762, 816	12. 08
Franklin	3, 655, 751	15. 07	1, 300, 667	12. 05
Atlantic	3, 974, 972	14. 78	3, 698, 837	12. 09
Central	1, 817, 023	14. 80	1, 270, 592	12. 57
Huron	2, 414, 169	14. 92	1, 900, 081	12. 83
Osceola	4, 134, 320	15. 03	4, 534, 127	11. 94
Quincy	6, 367, 809	15. 93	6, 405, 686	11. 96
Kearsarge	829, 185	16. 60	1, 918, 849	12. 58
Tamarack (*a*)	11, 036, 469	12. 90	8, 928, 249	11. 99

Mines.	1890.		1891.		1892.	
	Sales.	Average price.	Sales.	Average price.	Sales.	Average price.
	Pounds.	*Cents.*	*Pounds.*	*Cents.*	*Pounds.*	*Cents.*
Allouez	1, 407. 828	14. 73	1, 241, 423	12. 06	546, 530	11. 45
Franklin	2, 529, 542	14. 80	1, 862, 081	12. 61	3, 769, 605	11. 75
Atlantic	2, 821, 616	15. 21	3, 180, 135	12. 86	3, 703, 875	11. 69
Central	1, 413, 391	14. 94	1, 313, 197	12. 02	1, 625, 982	11. 95
Huron	1, 375, 000	14. 86				
Osceola	5, 294, 792	15. 51	6, 543, 358	12. 51	7. 098, 656	11. 69
Quincy	8, 064, 253	15. 36	10, 542, 519	12. 84	11, 103, 926	11. 27
Kearsarge	1, 598, 525	15. 08	1, 727, 390	12. 38	1, 467, 758	11. 39
Tamarack (*a*)	14, 076, 957	14. 01	16, 805, 360	11. 35		

a Fiscal years ending June 30, 1889, 1890, 1891, and 1892.

In some cases, notably that of the Quincy, the price is figured from the product and the gross amount received without any data concerning the stock at the beginning of the year.

As covering the longest period, the report of the yearly sales of the Osceola are the most interesting in showing the fluctuations in the price of Lake copper. Since 1874 the sales of this company have been as follows:

Sales of copper and average prices by the Osceola Mining Company, 1874 to 1892.

Years.	Sales.	Average price per pound.	Years.	Sales.	Average price per pound.
	Pounds.	*Cents.*		*Pounds.*	*Cents.*
1874	936,002	23.37	1884	4,247,630	12.82
1875	1,330,313	22.77	1885	1,639,169	10.75
1876	1,693,737	20.57	1886	3,560,786	10.51
1877	2,774,777	18.19	1887	3,583,723	11.86
1878	2,705,998	15.53	1888	4,134,320	15.03
1879	3,197,387	17.79	1889	4,534,127	11.94
1880	3,381,061	19.15	1890	5,294,792	15.51
1881	4,176,976	17.77	1891	6,543,358	12.51
1882	4,179,782	17.70	1892	7,098,656	11.69
1883	4,256,409	14.96			

In a general way it may be stated that the average price realized for Lake copper was 11.50 cents in 1892 as compared with 12.50 cents in 1891, 15 cents in 1890, and 12 cents in 1889.

The year opened with moderate purchases by home consumers, which raised the price from 10⅝ to close to 11 cents for Lake copper. When a declining tendency developed again, a sale of about 2,000 tons of Lake copper was effected in England at £51, less 2½ per cent. Birmingham, equivalent to 10⅝ cents New York. This led to purchases by American consumers to the extent of about 4,500,000 pounds of Lake copper for one or two months' delivery at 10.90 cents and 11 cents. Further offerings, however, brought out no takers, and the price declined to 10.70 cents, although the leading producers were holding at 11 cents.

The principal events in February were the sale of about 7,000 tons of Anaconda argentiferous matte, and 1,100 tons of Boston and Montana matte in England at "basis terms," a sliding scale based on average prices of copper in the English market. It was reported also that the leading Lake company had sold about 10,000,000 pounds at 10½ cents for March and later delivery.

The markets were agitated in March over the negotiations for a restriction of output between the leading producers of the world. Under heavy speculative purchases, involving transactions aggregating 25,000 tons, the markets on both sides of the Atlantic advanced, New York rising from 10.75 cents to 12¼ cents toward the close of the month. During the advance a further parcel of 8,700 tons of argentiferous Anaconda matte was placed on basis terms.

In April there were only sales from second hands at a moderate concession from the price of 12 cents established by the mining companies.

The only interesting feature of the month was the resale of some Arizona copper in England and its reshipment to this country, the price realized being $11\frac{3}{4}$ cents.

Meanwhile negotiations among the great companies were progressing, but it was not until the end of May that the matter was adjusted. The leading producers in the Lake, Montana, and Arizona districts agreed not to exceed an annual production of 139,728 long tons of 313,000,000 pounds from July 1, 1892, for one year, and to keep their export to Europe within 40,000 long tons per annum. In consideration of this they called upon the European producers to reduce their production by 15 per cent., but finally assented to a reduction of 5 per cent. on the output during the year 1891. This would make the maximum production of the companies included in the arrangement 85,000 tons per annum.

An interesting development during June was the sale of about 3,000,000 pounds of Lake copper, which proved a legacy of the old Secretan stock, the price being $11\frac{1}{2}$ cents. The clearing out of the last of the old syndicate stock has been heralded to the copper trade with a frequency which has shaken confidence in such assertions. An additional lot turned up in July, while in England the final disposal of such copper was announced with much flourish in the same month. Yet, early in 1893, a lot of several thousand tons was discovered to be "hidden away" in France.

The market was very dull in June, showing an easing tendency, which continued during July, during which the only large sale was 2,000,000 pounds of Lake to consumers at $11\frac{1}{2}$ cents. The Anaconda company placed 4,000 tons of matte in England at private terms.

August and the early part of September were very dull, while during the latter part of the month there were sales by the mining companies at 11.25 cents, and by second hands at 11.10 and 11.15 cents. In England speculative purchases involving about 4,000 tons were made.

October developed a livelier buying movement, under the stimulus of which the market rose to 11.75 cents.

The announcement early in November that the Anaconda mine would close down for three months induced quite heavy buying, consumers taking fully 10,000,000 pounds of Lake copper and advancing the market to 12 cents.

The advance of holders' price to $12\frac{1}{2}$ cents for Lake made the early part of November dull, until a number of sales were closed at 12.25 cents and $12\frac{3}{8}$ cents.

The fluctuations in the price of copper during the past thirteen years in the English market are shown in the following table:

Average values of copper in England.

Years.	Chile bars, or G. O. B.			Ore, 25 per cent.		Precipitate.	
	Long ton.			*Per unit.*		*Per unit.*	
	£	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
1880	62	10	0	12	9	12	11
1881	61	10	0	12	6	13	$8\frac{3}{16}$
1882	66	17	0	13	$6\frac{3}{4}$	13	$10\frac{1}{16}$
1883	63	5	10	12	$4\frac{1}{2}$	12	$10\frac{1}{16}$
1884	54	9	1	10	$5\frac{1}{2}$	11	1
1885	44	0	10	8	4	9	$0\frac{1}{8}$
1886	40	9	3	7	9	8	$3\frac{5}{8}$
1887	43	16	11	8	6	8	$11\frac{3}{4}$
1888	79	19	$4\frac{1}{2}$	14	$3\frac{1}{4}$	16	3
1889	49	10	5	9	$6\frac{1}{8}$	....	
1890	54	5	5	10	7	....	
1891	51	9	$8\frac{1}{2}$	9	7	....	
1892	45	12	$8\frac{3}{4}$	8	7	....	

In detail, the fluctuations, monthly, of good merchant copper in the English market were as follows in 1892:

Fluctuations in good merchant copper in England in 1892.

	£	*s.*	*d.*		£	*s.*	*d.*
January	45	13	$7\frac{1}{2}$	July	44	19	$5\frac{1}{2}$
February	44	1	$5\frac{3}{4}$	August	44	12	$2\frac{1}{2}$
March	46	1	1	September	44	5	2
April	45	16	10	October	45	14	4
May	46	10	4	November	46	13	$10\frac{1}{4}$
June	45	19	9	December	47	4	$10\frac{1}{2}$

Since England is still the leading copper market of the world, the following tables, showing the import and export movement, are of great interest:

British imports and exports of copper.

Years.	Imports of— Bars, cakes, and ingots,	Imports of— Copper in ores and furnace products.	Total imports.	Exports.	Apparent English consumption.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
1860	13, 142	13, 715	26, 857	26, 117	....
1865	23, 137	23, 922	47, 059	41, 398	....
1870	30, 724	27, 025	57, 749	53, 006	....
1871	33, 228	23, 671	56, 899	56, 633	....
1872	49, 000	21, 702	70, 702	53, 195	....
1873	35, 840	26, 756	62, 596	55, 716	....
1874	39, 906	27, 894	67, 800	59, 742	....
1875	41, 931	29, 483	71, 414	51, 870	....
1876	39, 145	36, 191	75, 336	52, 468	....
1877	39, 743	53, 582	93, 325	54, 088	....
1878	39, 360	48, 212	87, 572	55, 001	....
1879	46, 670	50, 421	97, 091	62, 412	30, 774
1880	36, 509	56, 225	92, 734	59, 482	32, 879
1881	32, 170	54, 057	86, 227	61, 689	31, 607
1882	35, 509	58, 366	93, 875	55, 683	42, 877
1883	35, 653	63, 493	99, 146	59, 350	40, 469
1884	39, 767	69, 623	109, 390	64, 691	51, 263
1885	41, 933	81, 616	123, 549	62, 080	54, 323
1886	42, 969	65, 046	108, 015	60, 511	41, 158
1887	29, 198	73, 891	103, 089	69, 453	53, 096
1888	44, 603	90, 867	135, 470	(*a*)72, 066	42, 562
1889	(*b*)38, 576	101, 407	139, 983	75, 627	65, 759
1890	(*c*)49, 461	91, 788	141, 249	89, 747	66, 170
1891	44, 213	94, 403	138, 616	59, 223	....
1892	(*d*)35, 015	99, 356	134, 371	(*e*)48, 367	....

a Including 22,557 tons of Chile bars transferred to France.
b Including 1,166 tons of Chile bars transferred from France to England.
c Including 3,501 tons of Chile bars transferred from France to England.
d Including 3,585 tons of Chile bars transferred from France to England.
e Add 4,001 tons for comparison with former years, the difference arising from the new method of making up stock.

The following figures from the Board of Trade returns for the past nine years show in detail the form in which the copper is brought into Great Britain and in what form it is exported:

Imports of copper into Great Britain from 1884 to 1892, inclusive.

Character.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Pure in pyrites	14, 077	16, 333	13, 905	14, 940	15, 448	16, 097	16, 422	15, 406	15, 110
Pure in precipitate	19, 688	21, 398	19, 323	21, 819	26, 366	25, 110	25, 563	29, 326	28, 444
Pure in ore	24, 677	15, 683	13, 749	15, 148	19, 452	22, 219	18, 000	14, 172	13, 585
Pure in regulus	11, 181	28, 202	18, 069	21, 984	29, 601	37, 981	31, 803	35, 499	42, 217
Bars, cakes, etc	39, 767	41, 933	42, 969	29, 198	44, 603	38, 576	49, 461	44, 213	35, 015
Total	109, 390	123, 549	108, 015	103, 089	135, 470	139, 983	141, 249	138, 616	134, 371

The following table gives the details relating to the British imports of precipitate and regulus:

Imports of precipitate and regulus into Great Britain from 1884 to 1892, inclusive.

Countries.	1884.	1885.	1886.	Fine copper.	1887.	Fine cop. per	1888. Fine copper.	1889. Fine copper.	1890. Fine copper.	1891. Fine copper.	1892. Fine copper.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Portugal	7, 161	8, 283	6, 657	24, 032	10, 758	24, 754	30, 119	28, 157	28, 018	32, 425	32, 509
Spain	27, 621	38, 267	38, 666		37, 892						
Chile	10, 699	5, 255	1, 637	737	1, 595	718	734	1, 919	2, 122	595	2, 040
United States	5, 805	29, 861	16, 105	10, 853	24, 229	15, 039	20, 752	26, 581	18, 897	19, 109	24, 668
Other countries	11, 124	6, 000	5, 240	1, 770	5, 366	2, 292	4, 362	6, 434	8, 329	12, 696	11, 444
Total	62. 410	87, 666	68, 305	....	79, 840	....	....	....	....	....	....
Fine copper	34, 172	49, 600	....	37, 392	....	42, 803	55, 967	63, 091	57, 366	64, 825	70, 661

It will be noted that there was quite a heavy increase in the receipts from the United States in 1892.

Messrs. James Lewis & Son, of Liverpool, estimate as follows the imports of other than Chile copper into Liverpool, London, and Swansea during the years 1885, 1886, 1887, 1888, 1889, 1890, 1891, and 1892, which represent the total imports, with the exception of precipitate, into Newcastle and Cardiff, reliable returns of which can not be obtained, but which is estimated to vary from 8,000 to 10,000 tons fine per annum:

Imports of copper product into Liverpool, Swansea, and London.

Countries.	1884.	1885.	1886,	1887.	1888.	1889.	1890.	1891.	1892.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Chile	31,298	28,985	27,191	20,008	24,479	22,070	22,909	14,378	17,619
United States	17,309	24,037	13,483	16,534	25,730	30,729	20,171	26,120	26,475
Spain and Portugal	2,359	4,655	5,721	5,178	5,915	5,189	5,202	4,734	5,372
Spain (precipitate)	10,009	9,186	10,038	13,042	15,568	17.192	18,430	17,439	14,831
Spain (pyrites)	14,077	16,333	13,905	14,940	15,448	16,097	16,422	15,406	15,110
Australia	9,685	8,951	10,096	6,047	6,746	6,285	6,561	6,265	5,547
Cape of Good Hope	6,042	5,405	7,073	8,271	8,829	11,507	9,927	7,452	8,092
New Quebrada	3,675	4,074	3,055	2,261	3,574	4,299	5,245	5,017	5,028
Japan	1,061	3,010	3,572	200	4,469	2,523	10,674	7,852	4,989
Italy	1,310	835	889	1,055	1,058	1,043	953	649	725
Norway	289	27	....	....	545	234	80	30	38
Canada	266	......	8	94	156	181	264	189	120
Newfoundland	224	723	891	359	465	631	1,552	1,617	3,229
Mexico	291	374	243	61	158	3.938	3,325	3,616	869
Peru	408	229	68	13	202	271	254	279	287
River Plate	131	233	179	167	135	184	143	211	196
Other countries	284	325	1,049	1,074	4,054	1,389	225	236	1,245
Total tons fine	98,721	107,382	97,461	89,304	117,531	123,762	122,337	111,490	109,772

The quantities of copper in different forms which were imported from the United States to Great Britain and France are given in the following table. The figures for the receipts in Germany, at times important, are, unfortunately, not available:

Imports of copper from the United States in England and France.

	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
England:									
Ore	11,023	1,875	420	26	298	349	5	4	18
Matte	2,722	18,895	10,853	15,039	20,752	26,581	18,897	19,109	24,668
Bars and ingots	3,584	3,375	2,210	1,469	4,680	3,799	1,269	7,007	1,427
Total	17,329	24,145	13,483	16,534	25,730	30,729	20,171	26,120	26,113
France	7,205	9,235	4,167	3,910	6,496	1,058	1,733	8,329	2,430
United States into England and France	24,534	33,380	17,650	20,444	32,226	31,787	21,904	34,449	28,543
Chile into England and France	42,384	35,342	35,448	29,019	32,947	22,020	24,641	18,820	19,840

The exports of copper from Great Britain, estimating the fine contents of alloys, were as follows:

Exports of copper from Great Britain from 1884 to 1892, inclusive.

Character.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Raw English	17,943	18,766	19,036 }	40,700	32,058	48,189	58,571	51,765	58,518
Sheets	20,669	21,108	17,927 }						
Yellow metal, at 60 per cent	11,602	12,551	11,958	10,153	4,513	9,195	10,514	8.547	8,853
Brass, at 70 per cent	3,735	3,233	3,001	3,146	2,650	3,773	3,721	3,992	3,783
Total	53,949	55,658	51,922	53,999	39,221	61,157	72,806	64,304	71,154
Fine foreign	10,742	6,422	8,589	15,454	a32,845	14,470	16,941	11,752	11,388
Total	64,691	62,080	60,511	69,453	72,066	75,627	89,747	76,056	82,542

a Including 22,557 tons Chile bars transferred to France.

FRANCE.

The direct imports of copper from different countries into France were as follows, for a series of years:

Direct imports into France, from 1884 to 1892, inclusive.

Countries.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Chile	11,686	6,357	8,257	9,011	8,468	2,470	2,803	4,442	2,221
United States	7,205	9,235	4,167	3,910	6,496	1,058	1,733	8,329	2,430
Mexico					2,700	738			2,515
Other countries	392	995	1,600	1,048	6,905	1,715	975	2,118	2,208
Total	18,683	16,587	14,024	13,969	24,569	5,981	5,511	14,889	9,374

THE PRINCIPAL FOREIGN PRODUCERS.

The copper production of the world, 1885 to 1892, inclusive.

Countries.	1892.	1891.	1890.	1889.	1888.	1887.	1886.	1885.
EUROPE.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Great Britain	(*a*)700	720	935	905	(*a*)1,500	389	1,471	2,773
Spain and Portugal:								
Rio Tinto	31,539	31,827	30,000	29,500	(*a*)32,000	26,663	(*a*)24,700	23,484
Tharsis	11,258	(*a*)11,100	(*a*)10,300	(*a*)11,000	(*a*)11,500	(*a*)11,000	(*a*)11,000	(*a*)11,500
Mason and Barry	(*a*)4,400	(*a*)4,150	(*a*)5,600	(*a*)5,250	(*a*)7,000	(*a*)7,000	(*a*)7,000	(*a*)7,000
Sevilla	1,070	875	870	1,850	1,700	2,300	2,135	1,800
Portugueza	(*a*)900	890	(*a*)1,200	1,200	(*a*)900	(*a*)856	1,258	1,665
Poderosa and others	(*a*)6,800	(*a*)5,500	(*a*)4,225	(*a*)6,500	(*a*)7,200	4,050	3,560	2,424
Germany								
Mansfeld	15,360	14,250	15,800	15,506	13,380	13,025	12,595	12,450
Other German	(*a*)2,600	(*a*)2,000	(*a*)2,000	(*a*)1,850	(*a*)1,850	(*a*)1,850	1,870	(*a*)2,800
Austria	(*a*)900	965	1,210	1,225	1,010	883	733	585
Hungary	285	285	(*a*)300	(*a*)300	858	531	366	504
Sweden	(*a*)655	655	830	830	(*a*)900	905	520	775
Norway	(*a*)1,235	(*a*)1,065	(*a*)1,375	1,357	1,570	1,450	2,220	2,560
Italy	2,500	2,200	2,200	3,500	(*a*)2,500	(*a*)2,500	900	835
Russia	4,300	4,800	4,800	4,070	4,700	5,000	4,875	(*a*)5,100
Total Europe	84,502	81,282	81,645	84,843	88,568	78,402	75,203	76,255
NORTH AMERICA.								
United States	154,072	126,839	115,966	101,239	101,054	81,017	70,430	74,052
Canada	2,500	3,500	3,050	2,500	(*a*)2,250	1,400	1,440	2,500
Newfoundland	2,390	2,040	1,735	2,615	2,050	1,180	1,125	778
Mexico:				3,780	2,766	2,050	850	375
Boleo	6,415	4,175	3,450					
Other Mexican	900	1,025	875					
Total North America.	166,277	137,579	125,076	110,134	108,120	85,647	73,845	77,705
SOUTH AMERICA.								
Chile	22,565	19,875	26,120	24,250	31,240	29,150	35,025	38,500
Bolivia:								
Corocoro	2,860	2,150	1,900	(*a*)1,200	1,450	(*a*)1,300	1,100	(*a*)1,500
Peru	290	280	150	275	250	50	75	229
Venezuela:								
New Quebrada	3,100	6,500	5,640	6,068	4,000	2,900	3,708	4,111
Argentine Republic	200	210	150	190	150	170	180	233
Total South America	29,015	29,015	33,960	31,983	37,090	33,570	40,088	44,573

a Estimated.

The copper production of the world, 1885 to 1892, inclusive—Continued.

Countries.	1892.	1891.	1890.	1889.	1888.	1887.	1886.	1885.
AFRICA.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Algiers	....	120	120	160	50	150	110	250
Cape of Good Hope:								
Cape Colony	5,670	5,100	5,000	(a)7,700	7,500	7,250	6,015	5,450
Namaqua	450	900	1,450					
Total Africa	6,120	6,120	6,570	7,860	7,550	7,400	6,125	5,700
ASIA.								
Japan	(a)19,000	(a)18,500	17,972	16,125	13,054	10,976	9,696	10,368
Total Asia	(a)19,000	(a)18,500	17,972	16,125	13,054	10,976	9,696	10,368
AUSTRALIA.								
Australia	6,500	7,500	7,500	8,300	7,550	7,700	9,700	11,400

a Estimated.

With the exception of the figures for the United States the data in the above table were taken from the annual statistics of Messrs. Henry R. Merton & Co., of London. In 1892 the United States produced 49.6 per cent, or practically one-half, of the whole output of the world, against 22.4 per cent, or less than a quarter, in the year 1882, when American production statistics were first carefully collected.

RECAPITULATION.

Countries.	1892.	1891.	1890.	1889.	1888.	1887.	1886.	1885.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Europe	84,502	81,282	81,645	84,843	88,568	78,402	75,203	76,255
North America	166,277	137,579	125,076	110,134	108,120	85,647	73,845	77,705
South America	29,015	29,015	33,960	31,983	37,090	33,570	40,088	44,573
Africa	6,120	6,120	6,570	7,860	7,550	7,400	6,125	5,700
Asia	19,000	18,500	17,972	16,125	13,054	10,976	9,696	10,368
Australia	6,500	7,500	7,500	8,300	7,550	7,700	9,700	11,400
Total	311,414	279,996	272,723	259,245	261,932	223,695	214,657	226,001

THE FOREIGN PRODUCERS.

The Spanish and Portuguese mines did not materially increase their production during 1892. The Rio Tinto, according to the report of its chairman, produced 1,402,063 tons of ore containing an average of 2.819 per cent. of copper as compared with 2.649 in the previous year. The deliveries of selected pyrites to customers in England, Germany, and the United States amounted to 435,758 tons, a slight excess over 1891. Contracts for the years 1894, 1895, and 1896 have been completed on the basis of a further annual increase of from 60,000 to 80,000 tons. The refined copper brought to market and realized was 19,576 long tons and in the pyrites 9,873 long tons, making a total of 29,449, which is somewhat less than the product. The stock in refined copper, matte, and precipitate amounted to 6,293 tons on the 31st of December, 1892, against 6,512 tons at the end of the previous year.

The Tharsis Sulphur and Copper Company, the second large producer of the Peninsula, raised 504,706 tons of ore against 585,422 tons in 1891, a decrease of 80,716 tons. The export of pyrites declined to 235,152 tons from 260,275 tons in 1891, while the shipments of precipitate rose from 6,477 tons in 1891 to 7,686 long tons in 1892. A dividend of 12½ per cent. was paid out of earnings, £57,625 being written off for depreciation.

Messrs. Mason & Barry, limited, raised at the mines 329,201 tons of ore in 1892, against 314,929 tons in 1891, the quantity of ore sold and invoiced for its sulphur value having been 116,619 tons in 1892 as compared with 118,419 tons in 1891.

The Bede Metal Company produced 46,300 tons of pyrites in 1892, of which 21,000 tons were shipped to England, the balance yielding 509 tons of 80 per cent. matte. In 1891 the company mined 50,472 tons of pyrites, exporting 23,230 tons and producing 372.5 tons of matte.

The Compañia de Aguas Teñidas, also in the Huelva district, extracted 200,000 tons of pyrites in 1892 as compared with 186,750 tons in 1891.

In the province of Seville two companies, the English Seville Copper and Sulphur Company and the Compañia Gaditana de Mines, produced together 19,753 tons in 1892 against 20,524 tons of ore in 1891, estimated to produce between 700 and 800 long tons of copper. The mines in the provinces of Granada, Leon, and Santander are unimportant.

The Chilean mines continue to decline in importance. The principal production is in the districts of Tamaya, Paym, Carrizol, Fasal-Puguios, Cerro Blanco, Condes, Guayacan, Panulcillo, and Lota. The ores are conveyed by rail to the smelting works at the coast. Some of them, like Cousino, Coronel, and Lota have introduced Bessemerizing and the electrolytic process. The low price of copper and the difficulty in competing for labor with the nitrate companies is cutting down the output. Some of the old mines like the Chanaral and the Panulcillo are closing down.

Aside from the Chilean deposits, the most important is that of Corocoro, south of Lake Titicaca in the department of La Paz, Bolivia. These are copper-bearing beds interstratified with shales and sandstones which have a thickness of from 1½ to 35 feet. They carry native copper and oxides. Until now only the richest ore has been available on account of lack of transportation facilities. Now that a railroad is approaching the mines a much heavier output may be looked forward to.

The Quebrada, the only producer of consequence in Venezuela, has suffered from local political disturbances and from floods. In 1892 the company produced only 3,065 tons against 6,356 tons in 1891, the loss incurred during the year 1892 being £66,905.

Small quantities of copper are produced in the Argentine Republic at Mejicana in the province of Rio Oja.

The principal producer of Africa is the Cape Copper Company, whose output has risen from 5,100 tons in 1891 to 5,670 tons in 1892, the cost declining to 5*s*. 2¾*d*. per unit from 6*s* 4*d*. per unit in 1891. The profit was £69,744 in 1891 and £61,000 in 1892. The Namaqua company has declined in importance, producing only 1,623 tons of ore of about 30 per cent. against 3,450 tons in 1891. The company lost £9,895 in 1892.

In Mexico the only producer of importance is the French Boleo company in Lower California. It is understood that the aim of the Rothschilds, who control the company, is to reach a product of between 8,000 and 10,000 tons per annum, and that it is expected that the former figure will be reached in 1893. In 1891 the output was 4,176 tons, which was increased to 6,415 tons in 1892, in which there was a profit of about £40,000, which has to be deducted from the balance of about £169,000 previously standing to the debit of profit and loss account.

In Australia the Wallaroo company continues by far the largest single producer. The fact that early during the current year its output has been sold for a period of three years indicates that no important expansion is proposed. The sale was for 12,000 long tons at the rate of 4,000 tons per annum at a price based upon that ruling at the time of delivery with £7 per ton added.

As a copper-producing country Japan now ranks fifth. Although small quantities of metal from that source reached the European markets since 1884, it was not until 1890 that it played any part. No reliable statistics concerning the production of the Japanese mines have been published in the European and American press, and it is only recently that a comprehensive report of the resources and production of copper in Japan have become available through the publication by the Mining Bureau of Tokio of a volume entitled "The Mining Industry of Japan," by Wada Tsunashiro. The following statistics of the production of copper in Japan from 1881 to 1890, both inclusive, together with the exports for the period from 1882 to 1891, inclusive, are presented:

Copper production and exports of Japan.

Years.	Production.	Exports.
	Pounds.	*Pounds.*
1881	10,603,601	....
1882	12,479,955	6,058,080
1883	15,054,690	5,252,053
1884	19,751,906	11,517,308
1885	23,223,281	17,994,956
1886	21,718,857	21,242.302
1887	24,585,519	18,990,821
1888	29,720,190	21,433,206
1889	36,119,364	22,446,923
1890	40,256,433	43,135,474
1891	....	38,501,311

The following table shows in detail the export movement of the years 1888, 1889, 1890, and 1891:

Exports of copper from Japan.

Countries.	1888.	1889.	1890.	1891.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
British India	94,193	4,287,132	467,904	1,815,936
China	12,116,993	6,881,225	3,385,004	8,002,599
Hongkong		3,815,211	15,424,437	24,164,731
Corea	848,760	1,954,417	2,112,900	1,368,473
France	642,616	435,661	444,144	290,840
Germany	169,176	1,075	393,887	233,544
Great Britain	7,559,017	5,072,111	20,903,329	2,616,582
Other countries	2,451	91	3,869	8,656
Total	21,433,206	22,446,923	43,135,474	38,501,311

China, it will be observed, receives the largest quantities, the shipments to England having undergone violent fluctuations. Possibly the markets of British India, now so important to the English trade, may be the first to feel, in the future, the active competition of Japanese producers, particularly if an important rolling-mill industry should develop in Japan.

The Japanese producers have been very progressive, quickly adopting European methods of mining and metallurgy, and have so aptly learned from the foreign managers, who at first introduced modern improvements, that practically all the plants are now controlled by native engineers.

The largest Japanese copper mine is the Ashio, in the province of Shimotsuke, which was discovered in 1610, but came into the hands of the present owners in 1877. In 1884 the product rose to 2,315 long tons, and developed since as follows:

Product of the Ashio mine.

	Long tons.		Long tons.
1883	655.03	1888	4,124.11
1884	2,314.97	1889	4,901.62
1885	4,141.74	1890	5,862.32
1886	3,638.13	1891	6,099.25
1887	3,031.79		

The ore, which is rich copper pyrites, often carrying erubescite, is hand sorted and dressed to an average of about 18 per cent. copper. It is washed and smelted to a matte, which is to be Bessemerized in a plant of four converters. To economize in fuel an elaborate system of utilizing water power and transmitting by electricity is being developed. Wire-rope tramways have also been built to carry ore and charcoal, and a road is being built with a capacity of carrying 7,000 tons of crude copper.

Next in importance is the Besshi mine in the central portion of Shikoku, which mines a cupriferous iron pyrites, carrying from 2 to 12 per cent. of copper and averaging 7 per cent. The mines, which produced 1,450 metric tons in 1887, increased steadily, making 1,745 metric tons in 1888, 1,760 tons in 1889, 2,025 tons in 1890, and 2,075 metric tons in 1891. Mining costs $1.62 per metric ton. The metallurgical methods embrace both smelting and the wet extraction, the iron being partly made on the spot. It is stated that the smelting costs a little over $15.29 per 100 pounds of fine copper. The transportation facilities have been and are still being improved.

The Ani group of seven mines, in the province of Ugo, differs from the preceding in that they produce also silver ore. During 1891 the mines produced about 70,000 short tons of ore, carrying 1.934 per cent. of copper, from which the dressing works turned out 7,530 tons of concentrates carrying 11.96 per cent. of the metal, the cost of mining per short ton of crude ore being $1.28, and that of dressing 59 cents per ton of dressed ore; the combined cost of mining and concentrating was $18.45. The final yield is 69 per cent. of the copper contents of the crude ore. The smelting costs $6.76 per short ton of dressed ore, making the total cost, exclusive of salaries and general expenses, $25.21 per ton of dressed ore, or considering the yield of 92.96 per cent, about 11.36 cents per pound of fine copper.

The Arakawa copper mines, also in the province of Ugo, work a series of veins carrying copper pyrites, and sometimes native copper, the rich ores ranging between 18 and 24 per cent, while the poor ore goes down to 3 per cent. In 1891 the mine produced 1,773,131 pounds of copper, the total cost of mining being $100,130.03 and that of concentrating and smelting $85,739.76, making the cost of copper per pound 10.43 cents.

Among the other larger mines are the Kusakura, which produced in 1890 1,694,610 pounds; the Ogoya, which made 1,235,394 pounds in 1890 and 1,509,998 pounds in 1889; the Yoshioka, which made 1,144,460 pounds in 1890, and the Osarusawa, which produced 1,000,000 pounds in 1891. A moderate amount of copper is also obtained from copper-bearing silver ores, this being notably the case with the Sado, Towado, Omori, Mozumi, and Hadasa mines, none of them, however, turning out large quantities of copper.

The following table shows the production in 1890 of the principal prefectures in Japan in which copper is produced:

Copper production of principal prefectures of Japan in 1890.

Prefecture.	Leading mines.	Production.
		Pounds.
Ehime	Besshi	4,910,011
Okayama	Yoshioka	2,463,272
Iwate	Yuda	711,422
Akita	Ani. Arakawa, Komaki	5,842,254
Tochigi	Ashio	13,111,272
Niigata	Kusakura	1,763,596
Ishikawa	Ogoya, Ate	2,280,476
Fukui	Omodani	844,912
Nara	Tateri	946,376
Shimane	Sasagatani	1,592,227
Miyasaki	Hibira	1,436,364

These prefectures account for 35,902,182 pounds out of a total of 40,256,433 pounds tabulated.

LEAD.

BY C. KIRCHHOFF.

Although the quantity of refined lead produced in 1892 was greater than ever before, the amount obtained from ores mined in the United States showed a slight falling off, chiefly attributable to the mining troubles in the Coeur d'Alene region.

The following table presents the figures of the total gross production of lead in the United States from 1825. Up to the year 1882 the figures have been compiled from the best data available. Since 1882 the statistics are those collected by this office, with the exception of the year 1889, when they were gathered by the Census Office.

Production of refined lead in the United States from 1825 to 1892, both inclusive.

Years.	Total production.	Desilverized lead.	Soft lead.	From foreign ores and base bullion.	Net American product.
	Short tons.	*Short tons.*	*Short tons.*		
1825	1,500				
1830	8,000				
1831	7,500				
1832	10,000				
1833	11,000				
1834	12,000				
1835	13,000				
1836	15,000				
1837	13,500				
1838	15,000				
1839	17,500				
1840	17,000				
1841	20,500				
1842	24,000				
1843	25,000				
1844	26,000				
1845	30,000				
1846	28,000				
1847	28,000				
1848	25,000				
1849	23,500				
1850	22,000				
1851	18,500				
1852	15,700				
1853	16,800				
1854	16,500				
1855	15,800				
1856	16,000				
1857	15,800				
1858	15,300				
1859	16,400				
1860	15,600				
1861	14,100				
1862	14,200				
1863	14,800				

Production of refined lead in the United States from 1825 to 1892, etc.—Cont'd.

Years.	Total production.	Desilverized lead.	Soft lead.	From foreign ores and base bullion.	Net American product.
	Short tons.	*Short tons.*	*Short tons.*		
1864	15,300				
1865	14,700				
1866	16,100				
1867	15,200				
1868	16,400				
1869	17,500				
1870	17,830				
1871	20,000				
1872	25,880				
1873	42,540	20,159	22,381		
1874	52,080				
1875	59,640	34,909	24,699		
1876	64,070	37,649	26,421		
1877	81,900	50,748	31,152		
1878	91,060	64,290	26,770		
1879	92,780	64,650	28,130		
1880	97,825	70,135	27,690		
1881	117,085	86,315	30,770		
1882	132,890	103,875	29,015		
1883	143,957	122,157	21,800		
1884	139,897	119,965	19,932		
1885	129,412	107,437	21,975		
1886	135,629	114,829	20,800	(*a*) 5,000	(*a*) 131,629
1887	160,700	135,552	25,148	(*a*) 15,000	(*a*) 145,700
1888	180,555	151,465	29,090	28,636	151,919
1889	182,967	153,709	29,258	26,570	156,397
1890	161,754	130,403	31,351	18,124	143,630
1891	(*b*) 202,406	171,009	31,397	23,852	178,554
1892	(*c*) 213,262	181,584	31,678	39,957	173,305

a Estimated. *b* Including 4,043 tons antimonial lead. *c* Including 5,039 tons of antimonial lead.

Prior to 1886 very little foreign ore had been smelted in American works. At different times during the past twenty years small quantities of Mexican base bullion, chiefly from the Minas Viejas have been imported into the United States. Practically, therefore, the gross production prior to 1886 was from domestic sources. Since then increasingly large quantities of ore and base bullion have been treated in this country and have added to its output of refined lead. A column has therefore been added to the above table to cover the net product of lead of the United States, which may be justly claimed as its mining product, while the total of refined lead in the first column of the table may be termed its metallurgical product.

This method of obtaining the net United States product by deducting the imports from the total product of refined lead, of course yields only approximate results, since the imported metal, particularly in ores, really does not appear in the returns of the refiners until some time later. If the imports of ore were to stop suddenly at the end of one year, the metal contents of the receipts of the last months would figure as United States product in the following year. The method, however, is the safest and most accurate available under the circumstances.

The following table shows the gross production, the metal contents of foreign ores imported, and the quantities of foreign argentiferous base bullion refined in bond by American desilverizing works:

Production of lead from 1887 to 1892.

Years.	Gross production.	Lead contents of Mexican and Canadian ores.	Foreign lead refined in bond.	Net American product.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
1887	160,700	(*a*) 15,000		145,700
1888	180,555	28,636		151,919
1889	182,967	26,570		156,397
1890	161,754	18,124		143,630
1891	202,406	21,152	2,700	178,554
1892	213,262	27,083	12,874	173,305

a Estimated.

The lead contents of silver ore imported in the calendar year 1892 are as follows in detail:

Lead contents of silver ore imported in the calendar year 1892.

Imported into—	Pounds of lead.	Value.
Arizona	2,364,259	$60,923
Corpus Christi, Texas	227,111	6,129
Detroit, Michigan	103,922	3,118
Montana and Idaho	20,835	528
Paso del Norte, Texas	43,407,600	1,034,025
Puget Sound, Washington	157,713	5,682
Saluria, Texas	7,468,272	148,864
San Francisco, California	417,138	11,707
Total	54,166,850	1,270,976

During the first six months of 1893 the gross production of lead was at an even greater rate than that of the year 1892. Returns from all the desilverizers showed a total of 95,621 tons, while the producers of soft lead made 16,305 tons, a slightly increasing rate. This includes 2,401 tons of antimonial lead. From the total of 111,926 tons must be deducted 12,230 tons of foreign base bullion refined in bond, leaving 99,696 tons available for American consumption. Deducting from this 15,860 tons, the lead content of foreign ores, leaves 83,836 tons as the amount of lead produced from domestic sources during the first six months of 1893.

Returns from the Rocky mountain smelters, including the Colorado, Montana, Utah, California, Portland, Tacoma, and Rio Grande works, show that together they did not derive more than 8,000 tons of metallic lead from these foreign sources, and of this quantity one establishment alone is credited with over 5,000 tons. It is evident, therefore, that under the conditions prevailing heretofore these smelting works are not aided in their operations by the employment of Mexican or Canadian material, although they produced about 150,000 tons of base bullion in 1892.

The lead-smelting industry of Colorado still continues to overshadow that of other States, reports from all the smelters showing a total out, put of 98,760 tons of lead. Reports from all the Colorado works, with the exception of one, indicate that about 60,000 tons of the lead product was obtained from ores mined in the State. Similar computations make the total 63,128 tons in 1891, 54,596 tons in 1890, and 66,970 tons in 1889, thus indicating that the supply has remained fairly stationary. The balance of the ores are drawn chiefly from Utah and Idaho.

The Utah smelters did more in 1892, making 20,813 tons of lead against 16,800 tons in 1891. They draw chiefly from the Territory and from Idaho.

Montana works turned out 15,474 tons of lead, a part coming from the operations of the Hecla Consolidated Company and the other from the Cumberland in the Castle districts, both of which companies smelt only their own ores. The Monte Cristo, Slocan, and Kootenai districts, which are expected to furnish a good deal of lead, did not contribute any appreciable quantities in 1892, nor did the Barker and Neihart districts add much to the product.

The following estimate of the lead contents of ores mined in Montana is published in a memoir distributed at the World's Fair by the State board of managers:

Lead production of Montana.

Counties.	Pounds.	Counties.	Pounds.
Beaverhead	3,452,442	Silverbow	4,000
Deer Lodge	1,000	Reported by foreign smelters and not otherwise included	4,425,579
Jefferson	9,464,305		
Lewis and Clarke	116,850		
Meagher	3,279,811	Total	25,716,197
Missoula	4,971,210		

The serious and protracted labor troubles in the Cœur d'Alene district cut off production heavily in that most important lead-mining district.

In the Missouri, Kansas, and Wisconsin mining regions production is developing. The quantities reported under soft lead, as covering the product of this section, deal with the aggregate returns of the smelters, and are reported in the manner given because they represent the total output of what is commercially often regarded a distinct article. Growing quantities of the lead ore raised in this section are purchased by desilverizers and lead-refiners and, therefore, are marketed with the desilverized lead. The extensive operations of the St. Joe, Desloge, and Mine La Motte companies produce slightly increasing quantities. The number of small smelting operations, producing from one to thirty cars of lead per annum from local ores, is decreasing. So far as the Joplin district is concerned the following figures, compiled by local authorities, show the product of lead ore:

Lead ore produced in the Joplin district.

	Pounds.		Pounds.
Joplin	13,065,105	Oronogo	2,180,040
Cartersville	5,907,270	Lehigh	31,570
Webb City	3,020,590	Carthage	161,380
Galena	11,969,230		
Zincite	211,830	Total	36,547,015

A part of the ore from this district is converted direct into paint by the Lewis process.

A comprehensive report on the lead and zinc deposits of the Mississippi Valley has been presented at the World's Engineering Congress before the American Institute of Mining Engineers by Dr. Walter P. Jenney, while the mineral deposits of southwest Wisconsin were the subject of a paper by Prof. William P. Blake. The latter estimates the lead-ore shipments of Wisconsin at 800,000 pounds.

THE LEAD MARKET.

The year 1892 was ushered in with a declining market until during the middle of the month of January values reached 4.10 cents, at which consumers bought moderate quantities. A slight but temporary recovery took place, but in February prices again declined to 4.05 cents, which brought out buyers. The market again became dull until the labor troubles in Idaho caused a hardening of values, some transactions being closed at slightly better prices. On the whole, however, the cessation of production in the Cœur d'Alene district had little effect upon buyers, who held off until well into March, when they purchased about 1,500 tons at 4.10 cents.

Again a period of inactivity followed, sellers holding for better prices, which were obtained, first, for smaller quantities, and in the middle of April had to be conceded for more extensive purchases, which were made at 4.22½ cents and 4.25 cents. May was characterized by firm prices and repeated purchases of moderate amounts by consumers. June brought a resumption of work in the Idaho mines, and with it a steady though slow decline under a light business, until the close of the month developed greater activity, coupled with a recovery to 4.20 cents. The advance held its own during the early part of July, but then pressure to sell forced the market down to 4 cents, a price which rested, under moderate transactions, until the last days of August Then prices recovered to 4.15 cents, fairly well maintained early in September. The middle of that month brought out buyers at a lower range of values, and 4 cents again became the ruling quotation. Excessive supplies caused a further weakening in October, which, under a very light business, gained headway in November, until 3.70 cents was reached toward the latter part of that month. December was very dull, moderate purchases bringing the price up to 3.85 cents for a few days in the middle of the month.

The following table, prepared from the annual reports of the daily price of lead, compiled by Mr. E. A. Caswell, of New York, shows the monthly average prices from 1884 to December, 1892, inclusive:

Average monthly prices of common pig lead in New York City.

[Cents per pound.]

Months.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
January	4.09	3.65	4.57	4.27	4.80	3.82½	3.82½	4.34½	4.17
February	3.98	3.65	4.75	4.43	4.92	3.68	3.79½	4.28½	4.11
March	4.12	3.67	4.87	4.35	5.14	3.69	3.91½	4.32½	4.16
April	3.84	3.63	4.77	4.29	4.72½	3.64½	3.87½	4.20½	4.22
May	3.64	3.67	4.72	4.49	4.24	3.79½	4.13	4.25½	4.21
June	3.62	3.73	4.77	4.62	3.88	3.97½	4.37	4.41	4.12
July	3.58	4.06	4.88	4.50	3.96	3.88	4.43	4.39	4.10
August	3.58	4.25	4.75	4.55	4.43	3.82½	4.51	4.44	4.02
September	3.61	4.26	4.63	4.44	4.99	3.92½	4.86	4.50	4.07
October	3.69	4.10	4.23	4.30	4.45	3.82½	5.21½	4.34	3.90
November	3.46	4.12	4.32	4.35	3.67½	3.79	4.90	4.17	3.78
December	3.60	4.57	4.32	5.00	3.73	3.82	4.19	4.00	3.74
Yearly average	3.73½	3.94½	4.63	4.46½	4.41	3.80½	4.33½	4.32½	4.05

The following table gives the highest and lowest prices monthly for a series of years:

Highest and lowest prices of lead at New York City, monthly, from 1870 to 1892, inclusive.

[Cents per pound.]

Years.	January.		February.		March.		April.		May.		June.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1870	(a)6.30	6.20	6.25	6.17	6.20	6.10	6.25	6.15	6.25	6.20	6.25	6.20
1871	(a)6.30	6.15	6.25	6.20	6.20	6.15	6.20	6.10	6.18	6.10	6.15	6.12
1872	(a)6.00	5.90	6.00	5.87	6.00	5.87	6.12	5.90	6.62	6.25	6.62	6.40
1873	(a)6.37	6.25	6.50	6.40	6.50	6.25	6.50	6.25	6.62	6.35	6.55	6.12
1874	(a)6.00	5.90	6.25	6.00	6.25	6.12	6.25	5.90	6.00	5.75	6.00	5.62
1875	(a)6.20	6.00	5.90	5.85	5.75	5.62	5.87	5.80	5.95	5.90	5.90	5.75
1876	(a)6.00	5.87	6.37	6.00	6.50	6.40	6.40	6.12	6.50	6.10	6.50	6.25
1877	(b)6.15	6.12	6.40	6.20	6.75	6.50	6.50	6.25	6.00	5.55	5.70	5.60
1878	4.35	4.00	3.87	3.65	3.87	3.62	3.75	3.50	3.50	3.25	3.50	3.12
1879	4.50	4.00	4.50	4.50	4.50	3.25	3.25	2.87	3.12	2.87	3.80	3.12
1880	6.10	5.50	6.00	5.87	5.95	5.30	5.75	5.40	5.25	4.40	4.75	4.50
1881	5.00	4.30	5.10	4.80	4.85	4.62	4.85	4.37	4.70	4.25	4.50	4.25
1882	5.15	4.95	5.20	5.00	5.12	4.85	5.00	4.90	4.85	4.60	4.90	4.55
1883	4.70	4.60	4.60	4.50	4.65	4.50	4.62	4.40	4.55	4.40	4.45	4.40
1884	4.50	3.75	4.10	3.75	4.15	4.10	4.05	3.62½	3.75	3.52½	3.65	3.57½
1885	3.70	3.55	3.70	3.60	3.70	3.62½	3.70	3.62½	3.75	3.60	3.85	3.62½
1886	4.70	4.50	4.90	4.60	4.95	4.85	4.90	4.65	4.75	4.65	4.90	4.65
1887	4.45	4.15	4.50	4.25	4.45	4.25	4.32½	4.20	4.70	4.30	4.70	4.50
1888	4.90	4.50	5.15	4.60	5.25	5.00	5.05	4.55	4.62½	4.00	4.10	3.65
1889	3.90	3.75	3.75	3.60	3.75	3.65	3.67½	3.60	3.87½	3.60	4.05	3.90
1890	3.85	3.80	3.85	3.75	3.95	3.85	4.07½	3.85	4.35	4.00	4.50	4.25
1891	4.50	4.05	4.50	4.25	4.37½	4.25	4.32½	4.10	4.37½	4.20	4.50	4.35
1892	4.30	4.10	4.25	4.05	4.22½	4.10	4.30	4.20	4.25	4.20	4.20	4.05

a Gold. *b* Currency.

Highest and lowest prices of lead at New York City, monthly, etc.—Continued

[Cents per pound.]

Years.	July.		August.		September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1870.....	6.30	6.20	6.37	6.32	6.37	6.30	6.37	6.25	6.35	6.25	6.35	6.25
1871.....	6.15	6.10	6.12	6.00	6.10	6.00	6.00	5.87	6.00	5.90	6.00	5.75
1872.....	6.62	6.40	6.50	6,40	6.50	6.30	6.62	6.40	6.60	6.50	6.60	6.42
1873.....	6.12	6.00	6.25	6.00	6.62	6.37	6.75	6.25	6.50	6.00	6.12	6.00
1874.....	5.80	5.62	5.80	5.65	6.10	5.65	6.35	6.10	6.50	6.25	6.40	6.12
1875.....	6.00	5.95	5.95	5.87	5.87	5.70	5.65	5.60	5.87	5.65	5.95	5.87
1876.....	6.35	6.20	6.37	6.25	6.25	6.00	6.00	5.80	5.80	5.70	5.70	5.65
1877.....	5.60	5.37	5.12	4.90	4.85	4.75	4.85	4.25	4.75	4.50	4.60	4.50
1878.....	3.62	3.25	3.50	3.20	3.45	3.25	3.60	3.37	3.95	3.60	4.00	3.90
1879.....	4.10	3.90	4.05	4.00	4.00	3.75	5.50	4.00	5.62	5.00	5.60	5.50
1880.....	4.75	4.25	5.00	4.30	4.90	4.80	4.87	4.65	4.85	4.75	4.75	4.25
1881.....	4.90	4.50	4.95	4.75	5.37	4.95	5.25	4.87	5.25	4.90	5.25	5.00
1882.....	5.15	4.90	5.10	4.95	5.15	4.95	5.15	4.85	4.90	4.50	4.75	4.50
1883.....	4.40	4.30	4.30	4.20	4.32	4.30	4.32	4.12	4.05	3.65	3.75	3.60
1884.....	3.70	3.55	3.70	3.52½	3.75	3.55	3.75	3.60	3.55	3.37½	3.75	3.50
1885.....	4.15	3.87½	4.25	4.12	4.25	4.00	4.25	4.00	4.60	4.00	4.67½	4.50
1886.....	4.90	4.75	4.80	4.75	4.70	4.45	4.30	4.00	4.40	4.10	4.35	4.25
1887.....	4.67½	4.40	4.62½	4.55	4.55	4.25	4.40	4.20	4.75	4.25	5.15	4.90
1888.....	4.07½	3.85	4.97½	4.15	5.12½	4.90	5.12½	3.62½	3.82½	3.60	3.82½	3.60
1889.....	4.05	3.80	3.95	3.75	4.00	3.85	3.90	3.75	3.90	3.75	3.90	3.75
1890.....	4.50	4.40	4.72½	4.35	5.00	4.67½	5.25	5.00	5.25	4.60	4.60	4.05
1891.....	4.45	4.30	4.55	4.40	4.55	4.40	4.55	4.10	4.35	4.10	4.25	4.25
1892.....	4.25	4.00	4.15	4.00	4.15	4.00	3.95	3.85	3.85	3.70	3.85	3.70

The following table, compiled by Mr. E. A. Caswell, shows the daily fluctuation in prices in 1892:

Price of common pig lead in New York City in 1892.

Days.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Days.
1	H	4.12½	4.15	4.22½	S	4.20	4.20	4.00	4.15	3.95	3.85	3.75	1
2	4.25	4.10	4.15	4.22½	4.25	4.20	4.25	4.00	4.15	S	3.85	3.75	2
3	S	4.10	4.15	S	4.25	4.20	S	4.00	4.15	3.95	3.85	3.70	3
4	4.30	4.10	4.15	4.22½	4.25	4.15	H	4.10	S	3.90	3.85	S	4
5	4.25	4.10	4.15	4.22½	4.25	S	4.25	4.05	H	3.90	3.85	3.70	5
6	4.25	4.05	S	4.22½	4.25	4.15	4.25	4.05	4.15	3.90	S	3.70	6
7	4.25	S	4.15	4.22½	4.20	4.15	4.25	S	4.15	3.90	3.85	3.70	7
8	4.25	4.05	4.15	4.22½	S	4.15	4.20	4.00	4.12½	3.90	H	3.70	8
9	4.20	4.05	4.15	4.22½	4.20	4.15	4.20	4.00	4.12½	S	3.80	3.70	9
10	S	4.05	4.15	S	4.20	4,10	S	4.00	4.12½	3.90	3.80	3.70	10
11	4.20	4.05	4.15	4.22½	4.20	4.10	4.15	4.00	S	3.90	3.80	S	11
12	4.20	4.05	4.15	4.22½	4.20	S	4.15	4.00	4.12½	H	3.80	3.70	12
13	4.15	4.05	S	4.22½	4.20	4.10	4.15	4.00	4.10	3.90	S	3.70	13
14	4.10	S	4.15	4.22½	4.20	4.05	4.15	S	4.10	3.90	3.80	3.70	14
15	4.10	4.05	4.15	4.22½	S	4.05	4.10	4.00	4.05	3.90	3.80	3.70	15
16	4.10	4.15	4.12½	4.22½	4.20	4.05	4.10	4.00	4.05	S	3.80	3.70	16
17	S	4.15	4.10	S	4.20	4.05	S	4.00	4.05	3.90	3.80	3.70	17
18	4.10	4.15	4.10	4.20	4.20	4.05	4.10	4.00	S	3.90	3.75	S	18
19	4.10	4.15	4.10	4.20	4.20	S	4.05	4.00	4.05	3.90	3.75	3.70	19
20	4.10	4.15	S	4.20	4.20	4.05	4.00	4.00	4.00	3.90	S	3.70	20
21	4.10	S	4.10	4.20	4.20	4.05	4.00	S	4.00	H	3.75	3.85	21
22	4.15	H	4.15	4.20	S	4.05	4.00	4.00	4.00	3.90	3.75	3.85	22
23	4.15	4.15	4.20	4.20	4.20	4.05	4.00	4.00	4.00	S	3.75	3.80	23
24	S	4.25	4.20	S	4.20	4.15	S	4.00	4.00	3.90	H	3.80	24
25	4.15	4.20	4.20	4.20	4.20	4.15	4.00	4.00	S	3.90	3.70	S	25
26	4.15	4.15	4.20	4.30	4.20	S	4.00	4.00	4.00	3.90	3.70	H	26
27	4.15	4.15	S	4.27½	4.20	4.15	4.00	4.00	4.00	3.90	S	3.80	27
28	4.12½	S	4.20	4.25	4.20	4.15	4.00	S	4.00	3.85	3.70	3.80	28
29	4.12½	4.15	4.20	4.25	S	4.20	4.00	4.15	4.00	3,85	3.75	3.75	29
30	4.12½	....	4.22½	4.20	H	4.20	4.00	4.15	4.00	S	3.75	3 75	30
31	S	....	4.22½	....	4.20	......	S	4.15	....	3.85	......	3.75	31
Average	4.17	4.11	4.16	4.22	4.21	4.12	4.10	4.02	4.07	3.90	3.78	3.74	

Lead imported and entered for consumption in the United States, 1867 to 1892, inclusive

[Calendar years ending December 31 from 1886 to 1892; previous years end June 30.]

Years.	Ore and dross.		Pigs and bars.		Sheets, pipe, and shot.		Shot.		Not otherwise specified.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*			
1867..	611	$25	65,322,923	$2,812,668	185,825	$9,560	....	....	$6,222	$2,828,475
1868..	6,945	239	63,254,677	2,668,915	142,137	7,229	....	....	6,604	2,682,987
1869..	....	....	87,865,471	3,653,481	307,424	15,531	....	....	18,885	3,687,897
1870..	5,973	176	85,895,724	3,530,837	141,681	6,879	....	....	10,444	3,548,336
1871..	316	10	91,496,715	3,721,096	86,712	4,209	....	....	8,730	3,734,045
1872..	32,331	1,425	73,086,657	2,929,623	15,518	859	....	....	20,191	2,952,098
1873..	....	....	72,423,641	3,233,011	105	12	420	$50	21,503	3,254,576
1874..	....	....	46,205,154	2,231,817	....	....	30,219	1,349	36,484	2,269,650
1875..	13,206	320	32,770,712	1,559,017	....	....	58	4	25,774	1,585,115
1876..	....	....	14,329,366	682,132	....	....	20,007	1,204	27,106	710,442
1877..	1,000	20	14,583,845	671,482	....	....	16,502	1,242	1,041	673,785
1878..	....	....	6,717,052	294,233	....	....	15,829	963	113	295,309
1879..	....	....	1,216,500	42,983	....	....	3,748	209	930	44,122
1880..	....	....	6,723,706	246,015	....	....	1,120	54	371	246,440
1881..	5,981	97	4,322,068	159,129	....	....	900	65	1,443	160,734
1882..	21,698	500	6,079,304	202,603	....	....	1,469	99	2,449	205,651
1883..	600	17	4,037,867	130,108	....	....	1,510	79	8,030	138,234
1884..	419	13	3,072,738	85,395	15,040	630	....	....	1,992	88,030
1885..	4,218	57	5,862,474	143,103	971,951	22,217	....	....	1,372	166,749
1886..	715,588	9,699	17,582,298	491,310	27,357	1,218	....	....	964	503,191
1887..	153,731	21,487	7,716,783	219,770	27,941	1,286	....	....	302	242,845
1888..	88,870	2,468	2,582,236	69,891	23,103	1,202	....	....	977	74,538
1889..	328,315	7,468	2,773,622	76,243	35,859	1,417	....	....	1,297	86,425
1890..	493,463	12,947	19,336,233	593,671	68,314	3,338	....	....	1,133	611,089
1891..	165,898	6,721	3,392,562	104,184	334,179	12,406	....	....	604	123,915
1892..	127,873	9,932	1,549,771	110,953	90,135	6,207	....	....	2,063	129,155

Old and scrap lead imported and entered for consumption in the United States, 1867 to 1889, inclusive.

Years ending—	Quantity.	Value.	Years ending—	Quantity.	Value.
	Pounds.			*Pounds.*	
June 30, 1867........	1,255,233	$53,202	June 30, 1879........	42,283	$1,153
1868........	2,465,575	101,586	1880........	213,063	5,262
1869........	2,983,272	123,068	1881........	123,018	2,729
1870........	3,756,785	150,379	1882........	220,702	5,949
1871........	2,289,688	94,467	1883........	1,094,133	31,724
1872........	4,257,778	171,324	1884........	160,356	4,830
1873........	3,545,098	151,756	1885........	4,866	106
1874........	395,516	13,897	1886........	24,726	882
1875........	382,150	13,964	1887........	136,625	4,323
1876........	265,860	9,534	1888........	33,100	904
1877........	249,645	8,383	1889........	50,816	1,494
1878........	106,342	3,756	1890........	(*a*)	(*a*)

a Included in pigs and bars after 1889.

Lead and manufactures of lead, of domestic production, exported from the United States.

Years ending—	Manufactures of— Lead.		Pewter and lead.	Bars, shot, etc.		Total value.
	Quantity.	Value.	Value.	Quantity.	Value.	
	Pounds.			*Pounds.*		
Sept. 30, 1790............	13,440	$810	....	....	....	$810
1803 (barrels)..	900	....	....	....	....	....
1804............	19,804	....	....	....	....	....
1805............	8,000	....	....	....	....	....
1808............	40,583	....	....	....	....	....
1809............	126,537	....	....	....	....	....
1810............	172,323	....	....	....	....	....
1811............	65,497	....	....	....	....	....
1812............	74,875	....	....	....	....	....
1813............	276,940	....	....	....	....	....
1814............	43,600	....	....	....	....	....
1815............	40,245	....	....	....	....	....

Lead and manufactures of lead, of domestic production, exported, etc.—Continued.

Years ending—	Manufactures of— Lead. Quantity.	Lead. Value.	Pewter and lead. Value.	Bars, shot, etc. Quantity.	Bars, shot, etc. Value.	Total value.
	Pounds.			*Pounds.*		
Sept 30, 1816	35,844					
1817	111,034	$9,993				$9,993
1818	281,168	22,493				22,493
1819	94,362	7,549				7,549
1820	25,699	1,799				1,799
1821	56,192	3,512				3,512
1822	66,316	4,244				4,244
1823	51,549	3,098				3,098
1824	18,604	1,356				1,356
1825	189,930	12,697				12,697
1826	47,337	3,347	$1,820			5,167
1827	50,160	3,761	6,183			9,944
1828	76,882	4,184	5,545			9,729
1829	179,952	8,417	5,185			13,602
1830	128,417	4,831	4,172			9,003
1831	152,578	7,068	6,422			13,490
1832	72,439	4,483	983			5,466
1833	119,407	5,685	2,010			7,695
1834	13,480	805	2,224			3,029
1835	50,418	2,741	433			3,174
1836	34,600	2,218	4,777			6,995
1837	297,488	17,015	3,132			20,147
1838	375,231	21,747	6,461			28,208
1839	81,377	6,003	12,637			18,640
1840	882,620	39,687	15,296			54,983
1841	2,177,164	96,748	20,546			117,294
1842	14,552,357	523,428	16,789			540,217
June 30, 1843 (9 months)	15,366,918	492,765	7,121			499,886
1844	18,420,407	595,238	10,018			605,256
1845	10,188,024	342,646	14,404			357,050
1846	16,823,766	614,518	10,278			624,796
1847	3,326,028	124,981	13,694			138,675
1848	1,994,704	84,278	7,739			92,017
1849	680,249	30,198	13,196			43,394
1850	261,123	12,797	22,682			35,479
1851			16,426	229,448	$11,774	28,200
1852			18,469	747,930	32,725	51,194
1853			14,064	100,778	5,540	19,604
1854			16,478	404,247	26,874	43,352
1855			5,233	165,533	14,298	19,531
1856			5,628	310,029	27,512	33,140
1857			4,818	870,544	58,624	63,442
1858			27,327	900,607	48,119	75,446
1859			28,782	313,988	28,575	57,357
1860			56,081	903,468	50,446	106,527
1861			30,534	109,023	6,241	36,775
1862			28,832	79,231	7,334	36,166
1863			30,609	237,239	22,634	53,243
1864			30,411	223,752	18,718	49,129
1865			29,271	852,895	132,666	161,937
1866			44,483	25,278	2,323	46,806
1867			27,559	99,158	5,300	32,859
1868			37,111	438,040	34,218	71,329
1869			17,249			17,249
1870		$28,315				28,315
1871		79,880				79,880
1872		48,132				48,132
1873		13,392				13,392
1874		302,044				302,044
1875		429,309				429,309
1876		102,726				102,726
1877		49,835				49,835
1878		314,904				314,904
1879		280,771				280,771
1880		49.899				49,899
1881		39,710				39,710
1882		178,779				178,779
1883		43,108				43,108
1884		135,156				135,156
1885		123,466				123,466
Dec. 31, 1886		136,666				136,666
1887		140,065				140,065
1888		194,216				194,216
1889		161,614				161,614
1890		181,030				181.030
1891		173,887				173,887
1892		154,375				154,375

ZINC.

By C. Kirchhoff.

Compared with the enormous development of the spelter industry in the United States during the year 1891, the increase in production during 1892 has been relatively small. Reports from all the mills in the United States show that the production has been as follows:

Production of spelter in the United States.

Years.	Short tons.	Years.	Short tons.
1873	7, 343	1886	42, 641
1875	15, 833	1887	50, 340
1880 (census year ending May 31)	23, 239	1888	55, 903
1882	33, 765	1889	58, 860
1883	36, 872	1890	63, 683
1884	38, 544	1891	80, 837
1885	40, 688	1892	87, 260

For a series of years the production has been as follows:

Production of spelter in the United States by States.

Years.	Eastern and Southern States.	Illinois.	Kansas.	Missouri.	Total.
	Short tons	*Short tons*	*Short tons*	*Short tons*	*Short tons*
1882	5, 698	18, 201	7, 366	2, 500	33, 765
1883	5, 340	16, 792	9, 010	5, 730	36, 872
1884	7, 861	17, 594	7, 859	5, 230	38, 544
1885	8, 082	19, 427	8, 502	4, 677	40, 688
1886	6, 762	21, 077	8, 932	5, 870	42, 641
1887	7, 446	22, 279	11, 955	8, 660	50, 340
1888	9, 561	22, 445	10, 432	13, 465	55, 903
1889	10, 265	23, 860	13, 658	11, 077	58, 860
1890	9, 114	26, 243	15, 199	13, 127	63, 683
1891	8, 945 4, 217	28, 711	22, 747	16, 253	80, 873
1892	9, 582 4, 913	*a*31,383	24, 715	16, 667	87, 260

a Including Indiana.

The larger number of works in the Eastern and Southern States has made it possible to separate the figures formerly presented in one group without revealing individual returns. In the above table the upper larger figures in 1891 and 1892 relate to the Eastern States.

During the first six months of the years 1892 and 1893 the production of spelter has been as follows:

Production of spelter in the first six months of 1892 and 1893.

States.	First six months 1892.	First six months 1893.
	Short tons.	*Short tons.*
Eastern and Southern States	6,901	7,380
Illinois and Indiana	15,483	16,427
Kansas	14,161	13,269
Missouri	8,954	8,718
Total	45,499	45,794

The growth in production during 1892 has been due to partial or full work on the part of new concerns, like the Wenona in Illinois, the Columbia in Indiana, and the American in Kansas. Some of the older companies, too, notably enlarged their operations. The Illinois Zinc Company did more in 1892 than in 1891. In Kansas the Pittsburg and Saint Louis Company rose to full production. The Weir City Company added four furnaces at Pittsburg and two at Weir City, thus making each plant consist of 12 furnaces, so that its capacity makes it the largest zinc producer west of the Mississippi. On the other hand, the Granby Company had its plant idle during the greater part of 1892 and during the first six months of 1893. The Girard Company fired a new block on December 15, 1892, and put up also a new four-story roasting kiln.

In the East, the Delaware Metal Refinery doubled its production in 1890, and at the close of the year had completed additions to the plant which carry the capacity up to 2,000 tons annually. Both the Lehigh and the Bertha companies yielded a greater product in 1892 than in 1891.

Stocks.—Reports from the producers show the following stocks. The figures, however, must be accepted with some reserve, since there is evidence that in some cases the true totals are withheld by producers for commercial reasons.

Stocks of spelter.

	January 1, 1889.	January 1, 1890.	January 1, 1891.	January 1, 1892.	January 1, 1893.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Eastern and Southern States	1,621	1,149	788	2,367	3,316
Illinois	580	304	68	32	12
Kansas	800	1,075	233	1,065	483
Missouri	....	43	45	61	349
Total	2,781	2,535	1,134	3,525	4,160

The increase in the stocks on hand has, therefore, taken place chiefly in the Eastern and Southern States.

Zinc oxide.—Reports from the works which make oxide from ore are not complete. The total product may be estimated at 26,829 short tons. The four principal works in New Jersey and Pennsylvania and one small producer show a total of 19,129 short tons, while the Western works produced about 7,700 tons.

Local authorities have compiled the following statistics of production of zinc ore for the Joplin district for the year 1892:

Zinc ore production in the Joplin district in 1892.

	Pounds.		Pounds.
Joplin	74, 526, 560	Lehigh	2, 292, 120
Cartersville	94, 136, 660	Burch Creek	366, 600
Webb City	30, 485, 570	Wentworth	525, 700
Galena	43, 447, 250	Carthage	9, 049, 073
Zincite	8, 100, 730		
Oronogo	2, 051, 530	Total	266, 632, 543

Southwest Wisconsin.—Prof. W. P. Blake, in a paper read at the Chicago meeting of the American Institute of Mining Engineers, gives the shipments from Benton, the principal ore-shipping station, as 13,800,000 pounds.

PRICES OF ZINC.

The following table summarizes the prices of spelter since 1875:

Prices of common Western spelter in New York City, 1875 to 1892, inclusive.

[Cents per pound. Figures in parentheses are combination prices.]

Years.	January.		February.		March.		April.		May.		June.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1875	6. 75	6. 37	6. 67	6. 25	6. 50	6. 20	(7. 00)	6. 50	(7. 25)	7. 15	(7. 25)	7. 15
1876	(7. 60)	7. 40	(7. 75)	7. 50	(7. 75)	7. 62	(8. 00)	7. 60	(8. 00)	7. 75	(8. 00)	7. 25
1877	6. 50	6. 25	6. 62	6. 50	6. 50	6. 37	6. 37	6. 25	6. 25	6. 00	6. 12	5. 87
1878	5. 75	5. 50	5. 62	5. 25	5. 62	5. 25	5. 25	5. 00	5. 00	4. 62	4. 62	4. 25
1879	4. 50	4. 25	4. 62	4. 40	4. 62	4. 37	4. 75	4. 25	4. 50	4. 25	4. 37	4. 12
1880	6. 50	5. 87	6. 75	6. 37	6. 75	6. 50	6. 50	6. 12	6. 00	5. 62	5. 50	5. 12
1881	5. 25	4. 87	5. 25	5. 12	5. 00	4. 87	5. 12	4. 75	5. 00	4. 87	5. 00	4. 75
1882	6. 00	5. 75	5. 75	5. 62	5. 62	5. 37	5. 50	5. 25	5. 62	5. 25	5. 37	5. 25
1883	4. 62	4. 50	4. 62	4. 50	4. 75	4. 62	4. 75	4. 60	4. 75	4. 50	4. 62	4. 37
1884	4. 37	4. 20	4. 40	4. 25	4. 60	4. 40	4. 65	4. 50	4. 60	4. 45	4. 60	4. 45
1885	4. 50	4. 12	4. 30	4. 25	4. 30	4. 12	4. 30	4. 12	4. 25	4. 10	4. 10	4. 00
1886	4. 50	4. 30	4. 55	4. 30	4. 60	4. 50	4. 60	4. 50	4. 60	4. 40	4. 40	4. 35
1887	4. 60	4. 50	4. 60	4. 40	4. 60	4. 40	4. 65	4. 45	4. 65	4. 45	4. 65	4. 50
1888	5. 37	5. 20	5. 35	5. 25	5. 25	4. 87	4. 87	4. 60	4. 65	4. 60	4. 60	4. 50
1889	5. 00	5. 00	5. 00	4. 90	4. 87	4. 70	4. 65	4. 65	4. 85	4. 62	5. 00	5. 00
1890	5. 45	5. 35	5. 35	5. 20	5. 20	5. 00	5. 00	4. 90	5. 45	5. 00	5. 60	5. 35
1891	6. 00	5. 25	5. 25	5. 00	5. 10	5. 00	5. 10	4. 90	4. 90	4. 85	5. 10	4. 90
1892	4. 70	4. 60	4. 60	4. 55	4. 60	4. 50	4. 80	4. 60	4. 90	4. 80	4. 90	4. 80

Prices of common Western spelter in New York City, 1875 to 1892, etc.—Continued.

[Cents per pound. Figures in parentheses are combination prices.]

Years.	July.		August.		September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1875	(7.35)	7.25	(7.25)	7.10	(7.25)	7.10	(7.40)	7.15	(7.40)	7.15	(7.40)	7.15
1876	7.25	7.12	7.25	7.00	7.12	6.80	6.75	6.62	6.62	6.37	6.50	6.37
1877	5.87	5.62	5.90	5.80	5.87	5.75	5.90	5.70	5.87	5.62	5.75	5.50
1878	4.75	4.50	4.87	4.50	4.87	4.75	4.82	4.50	4.75	4.50	4.37	4.25
1879	4.75	4.37	5.62	4.80	6.00	5.62	6.37	6.00	6.25	5.87	6.25	6.00
1880	5.00	4.87	5.25	4.87	5.12	4.75	5.00	4.87	4.90	4.65	4.75	4.65
1881	5.00	4.75	5.12	5.00	5.25	5.00	5.37	5.25	5.87	5.50	6.00	5.87
1882	5.37	5.12	5.50	5.12	5.37	5.12	5.37	5.12	5.12	4.87	4.87	4.50
1883	4.50	4.30	4.40	4.30	4.50	4.40	4.45	4.35	4.40	4.37	4.37	4.35
1884	4.55	4.45	4.62	4.52	4.62	4.50	4.55	4.40	4.40	4.30	4.25	4.00
1885	4.40	4.10	4.60	4.40	4.62	4.50	4.62	4.50	4.60	4.45	4.60	4.45
1886	4.40	4.30	4.40	4.30	4.40	4.25	4.30	4.25	4.30	4.25	4.50	4.35
1887	4.50	4.50	4.60	4.55	4.65	4.60	4.65	4.50	4.80	4.52	5.87	5.00
1888	4.55	4.50	4.87	4.50	5.12	4.75	5.12	4.87	5.12	4.87	5.12	4.87
1889	5.10	5.00	5.20	5.15	5.15	5.10	5.15	5.10	5.25	5.05	5.35	5.30
1890	5.60	5.40	5.55	5.40	5.65	5.50	6.00	5.65	6.10	5.90	6.00	5.90
1891	5.10	5.05	5.10	5.00	5.00	4.85	5.15	4.95	4.90	4.75	4.75	4.65
1892	4.85	4.70	4.70	4.65	4.65	4.50	4.50	4.35	4.40	4.35	4.40	4.35

The pressure of a heavy production told during the whole of the year 1892. There was a dragging market, with conservative purchases by galvanizers and brass manufacturers, until late in February some relief was obtained by export sales of western spelter. Larger quantities were disposed of to foreign buyers in March and April, which brought about a recovery to 4.75 to 4.80 cents in April. Floods in the Western mines in May kept the market steady, but the second half of the year witnessed an almost steadily declining, dull market, the supply being excessive, the demand moderate, and the possibility of relief by export shipments being cut off through the decline abroad. In all, over 6,000 tons of spelter were exported during the year.

IMPORTS AND EXPORTS.

Zinc imported and entered for consumption in the United States, 1867 to 1892, inclusive.

Years ending—	Blocks or pigs.		Sheets.		Old.		Value of manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
	Pounds.		*Pounds.*		*Pounds.*			
June 30, 1867..	5,752,611	$256,366	5,142,417	$311,767	....	....	$1,835	$569,968
1868..	9,327,968	417,273	3,557,448	203,883	....	....	1,623	622,779
1869..	13,211,575	590,332	8,306,723	478,646	....	....	2,083	1,071,061
1870..	9,221,121	415,497	9,542,687	509,860	....	....	21,696	947,053
1871..	11,159,040	508,355	7,646,821	409,243	....	....	26,366	943,964
1872..	11,802,247	522,524	10,704,944	593,885	....	....	58,668	1,175,077
1873..	6,839,897	331,399	11,122,143	715,706	....	....	56,813	1,103,918
1874..	3,593,570	203,479	6,016,835	424,504	....	....	48,304	676,287
1875..	2,034,252	101,766	7,320,713	444,539	....	....	26,330	572,635
1876..	947,322	56,082	4,611,360	298,308	....	....	18,427	372,817
1877..	1,266,894	63,250	1,341,333	81,815	....	....	2,496	147,561
1878..	1,270,184	57,753	1,255,620	69,381	....	....	4,892	132,026
1879..	1,419,791	53,294	1,111,225	53,050	....	....	3,374	109,718
1880..	8,092,620	371,920	4,069,310	210,230	....	....	3,571	585,721
1881..	2,859,216	125,457	2,727,324	129,158	....	....	7,603	262,218
1882..	18,408,391	736,964	4,413,042	207,032	....	....	4,940	948,936
1883..	17,067,211	655,503	3,309,239	141,823	....	....	5,606	802,932
1884..	5,869,738	208,852	952,253	36,120	....	....	4,795	249,767
1885..	3,515,840	113,268	1,839,860	64,781	....	....	2,054	180,103
Dec. 31, 1886..	4,300,830	136,138	1,092,400	40,320	....	....	9,162	185,620
1887..	8,387,647	276,122	926,150	32,526	....	....	11,329	319,977
1888..	3,825,947	146,156	295,287	12,558	....	....	12,080	170,794
1889..	2,052,559	77,845	1,014,873	43,356	....	....	19,580	140,781
1890..	1,997,524	101,335	781,266	43,495	....	....	9,740	154,570
1891..	808,094	41,199	21,948	1,460	....	....	....	42,659
1892..	297,969	16,520	27,272	2,216	115,293	$6,556	20,677	45,969

Imports of zinc oxide from 1885 to 1892, inclusive.

Years ending—	Dry.	In oil.
	Pounds.	*Pounds.*
June 30, 1885	2,233,128	98,566
Dec. 31, 1886	3,526,289	79,788
1887	4,961,080	123,216
1888	1,401,342	51,985
1889	2,686,861	66,240
1890	2,631,458	102,298
1891	2,839,351	128,140
1892	2,442,014	111,190

Exports of zinc and zinc ore of domestic production, 1864 to 1892, inclusive.

Years ending—	Ore or oxide.		Plates, sheets, pigs, or bars.		Value of manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.		
	Cwt.		*Pounds.*			
June 30, 1864	14,810	$116,431	95,738	$12,269	....	$128,700
1865	99,371	114,149	184,183	22,740	....	136,889
1866	4,485	25,091	140,798	13,290	....	38,381
1867	3,676	32,041	312,227	30,587	....	62,628
1868	8,344	74,706	1,022,699	68,214	....	142,920
1869	....	65,411	....	....	....	65,411
1870	15,286	81,487	110,157	10,672	....	92,159
1871	9,621	48,292	76,380	7,823	....	56,115
1872	3,686	20,880	62,919	5,726	....	26,606
1873	234	2,304	73,953	4,656	....	6,960
1874	2,550	20,037	43,566	3,612	....	23,649
1875	3,083	20,659	38,090	4,245	$1,000	25,904
1876	10,178	66,259	134,542	11,651	4,333	82,243
1877	6,428	34,468	1,419,922	115,122	1,118	150,708
1878	16,050	83,831	2,545,320	216,580	567	300,978
1879	10,660	40,399	2,132,949	170,654	....	211,053
1880	13,024	42,036	1,368,302	119,264	....	161,300
1881	11,390	16,405	1,491,786	132,805	168	149,378
1882	10,904	13,736	1,489,552	124,638	....	138,374
1883	3,045	11,509	852,333	70,981	734	83,224
1884	4,780	16,685	126,043	9,576	4,666	30,927
1885	6,840	22,824	101,685	7,270	4,991	35,085
Dec. 31, 1886	26,620	49,455	917,229	75,192	13,526	138,173
1887	4,700	17,286	136,670	9,017	16,789	43,092
1888	4,560	18,034	62,234	4,270	19,098	41,402
1889	26,760	73,802	879,785	44,049	35,732	153,583
1890	77,360	195,113	3,295,584	126,291	23,587	344,991
1891	3,791	149,435	4,294,656	278,182	38,921	466,538
1892	919	41,186	12,494,335	669,549	166,794	836,343

FOREIGN SPELTER PRODUCTION.

Messrs. Henry R. Merton & Co., of London, make the following report on the spelter production of Europe:

Estimate of the production of zinc in Europe.

Countries.	1892.	1891.	1890.	1889.	1888.	1887.	1886.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Rhine district and Belgium	143,505	139,695	137,630	134,648	133,245	130,995	129,020
Silesia	87,760	87,080	87,475	85,483	83,375	81,375	81,630
Great Britain	28,590	29,410	29,145	30,806	26,783	19,339	20,730
France and Spain	18,462	18,360	18,240	16,785	16,140	16,028	15,305
Poland	4,270	3,760	3,620	3,026	3,785	3,580	4,145
Austria	5,020	6,440	7,135	6,330	4,977	5,338	5,000
Total	287,607	284,745	283,245	277,078	268,305	256,655	255,830

Countries.	1885.	1884.	1883.	1882.	1881.	1880.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Rhine district and Belgium	129,754	129,240	123,891	119,193	110,989	98,830
Silesia	79,623	76,116	70,405	68,811	66,497	64,459
Great Britain	24,299	29,259	28,661	25,581	24,419	(*a*) 22,000
France and Spain	14,847	15,341	14,671	18,075	(*a*) 18,358	15,000
Poland	5,019	4,164	3,733	4,400	(*a*) 4,000	(*a*) 4,000
Austria	5,610	6,170	6,267	6,709	5,825	5,970
Total	259,152	260,290	247,628	242,769	230,088	210,259

a Estimated.

The output of the works in the different districts was as follows:

Productions of zinc by principal foreign producers.

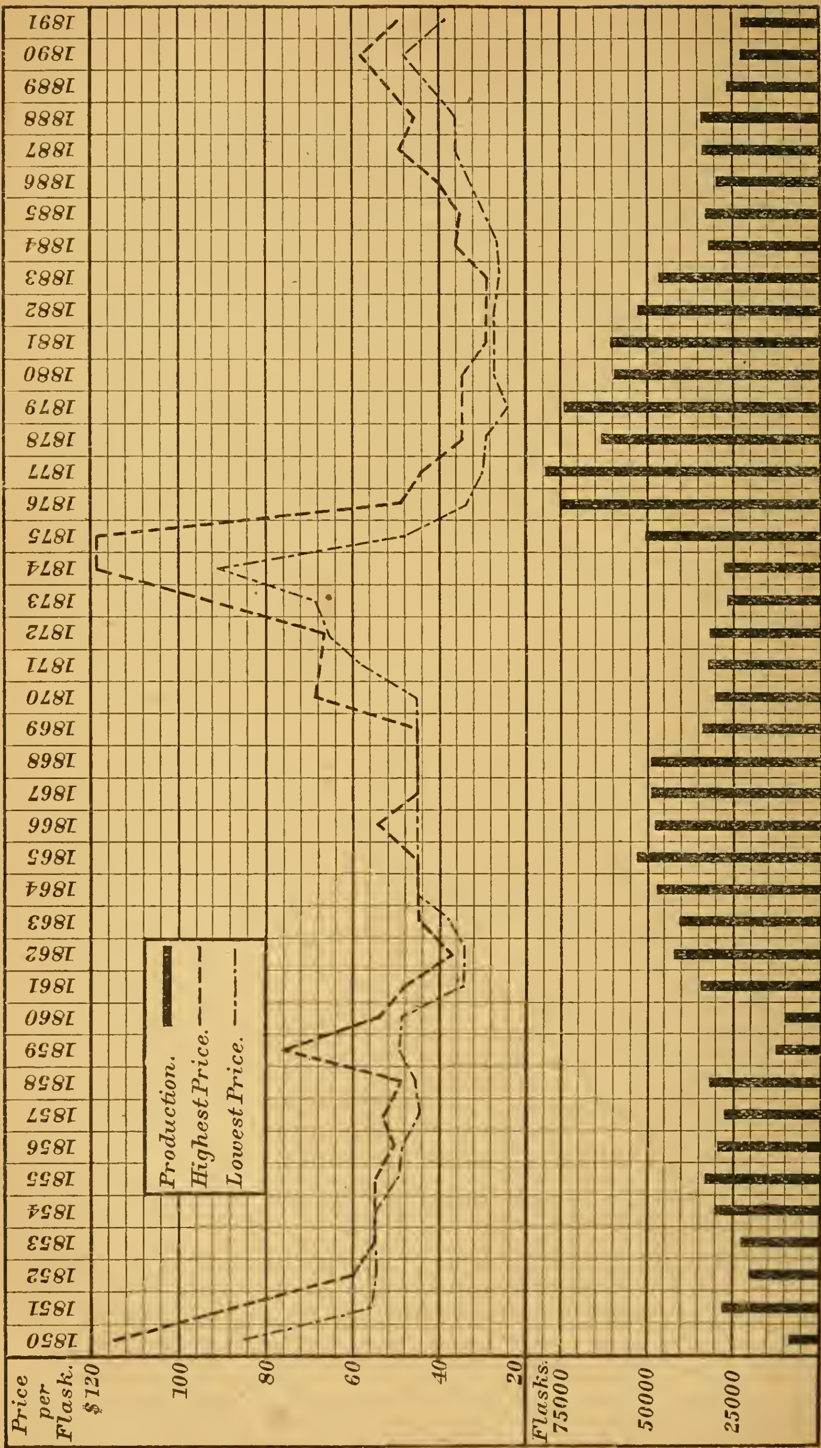
Districts.	1892.	1891.	1890.	1889.	1888.	1887.	1886.	1885.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Rhine district and Belgium:								
Vieille Montagne	55,770	53,820	52,865	52,016	51,670	51,517	50,790	50,687
Stolberg Co	14,950	15,040	14,855	14,634	14,036	14,070	14,065	14,452
Austro-Belge	9,720	9,425	9,250	9,245	9,140	9,280	9,130	9,610
G. Dumont & Frères	8,675	8,370	8,350	8,863	8,759	8,368	8,000	7,072
Rhein-Nassau Co	8,040	8,075	7,960	7,470	7,586	7,588	7,730	7,676
L. de Laminne	6,845	6,810	6,760	6,693	6,597	6,745	6,550	7,039
Escombrera Bleyberg	6,070	5,770	5,630	5,560	4,930	4,925	5,315	5,835
Grillo	5,550	5,390	5,490	5,353	5,299	5,100	5,075	5,159
Märk, Westf., Bergw., Ver	5,540	5,600	5,485	5,805	5,537	5,553	4,950	4,429
Nouvelle Montagne	5,240	5,550	5,350	5,090	5,032	4,975	4,995	5,079
Berzelius	5,290	5,155	5,175	4,910	4,818	4,890	4,985	5,046
Eschger Ghesquière & Co	4,100	3,840	4,065	4,303	4,137	4,079	3,710	3,792
Société Prayon	4,085	4,130	4,100	3,956	3,906	3,905	3,725	3,879
Société de Boom	5,430	2,720	2,295	(*a*) 750	1,798	....	....	....
St. Amand	200	....	....	....	....	....	....	....
	143,505	139,695	137,630	134,648	133,245	130,995	129,020	129,754
Silesia:								
Schlesische Actien-Gesellschaft	24,915	25,245	24,840	23,675	22,917	22,680	22,730	21,750
G. von Giesche's Erben	18,295	18,700	18,550	18,206	17,594	17,600	17,505	16,782
Herzog von Ujest	17,085	16,795	16,355	16,202	15,456	15,835	15,610	15,595
Graf H. Henckel von Donnersmarck	11,115	11,230	11,670	11,392	11,193	11,565	9,355	9,680
Graefin Schaffgotsch	6,070	5,310	6,265	6,405	6,402	6,430	6,505	6,091
Graf G. Henckel von Donnersmarck	4,070	3,905	4,090	3,943	4,114	1,565	1,670	1,682
Graf Lazy Henckel von Donnersmarck (included in Graf H. Henckel v. D.)	....	....	....	....	....	....	2,450	2,165
H. Roth	1,845	1,730	1,750	1,660	1,555	1,670	1,675	1,733
Wünsch	2,120	1,920	1,880	1,907	1,906	1,885	1,860	1,858
Vereinigte Königs & Laurahütte	1,230	1,180	1,020	1,130	1,166	1,065	1,185	1,305
Baron v. Horschitz'sche Erben	875	850	830	963	935	910	915	876
Fiscus	140	215	225	170	137	170	170	106
	87,760	87,080	87,475	85,653	83,375	81,375	81,630	79,623
Great Britain:								
Vivian & Sons	7,791	7,235	6,605	6,842	6,510	4,840	7,389	8,048
English Crown Spelter Co. (Limited)	5,527	5,180	4,945	4,981	4,980	4,007	3,248	3,500
Dillwyn & Co	3,759	3,580	3,930	4,540	3,904	2,843	3,015	2,967
Swansea Vale Spelter Co	2,063	1,840	1,615	2,161	2,150	1,798	2,060	2,185
Villiers Spelter Co	1,920	2,125	1,890	2,180	1,993	1,810	1,880	1,985
Pascoe, Grenfell & Sons	1,080	1,060	1,160	1,272	1,330	1,124	727	1,082
Nenthead & Tynedale Co	1,600	1,440	1,530	1,507	1,516	1,317	1,193	1,380
John Lysaght (Limited)	3,000	4,185	4,450	5,113	3,750	1,600	1,218	1,952
Staffordshire Knot	....	....	350	1,100	150	....	....	700
Minera Mines	1,350	2,265	2,170	610	....	....	....	....
H. Kenyon & Co	500	500	500	500	500	500	500	500
	28,590	29,410	29,145	30,806	26,783	19,839	21,230	24,299
France and Spain:								
Asturienne	18,462	18,360	18,240	16,785	16,140	16,028	15,305	14,847
Austria:								
Sagor	1,475	1,280	1,430	1,210	1,087	866	1,000	970
Cilli	1,710	1,810	1,880	1,670	1,240	1,275	1,360	1,440
Siersza-Niedzieliska	1,835	3,350	3,825	3,450	2,650	3,200	2,640	3,200
	5,020	6,440	7,135	6,330	4,977	5,338	5,000	5,610
Poland	4,270	3,760	3,620	3,026	(*a*)3,785	3,580	4,145	5,019

a Estimated.

Very complete metallurgical statistics are published annually relative to the zinc industry of Upper Silesia. The following are the principal data for the year 1892, the bracketed figures covering the year 1891: Twenty-three works used 156,147 (159,285) muffles in 188 (104) ordinary and 316 (392) Siemens gas furnaces, employing 7,168 (7,083) men, to whom 4,931,537 marks (4,808,166 marks) were paid in wages. The materials used were 561,187 metric tons (568,246), of which 287,990 tons were carbonate, 188,685 tons blende, 2,022 tons furnace scrap, and 10,478 tons zinc dust, etc. The fuel consumption was 1,018,591 tons (978,813) of coal.

The product was 89,175 tons of spelter (88,240), 3,206 tons of cadmium (2,849), and 716 tons (772) of argentiferous lead, valued at 34,735,141 marks (39,367,900 marks).

In the rolling mills 649 (663) workmen, to whom 458,926 (493,319) marks in wages were paid, produced 33,266 tons (37,669) of sheet zinc, valued at 13,578,534 (17,211,765) marks, including the value of some by-products. For the production there was required 34,369 (38,922) tons of spelter, the fuel consumption being 38,473 (41,788) tons.



Production and Price of Quicksilver in the United States.

QUICKSILVER ORE DEPOSITS.

By George F. Becker.

The following pages are intended to present the subject of quicksilver ore-deposits in a convenient shape for mining engineers, and they contain little that is absolutely new. Monograph XIII of the U. S. Geological Survey, completed in 1887, describes the quicksilver deposits of the Pacific slope in detail and gives a sketch of the more important deposits throughout the world. Since that time interesting memoirs by Prof. A. Schrauf, on Idria (*a*), and by Mr. P. de Ferrari, on the mines of Monte Amiata (*b*), have appeared, and their results have been used in this paper. A few simple experiments on the precipitating effects of bitumen on mercuric sulphide are incorporated, the importance of recent advances in the study of osmosis is pointed out, and the conditions under which different forms of deposit occur are outlined.

The first part of the paper deals with the observed facts of the occurrence of mercurial deposits, such as the mineral association, the age of the wall rocks, and the like. A second section treats of the inferences which have been drawn as to the transportation and precipitation of ores, and the classification of deposits. Finally, such information as is available with respect to recent discoveries is recorded.

References to the literature are given only when they are not to be found in Monograph XIII. Readers not satisfied with the information here presented would probably need to consult that report, even if the bibliography were entirely reproduced here.

Appended to the paper will be found the statistics published from year to year in this volume. The data for the United States are due almost entirely to Mr. J. B. Randol, who has also compiled the foreign statistics.

DATA FROM OBSERVATION.

Ores.—The number of mercurial minerals is considerable, though but few of them are of any economical importance. (*c*) Native quicksilver seldom occurs excepting in small globules accompanying cinnabar, though pockets containing several pounds of the metal have been met with. The native metal formerly enjoyed an exaggerated importance from the fact that "virgin" mercury was supposed to be superior to that reduced from the ores and fetched a higher price. This unfounded notion prevailed even in the last century. Pliny and other ancient authors distinguished native quicksilver as *argentum vivum* from the product of reduction, *hydrargyrum*. Agricola, however, was perfectly aware that no difference existed between the two. (*d*) Cinnabar, which

a Jahrbuch k. k. Geol. Reichsanstalt, vol. 41, 1892, p. 349.
b Appendice alla Revista mineraria del 1889, 1890.
c See Dana's Mineralogy, 1892, for these ores.
d De natura fossilium, 1546, liber viii.

is the minium of the ancients, and identical with the vermilion (*a*) of the moderns, is well known to be the principal ore of quicksilver. In ancient times selected pieces of the ore were ground to vermilion and curiously enough this manufacture was revived in California in the "fifties" on a small scale. Though cinnabar has been actively mined since before the Christian era, it was only in 1848 that the black sulphide was expressly noticed in the Bavarian Palatinate, and it was first described as an independent mineral species by Dr. G. E. Moore in 1870, from California, where it occurs at the Redington, Reed, Baker, New Almaden, Cerro Gordo, and New Idria mines. It has since been found in other countries, for example, in Mexico, Italy, New Zealand, and most recently in the famous Idria mine in Austria. It is not always amorphous, but mineralogists are not yet agreed as to its crystal system. (*b*) It has been, locally at least, an important ore. Closely allied to metacinnabarite, if not absolutely identical with it, is guadalcázarite, a black mercuric sulphide containing a little selenium and a small amount of zinc, both of variable amount. It does not seem probable that the selenium and zinc are essential portions of the mineral. Leviglianite is a ferriferous guadalcázarite, the type specimens being Italian.

Tiemannite has the formula Hg Se. It occurred in Utah in sufficient quantities to form for a time the basis of a small quicksilver industry. It was discovered in the Harz mountains and has been found in Mexico and elsewhere. It has very recently been described from the Argentine Republic. Onofrite is intermediate between the selenide and the sulphide, its formula being Hg (S Se), and is often associated with tiemannite. Metacinnabarite has sometimes been mistaken for onofrite and care should be used to distinguish them. Lehrbachite is a mixture or union of Hg_2 Se with Pb Se and is rare. Coloradoite is the telluride HgTe and occurs sparingly with other tellurides in Colorado. This is the only form in which quicksilver is found in the Rocky Mountains, so far as I have heard.

Mercurial tetrahedrite occurs particularly in Hungary, and quicksilver has been obtained from it as a by-product. Livingstonite, found in Mexico at Huitzuco and Quadalcázar, is an allied sulphosalt, HgS, 2 Sb^2 S^3.

Calomel, as a product of decomposition of other ores, is occasionally met with at quicksilver mines in small quantities.

History and uses.—The use of cinnabar as a pigment was known long

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a Vermilion is derived from *vermes* and meant originally the carmine pigment from the kermes insect Similarly minium has come to be the recognized name of an oxide of lead often substituted for cinnabar. The word cinnabar is of Asiatic origin and suggests a forgotten quicksilver industry in Persia or India. The ancients obtained some quicksilver from Asia Minor. (F. X. M. Zippe, Geschichte der Metalle, 1857, p. 208.)

b Prof. A. Schrauf determines the crystals from Idria as tesseral. Jahrbuch k. k. Geol. Reichsanstalt, vol. 41, 1891, p. 356. W. H. Melville, whose recent death is greatly to be deplored, determined some excellent crystals as hexagonal. Am Jour. Sci., vol. 40, 1890, p. 291.

before the Christian era, and it is said that Theophrastus (300 B. C.) described the process of the manufacture of vermilion in the dry way (*a*). It has also been known to the Chinese for many centuries. The preparation of vermilion in the wet way is modern.

The ancients were aware of many of the properties of amalgams and practiced fire gilding (*b*). The metallurgical process known as silver amalgamation, or the decomposition of silver compounds by the action of mercury, is ascribed to Bartholomé de Médina, a Mexican miner, in 1557.

The manufacture of vermilion and the amalgamation of silver ores are the chief uses for quicksilver. The amount used for fulminating powder, fire gilding, mirror backs, meteorological and other philosophical instruments, for medicine and for poison, is comparatively insignificant. The low price of this metal is due to its restricted uses.

Geographical distribution.—The great quicksilver-producing localities have been few. Almaden in Spain, Idria in southern Austria, Huancavelica in Peru, California, and the province of Kwei-chau in China have yielded most of the product since the Christian era. Smaller mines have existed in many localities, and traces of the metal are widely disseminated. If one enters the known localities on a map of the world, it appears that they are mainly distributed along the great mountain chain of Eurasia (for which I have suggested the name Alpimalayan chain), the volcanic belt of the eastern shore of Asia, and the western Cordilleras of North and South America. In other words, the deposits nearly coincide with the lines of most profound geological disturbance.

Quicksilver also occurs in the Italian mountains, mere offshoots of the Alps, and traces of little or no economical importance are found in Algeria, in the Harz, the Urals, in Siberia, the East Indian islands, and Australasia. The metal has also been detected in Nova Scotia, Santo Domingo, and Brazil. (*c*) Very recently it has been found in the Argentine republic and in the Transvaal.

Association with eruptive phenomena.—It follows from the mere distribution of the quicksilver deposits that they must frequently be associated with eruptive rocks, for the great mountain chains of the world are closely interspersed with massive rocks of various ages. But the association of the ore with eruptives is in a great many cases too close to permit of the hypothesis that the collocation is accidental. In the neighborhood of Almaden, where there are over seventy distinct occurrences of the ore, diabase is abundantly distributed, and in the great mine amygdaloid diabase is found carrying stringers and pockets of cinnabar. At Idria there is a tuff related to rhyolite, of which Pro-

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a B. Kerl, Muspratt's Chemie, Art. Quicksilver.

b Berthelot, Introduction à l'étude de la chimie ancienne, 1889, p. 40 et passim.

c A map showing the above localities has been printed in U. S. Geol. Survey Monograph XIII, Plate II.

fessor Schrauf says that it perhaps plays the same part as the diabase in Almaden. In Italy, near Monte Amiata, cinnabar is found in the lavas (trachyte passing over into andesite). The famous Vallalta deposit is also at the contact between quartz-porphyry and Triassic rocks. In Transylvania a vein carrying cinnabar exists at the contact between a dike of lava and shales. In Persia cinnabar is found in basalt.

In California, near Clear Lake, there are deposits in andesite, dacite, and basalt. In Napa county, near Ætna Springs, cinnabar was found on the contact between basalt and sandstone, both in the Starr claim and in the Silver Bow, and there was a similar occurrence in the Manhattan claim at Knoxville.

In Mexico Humboldt describes a vein carrying cinnabar "in veritable pitchstone porphyry," and there are other occurrences of this ore in eruptive rocks in that country. Cortázar states that the quicksilver ores of Mexico are everywhere found near eruptive rocks. In Peru quicksilver is reported in trachyte near Cajamarca and again at Ayaviri. In New Zealand also cinnabar occurs in lava.

In addition to this list of direct associations, which is not exhaustive, there are a considerable number of cases in which cinnabar is immediately or closely associated with hot springs almost beyond peradventure of volcanic origin.

In America deposition is going on from the highly heated waters of Sulphur Bank, California, and at Steamboat Springs, Nevada. A hot stream also issues from the workings of the Valley mine. Hot moist gases emanated from certain workings of the Redington mine. At the Manzanita mine, Colusa county, very hot springs exist a few hundred feet from the deposit which itself contains free sulphur and other indications of solfataric action, though there seems to be no lava near by. In Mexico, also, in the Guadalcázar district, free sulphur is associated with cinnabar. In Peru cinnabar is found at the Baths of Jesus, and close to the famous Huancavelica mines are extensive hot springs.

Quicksilver or its ores are reported from the fumeroles at Pozzuoli, near Naples, from a hot spring at St. Nectaire, Puy de Dome, France, (*a*) and from near Lake Omapere, New Zealand. The quicksilver found at the Great Geyser in Iceland probably came from a broken barometer. (*b*)

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a M. Garrigou states that he found in the Rocher spring traces of Cu., Pb., Ag, Hg, As, Sb, and Sn. Comptes Rendus, vol. 84, 1877, p. 963.

b Professor Schrauf mentions also as supplementary to my list Estelnek in Transylvania and Neumark in Galicia as containing mercurial springs on the authority of J. Grimm; Oest. Berg- und Hüttenmännische Zeitung, vol. 2, 1854, p. 274. I was aware of this paper. In both cases Grimm states that it is reported that, after heavy thunder showers, quicksilver makes its appearance in the springs in question. He was unable to verify the reports. Gas bubbles often adhere to detritus at the bottom of freshly disturbed springs and reflect the light so well that a peasant might mistake them for globules of mercury. I did not think these cases worth citing as geological evidence. Professor Suess makes brief mention of some mercurial springs in Sitzungsb. Wien. Akad., vol. 57, 1868, I, p. 791.

Age of the wall rocks.—There appears to be no relation between the age of the sedimentary rocks inclosing quicksilver deposits and the deposition of ores. The strata at Almaden are Silurian and Devonian, at the mines of the Bavarian Palatinate they are Carboniferous; at Idria they are Carboniferous and Triassic, at Vallalta, Triassic, at Monte Amiata chiefly Cretaceous and Eocene. In France near Montpellier quicksilver has been found in late Tertiary or Quaternary beds.

In California the deposits occur for the most part in metamorphosed Mesozoic beds which are probably early Cretaceous, but may turn out late Jurassic.(*a*) It is also found near New Idria in the Chico (late Cretaceous) strata, and there are mines in the Miocene of San Luis Obispo county. At Sulphur Bank rich ore was met with to a small extent in alluvium.

Similarly in Mexico the ore is said to be found in primary, transition, secondary, and Tertiary strata. The rocks of Guadalcázar are pronounced Cretaceous. Those of Huitzico are metamorphosed. The Huancavelica is said to be in Jurassic rocks.

Lithological character of the sedimentaries.—Cinnabar seems as indifferent to the composition of the walls within which it is deposited as to their age. At Almaden the greater part of the wall rock is quartzitic sandstone, but bituminous shales form a part of the walls. At Idria, schists, sandstones, and more or less dolomitic limestones are all found in contact with ore. At Monte Amiata, and many other points, limestone incloses the chief deposits. "If quicksilver," says de Prado, "exhibits an affinity or, if you choose, a propensity for any other substance, it is for carbonaceous or bituminous matter." I have not been able to verify even this slight preference, so far as the wall rocks are concerned.

In California quicksilver is abundant in sandstones and shales. It is rarely associated with limestone in that State, but limestone is itself rare in the belt of country where the mines are found. On the other hand, at Guadalcázar, the wall rock is limestone, while at Huancavelica schists, conglomerates, sandstones, and limestones alternate in thick beds.

Acidity of eruptives.—The chemical character of the associated massive rocks seems without influence on the ore deposits. Basic rocks, such as basalt and diabase, occur about as frequently as acid rhyolite and quartz porphyry, or those of intermediate composition, such as andesite. Thus at Almaden and in Rhenish Bavaria diabase and melaphyr appear; at Idria and Vallalta, rhyolite and quartz porphyry; in Corsica cinnabar is found in granite; at Monte Amiata the eruptive rocks are trachyte and andesite. In California basalt is intimately associated with cinnabar at Sulphur Bank, Knoxville, and elsewhere, but a rhyo-

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a The age of the metamorphic beds of the coast ranges of California and of the Mariposa formation in the Sierra Nevada is under discussion. There is seemingly conflicting evidence both stratigraphical and paleontological. The question can be definitely settled only by an extensive investigation in the field by a paleontologist and stratigrapher.

lite dike runs parallel to the deposits of the New Almaden district, and seems genetically connected with them. Andesite also accompanies some of the minor deposits of California. There is a similar wide range of composition in the eruptives accompanying the quicksilver veins of Mexico and South America. After the publication of Monograph XIII, Mr. H. W. Turner, acting as my assistant, proved to his own and my satisfaction that the serpentines of Monte Diablo are mainly or wholly due to the decomposition of peridotite and other basic eruptives not previously recognized in the Coast ranges (Geol. Soc. Amer., vol. 2, 1891, p. 383). This investigation convinced me that portions of the serpentines classed as metamorphic in Monograph XIII, in the absence of known evidence to the contrary, are also of eruptive origin. This additional information does not derogate from the importance or the interest of the occurrence of metamorphic serpentines in the coast ranges.

Associated minerals.—In a table below the principal metallic minerals and gangues, reported from nearly thirty of the most important mines or districts, are exhibited together in order that the reader may see at a glance both the frequency with which quicksilver is found in company with a given metallic or earthy mineral and the particular combination in a given district. The table is necessarily imperfect, since the reports are in many cases lacking in fullness. The attempt is also made to distinguish the relative frequency of the minerals noted so far as the reports enable one to judge. For example, the Almaden mine is tabulated as one in which the prevalent gangue is quartz, while it is not difficult to verify the presence of barite and of bitumen in the deposit; pyrite is abundant, though not to be found in every hand specimen, and chalcopyrite has been recognized, though it is rare. For some of the districts which I have not visited the letters indicating frequency may perhaps be somewhat inaccurate because of the difficulty of interpreting the statements made. Blanks represent the absence of reports, for it would manifestly be impossible to demonstrate the absence of any mineral in any deposit. The table must be supplemented by some additional data, which, however, do not pretend to be exhaustive.

Minerals associated with quicksilver ores.

p=prevalent; the mineral usually accompanies the ore or is present in great quantity in the mine.
a=abundant; a considerable part of the ore is characterized by the mineral.
o=occasional; presence easily verified but quantity small.
r=rare; seldom found or present in very minute quantities relatively to quicksilver.
Blanks indicate no report.

Deposits.	Bitumen.	Free sulphur.	Stibnite.	Other antimonial ores.	Realgar.	Mispickel.	Gold.	Silver ores.	Galena.	Chalcopyrite.	Zincblende.	Pyrite or Marcasite.	Millerite.	Quartz.	Calcite.	Gypsum.	Fluorspar.	Barite.	Borax.
Ebenezer, Kicking Horse Pass, B. C.							r					p			p				
Sulphur Bank, California	o	p					r			r		p		p	a				a
Manzanita Mine, California	a	p	a				p			a		p		p	a				
Knoxville District, California	o	r	o				r			r		p	r	p	o				r
Ætna District, California	a											p	o	p	a				
Napa Consolidated Mine, California	a											p		p	a			r	
Great Eastern Mine, California	a											p		p					
Great Western Mine, California	a											p		p					
Elephant Vein, California				p				p				p		p					
New Almaden Mine, California	o					r	r			r		p		a	a				
New Idria Mine, California	r											p		p	a				
Steamboat Springs, Nevada		a		p	p		o	o	o	o	r	a	r	a	a				a
Guadalcázar, Mexico		o							r			p			p	a	a		
Huitzuco, Mexico			a	o				r						p		a			
Huancavelica, Peru					a	a			r			p			p			a	
Mieres, Spain					a	a						p							
Santander, Spain									p		p								
Almaden, Spain	o									r		a		p				o	
Deposits in Algeria								a	p		p								
Cape Corso, Corsica		o	p								o	a		a					
Vallalta, Italy												p				p			
Mt. Amiata, Italy	o	r			r							p		o	p	a			
Rhenish Bavaria, Germany	o							r	r	o		p		a	p			a	
Idria, Austria	a											p		a	a		r	r	
Copper mines, Hungary				p				r				a		p				o	
Thihuthal, Transylvania									o		o	a		o	p				
Avala, Servia									r			p	o	p	a			o	
Tagora and Gading, Borneo			a									p			p			a	

Gangue minerals.—Whenever a quicksilver district has been at all fully reported upon it appears that either quartz (frequently associated with hydrous silica) or calcite accompanies the ore, and in the greater number of the cases both of these minerals are present in varying proportions. Not unusually dolomite also is present, as at New Almaden and at Idria. Ferrous carbonate is also met with. Relatively rare are barite and fluorspar. Barite is found in the Napa Consolidated, and thus far not elsewhere in California. It is also reported from near Lewiston, Utah, and from Guatemala. Barite occurs at Huancavelica. At Almaden a small part of the ore is accompanied by the same mineral, and Prof. Schrauf reports it from Idria. It was found in the deposits of the Palatinate and at Avala, as well as in Bohemia at Horowitz, in Hungary and in Borneo. Fluorspar is said to accompany cinnabar at Guadalcázar, La Tolfa in Italy, and at Idria. Gypsum, like fluorspar, is infrequent. I am not aware of its presence in the California mines, though it is common enough in the regions surrounding some of them. It is one of the gangue minerals at Guadalcázar and Huitzuco in Mexico, and at the Vallalta and Monte Amiata mines in Italy. A part of the gypsum is perhaps of secondary origin.

Borax is interesting in association with cinnabar because generally recognized as an indication of volcanic origin. It occurs at Sulphur bank, Knoxville and Steamboat springs, but has not elsewhere been definitely recognized. It is probable that examination would reveal it in the hot springs of the Ætna district, and at the Manzanita. The solubility of borax of course militates against its appearance, excepting where solfatarism is active.

Pyrite and marcasite.—Very much the most common metallic minerals in cinnabar deposits are pyrite and marcasite; indeed, it is doubtful if there is any quicksilver ore deposit of economical value in which one of them is not abundant. It has been asserted that they were not present in the Almaden mine, but this is an error. Pyrite is abundant there both in the ore and in bunches and nodules in the accompanying shales. As a rule, the amount of pyrite and marcasite in a quicksilver deposit is comparable with the amount of cinnabar.

Bitumen.—Bitumens, belonging to two or more different series of the hydrocarbons, are intimately associated with the Californian quicksilver deposits, sometimes in very large quantities. I do not know of a single producing district in the State where bitumen has not been found with cinnabar. Hepatic cinnabar is mentioned in one of the deposits of El Doctor in the state of Queretaro, Mexico. (*a*) In Europe small quantities of bitumen are met with at Almaden; it is mentioned in the deposits of the Palatinate, and is extremely abundant in the Idrian ores. Bituminous matter is mentioned in Mr. Ferrari's report as present in clays at Monte Amiata, (*b*) and Mr. E. Rosselli states that it is present in the Siele mine, though not in great abundance. (*c*) I have not observed any mention of bitumen in descriptions of the South American deposits, but it would certainly cause no surprise to learn that some of them contain organic matter. It is a curious fact that in California the bitumen is very often associated with and sometimes embedded in hydrous silica.

Free sulphur.—The presence of free sulphur is interesting as an indication of the mode of genesis of the deposits inasmuch as it usually arises from the decomposition of hydrogen sulphide. It occurred in great quantities at Sulphur Bank, the amount at Steamboat Springs is considerable, and there is a little at Knoxville and at the Manzanita. It is reported from Guadalcázar and may fairly be suspected in South America at such localities as the Baths of Jesus. A little sulphur is found in the Amiata mines and the same substance accompanies cinnabar in Corsica, Persia, and New Zealand.

Arsenical ores.—Arsenic is not very common in quicksilver deposits, though it can hardly be called infrequent. It is abundant as realgar at Steamboat Springs, and mispickel has been reported from New Almaden. Both sulphides, as well as mispickel, were exceptionally

a Observation by M. Bárcena quoted by S. Ramirez, Noticia Hist. de la riqueza minera de Mex. 1884, p. 95.

b Op. cit., p. 161.

c La miniera cinabrifera del Siele, Atti. Soc. Tosc. Sc. Nat., Vol. II, 1890, p. 14 of separate.

abundant at Huancavelica. The ore of Mieres in Spain, too, contains realgar and mispickel. Realgar accompanies quicksilver ores at Pozzuoli in Italy, in Corsica, and in Persia. Realgar is one of the exports of Kwei-chau in China, but whether it is there intimately associated with cinnabar is unknown.

Antimony.—Metastibnite (the red sulphide) is abundant at Steamboat Springs. (*a*) Stibnite occurs at the Manhattan, Manzanita, and Stayton mines in California. Antimonial pyrargyrite is found with cinnabar in the Elephant vein. In Mexico, at Huitzuco, livingstonite is an important ore and stibnite is abundant. Stibnite accompanies cinnabar in Corsica, at Avala in Servia, at Nikitovka in southern European Russia, (*b*) and at Gading in Borneo. The mercurial tetrahedrite of Hungary is of course antimonial.

Gold.—A little gold is reported from the deposit at Serajevo in Bosnia, and there is said to be cinnabar in a gold vein in Bendigo county, Victoria. In the United States the Manzanita mine has been worked sometimes for gold and sometimes for quicksilver. The gold and cinnabar are there found mingled. There are also several instances on the Gold Belt of California of auriferous veins carrying cinnabar. At Kicking Horse Pass, in British Columbia, traces of gold are found in the vein carrying cinnabar. Traces of gold also exist in the Steamboat Springs deposit, and have been detected in the iron sulphides of the Sulphur Bank and the Baker mines. Pyrite is so frequently auriferous that careful assays would probably disclose gold in great numbers of quicksilver deposits. Gold amalgam is reported from Vermont, British Columbia, from the Gold Belt of California, and from near Choco, Colombia.

Gold in placers is very often accompanied by cinnabar, e. g., in Persia; in the Ural mountains at many localities north of Miask; in Borneo at Sarawak and other points; in Queensland; in British New Guinea; and in the Transvaal, South Africa. In America cinnabar accompanies gold in placers on the Frazer river, British Columbia; near Placerville, California; near the town of Azogue in Ecuador; and at Ouro Preto (Villa Rica) in Brazil.

Silver.—Silver ores are found with mercurial ores in a few cases only. Silver minerals were of rare occurrence in the Palatinate, and quicksilver ores occur in small quantities in the Harz in the neighborhood of silver ores.

Silver amalgam is met with in the Hungarian copper mines. In Algeria also the two metals are found in the same deposits. A noteworthy instance of this association was a rich seam of cinnabar in the argentiferous vein of the Barcelona mine, Belmont district, Nevada. Near Calistoga, in California, there is a quartz vein known as the Ele-

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a This mineral is probably exclusively superficial. In closed tubes at about 150° C. I have found that the red sulphide readily crystallizes to stibnite.

b Schrauf, loc. cit., p. 389.

phant, in andesite, which carries cinnabar and antimonial pyrargyrite. Silver has been detected in the deposits of Steamboat Springs, Nevada. Specimens said to be from Arizona, in which gold and silver ores accompanied cinnabar, are also reported. The Tepozonelco vein, near Huitzuco in Mexico, carries both metals, and the Colorada silver mine in the Guanacevi district, state of Durango, contains cinnabar.

Silver amalgams occur in British Columbia, Chile, Bolivia, Norway, and the province of Almeria in Spain.

The only definitely known quicksilver locality in the Argentine Republic is in a silver vein containing the rare ore, eukairite (Cu^2Se, Ag^2Se) with peacock ore and tiemannite, the gangue being calcite.

Lead.—Lead ores, like silver, are rare in deposits which would be regarded economically as quicksilver mines. It is found in small quantities in the deposits of Steamboat Springs, and it is not improbable that it might have been detected in the mercurial silver mine, the Barcelona, near Belmont, Nev. Galena with cinnabar is reported from the Guadalcázar district and from Huancavelica. In France this association is said to occur in two districts. The ores of Santander, Spain, are chiefly lead and zinc with pockets of cinnabar. The Algerian ores are in part similar to those of Santander. In the Palatinate traces of lead occurred, and the deposit of the Rammelsberg mine, Germany, is essentially lead and copper ores. The Thihuthal vein in Transylvania contains galena, so do the deposits at Avala, and at Nikitovka, in Russia, the same association occurs.

Copper.—Traces of copper ore are not infrequent in cinnabar deposits. It is noteworthy that the Rammelsberg copper-lead mine contains a little mercury, that quicksilver is obtained from copper ores in Hungary, and that Hautefeuille detected quicksilver in some Lake Superior copper. Chalcopyrite occurs in small quantities at Almaden and at New Almaden. Copper is a constituent of the ores at Sulphur Bank, the Manhattan mine, and Steamboat Springs in the United States. It has also been observed at Chilapa in Mexico and at Aucachs in Peru.

Zinc.—Zinc ores have been observed in quicksilver deposits at a few points. It is one of the components of the Steamboat Springs deposits. Blende is also reported from Prunières in France, Corsica, Algeria, the Palatinate, Thihuthal in Transylvania, and Serejevo in Bosnia.

Nickel.—Millerite, when found in quicksilver ores, usually assumes the form of minute needles, and it is probably more common than the reports would indicate. At one point in the Ætna mines it appears in visible crystals, while at Knoxville it is nearly or quite microscopic. Traces of nickel, almost certainly the sulphide, were found at Steamboat Springs. It is reported from the mercurial veins of the Sierra Nevada of Spain, and from Avala in Servia.

General features of the ores.—If one surveys the deposits which are substantially valuable only for their quicksilver, it appears that they bear a strong resemblance to one another. One may say that they consist essentially of quicksilver ores with iron sulphides in a gangue of hydrous silica, quartz, calcite or both silica and calcite, accompanied in the most notable cases by bitumen, and not infrequently by stibnite.

Many of the rarer components may be regarded as natural consequences of this association. In nonmercurial deposits of pyrite it is usual to find traces of arsenic, copper, lead, zinc, silver, and gold. It is therefore not surprising that the highly pyritiferous quicksilver mines should also show interesting but unimportant quantities of these metals. Again, calcite is accompanied by barite and gypsum elsewhere quite as frequently as in the quicksilver mines. Fluorite is so rare in these mines as scarcely to deserve mention.

Free sulphur and borax are genetic indications of importance, since they are at least usually of volcanic origin.

The association of cinnabar with bitumen and with stibnite suggests that the geological history of these three substances has much in common.

THEORETICAL INFERENCES.

Theories of transportation.—The volatility of quicksilver and its sulphide were among the facts earliest recognized in chemical physics, and it is not unnatural that they should have been applied to the explanation of quicksilver ore deposits. Dolomieu, for example, classified cinnabar and stibnite as volcanic emanations, and the sublimation theory has been widely entertained during the present century. Recently Prof. Schrauf has recalled attention to the subject, pointing out that mercuric sulphide volatilizes at about 240° C., a temperature which may possibly have existed during the deposition of the mercurial ores. He considers that the cinnabar deposits of Idria are divisible into a primary and a secondary class, and believes that the earlier part of the mass is of pneumatogenic origin, while the later portion is due to hydatogenic action. In other words, he supposes that impregnations and incrustations of cinnabar not accompanied by quartz, calcite, or other nonvolatile gangue minerals have been deposited from hot moist vapors, while the cinnabar mingled with such gangue or with pyrite has been precipitated from solution.

It can not be denied that cinnabar might have been deposited from superheated vapors or from solutions of such vapors in highly heated waters. (*a*) Many other ores might also have been formed in an analogous manner, and it is well known that Baron von Richthofen ascribed the ores of the Comstock lode to deposition from vapors of the fluorides and chlorides. On the other hand the pressure existing at even small distances beneath the surface tends to limit the amount of material existing in the gaseous state, and such vapor as does exist below the surface will escape towards the surface much faster than accompanying solutions. These are facts which must tend to limit

(*a*) Schrauf, loc cit., p. 397.

pneumatogenic depositions. As for solutions of vapors in fluids, I doubt whether they are geologically distinguishable from solutions of fluids in fluids. Hence it seems to me that deposition of cinnabar from solution is *a priori* more probable than from vapor, and that the evidence in favor of the latter hypothesis in any case should be of a positive character. It is certainly true that cinnabar occurs as incrustations, almost or quite free from gangue or accompanying sulphides; but it seems to me questionable whether this necessarily implies deposition from vapor. Cinnabar is not the only substance which occurs in this manner. One not infrequently finds incrustations of pyrite, or of quartz, or of calcite, in cinnabar deposits unaccompanied by sensible quantities of other minerals; and certainly that explanation is most satisfactory which accounts for all these phenomena. Now when the ores and gangues are deposited in contact, it is clear that as a rule there is at least a little difference in age between the various species; for a hand specimen is not usually a homogeneous mixture of minerals, but on the contrary shows more or less imperfect banding, which indicates that there is a tendency to successive deposition. If one fancies a particular small portion of a solution containing cinnabar, pyrite, quartz, and calcite moving upwards through a fissure system, the solvent power of the fluid diminishing with relief of pressure, it will almost certainly reach complete saturation for the separate minerals at different points in space. Thus it may come in contact with a surface of limestone or dolomite when supersaturated with cinnabar and nearly saturated with the other minerals. It will then deposit a "paint" or film of the mercurial ore without admixture and without producing sensible corrosion of the wall rock. In a similar way it may elsewhere deposit incrustations of substantially pure calcite, quartz, or pyrite.

In the more open channels of a fissure system the solutions present at a particular point will vary in composition from time to time and give rise to more or less imperfect banded structures; but in a joint of a rock mass it is quite conceivable that a single small supply of solution should penetrate and the entrance then be closed either by deposition or by some small disturbance. It is also on joints that one usually finds these isolated incrustations which are relatively infrequent.

As for impregnations, conditions similar to those noted above may sometimes explain the presence of a single impregnating mineral which is more apt to be pyrite, quartz, or calcite than cinnabar. Many impregnations in porous sandstones show simultaneous deposition of gangue and ore and must be produced by solutions. It appears to me, then, that while neither dry sublimation of cinnabar nor its distillation with steam can be pronounced impossible, the usual association of minerals in quicksilver deposits shows precipitation from solution to be the ordinary genetic process, and I have yet to meet with cases which must necessarily be regarded as of exceptional genesis. In this, as in most respects, cinnabar seems to present the closest analogy to the other metallic sulphides.

Natural solutions.—Mercuric sulphide forms double sulphides with sodic sulphide of the form HgS, n Na_2S where n may be 1, 2, or 4, and may, perhaps, have other values. Free alkali is not needful to the existence of HgS_4, Na_2S, and some of the double salts remain soluble in the presence of soluble carbonates and of borax. Ammonia precipitates the metallic sulphide completely at ordinary temperatures and at 100°, but not at 145° C. Gold, pyrite, chalcopyrite, and blende are also more or less soluble in sodic sulphide. Potassic sulphide behaves very like sodic sulphide.

In nature, waters containing alkaline sulphides, and particularly sodic sulphide, are common; and the hot springs so closely associated with the quicksilver deposits often contain them. Hence it is nearly certain that a large part of the quicksilver deposits have been precipitated from such solutions. Barium sulphide, however, also forms soluble sulpho-salts with quicksilver, and may play a subordinate part. Roth also regarded it as probable that calcium sulphide has a similar action.(*a*)

Metacinnabarite.—While mercuric sulphide precipitated in menstrua in which it is insoluble is usually black, it is readily converted into cinnabar in the presence of solvents. Thus even at ordinary temperatures the black sulphide reddens in the presence of sodic sulphide. Heat also, of course, effects the conversion. Cinnabar is denser than the black sulphide, and the liberation of energy attending the condensation is a sufficient explanation of the tendency to the red modification. Prof. Schrauf gives good reasons for supposing that the true formula for cinnabar is Hg^2 S^2, while that for metacinnabarite is Hg^3 S^3. In the mines metacinnabarite is sometimes so mingled with cinnabar as to indicate that the black sulphide is undergoing conversion to the red.

These facts make it probable that much of the cinnabar of the ore deposits was precipitated as metacinnabarite and subsequently converted to red ore. It is also probable that in some cases, particularly at Idria, the black sulphide has been formed by the action of hydrogen sulphide on globules of metallic mercury, and indeed since mining operations began, with the attendant rotting of timber and the consequent formation of hydrogen sulphide.

There appears to be a strong tendency for mercuric sulphide to assume the form of metacinnabarite as a preliminary stage, even under conditions favoring the generation of cinnabar. Thus in the substitution of mercuric sulphide for stibnite studied by Prof. Sandberger in the Huitzuco ores, replacement by metacinnabarite takes place first and reddening occurs subsequently. So at the Great Geyser, globules

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a Prof. Schrauf thinks that organic solvents may come in play. While it is not improbable that there may be organic solvents of cinnabar, the bitumens and ammonia act rather as precipitants than as solvents.

of mercury first turn to black sulphide and this to the red modification. Schrauf also states that a part of the cinnabar of Idria is pseudomorphic after metacinnabarite (*a*).

The presence of crystals of cinnabar is a sufficient proof that a part of the mercuric sulphide has been directly deposited in the denser modification, and it is probable that this was the main process when precipitation was slowly effected, or that metacinnabarite was thrown down only when precipitation was relatively sudden.

Native quicksilver.—There is an observed tendency in the precipitation of the sulphide from some of the salts of mercury to the isolation of small quantities of the metal. Such a separation also takes place when strong solutions in alkaline sulphides are rapidly diluted. The production of much of the native quicksilver in the deposits is probably analogous to these processes, and may have been assisted by the action of bitumens at high pressures (*b*). Prof. Schrauf is of the opinion that a part of the native metal may be due to the dissociation of cinnabar, and feels sure that oxidation of cinnabar with the liberation of the metal goes on at ordinary temperatures. That vermilion decomposes under the action of light is known, but the process is a very slow one, and the evidence thus far presented that oxidation of cinnabar takes place in the mines seems to me insufficient to establish this hypothesis.

Effect of bitumens.—The bituminous substances found in the quicksilver deposits are largely composed of hydrocarbons; but few of them have been sufficiently investigated to determine in what series of hydrocarbons they belong. It appears, however, that the paraffins at least are represented, for marsh gas issues from crevices in the Sulphur Bank and the Phenix mines and, according to Schröckinger, posepnyte contains ozocerite. This is not the only series represented, for napalite, the centessimal composition of which is $C_3 H_4$, can not be represented as a member of the paraffin series. Its formula may be written $C_n H_{2n-2n/3}$ and here n must be a multiple of 3. There are members of the benzol series of the form $C_9 H_{12}$, but none of these seem to be so dense as napalite, 1.02. Idrialite in the pure state and aragotite have been referred to the naphthalene series, but it appears doubtful whether this reference is fully justified.

There is strong evidence that the most important soluble quicksilver compounds are sulpho-salts of mercury and sodium. It is therefore a matter of interest to determine the effect of hydrocarbons on such solutions. For this purpose I prepared solutions of mercuric sulphide in sodium sulphide rendered alkaline with sodium hydrate, and boiled separate portions with paraffin, benzol, naphthalene and anthracene.

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a This behavior would accord with a theory propounded by me if the formation of metacinnabarite liberates less heat than the formation of cinnabar, but sets it free more rapidly. Am. Jour. Sci., vol. 31, 1886, p. 120.

b It is quite conceivable that mercuric sulphide dissolved in sodic sulphide in contact with water and carbon should yield metallic mercury, sodium sulphydrate, and carbonic acid.

All of them gave black precipitates of mercuric sulphide, which in the case of paraffin and naphthalene were copious, though by no means all of the mercury was precipitated. The same solution boiled without hydrocarbons remained colorless. I did not succeed in detecting metallic quicksilver in the precipitates. (*a*) It is also well known that solutions of mercuric sulphide in sodic sulphide blacken horn, ivory, and the human epidermis.

It seems substantially certain, then, that the bituminous substances so frequently met with in quicksilver mines must tend to precipitate ore, though perhaps only within certain ranges of pressure.

Source of bitumen.—The great quantity of bituminous matter found in some of the Californian mines and at Idria demands an explanation which it has not yet received. Is this material gathered into the deposits by lateral secretion, or is it brought to the surface from sources far below the sedimentary rocks?

The fact that bitumen is often deposited in gelatinous silica or opal is evidence that it reached the mines in solution; but the solutions may possibly have taken up the hydrocarbons tolerably near the surface. The question belongs as much to the geology of bitumen as to that of quicksilver. It is well known that there is much to be said in favor of an interterrestrial origin for some bitumen deposits, of which the most striking instance is perhaps the asphalt lake of Trinidad.(*b*) The bitumens of the quicksilver deposits ought to be studied in connection with researches on bitumen deposits and the two lines of investigation should throw light upon one another.

Substitution.—It was held by de Prado that a part at least of the cinnabar of Almaden was deposited by substitution for quartz. Lipold mentions replacements of the Lagerschiefer at Idria, and according to Prof. Schrauf this formation consists of a bituminous clay slate. Lipold ascribed to substitution only a very subordinate part in the deposition. In the Palatinate cinnabar played the part of a fossilizing mineral, and was therefore truly substituted for organic matter. At Avala, von Groddeck regarded a part of the ore as substituted for serpentine. A. Krantz reported cinnabar as pseudomorphic after dolomite at Idria, and Mr. P. di Ferrari has recently come to the conclusion that in the mineralization of the marly limestones at Monte Amiata "a true substitution, if not molecular at least chemical, took place between the calcite of the rock and the cinnabar."

The substitution of cinnabar in some cases for organic substances may be granted. The instances from the Palatinate prove it, and the experiments described on a previous page show that the process is open

a These simple tests suggest an interesting investigation into the reactions between the hydrocarbons and solutions of mercuric sulphide, at ordinary temperatures and at higher temperatures in sealed tubes, which I have no opportunity to make.

b Mr. Clifford Richardson's Report on Trinidad Pitch; Sixth Annual Report of Inspector of Asphalts and Cements, Washington, 1892. Mendelejeff's hypothesis of the inorganic origin of hydrocarbons is extremely interesting and very plausible.

to investigation. Lipold's observations on the partial replacement of bituminous schist need no further explanation. On the other hand, the asserted cases of replacement of quartz, calcite, and dolomite seem to me at variance with observed facts and to require substantiation.

At Almaden de Prado's theory of replacement was founded mainly on the hypothesis that the richness of the impregnations of siliceous sandstone could be only thus explained. On the other hand I have shown that a quartz sandstone without matrix, but composed of spherical grains of uniform size, large or small, packed as closely as possible (like piled cannon balls), would leave an amount of interstitial space per unit volume represented by $1-\pi/3\sqrt{2}=0.26$ nearly. This space, if filled with cinnabar, would make an ore containing about 48 per cent of quicksilver. The richest impregnation which I could find at Almaden contained only 33 per cent of metal. Furthermore, many slides which I had made of the Almaden ore showed that the cinnabar had crystallized simultaneously with quartz in the interstices of the siliceous sandstone. Macroscopical observation also shows that at Almaden the cinnabar has crystallized simultaneously with quartz in stringers.

In California, also, both macroscopical and microscopical observations show that cinnabar has almost invariably been deposited simultaneously with quartz, calcite, or dolomite. Lipold mentions cinnabar and dolomite gangue as having been deposited simultaneously at Idria and does not refer to pseudomorphs. Prof. Schrauf, to whom Krantz's assertion is certainly known, does not mention it. On the contrary, he minutely describes the relations of calcite and cinnabar, and concludes that the solutions of calcium carbonate were neutral in their behavior to those of mercuric sulphide.

Krantz's note on his pseudomorph is extremely brief, simply stating that on a specimen from Idria he has seen saddle-shaped crystals of dolomite which are completely converted into cinnabar. He makes no mention of partial pseudomorphs, and the determination of the pseudomorphic character seems to rest entirely on the external form (*a*). The so-called saddle-shaped crystals of dolomite are crystalline aggregates (*b*) without determinably constant angles, and the fact that cinnabar has been seen in similar forms does not establish the pseudomorph. It is easy to imagine penetration twins of cinnabar, such as Prof. Tschermak (*c*) has described from Nikitovka, which, in imperfect examples, would bear a considerable resemblance to dolomitic saddles. The pseudomorphism in question has not been observed, so far as I can ascertain, by anyone excepting Krantz, and in my opinion the evidence of its existence is entirely insufficient.(*d*)

a Blum's Pseudomorphosen Nachtrag, III, p. 262.

b Dana's Mineralogy, 1892, p. 272.

c Tschermak's Min. Mitth., vol. 7, 1886, p. 361.

d In referring to the substitution of galena for calcite in U. S. Geol. Survey, Mon. XIII, p. 398, I should have cited Mr. S. F. Emmons's paper on Leadville in the Second Annual Report, 1882, before Mr. J. S. Curtis's monograph of 1884 on Eureka.

At Monte Amiata Mr. Ferrari describes the ore as commonly accompanied by calcite gangue, which accords with my own observations in that district. Mr. Rosselli describes crystals of cinnabar enveloped in calcite and also veinlets of calcite in cinnabar at the Siele mine. Now a solution which deposits calcite must be supersaturated with calcite and unable to dissolve more calcite. Hence, evidently a mixture of cinnabar and calcite can not be deposited by substitution for wall rock composed of limestone. This would amount to the pseudomorphism of calcite after calcite, a process with no efficient cause. Nevertheless Mr. Ferrari seems to find evidence that the fissures in marly limestone have been enlarged at or before the time at which ore was deposited in them.

The clays which accompany the ores in these chambers contain very little lime, as is shown by the analyses accompanying Mr. Ferrari's report. They seem to represent the residue of the marly limestone after subtraction of calcium carbonate; and this is Mr. Ferrari's own view, who speaks of them as due to the alteration of the inclosing rock. This alteration is evidently caused by solutions *not* supersaturated with calcium carbonate, and therefore also not by those particular solutions which deposited mingled cinnabar and calcite.

These relations would seem to be adequately explained by the hypothesis that the ore-bearing solutions were preceded by solutions containing free carbonic acid, which exerted a corrosive effect upon the fissure walls and thus made space for the deposition of ore from subsequent solutions of a different character.

It is even possible that some solutions carrying free carbonic acid and not saturated with calcium carbonate may have been supersaturated with mercuric sulphide. In such cases it would seem that fissures might be enlarged and cinnabar deposited in them simultaneously, but the two processes would be independent of one another and only accidentally associated; no true substitution would occur in such a case, and it is difficult to see what evidence would remain that the events occurred at the same time.

Mr. Ferrari does not describe either hand specimens or slides giving evidence of metasomatism. Rounded nodules of limestone inclosed in enveloping layers of cinnabar, growing less regular in outline as the distance from the center increased, would be a substantial proof of substitution; and under the microscope grains of calcite undergoing replacement by cinnabar would be comparable with olivines changing to serpentine, hornblendes to chlorite, and the like. Such cases may occur under some peculiar conditions of temperature and pressure, just as ammonia precipitates mercuric sulphide at 100° but not at 145° and a pressure of 60 pounds per square inch; I have not, however, seen sufficient proof to establish their existence.

The wall rocks of quicksilver deposits are not unfrequently altered, being substantially converted into either silica or calcium carbonate by the action of solutions of these minerals. Siliceous fluids are capable of extracting the bases from basic rock, such as serpentine. The process of silicification of serpentine has been studied by Schrauf and Doelter, with whose results my observations agree. Other rocks also are certainly subject to silicification, though the details of the process are less well known. Calcification, too, is a common phenomenon, as indeed might be guessed from an inspection of the minerals, after which calcite is said to form pseudomorphs. Among them are quartz and chalcedony, feldspar, mica, garnet, chlorite, and iron oxides. Thus a somewhat decomposed crystalline schist, or a granite, might be almost wholly replaced by calcite, and instances of such replacement are known (*a*).

It is quite conceivable that in such cases cinnabar should mingle with the mineral which replaces the country rock. This, however, would not prove that substitution of cinnabar for the original rock had taken place. The mercurial solution might itself be wholly without effect upon the rock, although mingled with active siliceous or calciferous solutions. It seems to me probable that the apparent substitution of cinnabar for serpentine, studied by von Groddeck at Avala, was of this description. In California I have been surprised not to find instances of at least apparent replacements of this kind. In the mines of that State it seemed as if only the chemically active solutions had the power of permeating dense rocks, the indifferent mercurial solution remaining in the preexisting crevices as if separated by filtration.

Osmotic hypothesis.—These observations would be explained if it were true in general that liquids will penetrate a dense wall or septum at a sensible rate only when there is a chemico-physical reaction between the solid and the fluid. Here the term chemico-physical reaction is intended to express any chemical union or physical change attended by the evolution of heat, or rather by the degradation of energy. There is reason to think that such a law really exists, though it can not be said that it is conclusively proved. So far as elastic fluids (gases) are concerned it is pretty well established; for the absorption of hydrogen by palladium is attended by the formation of a definite palladium-hydrogen compound, the transfer of carbonic oxide through hot cast iron is explained by the discovery of the compound $Fe(CO)^4$, and there are other confirmatory facts. As for fluids in contact with solids, it has been found of late that their behavior is, in many respects, almost exactly like that of gases (*b*), and Prof. P. G. Tait states that "Osmose is undoubtedly a case of ordinary diffusion complicated by the molecular actions between the material of the septum and the various liquids

a A very fine example has been found by Mr. W. Lindgren in the Ophir gold mining district, California. 14th Ann. Rep. of the Director of the U. S. Geological Survey.

b According to Prof. Geo. F. Barker, Physics, 1892, p. 188, fluids in osmosis obey the laws of Boyle, Gay-Lussac, and Avagadro like gases.

employed (*a*)." These considerations point so decidedly toward the relation expressed in the first sentence of this paragraph, that the idea there expressed may fairly be assumed as a trial hypothesis in the study of ore deposits, whether of quicksilver or of other metals.

On this hypothesis the concentration of ores in deposits would be largely due to the fact of the *lack* of action between their solutions and the wall rocks; and the decomposition of the country rock, so often observed near veins, would be due to the absorption of solutions of gangue minerals by the walls. In short, there would be a species of concentration by dialysis.

This hypothesis lends to the chemical nature of the wall rocks and to the character of the reactions between the walls and the solutions an interest and a possible practical importance which they have not hitherto possessed.

Origin of the ore.—In any one quicksilver bearing region, such as the Coast Ranges of California or inner Austria, it is difficult to avoid ascribing a common source to the ore. This can not be the adjoining rocks, for they are most various. On the other hand, granitoid rocks seem everywhere to underlie the superficial, more heterogeneous formations, within a very few miles of the surface. The evidence is overwhelming that in many cases quicksilver ores were deposited from thermal springs of volcanic origin; and the analogy between the deposits is so great that, in the absence of positive evidence of a different origin, the probabilities are in favor of the hypothesis of a similar origin for all of them. This does not imply that all quicksilver deposits are of the same age; those of Almaden, for example, seem to be far older than most or perhaps any of the Californian deposits. Assuming that the quicksilver ores have been deposited from hot springs due to volcanism, it would seem that cinnabar might be classed as a volcanic emanation. In that case, however, one would look for this ore as a component of lavas and in craters. It is not certainly known to occur in this way, and if it exists in this association it must be very rare. It seems to follow that the volcanic springs must have leached the quicksilver from deep-seated rocks of very wide distribution, *i. e.*, either from the granitic masses or from some unknown infragranitic rocks overlying the foci of volcanic activity.

To account for the limited areas in which quicksilver occurs it must further be supposed either that the volcanic emanations are not everywhere charged with solvents for quicksilver, or that the rocks overlying the volcanic foci do not everywhere contain quicksilver. Each of these suppositions involves a certain amount of irregularity in subterranean conditions. This, however, is not of itself a stumbling-block, since the mere existence of mountain ranges forbids the hypothesis of uniformity within scores of miles from the surface.

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a Properties of Matter, 1890, p. 275. The late Dr. Melville and I began a series of experiments designed to throw light on osmosis as a geological agent, but were obliged to abandon them for lack of time.

The theory of the origin of quicksilver stated above is far too indefinite to be satisfactory, but I can see no way as yet of giving it greater precision. The study of antimonial deposits, and to a much greater degree the study of the origin of bitumen, may clear the way to deeper insight.

Form of the deposits.—Quicksilver deposits occur as fissure veins, reticulated veins, irregular bodies (stocks), impregnations, and placers. It used to be supposed by some that these ores never occurred as simple fissure veins. If, however, von Cotta's simple definition of vein, "the filling of a fissure," is accepted, many deposits must be thus classified, while small filled fissures, or stringers, which differ from veins only in size, occur, so far as I can ascertain, in all quicksilver deposits. The greatest of the quicksilver deposits, that of Almaden, contains two large, well-developed veins in part conformable with the strata and in part cutting strata. These veins are filled with wall rock, gangue minerals and ore, and frequently show comb structure. At Idria also a large portion of the deposit consists of veins in part concordant and in part discordant with the bedding. Many of the smaller Californian deposits are also simple veins, the New Hope at New Idria being an important instance.

In many cases the deposits occupy zones of broken country rock and can not be regarded as simple veins. They may be divided into stocks, stockworks, etc., but nearly or quite everywhere the various ore chambers are connected by fissures in such a way that the whole deposit may be better considered as consisting of fissures with excrescent chambers. I have suggested the term "chambered veins" for such occurrences as distinguished from simple fissure veins. (*a*) In such deposits one may distinguish lateral chambers and cap chambers according to the relations which the ore chambers bear to the main fissure. These terms have met the approval of some mining engineers. No better or more important instance of a chambered vein can be given than the deposits of New Almaden.

It is only under very exceptional circumstances that disturbances in the earth result in the formation of a single fissure. Much more frequently a system of parallel fissures is produced which, when filled with ore, forms a system of parallel veins. A "Gangzug" or system of linked veins seems to occur in rocks which present somewhat irregular resistance under the action of forces such as would produce a system of parallel fissures if the rock presented uniform resistance. These systems of fissures occur only when the deformations to which the rock has been subjected are "rotational," and they are closely allied to the structures known as schistosity and slaty cleavage.

The character of a rotational strain may be made clear, as follows: If a rubber ball or cylinder is placed between two flat surfaces and an in-

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a Siphunculated chambered shells furnish the suggestion for chambered veins.

clined pressure is exerted on the upper surface, the effect will be not merely to distort the ball but to roll it along through some angle, great or small. Such a deformation is called rotational. So, too, one may consider a spherical portion of a rock mass, before strain takes place, with any point for a center. If the forces exerted on the rock mass tend not only to change the shape of this sphere but to roll it along through any angle the strain is "rotational," while when there is no such rolling the strain is "irrotational." When a strain is rotational a certain set of parallel planes is subjected to a maximum dislocating tendency for a longer time than any others in the mass. Now, the longer given planes in the rock are subject to dislocating forces the smaller is the resistance which they offer, on account of the property called "the viscosity of solids." Under such circumstances parallel cracks will form if the deformation is pushed to the rupturing point. In an extreme and special case the number of cracks reduces to one. If the rock yields plastically and the force is not too intense, slaty or schistose cleavage will ensue.

When a deformation is irrotational and pushed to the point of rupture, either two or four systems of fissures will be produced. When there are four planes (which happens in the case of resistance uniform in all directions) they correspond in direction to the four planes of a tetrahedron. All of the four planes may be simultaneously slickensided, but not more than four sets of parallel planes, each set having a distinct direction, can be formed simultaneously. (*a*)

In relatively homogeneous rocks, joints, fissures, and veins are often developed with great symmetry; but when the rock offers a resistance which varies rapidly with the locality, the deformation produced by a subterranean force will be rotational at some points and irrotational at others. In such rocks systems of fissures will form at some places, linked fissures at others, and two or four systems of intersecting fissures at still other points. If ore-bearing solutions then gain access to the region, stocks or stock-works will deposit on the intersecting fissures, and these will pass over into simple fissure veins or vein systems. Taking these separate portions in conjunction, they will form what have been called above chambered veins, and these are characteristic of rock which offers variable resistance to subterranean force. The Coast ranges of California are unusually heterogeneous and chambered veins are very frequent in them.

Impregnations of cinnabar and gangue usually occur wherever the ore exists in contact with sandstone. This rock is generally permeable, even where it is quartzitic, and the pores or interstices are not minute enough to set up osmotic action. Valuable impregnations of cinnabar seldom occur except in sandstone.

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a Bull. Geol. Soc. Am., vol. 4, 1893, p. 13.

RECENT DEVELOPMENTS AND INFORMATION.

California.—For some years past the quicksilver industry of California has been in a very unsatisfactory state, but 1892 shows some improvement. The New Almaden mine is regarded as almost exhausted, though the cleaning up of the mine still yields not a little metal, 5,563 flasks having been turned out in 1892. The New Idria is also in very poor condition and produced only a few hundred flasks. To the north of the bay of San Francisco there is somewhat increased activity. The Redington, which has done but little since 1883, increased its product by a few hundred flasks last year, and the Lake mine, immediately adjoining the Redington, is credited with 612 flasks, the first which it has produced. Sulphur Bank about held its own, with 1,393 flasks. The Napa Consolidated yielded 5,680 flasks, or 1,500 more than in the preceding year; but the Great Eastern fell off about 900 flasks. The Great Western, however, yielded 5,867 flasks, an increase of 3,810, and now leads all the mines of the country. This is an old mine, which has produced altogether nearly 69,000 flasks.

The only new development of much consequence is the Mirabel, formerly known as the Bradford, which began to produce in 1887. Since then it has yielded 13,605 flasks, of which 3,208 are credited to 1892. It lies about three miles nearly north of Mount St. Helena and in a straight line between the Great Western and the Ætna.

The Mirabel did not crop out at the surface and the deposit was detected from the presence of float cinnabar in the creek. The deposit contains cinnabar with occasional globules of native mercury, accompanied by pyrite, in a gangue of quartz and calcite. Bitumen (napalite) and free sulphur are also reported. The rock is hot in some places, especially along fissures, but no water or gas rises into the mine. The country rock is very variable, including sandstone, shale serpentine, greenstone, silicified material, and agglomerates. The ore bearing zone is regarded as having a cemented agglomerate as foot wall and sandstone as hanging wall. The deposits themselves are lens-shaped or pipe-like, connected chambers, and associated with them are seams or stringers of ore. Three of the ore bodies are so closely connected that they are described as forming in reality one large chamber with two branches. There is a second detached vein 450 feet distant from that described. (*a*)

There have also been several reports of valuable discoveries in the Siskiyou mountains, but I am not aware that any deposit in that region is being worked.

Traces of quicksilver were known many years since in San Francisco near the mission. During the past year the ore has also been found on Devisadero street, near McAllister street. The cinnabar occurs in

a This information is from a manuscript report by Mr. F. von Leicht, the superintendent, kindly placed at my disposal by Mr. J. B. Randol.

stringers and bunches in a siliceous vein inclosed in serpentine. Explorations, not yet decisive of the value of the deposit, are being made. (*a*)

Arizona. Quicksilver ore in places is said to have been found near Copper Basin, Yavapai county, Arizona.(*b*) This is the only deposit in this Territory of which anything seems to be known.

Argentine Republic.—Tiemannite mixed with eukairite occurs in a vein worked for silver on the west slope of the Sierra de Umango, on a spur called El Cachito. Calcite and peacock ore accompany the mercurial mineral. (*c*)

Belgium.—Float cinnabar has been detected in Belgium. It occurs in paints and stringers with calcite and pyrite in a block of siliceous dolomite containing several cubic decimeters, found at Dave. (*d*)

Russia.—The mine in the province of Ekaterinoslav, less than two miles west of the Nikitovka railway station, has been prosperous of late years, and the product for the years 1890 and 1891, respectively, was 8,383 and 8,353 flasks. (*e*) It is said that about three-quarters of this is exported, the Russian consumption of the metal being only about 2,000 flasks or 4,000 poods. (*f*) There is little geological information available further than that recorded in Monograph XIII. It is now known, however, that stibnite and valentinite accompany the ore, as well as galena. (*g*) The gangue mineral seems to be quartz. (*b*) No mention is made of pyrite, though its absence would be most remarkable.

In a lettter to Mr. Ch. de Struve (then Russian minister to the United States), Mr. Vechniakoff in January, 1892, mentions the occurrence of quicksilver in the Altai mountains and in the Okhotsk region. These were previously unknown to me. He also confirms the report of the occurrence in Kamtschatka. A late discovery also mentioned by the same authority is in the Caucasus, in the district of Daghestan, near a settlement called Geptze.

Quicksilver in Thibet.—In 1887 I was unable to cite any original authority for the occurrence of quicksilver in Thibet. Capt. S. Turner, in 1800, writing of the resources of that country, states: "Here are also mines of cinnabar, which they use for coloring in paint."(*h*) In a compilation of missionary reports published in 1885, also, there are several mentions of the subject. Mines producing quicksilver are stated to exist on the right bank of the Lan-tsang-kiang, at Che-men-to, and on the left bank at Pe-to. Mercurial silver is found at To-y tchang; mercury, silver, and lead at Ye-tche; iron and mercury at Lo-Nong. A rich quicksilver mine and one of gold occur at Ta-chien-lon. All of these localities lie between latitudes 27° 30′ and 30° in a direction north of

a I owe this information to the kindness of Mr. Ch. Palache.
b Eng. and Min. Journ., Oct. 24, 1890.
c F. Klockmann: Groth's Ztschr. für Krystallographie, Vol. 19, 1891, p. 267.
d X. Stanier: Soc. Géol. de Belg, Vol. 18, 1891, p. 48
e Berg- und Hüttenmännische Zeitung, 1892, p. 313.
f Russian Mining Journal, 1888, paper on Nikitovka, by A. Auerbach.
g Tschermak loc. cit.
h Embassy to the court of the Teshoo Lama, pp. 373 and 405.

west from the quicksilver region par excellence of China, the province of Kwli-chau. (*a*)

In Thibet quicksilver is used only for medicine and for killing vermin. Vermilion is imported from China.

It is a noteworthy fact that both the Chinese and the Thibetian names for quicksilver mean "fluid silver." The metal is mentioned in Thibetian literature as early as the ninth century.

All of the above notes were kindly furnished me by Mr. W. W. Rockhill.

Transvaal.—Brief notes have appeared in a number of journals announcing that mercurial ores have been detected in the Transvaal in or near the gold fields, but I have failed to find any satisfactory account of the deposits. According to Mr. W. H. Furlonge cinnabar is met with in small quantities in the contorted rocks of the Dekaap gold fields and also on the High Feldt. (*b*) Stibnite and mineral wax are mentioned from the same region. (*c*) It is interesting to know that these substances, so intimately associated with quicksilver ores in America and Europe, occur in the same neighborhood in a region so far removed from any other known mercurial deposits.

Australia.—No quicksilver deposit of considerable value is yet known in Australia. Cinnabar was detected in place, however, in 1890, at two localities in New South Wales, and the prospects of a workable deposit are said to be good. At one of the localities, Bingera, the cinnabar is found in the joints of a serpentinous rock; in the other Solferino, the vein matter is said to be quartz and feldspar. (*d*)

The Kilkivan district in New Zealand has yielded a little quicksilver, the total product up to the end of October, 1891, being 124 flasks. The cinnabar is associated with quartz and calcite, and the veins and stockworks occur chiefly in granite near the contact with a decomposed porphyry. Veins are also found in sandstone and shale, and there are some alluvial deposits. (*e*)

New Guinea.—Cinnabar is reported from Merani, in Cloudy bay, British New Guinea, and from Normanby island. In the latter locality it was found in water-worn fragments with alluvial gold. Normanby island (or Duau) contains many hot springs, sulphur banks, and fumeroles. The association is strongly suggestive of the origin of the cinnabar. (*f*)

PRODUCTION.

The following tables are well known to mining men as due to the energy of Mr. J. B. Randol.

The import statistics are obtained from the Bureau of Statistics, Treasury Department.

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a These notes are from Thibet d'aprés la correspondence des missionaires, 1885.

b Trans. Am. Inst. M. E., vol. 18, 1890, p. 347.

c "H." in Eng. & Min. Journ., vol. 51, 1891, p. 739.

d New S. W. statistics, etc., compiled for the World's Columbian Exposition, 1893.

e Official report by W. H. Rands, 1892.

f Official report by A. Gibb, Maitland, Queensland, 1892, p. 32.

Production of quicksilver in flasks, in California, from 1880 to 1892, by months.

Months.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna (a).	Napa (a).	Great Eastern.	Bradford (b).	Various mines.	Total.
1880.												
January	1,539	203	142	760	1,000	550	......	205	39	......	232	4,670
February	1.809	96	310	965	535	565	......	375	110	......	130	4,895
March	2,155	443	239	1,286	730	565	......	251	210	......	98	5,977
April	1,667	165	103	611	645	574	......	161	96	......	239	4,261
May	1,938	226	356	1,130	560	572	......	315	164	......	90	5,351
June	1,985	269	127	819	550	585	......	420	142	......	386	5,283
July	1,688	250	135	933	......	540	......	455	118	......	70	4,189
August	2,360	312	189	878	340	525	......	455	133	......	68	5,260
September	2,166	245	175	687	300	452	......	480	122	......	81	4,708
October	1,858	216	166	865	1,100	557	......	358	57	......	98	5,275
November	2,238	539	96	1,209	500	467	......	591	42	......	66	5,748
December	2,062	245	101	563	410	490	......	350	46	......	42	4,309
Total	23,465	3,209	2,139	10,706	6,670	6,442	......	4,416	1,279	......	1,600	59,926
1881.												
January	2,259	330	140	895	1,300	451	......	430	13	......	43	5,861
February	2,187	171	32	635	600	399	......	233	......	......	4	4,261
March	2,466	206	354	1,100	350	400	......	505	179	......	......	5,560
April	2,507	158	284	706	357	447	......	466	123	......	23	5,071
May	1,346	200	218	1,163	500	681	......	659	97	......	25	4,889
June	1,780	201	196	1,463	340	801	......	621	94	......	68	5,564
July	2,208	110	160	1,057	255	714	......	481	47	......	156	5,188
August	2,260	209	190	1,139	300	585	......	490	57	......	120	5,350
September	2,090	212	187	1,076	201	457	......	592	113	......	37	4,965
October	2,223	140	165	969	400	414	......	485	106	......	63	4,965
November	2,572	577	180	588	375	434	......	310	166	......	30	5,232
December	2,162	261	88	361	250	458	......	280	70	......	15	3,945
Total	26,060	2,775	2,194	11,152	5,228	6,241	......	5,552	1,065	......	584	60,851
1882.												
January	1,632	179	178	623	50	395	......	430	144	......	33	3,664
February	1,924	121	145	460	210	348	......	440	98	......	21	3,767
March	2,078	160	70	359	200	505	......	459	91	......	24	3,946
April	2,110	127	174	319	229	486	......	525	57	......	......	4,027
May	2,446	269	211	354	13	521	......	737	55	......	5	4,611
June	2,318	121	131	522	30	456	......	485	76	......	28	4,167
July	2,522	169	195	579	......	410	......	380	111	......	15	4,381
August	2,432	130	184	418	50	490	......	582	388	......	11	4,685
September	2,766	129	225	430	140	513	......	641	348	......	17	5,209
October	2,844	266	251	370	60	516	......	580	229	......	13	5,129
November	2,619	156	96	280	81	200	......	718	306	......	55	4,511
December	2,379	126	311	300	75	339	......	865	221	......	19	4,635
Total	28,070	1,953	2,171	5,014	1,138	5,179	......	6,842	2,124	......	241	52,732
1883.												
January	2,497	112	367	280	77	390	......	590	262	......	7	4,582
February	2,150	133	181	310	7	364	......	295	156	......	4	3,600
March	2,230	142	202	335	......	305	......	485	162	......	14	3,875
April	1,756	76	243	310	......	294	......	530	142	......	3	3,354
May	2,344	144	135	350	......	293	......	325	164	......	13	3,768
June	2,214	137	165	91	......	400	......	360	184	......	10	3,561
July	2,618	85	141	130	......	446	......	452	150	......	2	4,024
August	3,000	139	94	112	......	315	......	695	76	......	......	4,431
September	3,010	164	45	265	......	297	......	750	81	......	30	4,642
October	2,672	272	109	206	......	215	......	521	134	......	......	4,129
November	2,212	115	78	160	......	208	......	613	102	......	......	3,488
December	2,297	87	134	63	......	342	......	274	56	......	18	3,271
Total	29,000	1,606	1,894	2,612	84	3,869	......	5,890	1,669	......	101	46,725
1884.												
January	1,440	103	127	263	......	373	329	135	28	......	7	2,805
February	1,458	59	104	......	......	241	276	174	9	......	......	2,321
March	1,606	36	123	68	......	223	249	152	2	......	......	2,459
April	1,785	75	50	76	......	232	422	69	......	......	......	2,709
May	1,672	125	53	200	......	169	245	6	......	......	......	2,470
June	1,859	44	118	......	200	258	215	......	......	......	......	2,694

a Production of Ætna and Napa mines from 1880 to 1883 under heading of Napa mine. *b* New mine.

Production of quicksilver, in flasks, in California, etc.—Continued.

Months.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna.	Napa.	Great Eastern.	Bradford.	Various mines.	Total.
1884—con'd.												
July	1,543	29	71	52	200	258	374	101	......	......	......	2,628
August	1,804	63	47	20	306	334	228	110	......	......	......	2,912
September	1,448	67	52	35	58	354	136	169	58	......	......	2,377
October	1,625	115	68	25	160	328	153	90	104	......	......	2,668
November	1,900	157	32	53	150	230	132	240	91	......	......	2,985
December	1,860	152	36	98	105	292	172	130	40	......	......	2,885
Total	20,000	1,025	881	890	1,179	3,292	2,931	1,376	332	......	7	31,913
1885.												
January	1,700	190	40	24	......	172	189	131	37	......	......	2,483
February	1,506	70	24	85	35	245	96	180	75	......	......	2,316
March	1,500	80	......	83	......	314	88	145	33	......	19	2,262
April	2,003	80	......	69	......	340	142	145	37	......	......	2,816
May	2,000	75	......	194	......	269	62	190	......	......	3	2,793
June	1,750	62	50	91	......	330	112	250	63	......	5	2,713
July	1,750	75	43	209	......	321	45	191	50	......	10	2,694
August	2,104	80	49	150	......	324	118	175	......	......	47	3,047
September	1,936	95	57	85	......	347	201	180	......	......	77	2,978
October	1,598	85	42	123	......	236	52	185	65	......	82	2,468
November	1,576	122	43	61	......	292	54	190	43	......	87	2,468
December	1,977	130	37	122	......	279	150	235	43	......	62	3,035
Total	21,400	1,144	385	1,296	35	3,469	1,309	2,197	446	......	392	32,073
1886.												
January	1,431	70	42	100	......	339	162	147	73	......	34	2,398
February	1,100	175	24	108	......	274	132	192	53	......	45	2,103
March	1,522	20	21	91	......	226	209	218	43	......	75	2,425
April	1,256	90	36	172	......	115	328	172	62	......	62	2,293
May	1,600	101	18	36	......	99	228	128	76	......	95	2,381
June	1,806	110	19	113	......	126	276	123	71	......	78	2,722
July	1,572	95	24	98	......	138	345	138	64	......	127	2,601
August	1,240	105	35	119	......	156	313	74	76	......	84	2,202
September	1,210	179	30	100	......	107	303	82	64	......	33	2,108
October	1,280	106	50	150	......	171	392	124	65	......	52	2,390
November	1,900	180	76	191	......	109	477	209	55	......	35	3,232
December	2,083	175	34	171	......	89	313	162	33	......	66	3,126
Total	18,000	1,406	409	1,449	......	1,949	3,478	1,769	735	......	786	29,981
1887.												
January	1,904	162	76	185	......	56	450	181	51	......	12	3,077
February	1,700	149	43	40	......	86	240	150	......	......	......	2,408
March	1,584	110	48	95	......	105	125	275	74	......	140	2,456
April	1,671	157	29	105	......	90	200	212	91	......	31	2,586
May	2,040	126	27	50	......	152	100	215	80	......	40	2,830
June	1,700	127	93	170	......	126	200	220	82	......	104	2,822
July	1,567	175	57	125	......	194	200	205	56	201	40	2,820
August	1,517	160	61	90	......	108	200	275	72	220	78	2,881
September	1,535	297	42	120	......	123	400	160	26	195	25	2,923
October	1,405	171	64	140	......	132	300	304	66	228	49	2,859
November	1,225	113	71	214	......	127	165	247	82	295	74	2,613
December	2,152	143	62	156	......	147	300	250	9	232	34	3,485
Total	20,000	1,890	673	1,490	......	1,446	2,880	2,694	689	1,371	627	33,760
1888.												
January	2,650	118	......	292	......	61	246	235	84	179	84	3,949
February	1,730	82	......	156	......	64	105	223	79	243	51	2,733
March	1,400	90	......	150	......	43	95	288	108	270	37	2,481
April	1,579	110	......	138	......	95	143	324	153	292	28	3,862
May	1,610	125	......	155	......	69	226	320	80	357	95	3,037
June	1,500	120	......	189	......	26	94	345	110	454	118	2,956
July	1,100	120	......	167	......	34	50	248	94	463	83	2,359
August	1,109	110	......	215	......	29	......	347	93	527	117	2,547
September	1,178	60	......	195	......	42	......	370	58	357	88	2,348
October	1,269	185	36	180	......	47	......	444	88	294	96	2,635
November	1,400	90	30	176	......	28	......	475	82	220	103	2,604
December	1,475	110	60	151	......	87	......	450	122	192	92	2,739
Total	18,000	1,320	126	2,164	......	625	959	4,065	1,151	3,848	992	33,250

Production of quicksilver, in flasks, in California, etc.—Continued.

Months.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Guadalupe.	Great Western.	Ætna.	Napa.	Great Eastern.	Bradford.	Various mines.	Total.
1889.												
January	1,200	65	......	173	......	81	......	385	94	230	109	2,337
February	820	65	......	173	......	45	......	400	76	182	52	1,813
March	1,290	70	......	175	......	34	......	380	89	116	63	2,217
April	1,249	70	......	215	......	30	......	320	92	119	108	2,203
May	870	70	206	192	......	......	......	445	97	132	73	2,085
June	950	75	117	235	......	......	......	415	211	152	63	2,218
July	966	70	124	211	......	41	......	340	135	110	69	2,066
August	1,000	70	64	216	......	17	......	450	168	170	68	2,223
September	970	75	73	224	......	97	......	360	77	136	61	2,073
October	1,300	80	89	164	......	70	......	385	87	214	64	2,453
November	1,300	130	139	150	......	80	......	380	107	134	72	2,492
December	1,185	140	......	155	......	61	......	330	112	179	122	2,284
Total	13,100	980	812	2,283	......	556	......	4,590	1,345	1,874	924	26,464
1890.												
January	952	100	60	109	......	55	......	270	46	75	41	1,708
February	728	60	......	186	......	11	......	245	126	46	60	1,462
March	1,000	57	11	80	......	110	......	265	77	121	111	1,832
April	779	70	1	89	......	48	......	210	109	82	......	1,388
May	1,100	60	......	82	......	70	......	175	84	93	5	1,669
June	1,066	65	......	178	......	111	......	155	74	85	68	1,802
July	1,100	70	......	131	......	106	......	210	70	127	95	1,909
August	1,000	100	80	147	......	129	......	190	153	119	69	1,987
September	1,000	55	120	174	......	202	69	195	66	136	38	2,055
October	1,064	95	111	127	......	203	303	135	58	173	42	2,311
November	1,084	165	97	143	......	115	326	238	78	125	68	2,439
December	1,127	80	25	162	......	174	233	210	105	108	140	2,364
Total	12,000	997	505	1,608	......	1,334	931	2,498	1,046	1,290	737	22,926
1891.												
January	850	60	22	170	......	131	347	260	119	142	216	2,317
February	814	75	70	93	......	274	135	296	121	132	85	2,095
March	827	22	50	130	......	94	......	365	166	75	......	1,729
April	968	65	60	109	......	164	......	315	153	96	48	1,978
May	800	70	123	120	......	76	......	240	67	151	100	1,747
June	700	55	61	126	......	210	......	101	187	104	177	1,721
July	545	55	27	92	......	131	......	235	113	111	164	1,473
August	620	......	27	57	......	243	......	336	98	141	126	1,648
September	500	65	......	122	......	46	......	359	72	49	256	1,469
October	500	95	......	100	......	145	......	413	201	139	97	1,690
November	455	100	2	105	......	130	125	380	136	296	202	1,931
December	621	130	......	151	......	200	242	305	227	250	980	3,106
Total	8,200	792	442	1,375	......	1,844	849	3,605	1,660	1,686	2,451	22,904

Months.	New Almaden.	Napa Con'd.	Great Western.	Mirabel.	Great Eastern.	Sulphur Bank.	Ætna.	Redington.	Abbott.	New Idria.	Lake.	Various.	Total.
1892.													
January	610	570	298	262	175	105	......	38	75	73	226	42	2,474
February	633	390	583	226	127	129	......	51	46	60	97	41	2,383
March	600	625	625	137	125	96	......	41	58	60	......	5	2,372
April	516	409	620	207	150	127	......	101	40	90	......	10	2,270
May	485	415	563	296	73	130	......	37	67	75	......	......	2,141
June	500	386	500	279	137	120	......	55	20	70	12	......	2,079
July	350	440	588	199	113	110	200	36	71	45	9	8	2,169
August	328	570	547	108	134	106	200	73	50	65	70	......	2,251
September	300	480	379	167	155	120	70	44	89	50	43	94	1,991
October	400	635	437	384	161	125	285	95	62	75	48	......	2,707
November	488	420	382	525	165	112	395	57	58	95	21	......	2,718
December	353	340	345	418	115	113	442	100	36	90	86	......	2,438
Total	5,563	5,680	5,867	3,208	1,630	1,393	1,592	728	672	848	612	200	27,993

Total product of quicksilver in the United States.

[Flasks of 76½ pounds, net.]

Years.	New Almaden.	New Idria.	Redington.	Sulphur Bank.	Great Western.	Napa Consolidated. (*a*)	Great Eastern.	Mirabel. (*b*)	Various mines.	Total yearly production of California mines.
1850	7,723	Production from 1858 to 1866, 17,455 flasks—no yearly details obtainable—included in production of various mines.	....	....	....	....	....	....	....	7,723
1851	27,779		....	....	....	....	....	....	....	27,779
1852	15,901		....	....	....	....	....	....	4,099	20,000
1853	22,284		....	....	....	....	....	....	....	22,284
1854	30,004		....	....	....	....	....	....	....	30,004
1855	29,142		....	....	....	....	....	....	3,858	33,000
1856	27,138		....	....	....	....	....	....	2,862	30,000
1857	28,204		....	....	....	....	....	....	....	28,204
1858	25,761		....	....	....	....	....	....	5,239	31,000
1859	1,294		....	....	....	....	....	....	11,706	13,000
1860	7,061		....	....	....	....	....	....	2,939	10,000
1861	34,429		....	....	....	....	....	....	571	35,000
1862	39,671		444	....	....	....	....	....	1,885	42,051
1863	32,803		852	....	....	....	....	....	6,876	40,589
1864	42,489		1,914	....	....	....	....	....	3,086	47,489
1865	47,194		3,545	....	....	....	....	....	2,261	53,000
1866	35,150	6,525	2,254	....	....	....	....	....	2,621	46,550
1867	24,461	11,493	7,862	....	....	....	....	....	3,184	47,000
1868	25,628	12,180	8,686	....	....	....	....	....	1,234	47,728
1869	16,898	10,315	5,018	....	....	....	....	....	1,580	33,811
1870	14,423	9,888	4,546	....	....	....	....	....	1,220	30,077
1871	18,568	8,180	2,128	....	....	....	....	....	2,810	31,686
1872	18,574	8,171	3,046	....	....	....	....	....	1,830	31,621
1873	11,042	7,735	3,294	....	340	....	....	....	5,231	27,642
1874	9,084	6,911	6,678	573	1,122	....	....	....	3,388	27,756
1875	13,648	8,432	7,513	5,372	3,384	....	412	....	11,489	50,250
1876	20,549	7,272	9,183	8,367	4,322	573	387	....	22,063	72,716
1877	23,996	6,316	9,399	10,993	5,856	2,229	505	....	20,101	79,395
1878	15,852	5,138	6,686	9,465	4,963	3,049	1,366	....	17,361	63,880
1879	20,514	4,425	4,516	9,249	6,333	3,605	1,455	....	23,587	73,684
1880	23,465	3,209	2,139	10,706	6,442	4,416	1,279	....	8,270	59,926
1881	26,060	2,775	2,194	11,152	6,241	5,552	1,065	....	5,812	60,851
1882	28,070	1,953	2,171	5,014	5,179	6,842	2,124	....	1,379	52,732
1883	29,000	1,606	1,894	2,612	3,869	5,890	1,669	....	185	46,725
1884	20,000	1,025	881	890	3,292	4,307	332	....	1,186	31,913
1885	21,400	1,144	385	1,296	3,469	3,506	446	....	427	32,073
1886	18,000	1,406	409	1,449	1,949	5,247	735	....	786	29,981
1887	20,000	1,890	673	1,490	1,446	5,574	689	1,543	520	33,825
1888	18,000	1,320	126	2,164	625	5,024	1,151	3,848	392	33,250
1889	13,100	980	812	2,283	556	4,590	1,345	1,874	924	26,464
1890	12,000	977	505	1,608	1,334	3,429	1,046	1,290	737	22,926
1891	8,200	792	442	1,375	1,844	4,454	1,660	1,686	2,451	22,904
1892	5,563	848	728	1,393	5,867	7,272	1,630	3,208	1,484	27,993
Total	930,122	132,906	100,923	87,451	68,433	75,559	19,276	13,449	188,214	1,616,353

a Includes Ætna.
b This mine previous to 1892 was called Bradford.

Highest and lowest prices of quicksilver in 1892.

Months.	San Francisco, per flask.		London, per flask.	
	Highest.	Lowest.	Highest.	Lowest.
			£ s. d.	£ s. d.
January	$47.50	$45.00	7 10 0	7 7 6
February	45.00	43.00	7 2 6	7 0 0
March	43.00	41.50	7 2 6	7 2 6
April	43.00	42.00	7 0 0	6 15 0
May	43.00	42.00	6 17 6	6 15 0
June	44.00	42.50	7 2 6	6 15 0
July	44.00	43.50	7 2 6	7 2 6
August	42.00	41.50	7 2 6	6 5 0
September	42.00	41.50	6 7 6	6 7 6
October	42.00	41.50	6 10 0	6 7 6
November	42.50	41.50	6 10 0	6 10 0
December	42.50	41.50	6 10 0	6 2 6
	47.50	41.50	7 10 0	6 2 6

The following table shows the range in price of quicksilver in the San Francisco and London markets for the past forty-three years:

Highest and lowest prices of quicksilver during the past forty-three years.

Years.	San Francisco, per flask.		London, per flask.	
	Highest.	Lowest.	Highest.	Lowest.
			£ s. d.	£ s. d.
1850	$114.75	$84.15	15 0 0	13 2 6
1851	76.50	57.35	13 15 0	12 5 0
1852	61.20	55.45	11 10 0	9 7 6
1853	55.45	55.45	8 15 0	8 2 6
1854	55.45	55.45	7 15 0	7 5 0
1855	55.45	51.65	6 17 6	6 10 0
1856	51.65	51.65	6 10 0	6 10 0
1857	53.55	45.90	6 10 0	6 10 0
1858	49.75	45.90	7 10 0	7 5 0
1859	76.50	49.75	7 5 0	7 0 0
1860	57.35	49.75	7 0 0	7 0 0
1861	49.75	34.45	7 0 0	7 0 0
1862	38.25	34.45	7 0 0	7 0 0
1863	45.90	38.25	7 0 0	7 0 0
1864	45.90	45.90	9 0 0	7 10 0
1865	45.90	45.90	8 0 0	7 17 6
1866	57.35	45.90	8 0 0	6 17 0
1867	45.90	45.90	7 0 0	6 16 0
1868	45.90	45.90	6 17 0	6 16 0
1869	45.90	45.90	6 17 0	6 16 0
1870	68.85	45.90	10 0 0	6 16 0
1871	68.85	57.35	12 0 0	9 0 0
1872	66.95	65.00	13 0 0	10 0 0
1873	91.80	68.85	20 0 0	12 10 0
1874	118.55	91.80	26 0 0	19 0 0
1875	118.55	49.75	24 0 0	9 17 6
1876	53.55	34.45	12 0 0	7 17 6
1877	44.00	30.60	9 10 0	7 2 6
1878	35.95	29.85	7 5 0	6 7 6
1879	34.45	25.25	8 15 0	5 17 6
1880	34.45	27.55	7 15 0	6 7 6
1881	31.75	27.90	7 0 0	6 2 6
1882	29.10	27.35	6 5 0	5 15 0
1883	28.50	26.00	5 17 6	5 5 0
1884	35.00	26.00	6 15 0	5 2 6
1885	33.00	28.50	6 15 0	5 10 0
1886	39.00	32.00	7 10 0	5 16 3
1887	50.00	36.50	11 5 0	6 7 6
1888	47.00	36.00	10 0 0	6 12 6
1889	50.00	40.00	9 15 0	7 10 0
1890	58.00	47.00	10 10 0	9 1 0
1891	51.00	39.50	8 12 6	7 5 0
1892	47.50	41.50	7 10 0	6 2 6
Extreme range in forty-three years	118.55	25.25	26 0 0	5 2 6

IMPORTS.

Quicksilver imported and entered for consumption in the United States, 1867 to 1892, inclusive.

Years ending—	Quantity.	Value.	Years ending—	Quantity.	Value.
	Pounds.			*Pounds.*	
June 30, 1867	....	$15, 248	June 30, 1880	116, 700	$48, 463
1868	152	68	1881	138, 517	57, 733
1869	....	11	1882	597, 898	233, 057
1870	239. 223	107, 646	1883	1, 552, 738	593, 367
1871	304, 965	137, 332	1884	136, 615	44, 035
1872	379, 353	189, 943	1885	257, 659	90, 4[illegible]6
1873	99, 898	74, 146	Dec. 31, 1886	629, 888	249, 411
1874	51, 202	52, 093	1887	419, 934	171, 431
1875	6, 870	20, 957	1888	132, 850	56, 997
1876	78, 902	50, 164	1889	341, 514	162, 064
1877	38, 250	19, 558	1890	802, 871	445, 8[illegible]7
1878	294, 207	135, 178	1891	123, 966	61, 355
1879	519, 125	217, 707	1892	96, 318	40, 133

Imports of quicksilver vermilion from 1867 to 1892, inclusive.

Years ending—	Quantity.	Value.	Years ending—	Quantity.	Value.
	Pounds.			*Pounds.*	
June 30, 1867	....	$123, 506	June 30, 1880	11, 952	$5, 997
1868	....	90, 648	1881	14, 243	7, 391
1869	247, 382	145, 665	1882	12, 496	6, 214
1870	104, 523	57, 262	1883	19, 549	8, 795
1871	79, 195	43, 935	1884	....	10, 472
1872	120, 067	49, 237	1885	....	8, 244
1873	87, 008	65, 796	Dec. 31, 1886	....	11, 016
1874	42, 324	39, 443	1887	....	16, 542
1875	9, 460	10, 831	1888	....	9, 342
1876	18, 981	17, 679	1889	....	3, 263
1877	23, 315	14, 660	1890	....	6, 916
1878	9, 843	5, 772	1891	....	24, 152
1879	11, 382	6, 105	1892	....	26, 151

Mercurial preparations imported and entered for consumption in the United States, 1867 to 1883, inclusive. (a)

Fiscal years ending June 30—	Blue mass.		Calomel.		Mercurial preparations not otherwise specified.	Total value.
	Quantity.	Value.	Quantity.	Value.		
	Pounds.		*Pounds.*			
1867	....	....	....	$4, 242	....	$4, 242
1868	....	....	....	4, 440	....	4, 440
1869	....	....	....	4, 516	....	4, 516
1870	....	....	....	6, 306	....	6, 306
1871	....	....	....	3, 147	....	3, 147
1872	1, 009	$667	8, 241	6, 590	$629	7, 886
1873	919	660	5, 520	5, 240	699	6, 599
1874	259	192	6, 138	6, 676	4, 334	11, 202
1875	125	109	2, 424	2, 817	52	2, 978
1876	489	365	5, 433	5, 820	92	6, 277
1877	455	327	4, 649	4, 305	90	4, 722
1878	397	252	4, 133	3, 576	363	4, 191
1879	485	266	5, 875	4, 635	6, 453	11, 354
1880	533	262	4, 780	3, 230	30	3, 622
1881	395	236	8, 177	5, 640	116	5, 992
1882	207	124	5, 215	3, 411	58	3, 593
1883	188	79	8, 732	5, 503	190	5, 772

a Not specified since 1883.

MANGANESE.

By Joseph D. Weeks.

THE ORES OF MANGANESE.

The ores of manganese mined in the United States are in every case oxides. Indeed the commercial ores of this metal are, with rare exceptions, one or the other of the three well-known oxides or mixtures of two or more of them. Carbonate of manganese is mined in Merionethshire, Wales, and at Chevron, Belgium, and possibly at one other locality, but the manganese ores that are almost universally mined the world over, psilomelane, pyrolusite, braunite, and wad, are all oxides, most of them containing more or less water of hydration. These oxides are rarely found pure, but are usually intimately associated with other metallic oxides, as those of iron and zinc, and with carbonate ores of silver, so much so that it is difficult at times to decide whether the mineral should be classed as a manganese ore, or as an iron, zinc, or silver ore. This fact has given rise to the classification of manganese ores noted below.

Three oxides of manganese of commercial importance are noted:

Protoxide (MnO), known also as monoxide. Multiplying the amount of the protoxide (MnO) in any ore by 0.7746 will give the contents of metallic manganese in the ore.

Sesquioxide (Mn_2O_3), brown oxide, known also as manganic oxide. This oxide occurs in nature as braunite, and in the state of hydrate as manganite (Mn_2O_3, H_2O). Multiplying the amount of sesquioxide (Mn_2O_3) in an ore by 0.6392 will give the amount of metallic manganese in the ore.

Peroxide (MnO_2). Multiplying the amount of peroxide (MnO_2) in an ore by 0.63218 will give the amount of metallic manganese in the ore.

The common ores of manganese are as follows:

Hausmannite is a form of the brown oxide, containing theoretically 72.1 per cent of metallic manganese.

Pyrolusite or binoxide, the black oxide of manganese, is the most common of its ores used commercially, and is the peroxide. Pyrolusite is the name properly applied to the iron-black or shining dark steel-gray crystals of manganese. It generally occurs in minute crystals, grouped together and radiating from a common center. It is this variety that is chiefly used by glass makers, as in its crystallized form manganese ore contains the least iron.

Psilomelane, an impure peroxide or black oxide allied to wad by containing water, is one of the most generally diffused of the ores of manganese. It is compact and fibrous, and has a dark steel-gray color and submetallic luster. It generally occurs in botryoidal or grapelike masses.

Braunite is the brown or sesquioxide. It occurs massive and also crystallized. It is distinguished by its brownish color. It is one of the most common ores in the United States.

Wad is a hydrate peroxide of black oxide. It is not used at all in the United States. It sometimes occurs as a hard and compact ore, though usually in brownish-black masses loosely agglomerated.

There is a most intimate connection between the ores of iron and the ores of manganese. The distribution of manganese in the United States is almost coextensive with that of brown hematite. In nearly all of these hematite iron ores manganese occurs as a constituent, while there are few samples of manganese which do not show by analysis more or less iron. Indeed, manganese and iron displace each other in most of the ores which are classed as manganese ores, and wherever manganese is present in an ore the other chief metallic constituent is usually iron. When manganese and iron are the chief constituents and manganese predominates the ore is called manganese ore; when the iron contained exceeds that of manganese and the latter is present in appreciable quantity—say, not less on the average than 4 to 5 per cent.—the ore is termed a manganiferous iron ore.

In close proximity to certain of the silver ores of the West, especially the carbonates of Leadville, iron and manganese ores carrying a percentage of silver are found. These ores, which have been termed manganiferous silver ores, are from the upper workings of Leadville, and carry manganese in varying quantities from 5 up to 25 per cent., and occasionally 30 to 35 per cent., with 5 to 20 ounces of silver, 0 to 4 per cent. of lead, 7 to 18 per cent. of silica, and 30 to 50 per cent. of iron.

The zinc ores of Sussex county, New Jersey, which are mined for zinc, contain considerable manganese. These zinc ores are a mixture of willemite, franklinite, zincite, and calcite. The residuum from working these ores for zinc, which may be termed manganiferous zinc ores, is used in blast furnaces in New Jersey and in eastern Pennsylvania for the manufacture of spiegeleisen.

The ores of manganese, or those carrying manganese, will therefore be divided into four general classes: First, manganese ores; second, manganiferous iron ores; third, manganiferous silver ores, and, fourth, manganiferous zinc ores. The dividing line between the first two grades is taken at 70 per cent. binoxide of manganese, equal to 44.25 per cent. metallic manganese; this being the standard of shipments to English chemical works. All ores containing at least this amount of manganese are classed as manganese ores; those containing a less percentage of manganese, and containing also more or less iron, are classed as manganiferous iron ore. In the third class are included the manganiferous silver ores of Colorado, which are utilized chiefly for the silver they contain. They have an added value, however, by reason of the fluxing qualities imparted to them by the presence of manganese and iron. In the fourth class is placed the residuum or clinker from the zinc ores of New Jersey.

The ton used in this report is the long ton of 2,240 pounds, if not otherwise designated.

ORIGIN AND OCCURRENCE OF MANGANESE.

From the close association in which iron and manganese are usually found it is probable that they have the same origin. In many parts of the United States the manganese nodules, which form the bulk of the ore, were originally embedded in the ferriferous shales. The tenacious clay in which the manganese at present mined is found embedded was evidently formed by the decomposition of these shales. A nodular ore of manganese is even now found in Arkansas embedded in an undecomposed shale.

Many of the masses of manganese found in the deposits worked at present are evidently concretionary in their origin. These masses are not only incased in clay, as noted above, but they often inclose clay. Near Lyndhurst, Virginia, on the Shenandoah valley branch of the Norfolk and Western railroad, manganese in the process of formation into these concretionary lumps has been observed. The ore is chiefly psilomelane, with some pyrolusite and manganite, the softer material being found in cavities of the lump or forming seams in the harder ore. Lumps and crusts of manganese may be seen embedded in the clay, and are plainly now in process of formation. The manganese seems to be freely diffused through the dark-brown umber, and to be gradually concentrated out of the clay into lumps and crusts. In some cases crusts of manganese may be seen inclosing the clay, while the nodules often show inclosed clay.

In the United States manganese is usually, if not always, found in pockets, like its cousin-german brown hematite iron. It is usually embedded in clay or loam, and requires washing, even when it is found in large lumps, in order to remove the clay, which is exceedingly tenacious, clinging to the lumps of ore so closely as to require a large amount of water, sometimes under pressure, to remove it. When the ore occurs as shot ore, sparsely distributed through the inclosing clay or loam, washing also has to be resorted to, more for the purpose of separating the ore from the gangue of dirt than for washing the clay from the ore. For these reasons it is usually necessary that there be an abundant supply of water near a manganese mine. There are deposits of manganese ore in the United States of fairly good quality that can not at present be made available to commerce from the lack of water for washing in the near vicinity of the mine.

Manganese ore occurs as shot ore in nodules, lumps, and masses from the size of a pin head to masses weighing tons. "Sheets" of ore are sometimes formed by the union of masses that lie in a uniform direction. These masses are evidently concretionary in their origin.

MINING LOCALITIES IN THE UNITED STATES.

By far the larger proportion of the manganese ores proper produced in the United States is mined in three localities, Crimora, Virginia; Cartersville, Georgia; and Batesville, Arkansas. Of the 13,613 tons of these ores produced in the United States in 1892, 11,923 tons were from these three districts. Manganese is found, however, in many places in the United States. Indeed, as we have already indicated, its occurrence is almost coextensive with that of brown hematite iron ores. As a result, manganese is found all along the western slope of the eastern ridge of the Appalachian range of mountains from Maine to Georgia. Considerable manganese ore is found associated with the hematite ores of the Lake Superior region, and in Arkansas, southwestfrom Batesville. The indications are that there are large deposits in the Rocky Mountain regions, and on the California coast very large deposits of manganese ore have been observed. In many cases, however, the ore is so far from transportation lines and from the points of consumption as to make it impossible to mine it profitably.

Outside of the three districts named above, with few exceptions, the deposits are small and the indications not such as to justify the expenditure of large amounts of money in mining and washing plants which are usually necessary to the economical production of manganese. It is not to be understood that there are no localities outside of those named in which manganese can be profitably mined. The mining of manganese ore, however, is one of the most uncertain undertakings in the whole list of mining operations. The amount of manganese produced in the country is much smaller than is generally believed; its mining, as a rule, is not profitable, and the risks, by reason of the pockety character of the deposits, are very great.

The largest proportion of the manganiferous iron ores produced in the United States is from the Lake Superior region, where it is found associated with the iron ores of that section. Some manganiferous iron ore is mined in Virginia—a much larger proportion in 1892 than in any recent year. In Colorado some manganiferous iron ore was produced in 1892 in addition to the manganiferous silver ore, which is the chief manganese product of Colorado. This ore was used at Pueblo and Chicago in the manufacture of spiegeleisen. All of this ore was from the Leadville district.

Most of the manganiferous silver ore mined in 1892 was from the Leadville district in Colorado. Some ore was produced in Montana and the deposits are so extensive as to lead to the belief that it will be produced in this state in increasing quantities.

All of the manganiferous zinc ores were from Sussex county, New Jersey.

THE PRINCIPAL MANGANESE DEPOSITS IN THE UNITED STATES.

As stated above, the larger portion of the manganese ores produced in the United States are from three localities, Crimora, Virginia; Cartersville, Georgia; and Batesville, Arkansas. A brief description of the two latter, with a more extended notice of the Crimora deposit, which is the most important in the United States, may be of interest as indicating the method of the occurrence of the ore as well as the methods of mining and washing adopted.

In the Cartersville (Georgia) district the ore occurs in pockets embedded in a drift deposit, usually covering hilltops and outcropping, but at times at a depth of from 3 to 30 and even 100 feet below the surface. These deposits are at times bedded quite regularly and at others scattered without the least regularity. There are frequently "leads" running from one deposit to another. The drift in which the ore is embedded varies greatly, being sometimes ocher, at others a blue dirt, soft and without grit, and at still others the ore is said to be found in sand rock. These deposits have as their base the Silurian rocks, usually the Potsdam, and lie near the metamorphic rocks of the state. They are associated with limonite deposits of a similar character, the limonite usually occurring to the west of the manganese. The ore occurs as massive, crystallized, and needle ore, and is found in grains from the size of a mustard seed to that of a pea, and even a walnut, and also in much larger masses.

In the Batesville (Arkansas) district it is stated that the ores occur in two horizons and under two distinct conditions:

1. The drift ores of the northwestern portion of the region.
2. The regular stratified bed of the eastern portion of the belt.

The drift manganese ore is found under the tops of the hills in pieces from the size of a pea up to bowlders 2 and 3 and even 4 tons in weight. The diluvian deposit carrying the ore is from 5 to 25 feet in thickness, averaging, say, 9 feet, and rests upon a floor of limestone, a brown clay of varying thickness being interposed. This ore drift yields from 12 to 30 per cent. of ore. Above the manganese drift is an earthy wash interspersed with fragments of chert from 3 to 30 feet thick. At the Southern mine the stripping is 2 to 25 feet thick and the drift in which the manganese is found 20 feet thick. The pit at this mine covers a little more than half an acre. At other pits opened the stripping is 10 feet and the ore drift is 5 to 11 feet.

As the Crimora mine, in the Shenandoah valley of Virginia, is the most important manganese mine in this country, if not in the world, a description of the mine and the mode of occurrence of the manganese will be of interest.(a)

The Crimora mine is situated in Augusta county, Virginia, 2½ miles from Crimora station, on the Shenandoah valley division of the Norfolk and Western Railroad, with which it is connected by a branch road.

The ore deposit, which is most peculiar in its location and accumulation, occurs in an elliptical basin about 500 feet broad on its transverse axis and 800 to 900 feet long. This basin is cut out of the Potsdam sandstone, which is hard rock at this place. Opposite to the basin and at right angles to its longer axis is a deep ravine, Turks gap, sharply cut into the flanks of the mountain, through which a stream flows. Nearly opposite to this ravine is a ridge that served as a bulwark to the action of the forces at work in this section. Evidently this basin is the work of old-time eroding agencies, acting just as water now acts below a river dam, excavating a deep curved section. The formation and location of this basin, as well as the deposits it contains, is exceedingly interesting and peculiar.

The basin is filled with wash and manganese ore lumps. The general body mixture, the mud, sand, and clay, with the lumps of manganese ore, were carried to place by agencies more recent than those which excavated the basin, just as the iron ore pits in the limestone valleys of Pennsylvania were filled in.

There are two, possibly three, special layers of yellow clay, which are rich in lumps and masses of ore, the lower about 30 feet, the upper about 25 feet, in thickness. A layer of clay 20 feet thick, almost barren of manganese ore, separates these two ore-bearing layers. The mining operations are at present confined to these beds.

The ore is found in lumps and masses from the size of a small pebble to lumps weighing a quarter of a ton or more. One mass was found which was 115 feet by 60 feet and 50 feet high. These lumps are found scattered through the basin as above indicated, and cover an area of about 6 acres. The basin at the shaft is 117 feet deep. Some "sheets" of ore formed by the union of masses that lie in a pretty uniform direction are also found. The larger masses are blasted in the mine.

THE OCCURRENCE OF MANGANESE AT CRIMORA, VIRGINIA.

Fig. 1 is a ground plan of the immediate vicinity of the mine. The line AA is the general line of axis of the monoclinal of the Potsdam sandstone, with westward dip. BB indicates the synclinal axis, which sinks rapidly to the southward. CC is the line of the anticlinal of the Potsdam. Near the center of the figure a brook is indicated flowing from the monoclinal ridges of the Potsdam on the east and crossing the

a For much of this description and the cuts credit is due to an article in the American Manufacturer and Iron World, and to a paper read before the American Institute of Mining Engineers by Mr. Charles E. Hall.

synclinal basin and also the anticlinal fold CC to the westward. W. indicates the location of the ore washer. The sections Nos. 1, 2, 3, and 4, Fig. 2, are taken on lines indicated by the respective numbers in Fig. 1.

Fig. 1.

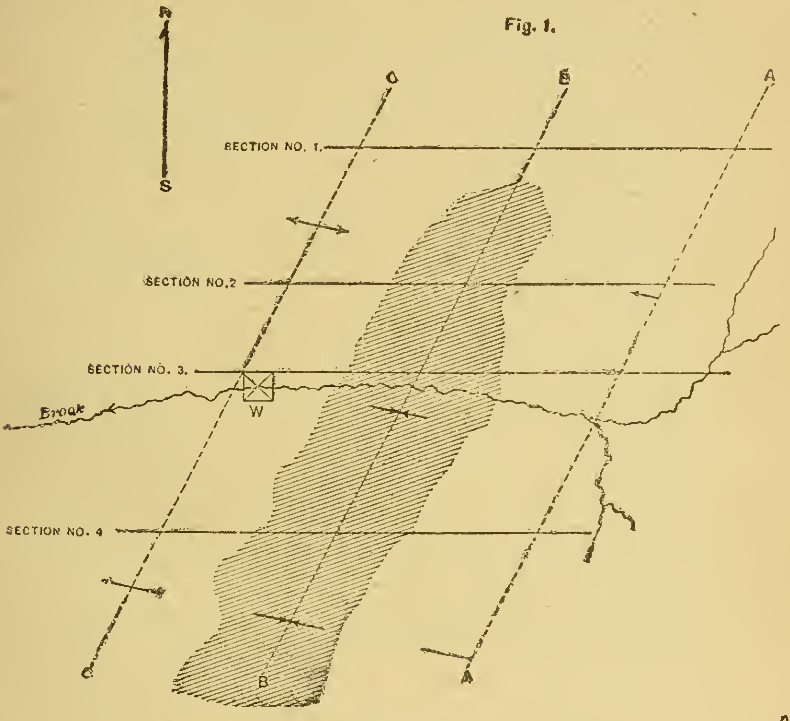
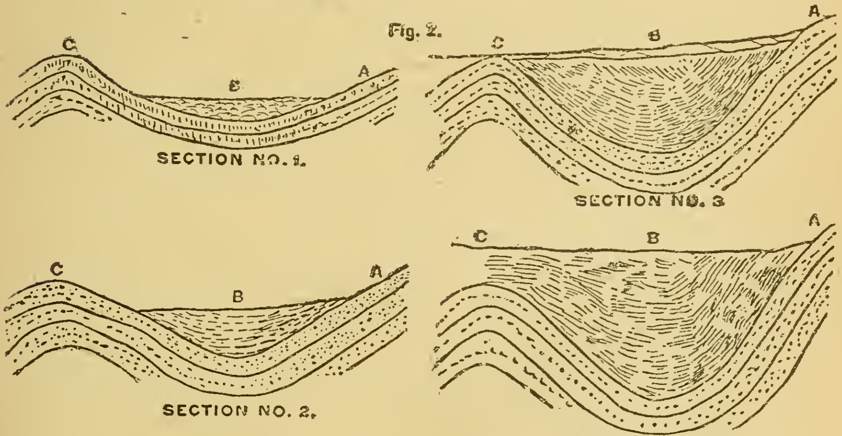


Fig. 2.



It will be seen from Fig. 1 that east of the mine there is a large area drained by the brook which crosses the ore basin. This drainage area is principally within the Potsdam sandstone belt. The brook leaves the synclinal (ore-bearing) basin at the point where the Potsdam anticlinal fold, indicated in the sections by C, sinks below the surface. It will be seen from the sections, Fig. 2, that the axis C, as well as B, rapidly sinks to the northward.

The clay resulting from the decomposition of the shales has been preserved within this sharp synclinal. In section 1 scarcely any clay appears, while between sections 3 and 4 more than 300 feet of clay have been penetrated in boring for ore. The shaded portion of Fig. 1 indicates the ore area, which extends irregularly northeast and southwest with the axis of the basin. The distance across the basin is one-fourth of a mile. The drainage area of the brook west of the basin is fully 10 square miles.

The fold C, section 3, forms a complete dam, back of which the seepage water is held until it can slowly work its way through the sandstone of C, or southward and past the end of the sinking anticlinal axis.

The Crimora mine passed out of the possession of the American Manganese Company, Limited, in 1892, the lease on the property having expired. It is now worked by the owners of the fee, the Virginia Manganese Company. These parties were compelled to sink new shafts, and operations consequently were suspended for quite a portion of the year, mining being resumed only during the last months.

As the method adopted by the American Manganese Company, Limited, for sinking shafts and washing the ore was very elaborate, more so than that adopted at any other manganese mine in the United States, a brief description is given of the methods used. It should be noted that previous to sinking the shafts a number of test holes were drilled in various portions of the property to give an idea of the extent and locality of the ore pockets.

The shafts were sunk through the clay to below the bottom of the ore and at a distance from it, so that their stability would not be interfered with by the mining operations. The main tunnel was also driven outside of and below the ore for a similar reason.

From the main tunnel chutes run out in all directions to the ore pockets, where headings are driven out on the level in various directions. The excavations of the ore proceeds at several levels at once in the same pocket by stopping with timber, as shown, secondary chutes being provided, into which the material from the various levels is dumped, which finds its way to the main chute, and so to the cars. All of the mining is done by hand. Where the material is hard, hand drills and dynamite are used.

The water in the workings is conveyed in wooden troughs to the chutes, where it passes down with the material and partly washes it.

About 300 tons of material were mined in a day of twelve hours, which, after crushing, washing, and separating, leaves about 50 or 60 tons of ore.

The material having no regular formation, but being heavy and loose, necessitates strong timbering of the headings, and the timber is in some places subjected to such a great strain that it has to be renewed about every thirty days. The large quantity needed may be gathered from the fact that about 1,500,000 feet are used in the Crimora mine in a year.

The main tunnel is 7 feet square, inside measurement, having timbers 12 by 12 inches 3 feet apart, which are framed to fit into each other, as shown, to make a framework, and have planking or slabs 12 by 12 inches at top and sides to resist the outside pressure.

All material as it comes from the mine is dumped into the chute above the crusher and fed through it. It falls directly into the "log" washer, which consists simply of two shafts about 18 inches in diameter and 24 feet long, on which are bolted spiral-shaped teeth, running in a box or frame 24 feet long, 5½ feet wide, and 3 feet deep, filled with water. From this material in a semiwashed state passes into the Bradford washer, which is a cylinder 13 feet long and 4½ in diameter, with teeth about 7 inches long on the inner circumference. From this it goes into the classifying screen (conical shape) with a three-eighths inch mesh. All that passes over the screen runs out on the conveyor, and while it is being conveyed into the cars the flint and other refuse matter is picked out. What passes through the three-eighths-inch mesh in the classifying screen runs by a chute into an elevator, and is then dropped into a jig, where all foreign matter is removed, the refuse passing off at the top, and the cleaned ore at the bottom runs into settling tanks and is raised by another elevator and dropped by chute into cars. All machinery works automatically, and the material is not handled after it is put into the crusher.

THE USE OF MANGANESE.

The earliest known use of manganese was as coloring matter in the manufacture of pottery and glass. The violets, browns, and blacks of pottery are usually produced with oxide of manganese, the depth of coloring depending upon the quantity used and the heat applied. Excess of manganese gives a jet black. Basalt or black Egyptian bodies require at times as high as one-sixth of the weight of the mass of manganese. Doorknobs are colored black by an excess of manganese. Various shades of brown result from varying proportions, while a slight amount will give a violet or purplish tinge to the ware. Manganese may be used either in the body of the ware itself, in the glaze, or in the decorations.

Manganese, always as pyrolusite in its purest state, is used in glass-making for two purposes, first, to color violets, purples, browns, and blacks, and, secondly, as a decolorizer to remove the greenish tinge due to the presence of iron in the glass sand. It is to the latter use that it owes its name "savon de verriers" (glass-makers' soap).

One of the chief uses of manganese, indeed, its chief one for many years, was in the manufacture of chlorine gas used in the production of bleaching powder (chloride of lime). Little or no manganese is used in the United States for this purpose.

A small amount of manganese is used in the United States in the manufacture of bromine, a process somewhat analogous to chlorine production.

Manganese is also used in a small way as a paint, as a coloring matter and mordant in dyeing and calico printing, in the manufacture of oxygen, as a material in the manufacture of disinfectants, in electrical batteries, and alloyed with copper, iron, bronze, and other metals for various uses, especially for journal bearings.

For all of these purposes, however, the amount of manganese used in the United States is very small. It is probable that the total consumption in pottery and glass manufacture does not exceed 500 tons a year, of which about two-thirds is used in glass-making. The amount used in bromine manufacture and the other uses enumerated probably amounts to another 500 tons. The remainder is used in connection with iron and steel manufacture, chiefly in the production of steel and of a pig iron containing considerable manganese for use in cast-iron car wheels. In the crucible process of steel manufacture manganese is charged into the pots either as an ore at the time of charging the pots or it is added as spiegeleisen or ferro-manganese at the time of charging or during the melting, usually toward the close of the melting so as to prevent too great a loss of manganese by oxidation. In the bessemer and open-hearth process the manganese is added as spiegeleisen or ferro-manganese at or near the close of the process, just before the casting of the metal into ingots.

It has been found in recent years that a chilled cast-iron car wheel containing a percentage of manganese is much tougher, stronger and wears better than when manganese is absent. For this reason large amounts of manganiferous iron ores are used in the manufacture of Lake Superior charcoal pig iron intended for casting into chilled cast-iron car wheels.

CHARACTER OF THE MANGANESE ORES OF THE UNITED STATES.

As has already been stated, the ores of manganese mined in the United States are all oxides, pyrolusite, psilomelane and braunite, chiefly the two latter, which are the impure black oxide and the brown oxide. The amount of pyrolusite mined is comparatively small.

The chief impurities in these manganese ores are silica and phosphorus. There are many ores in the United States high in manganese that contain too much phosphorus to make them commercially valuable under the present conditions of the use of manganese ores. Take a manganese ore containing from 45 to 47 per cent. of manganese as a standard and the price of this ore at say 29 cents a unit of manganese would be based on ores containing not more than 8 per cent. of silica nor more than 0.100 per cent. of phosphorus. For each 1 per cent. of silica in excess of 8 per cent. 15 cents a ton would be deducted; for each 0.020 per cent. increase of phosphorus 1 cent per unit of manganese would be deducted. A 45 per cent. manganese ore, therefore, containing say, 9 per cent. of silica and 0.120 per cent. of phosphorus would be worth 60 cents a ton less than the standard, the excess of silica reducing the price 15 cents a ton and the excess of phosphorus reducing the price 1 cent per ton for each of the 45 units or 45 cents per ton in the total for phosphorus, making a total reduction of 60 cents.

While there are many grades of manganese ores in the United States, for the purposes of this report, in view of the fact that most of the manganese ore mined is from three localities, it will only be necessary to give analyses of the ores from these three districts, namely, Batesville, Arkansas; Cartersville, Georgia, and Crimora, Virginia. The analyses given are of the standard ores of these districts. For analyses of other manganese ores from these same districts and also of ores from other districts, those interested are referred to the report on the mineral industries in the United States at the Eleventh Census and to the yearly volumes of the Mineral Resources of the United States, published by the U. S. Geological Survey.

Character of the manganese ores of the Batesville, Arkansas, region.—As has already been stated, the ores in the Batesville region occur in two horizons and under two distinct conditions as drift ores and in a regular stratified bed. The ores of these two horizons, which are black oxides, do not differ materially in character, the drift ore, if anything, being the better.

The percentage of manganese varies from 40 to 60 per cent. The ore is of a bright luster, submetallic in color, crystalline, brittle and with a fracture like that of cast iron. An analysis of the drift ore is as follows:

Analysis of Batesville, Arkansas, drift manganese ore.

Component parts.	Per cent.
Metallic manganese	55.95
Phosphorus	0.17
Insoluble matter	1.27

The following is an analysis of an average of seven shipments of the Batesville ore:

Average composition of seven analyses of Batesville, Arkansas, manganese ore.

Component parts.	Per cent.
Metallic manganese	50.43
Metallic iron	3.66
Phosphorus	0.16
Water	2.28

Analyses from three separate pits in the Batesville region give the following:

Analyses of Batesville, Arkansas, manganese ores.

Component parts.	Pit 1.	Pit 2.	Pit 3.
	Per cent.	*Per cent.*	*Per cent.*
Metallic manganese	56.92	54.33	56.88
Phosphorus	0.16	0.29	0.18
Insoluble matter	2.10	1.34	0.72

Character of the manganese ores of the Cartersville, Georgia region.—The ores of the Cartersville region, which is the oldest of the manganese ore regions of the United States, occur in massive, crystalized, and in needle forms, and are found in grains from the size of a mustard seed to that of a pea and even a walnut and also in much larger masses. The ore varies greatly, not only in percentage of ore to gangue, but also in its richness. In the same mines some ore will run as high as 60 per cent. metallic manganese, in exceptional cases even higher, while on the other hand pieces containing as low as 38 per cent. are found.

The oldest mine operated in this district and the one which has produced most ore is what is known as the Dobbins mine. The ore is quite good, as will be seen from the following analyses.

Analyses of manganese ore from the Dobbins mine, Cartersville, Georgia.

Component parts.	No. 1.	No. 2.
	Per cent.	*Per cent.*
Metallic manganese	52.726	48.832
Metallic iron	4.490	5.400
Silica	4.300	5.050
Phosphorus	0.188	....

The largest producer of manganese in this district in recent years has been the Dade mine. The ore from this deposit shows the usual characteristics of the Cartersville manganese ore. It varies greatly in its composition, and the pockets in which the ore has been found as greatly in production. Some years the mine has produced but 100 tons, when it produced any ore; in others the production has reached 4,000 tons. A series of anylses from this mine is given in the following table:

Analyses of manganese ore from the Dade mine, Bartow county, Georgia. (a)

Analyses.	Silica.	Iron.	Manganese.	Phosphorus.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
No. 1	6.370	23.900	30.320	0.100
No. 2	7.560	15.836	36.489	0.089
No. 3	17.490	3.286	40.354	0.119
No. 4	7.520	11.055	41.430	0.215
No. 5	11.370	10.956	36.950	0.167
No. 6	9.450	25.250	27.711	0.123
No. 7	12.300	8.534	42.933	0.109
No. 8	17.370	4.216	42.612	0.106
No. 9	20.151	6.292	41.655	0.134
No. 10	14.100	10.341	39.226	0.179
No. 11	16.450	4.267	43.457	0.103

a All samples dried at 212°. Some ores run as low as 5 per cent. manganese and 46 per cent. iron.

Character of the manganese ores from Crimora, Virginia.—The ore from the Crimora mine, which is the most important manganese mine in the United States, is a high-grade ore found in lumps and masses and sometimes in sheets. The masses found in this mine at times are so large as to require blasting before elevating to the surface.

The ore as a rule is psilomelane; occasionally some pyrolusite is found forming thin veins and nests in the lumps of psilomelane. Upwards of 125,000 tons of high-grade manganese have been taken from this mine.

An analysis of the best quality of the ore by Prof. A. S. McCreath shows as follows:

Analysis of best grade of manganese ore from Crimora, Virginia.

Component parts.	Per cent.
Metallic manganese	57.291
Metallic iron	.373
Phosphorus	.075

In the following table is given an analysis of what may be regarded as average shipments of ore from the Crimora mine during the years 1887 and 1888, when it was worked by the American Manganese Company, limited, and will probably represent the average analysis of 50,000 tons of the product of this mine.

As is indicated by the analyses the quality of the ore, at least in its percentage of manganese, deteriorated greatly in the closing years when it was operated by the American Manganese Company, limited.

Analysis of Crimora, Virginia, manganese ores.

	Silica.	Iron.	Manganese.	Phosphorus.
1887.				
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
January	10.20	1.985	48.530	0.103
March	10.12	1.957	50.541	(*a*)
April	10.30	4.568	48.162	.095
1888.				
January	14.00	3.263	44.541	.087

a Not determined.

CHARACTER OF THE MANGANIFEROUS IRON ORES OF THE UNITED STATES.

While manganiferous iron ores exist in many parts of the United States, they are mined in but few localities. Their use is chiefly in the manufacture of spiegeleisen, some of those approaching manganese ores proper being used also in the production of ferromanganese. These products are made in but three or four places in the United States, chiefly at Johnstown and Bessemer, Pennsylvania, Chicago, Illinois, and Pueblo, Colorado. An ore must be quite rich in manganese and ocated not far from some one of these points to make it profitable to mine it and ship it, and it can not be used in the manufacture of ordinary pig iron, as an excess of manganese unfits the ore for the manufacture of the ordinary grades of iron, except in the case noted elsewhere, in which an iron ore carrying from 4 to 8 per cent. of manganese is used in the manufacture of charcoal pig iron for chilled iron car wheels. For these reasons but little manganiferous iron ore is produced outside of the Shenandoah valley in Virginia, the Lake Superior iron ore regions, and the silver regions of Colorado.

Character of the manganiferous iron ores of the Lake Superior region.—The manganiferous iron ores of the Lake Superior region are found, as has been stated, in connection with the hematites of the district. They are found in pockets of greater or less extent. When the amount of manganese in the ore is very small it is ignored; when it reaches 4 per cent or more it is usually mined and sold separately. By reason of the pockety character of the ores, however, it frequently happens that a mine will report a production of manganese in one year and none the next. Strictly speaking, therefore, there are no manganese mines in the Lake Superior region, though many mines carry a slight percentage of manganese. At times thin streaks of high grade ore are found in the iron ore beds. Quite an amount of ore, however, carrying from 4 to 17 per cent. is produced. In 1892 the ore raised averaged from 4.839 per cent. of manganese to 12.028 per cent., much the larger proportion of that mined carrying 5 per cent. and under. The shipments of ore in 1892 from the Lake Superior region averaged as follows:

Average analyses of manganese in ores shipped from the Lake Superior region in 1892.

Amount shipped.	Metallic iron.	Metallic manganese.	Silica.	Phosphorus.	Moisture.
Long tons.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
7,500	44.47	8.00	9.42	0.100	5.60
4,478	50.00	5.00	7.50	0.115	7.00
22,254	47.937	12.028	....	0.046	....
8,272	52.62	9.998	....	0.058	9.96
98,217	57.00	5.000	....	0.063	....
6,710	56.358	4.893	....	0.0546	....

These analyses represent the average shipments of 147,431 tons. It will be noticed that as a rule they are exceedingly low in phosphorus and fairly high in metallic iron. The shipment containing the lowest percentage of metallic iron has with one exception the highest percentage of phosphorus, while the shipment which shows about the average amount of iron—that is, 50 per cent.—contains the highest amount of phosphorus. It is evident from this fact that in these ores at least there is no relation existing between the amount of iron and the amount of phosphorus.

The following is a very thorough analysis of manganiferous iron ore containing a little less than 11 per cent. of manganese found in the McComber mine at Negaunee. Some of the pockets of the ore met with in this mine are occasionally 25 feet across and of a fairly good quality:

Analysis of McComber, Michigan, manganese ores.

Component parts.	Per cent.
Oxide of iron	71.430
Oxide of manganese	17.250
Alumina	2.200
Phosphoric acid	0.073
Sulphuric acid	0.073
Silica	2.050
Water combined	5.320
Undetermined	1.604
	100.000
Metallic iron	49.800
Metallic manganese	10.900
Phosphorus	0.034
Sulphur	0.021

Character of the manganiferous iron ores of Virginia.—The amount of manganiferous iron ore that has been shipped from Virginia has been comparatively small, the production of this state being chiefly manganese ore. In the last six months of 1892 nearly 3,000 tons was shipped from the mines of the Virginia Mining and Investment Company in the Shenandoah valley. The mines are located in the Blue Ridge mountains, in Augusta county, the station from which the ore is shipped being known as Mine Hill. This ore had an average content of iron of 33.397 per cent. and of manganese, 15.548 per cent.

At times considerable manganese has been shipped from the Houston mines, near a station of the same name on the Shenandoah Valley division of the Norfolk and Western railroad, in Botetourt county, but none was shipped as far as has been learned in 1892. Some of the ore mined at this point is manganese ore, but the average is manganiferous iron ore. The average analyses of the monthly shipments from this mine for 1884 and 1885 showed 39 per cent. of metallic manganese and 12 per cent. of metallic iron, with phosphorous about 0.07 per cent. Prof. A. S. McCreath made a selection of 115 pieces to represent the manganiferous iron ore at this mine and 68 pieces to represent the manganese. These samples gave upon analysis the following results:

Analyses of manganese and manganiferous iron ores from Houston, Virginia.

Component parts.	Iron ore.	Manganese ore.
	Per cent.	*Per cent.*
Metallic manganese	7.277	44.312
Metallic iron	47.150	12.325
Phosphorus	0.061	0.101
Siliceous matter	8.030	5.470

Character of the manganiferous iron ores of Colorado.—No manganese ores are mined in Colorado. Considerable iron and manganiferous iron ores are mined in the Leadville district, being used either as a flux in the smelting of silver or at Pueblo in the manufacture of spiegeleisen, Some of the ore containing the highest percentage of manganese has been sent to the Illinois Steel Company at Chicago. Analyses of these ores carrying about 20 per cent. and over of manganese are as follows:

Analyses of manganiferous iron ores in Colorado.

Component parts.	Catalpa.	Crescent No. 1.	Crescent No. 2.	Hull.	Emmett mining Company.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	34.90	17.80	21.15	35.00	11.00	11.45
Silica	6.90	6.30	7.00	3.83	8.06	5.02
Manganese	21.30	34.00	31.00	19.30	35.36	38.22
Alumina	4.15			2.00	2.37	
Lime	0.34			0.46	1.23	
Magnesia	0.07			0.45	1.36	
Sulphur	0.06	0.027			0.33	
Phosphorus	0.04	0.056			0.111	0.073
Copper	Trace			0.03		
Oxide of lead				1.85		
Volatile matter				9.36		
Water				2.96	18.06	

CHARACTER OF THE MANGANIFEROUS SILVER ORES OF THE UNITED STATES.

As has already been stated, iron and manganese ores carrying a percentage of silver are often found associated with the silver ores of the West, especially the carbonates of Leadville. These ores carry manganese in varying quantities up to as high as 35 per cent., with 5 to 20 ounces of silver, often as much as 4 per cent. of lead, 18 per cent. of silica, and 30 to 50 per cent. of iron. They vary so greatly in their composition that it is almost impossible to give analyses that will indicate their average content of different minerals. The average analysis of the ores from the Small Hopes Consolidated Mining Company showed 42.5 per cent. of iron, 8.5 per cent. of manganese, 12.5 per cent. of silica, with about 9 ounces of silver. This deposit is a contact vein of about 30 inches in thickness, of great extent and quite regular. The ore would be classed as a limonite iron ore.

The average percentage of manganese in 14,315 tons of the total production of manganiferous silver ores from Colorado in 1892 was 24.9, and 12 per cent. in the remaining 45,262 tons.

CHARACTER OF THE MANGANIFEROUS ZINC ORES OF THE UNITED STATES.

The so-called manganiferous zinc ores are the residuum obtained from working the zinc ores of Sussex county, New Jersey. The principal deposits of this ore are at Franklin, where there are two mines, the Taylor and the Sterling Hill. The mineral worked here is a mixture chiefly of franklinite and willemite, with varying quantities of zincite and calcite. The larger part of the manganese in the ore is associated with the franklinite, which contains from 9 to 20 per cent. of this mineral. Willemite contains from 2 to 7 per cent. Two silicates of manganese, rhodonite with 42 per cent. and tephroite with 54 per cent., while present in the ore at times, are rarely in sufficient quantities to add to the value of the ore.

In the following table are given analyses of large lots of the ore from Franklin:

Analyses of Franklin, New Jersey, manganese ores.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
SiO_2	10.21	11.08	10.33	4.86	5.15	11.77
Fe_2O_3	31.41	27.54	30.36	30.33	27.62	30.91
MnO	15.84	17.63	15.95	12.30	13.09	10.27
ZnO	32.83	35.88	26.34	29.42	23.28	25.71
Al_2O_3	0.21	0.24	1.16	0.67	0.64	2.01
CaO	5.09	2.01	7.15	12.65	14.37	10.43
MgO	....	0.77	1.09	....	1.98	0.99

In the above tables Nos. 1 and 2 are selected ores from the Taylor mine; No. 3, a lean ore from the same mine; Nos. 4 and 5, Sterling Hill ore; No. 6, ore from the north end of Mine Hill, leaner than the average.

This zinc ore is first treated by the Wetherill process for making zinc oxide, the resulting clinker or residuum alone being used in the blast furnace for the manufacture of spiegeleisen. The clinker is in pieces varying from flat cakes a foot in diameter and 2 inches thick to fine dust, and is all charged in the blast furnace. Below are analyses of the cinder used.

Analyses of manganiferous zinc clinkers.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
SiO_2	35.77	32.60	37.12	32.59	30.51
Al_2O_3	11.67	13.06	11.72	10.61	12.12
ZnO	....	....	....	0.71	0.82
FeO	2.09	2.85	2.27	1.85	5.26
MnO	9.51	13.07	12.42	8.35	6.44
CaO	30.36	30.58	27.24	32.80	32.02
MgO	10.39	7.54	8.84	11.47	13.31
Total	99.79	99.70	99.61	98.38	100.48

Nos. 1, 2, and 3 are from the New Jersey furnaces; No. 1 is a normal cinder; No. 2 unusually basic and No. 3 unusually acid, both containing too much manganese. No. 4 is cinder made at the Passaic furnace. No. 5 was made at the same furnace, and is rather remarkable for the high iron with low manganese.

PRODUCTION OF ALL CLASSES OF MANGANESE ORES IN 1892.

On the basis of the classification heretofore given the total production of all classes of manganese and manganiferous ores in the United States in 1892 was as follows:

Production of manganese and manganiferous ores in the United States in 1892.

Ores.	Quantity.	Total value.	Value per ton.
	Long tons.		
Manganese	13,613	$129,586	$9.52
Manganiferous iron	153,373	354,667	2.31
Manganiferous silver	62,309	323,794	5.20
Manganiferous zinc	31,859	25,937	0.814
Total	261,154	833,984	3.19

The total production of manganese and manganiferous ores in the United States in 1891 is shown in the following table:

Production of manganese and manganiferous ores in the United States in 1891.

Ores.	Quantity.	Total value.	Value per ton.
	Long tons.		
Manganese	23,416	$239,129	$10.21
Manganiferous iron	132,511	314,099	2.37
Manganiferous silver	79,511	397,555	5.00
Manganiferous zinc	38,228	57,432	1.25
Total and average	273,666	1,008,215	3.68

These figures are given for the purpose of comparison. From them it will be seen that the total production of 1892 did not differ much from that of 1891, being 261,154 tons in the former year and 273,666 tons in the latter year. The several items making up this total in the two years vary greatly. The production of manganese ore fell from 23,416 tons in 1891 to 13,613 in 1892; a reduction of some 9,803 tons, or nearly 42 per cent. The production of manganiferous iron ore increased from 132,511 tons to 153,373 tons. The production of manganiferous silver ores decreased from 79,511 tons to 62,309 tons, while the production of manganiferous zinc decreased from 38,228 tons to 31,859 tons.

The total value of all these ores decreased from $1,008,215 in 1891 to $833,984 in 1892, while the average value per ton decreased from $3.68 to $3.19. There was also a notable decrease in the value per ton of each class of ore except the manganiferous silver, which increased from $5 in 1891 to $5.20 in 1892.

Statements similar to the above have been collected only for the years 1889 to 1892. The total production and value in these four years of all classes of ore carrying manganese has been as follows:

Production and value of manganese and manganiferous ores in the United States from 1889 to 1892.

Years.	Total production.	Total value.	Average value per ton.
	Long tons.		
1889	216,266	$794,254	$3.67
1890	187,947	692,845	3.69
1891	273,666	1,008,215	3.68
1892	261,154	833,984	3.19

PRICE OF MANGANESE AND MANGANIFEROUS ORES IN 1892.

The chief buyers of manganese in the United States are the Cambria Iron Company, Johnstown, Pennsylvania; the Carnegie Steel Company, limited, Pittsburg, Pennsylvania; and the Illinois Steel Company, Chicago, Illinois. The largest buyer is the Carnegie Steel Company, limited. Its memorandum of prices paid for manganese ores delivered at

Bessemer, Pennsylvania, which is the point where its furnaces for making spiegeleisen and ferro-manganese are located. This was issued on November 1, 1892, and was also ruling at the close of the year.

"Prices are based on ores containing not more than 8 per cent. silica and not more than 0.10 per cent. phosphorus, and are subject to deductions as follows: For each 1 per cent. of silica in excess of 8 per cent., 15 cents per ton; for each 0.02 per cent. phosphorus in excess of 0.1 per cent., 1 cent per unit of manganese.

Prices paid for manganese ores delivered at Bessemer, Pennsylvania.

Manganese.	Prices per unit.	
	Iron.	Manganese.
	Cents.	*Cents.*
Ore containing above 49 per cent	10	31
47 to 49 per cent	10	30
45 to 47 per cent	10	29
43 to 45 per cent	10	28
40 to 43 per cent	10	27
36 to 40 per cent	10	26
32 to 36 per cent	10	25
28 to 32 per cent	10	23
24 to 28 per cent	9	21
20 to 24 per cent	9	19
16 to 20 per cent	9	17
12 to 16 per cent	9	15

"Settlements are based on analyses made on samples dried at 212°, one-fourth the percentage of moisture in samples as taken being deducted from the weight.

"These prices are subject to change without notice, unless otherwise specially agreed upon."

The unit of manganese or iron is 1 per cent. of either of these metals in the metallic state contained in the ore dried at 212° F. For instance, if an ore contain 49 per cent. manganese and 5 per cent. of iron there would be 49 units of manganese and 5 units of iron. The price of such an ore, according to the above table, would be 10 cents a unit for the iron and 30 cents a unit of manganese, provided the silica and phosphorus were within the limits named. This would make the iron in the ore worth 50 cents and the manganese $14.70; the total value of the ore being therefore $15.20 delivered at Bessemer, which is practically a Pittsburg delivery.

The prices given in the above table practically govern the price of all the manganese ore produced in the United States. The price at the mine would be the price obtained for the ore at Bessemer less the transportation charges. Prices for ore delivered at either Chicago or Johnstown would be practically based on these same rates, with allowances for difference in location, freight charges, etc. By reference to the statement of production of manganese in 1892 it will be seen that the average value at the mines of the ore shipped from Virginia in

1892 was $9.70 per ton. Some of the ore, by reason of excessive cost for transportation, was worth only $6.89. A small portion of it, which contained a large amount of pyrolusite, sold for $10. The greater portion, however, was worth about $9.75 per ton at the mines.

The average value of the ores shipped from Arkansas in 1892 was $9.67, while the value of that shipped from Georgia was but $7. Most of the ore from Arkansas went to Chicago. The ore from Georgia was shipped chiefly to Pittsburg, and its grade was slightly lower than the Virginia and Arkansas ore. Consequently it would be worth a little less delivered; but the chief difference in the cost is the greater expense of transportation, a great deal of the ore having to be hauled by carts to the railroad, while the cost of the railroad transportation to Pittsburg would be greater than from Virginia to the same point.

The average price per ton of the 153,373 tons of manganiferous iron ores produced in 1892 was $2.31. Ore of this character, containing, as a rule, small amounts of manganese, is not worth much in excess of its value as iron ore. The ore shipped from Virginia, amounting to 2,842 tons, contained 15 per cent. of manganese, and was worth on an average $2.81 per ton. The 3,100 tons mined in Colorado, containing from 25 to 38 per cent. of manganese, was worth $5 a ton, while the 147,431 tons produced in the Lake Superior region, containing from 4 to 12 per cent. of manganese, was worth $2.25 a ton. The value of this Lake Superior ore ranged from $1.50 to $2.50 a ton. At one mine from which two grades of ore were produced, that containing 8 per cent. of manganese and 44.47 of iron was worth $2 a ton at the mine, while the ore containing 5 per cent. of manganese and 50 per cent. of iron but 0.115 per cent. of phosphorus, the 8 per cent. ore containing but 0.100 per cent, was worth $1.50 a ton.

As has already been stated, the value of the manganiferous silver ore depends largely upon its content of silver and silica. These ores are usually bought by the smelters according to their so-called "silica excess;" that is, the excess of iron and manganese over silica. Suppose this silica excess to be placed at 40 per cent.—that is, there must be an excess of 40 per cent. of manganese and iron over the silica in the ore—it is then accepted and paid for not according to the manganese content, but its silver. When the excess of iron and manganese is above 40 per cent., the excess may be paid for at, say, 10 cents a unit. Thus an ore with the following composition, namely, metallic manganese 25 per cent., metallic iron 30 per cent., silica 2.5 per cent., and silver 5 ounces, would have an excess of iron and manganese over silica of 52.5 per cent., or 12.5 per cent., above the 40 per cent. minimum excess. This, supposing the price to be 10 cents a unit, would be $1.25; the 5 ounces of silver, say at 45 cents an ounce, would be $2.25, and the ore would be worth $3.50. It will not pay to produce these ores at less than $3.50 free on board at the mines.

The ores mined in the Leadville region in 1892 averaged in value

$5.20. An average value is about all that can be named on these ores, as almost every lot varies in price.

The manganiferous zinc ores are the residuum or clinker left from the working of the ores at Franklin, New Jersey, for zinc. It is difficult to fix a price for this residuum. In some cases it is charged on the furnace books—the furnace being owned by the zinc producers—at the cost of handling and freight to the furnace, the clinker being regarded as of no value. In other cases a value of $1.25 is placed upon the ore. The average value of the residuum, which is the only one that can be given, was for 1892, 81.4 cents per ton.

PRODUCTION OF MANGANESE ORES IN 1892.

In 1892 the production of manganese ores in the United States aggregated but 13,613 tons; the smallest production of any year since 1884, and a reduction from 1891, when 23,416 tons was produced, of 9,803, or 42 per cent. The total value of these 13,613 tons was $129,586, or $9.52 a ton, as compared with the total value in 1891 of $239,129, or an average of $10.21 a ton.

The amount and value of the manganese ore produced in the United States in 1891 and 1892 is shown in the following table:

Amount and value of manganese ores produced in the United States in 1891 and 1892.

States.	1891.			1892.		
	Production.	Total value.	Value per ton.	Production.	Total value.	Value per ton.
	Long tons.			*Long tons.*		
Arkansas	1,650	$18,150	$11.00	6,708	$64,838	$9.67
California	705	3,830	5.44			
Colorado	964	7,220	7.50			
Georgia	3,575	27,825	7.78	826	5,782	7.00
Indian Territory	206	1,174	5.70			
South Dakota	19	152	8.00			
Vermont	49	245	5.00			
Virginia	16,248	180,533	11.17	6,079	58,966	9.70
Total	23,416	239,129	(a)10.21	13,613	129,586	(a)9.52

a Average.

In the year 1892, as will be seen from this table, but three States produced manganese ores, namely, Arkansas, Georgia, and Virginia. If the other States produced any it was very small quantities, that have not been reported. It will be noted that the Arkansas production increased from 1,650 tons in 1891 to 6,708 tons in 1892, and this was the only State which showed any increase. The production of Georgia decreased from 3,575 tons in 1891 to 826 tons in 1892, while the decrease in Virginia was from 16,248 tons in 1891 to 6,079 tons in 1892. The increase in production in Arkansas seems to be due to the finding of a new pocket. The decrease in Georgia was due to the exhaustion of the pockets and the failure to discover new ones, while the decrease in Virginia was due to the cessation of operations for a while at Crimora, owing to the abandonment of the lease of this mine by the American Manganese Company, limited, and the work necessary to be done before the owners of the fee, the Virginia Manganese Company, resumed operations at this mine.

There was a decrease in each of these States in the value per ton; in Arkansas from $11 in 1891 to $9.67 in 1892; in Georgia from $7.78 to $7; and in Virginia from $11.17 to $9.70. The reduction in price is mainly due to the fact that the ores mined in 1892 were somewhat leaner than those mined in 1891. The Crimora ores, for example, towards the close of mining ran very much lower in manganese than during the early part of 1891. The Georgia ores, as is usually the case both at the beginning and close of working a pocket, were somewhat leaner than during the period when the pocket was yielding large returns in ore.

In the following table is shown the production of manganese ores in the United States from 1880 to 1891, the output of the three chief producing States being reported separately, while the production of the other States, which vary greatly, are consolidated.

Production af manganese ores from 1880 to 1892.

Years.	Virginia.	Arkansas.	Georgia.	Other States.	Total.	Total value.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	
1880	3, 661		1, 800	300	5, 761	$86, 415
1881	3, 295	100	1, 200	300	4, 895	73, 425
1882	2, 982	175	1, 000	375	4, 532	67, 980
1883	5, 355	400		400	6, 155	92, 325
1884	8, 980	800		400	10, 180	122, 160
1885	18, 745	1, 483	2, 580	450	23, 258	190, 281
1886	20, 567	3, 316	6, 041	269	30, 193	277, 636
1887	19, 835	5, 651	9, 024	14	34, 524	333, 844
1888	17, 646	4, 312	5, 568	1, 672	29, 198	279, 571
1889	14, 616	2, 528	5, 208	1, 845	24, 197	240, 559
1890	12, 699	5, 339	749	6, 897	25, 684	219, 050
1891	16, 248	1, 650	3, 575	1, 943	23, 416	239, 129
1892	6, 079	6, 708	826		13, 613	129, 586
Total	150, 708	32, 462	37, 571	14, 865	235, 606	2, 351, 961

PRODUCTION OF MANGANIFEROUS IRON ORES.

No attempt has been made to collect the statistics of manganese-bearing iron ores except in cases where the manganese has added somewhat to their value.

In the following table is shown the production of manganiferous iron ores in the United States in 1892.

Production of manganiferous iron ores in the United States in 1892.

Locality.	Production.	Total value.	Value per ton.	Per cent of manganese.
	Long tons.			
Colorado	3, 100	$15, 500	$5. 00	25 to 38
Lake Superior	147, 431	331, 178	2. 25	4 to 12
Virginia	2, 842	7, 986	2. 81	15
Total	153, 373	354, 664	2. 31	4 to 38

All the manganiferous iron ores reported in 1891, which amounted to 132,511 tons, were from the Lake Superior district. There was an increase in the total production in 1892 of manganiferous iron ores of 20,862 tons, the increase in the Lake Superior district being 14,920 tons. The total value of the manganiferous iron ores produced in 1891 was $314,099, an average of $2.37 a ton. Though the value of the production of 1892 was $354,664, an increase of $40,565, the average value had fallen to $2.31 a ton, a decrease of 6 cents a ton.

In the following table is shown the total production of manganiferous iron ores in the United States from 1889 to 1892, inclusive:

Total production of manganiferous iron ores in the United States from 1889 to 1892.

Years.	Total production.	Total value.	Value per ton.
	Long tons.		
1889	83,434	$271,680	$3.26
1890	61,863	231,655	3.74
1891	132,511	314,099	2.37
1892	153,373	354,664	2.31
Total	431,181	1,172,098	2.72

PRODUCTION OF MANGANIFEROUS SILVER ORES.

All the manganiferous silver ores produced in the United States in 1892 of which we have any report were from Colorado and entirely from the Leadville region. Some ores of this character were produced in Montana, but no record appears to have been kept, or at least none is available.

The total production was 62,309 tons, valued at $323,794, or $5.20 a ton. Of this ore 2,732 tons carried 34 per cent. of manganese, 14,315 tons an average of 24.9 per cent. of manganese, and 45,262 tons an average of 12 per cent. In 1891 the total production was 79,511 tons, valued at $397,555, or $5 a ton. Of this ore 19,560 tons contained 20 per cent. and over of manganese, and 59,951 tons contained less than 20 per cent.

The total production of manganiferous silver ores in the United States for the years 1889 to 1892, for which returns have been received, is given in the following table, the entire production being from Colorado:

Production of manganiferous silver ores in the United States from 1889 to 1892.

Years.	Containing 20 per cent and over.	Containing less than 20 per cent.	Total.	Total value.	Average value per ton.
	Long tons.	*Long tons.*	*Long tons.*		
1889	9,987	55,000	64,987	$227,455	$3.50
1890	7,826	44,014	51,840	181,440	3.50
1891	19,560	59,951	79,511	397,555	5.00
1892	17,047	45,262	62,309	323,794	5.20

PRODUCTION OF MANGANIFEROUS ZINC ORES IN THE UNITED STATES.

The production of this class of manganese-bearing ores for 1892 was 31,859 tons, valued at $25,937, or 81.4 cents a ton. This is a slight reduction in production from 1891 and a considerable reduction in value, as will be seen from the following table, which gives the product of manganiferous zinc ores in the United States from 1889 to 1892:

Product of manganiferous zinc ores in the United States from 1889 to 1892.

Years.	Quantity.	Value.
	Long tons.	
1889	43,648	$54,560
1890	48,560	60,700
1891	38,228	57,432
1892	31,859	25,937

DEPOSITS OF MANGANESE ORES AND THE PRODUCTION OF THE SEVERAL STATES.

Many, indeed most, of the brown hematite ores of the United States carry more or less manganese, and consequently the distribution of manganese-bearing ores in the United States is practically coextensive with that of these hematites. All along the Appalachian chain of mountains and in the Lake Superior district more or less manganese is found associated with these ores. This is especially true along the Appalachians in Virginia, in their outspread in Georgia, and in the Gogebic region of Lake Superior.

We have given in detail elsewhere statements of the chief deposits of ore that were worked in 1892. A brief description of other deposits that either have been worked or give promise of being sources of ore in the future, as well as the production of the several States so far as this production has been ascertained, is given below.

Alabama.—Though but little manganese ore has ever been mined in Alabama the brown hematite ore beds of this State often contain an iron ore high enough in manganese to be classed as manganiferous. As early as 1875 one of these deposits was utilized by the Woodstock Iron Company, of Anniston, Calhoun county, in the manufacture of spiegeleisen. The ores at this point occur sometimes as veins and crusts resting upon the iron ore; at others in chimneys or pockets in the ore belt or vein. Analyses of this ore showed from 11.44 per cent. to 14.68 per cent. of metallic manganese and from 38.50 per cent. to 41.76 per cent. of metallic iron. The phosphorus was high, running from 0.27 per cent. to 0.50 per cent. The ore containing the largest quantity of manganese also had the largest percentage of phosphorus and metallic iron.

The only ore shipped from this State in recent years was a little in 1886, some 75 tons, analyzing some 45 per cent. of manganese, 5 per cent. of iron, 8 per cent. of silica, and 0.08 per cent. of phosphorus.

Arkansas.--There are two localities in this State in which manganese has been found in considerable quantities, the one, Batesville region, lying chiefly in Independence and Izard counties, in the northeastern part of the State; the other in the southwestern part of the State, extending from Pulaski county on the east to Polk county and Indian Territory on the west. The work done in the southwestern district has been principally in the way of development. The Batesville, or northeastern district, has furnished all of the ore produced commercially in Arkansas.

The existence of manganese in the Batesville region has been known for over forty years, small quantities having been shipped as early as 1840. The total amount produced up to 1868, however, was but a few hundred tons. In this year a shipment of 10 tons was made to Pittsburg, at which place it was sold for $30 a ton. From 1868 to 1881 but little ore was mined. In the latter year, however, mining began on a commercial scale and has been continued ever since. From 1881 to 1887 the shipments amounted to possibly 5,000 tons. In October, 1885, the Keystone Iron and Manganese Company, of Pennsylvania, acquired large tracts of land, and have since been the largest shippers of ore from Arkansas.

The manganese belt at Batesville is somewhat elliptical in shape and has a length east and west of about 16 miles, with an average breadth of about 3 miles. The ore, however, is by no means continuous, there being frequent interruptions and many places from which it is absent. It is probable that 7 or 8 square miles would cover the ascertained extent of the deposit.

As this deposit has been described[1] somewhat in detail elsewhere, and as the complete facts regarding it can be obtained, as can also very complete details of all the manganese deposits of the United States from the paper on manganese in the report on the Mineral Industries in the United States at the Eleventh Census, 1890, we need not enter into more complete details.

The production of manganese in Arkansas since the beginning of shipments in 1850, as far as can be ascertained, is shown in the following table. The authorities for the figures are quoted in each instance. It has been estimated that the total production of manganese in Arkansas from 1850 to 1885 amounted to 5,000 tons, but this is probably exaggerated. The product from 1881 to 1884, inclusive, has been obtained from the railroad reports of shipments and may be considered fairly reliable. From 1885 to 1888 and from 1890 to 1892 the statistics were collected for Mineral Resources of the United States, while those for 1889 are from the mineral volume of the Eleventh Census. The figures from 1885 to 1892 have been verified by statements of shipments kindly furnished by the officers of the St. Louis, Iron Mountain and Southern Railroad.

Production of manganese in the Batesville district of Arkansas to December 31, 1892.

Years.	Authority.	Long tons.
1850 to 1867	Estimated	400
1868	do	10
1881	Railroad reports of shipments	100
1882	do	175
1883	do	400
1884	do	800
1885	Mineral Resources of the United States	1,483
1886	do	3,316
1887	do	5,651
1888	do	4,312
1889	Census	2,528
1890	Mineral Resources of the United States	5,339
1891	do	1,650
1892	do	6,708

California.—Manganese mining is an industry of but little importance in California, none having been produced in 1892. It is estimated in the report on manganese in "Mineral Resources of the United States, 1889 and 1890," that the total amount of manganese produced in California up to the close of 1890 was between 6,000 and 6,500 tons. This estimate is made on the basis that 5,000 tons were mined for shipment to England from 1867 to 1874. After 1874 only small amounts were produced each year, the product in 1889 being 53 tons; in 1890, 386 tons, and in 1891, 705 tons.

There is but small demand for manganese ore on the Pacific coast, and that is chiefly for the manufacture of chlorine gas to be used in working sulphuret gold ore.

As nearly as can be ascertained, the following represents the production of manganese in California from the beginning of mining:

Total production of manganese in California to December 31, 1892.

Years.	Tons.
1874 to 1888	6,000
1889	53
1890	386
1891	705
1892	....
Total	7,144

All of this manganese produced in 1891 was from two mines, one in Alameda, the other in San Joaquin county.

Colorado.—Colorado produces two classes of manganese-bearing ores, a manganiferous iron ore used to some extent in the production of spiegeleisen, and a manganiferous silver ore used as a flux in the smelting of silver-lead ores. The manganiferous iron ores carry, as a rule, but little silver, though some of the slags from the blast furnaces of the Colorado Coal and Iron Company at Pueblo, where these manganiferous ores are used in the manufacture of spiegeleisen, are so high in silver as to make it profitable to rework them for the recovery of the silver. Occasionally some of the manganiferous ores are sent to the Illinois Steel Company at Chicago.

The total production of manganiferous iron ores in Colorado in 1892 was 3,100 tons, worth at the mines $15,500, or $5 a ton. These ores carried from 25 to 38 per cent. of manganese. The indications are that the production of these ores in 1893 will be considerably in excess of that of 1892.

In most of the mines of the Leadville district are found considerable quantities of what have been termed and described in another portion of this report as manganiferous silver ores. It is stated that there are not more than three properties in the Leadville district where the ores do not carry a percentage of iron and manganese. A full description of these ores is given under the title "Character of the manganiferous silver ores of the United States," elsewhere in this report, and of the prices obtained and the methods of payment under the title "Price of manganese and manganiferous ores in 1892."

The total amount of manganiferous silver ores shipped in 1892 was 62,309 tons, of which 2,732 tons contained an average of 34 per cent. of manganese, 14,315 tons an average of 24.9 per cent., and 45,262 an average of 12 per cent. The total value of this manganiferous silver ore was $323,794, an average of $5.20 a ton.

I again desire to express my great indebtedness to Mr. Franklin Ballou for assistance in collecting these statistics of production of manganiferous silver ores in Colorado.

The statistics of the production of manganese-bearing ore in Colorado from 1889 to 1892, are as follows:

Production of manganiferous ore in Colorado from 1889 to 1892.

	1889.	1890.	1891.	1892.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*
Manganiferous iron ores used for spiegeleisen	2,075	....	964	3,100
Manganiferous silver ores. with 20 per cent and over of manganese	9,987	7,826	19,560	17,047
Manganiferous silver ores with less than 20 per cent of manganese	55,000	44,014	59,951	45,262
Total	67,062	51,840	80,475	65,409

Georgia.—The third State in point of production of manganese ores in 1892 was Georgia, the production being 826 tons, as compared with 3,575 tons in 1891.

Manganese mining began in the Cartersville district as early as 1866, 550 tons being mined and sold in that year. The production of Georgia, most of which is from the Cartersville district, since 1879, from which date we have fairly accurate statistics, has varied from nothing in 1883 and 1884 and from 749 tons in 1890 to 9,024 tons in 1887.

The deposits of manganese in this State resemble each other in their association with brown hematite and in the general character of the ores. The pockets in which are the ores of the Cartersville district, which is located in Bartow county, extending into Cherokee county, are in closer proximity to each other than those of any other part of the State, and the amount of ore in these pockets seems to be greater. Indeed, it is only the Cartersville district that is a producer of manganese on a commercial scale. In its topography this district is broken and knobby, the elevations, however, rarely exceeding 200 feet above the drainage level. The belt in which the manganese is found is some 12 miles long by 3 miles wide, though the explorations do not yet justify any definite conclusions as to the extent of the deposits. The matrix of the ore appears to be a residual clay, the result of the decay of the rock in place. The ore is frequently accompanied by fragments of sandstone, which has led to the statement that true veins of manganese have been found.

The method of mining varies with the locality. There is no definite system. Sometimes the pockets of ore are worked by open cuts, sometimes by tunneling. The method of washing the ore in general use is to rotate it in a horizontal cylinder, into which water is admitted. These cylinders are made either with boiler-iron jackets and lined with cast-iron or else of iron slats running longitudinally with sixteenth-inch interstices between them.

The following table shows the annual production of manganese ores in Georgia, so far as it could be ascertained:

Production of manganese ore in Georgia from 1866 to 1892, inclusive.

Years.	Quantity.	Years.	Quantity.
	Long tons.		*Long tons.*
1866	550	1880	1,800
1867	}	1881	1,200
1868	}	1882	1,000
1869	}	1883	....
1870	} 5,000	1884	....
1871	}	1885	2,580
1872	}	1886	5,981
1873	}	1887	9,024
1874	2,400	1888	5,568
1875	2,400	1889	8,208
1876	2,400	1890	749
1877	2,400	1891	3,575
1878	2,400	1892	826
1879	2,400		

Indian territory.—No manganese was produced in the Indian territory in 1892, though 206 tons, valued at $1,174, or $5.70 a ton, free on board cars, was produced in 1891. Mr. F. W. Hunton, who is interested in these mines, made the following statement in January, 1893, to the American Manufacturer, Pittsburg, as to the production and character of the ores of this Territory:

Some two years ago manganese ore was discovered about 15 miles west of Lehigh, Indian territory. The ore exists in the forms of black oxides and carbonates. Both varieties exist together in the same bed, or pockets, averaging say 20 per cent black oxide and 80 per cent carbonates. The deposits lie, apparently, on the Lower Silurian limestone, and have been covered by the Middle Silurian limestone. The black oxides are found mostly in the uppermost parts of the pockets, but they are also found at the bottom and under the carbonates. The carbonates are red, brown, and gray. By surface indications, this manganese belt has been traced some 12 miles north and south. Three openings have been made, about 1 mile from the other, out of which seventeen carloads were shipped to the Illinois Steel Company, with the following result:

Analyses of other manganese ores from near Lehigh, Indian Territory.

Weight, less moisture.		Iron.	Silicon.	Phosphorus.	Manganese.	Moisture.	Price, per ton.
	Pounds.	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
2 cars	44,003	6.00	1.40	0.055	39.66	4.05	$10.32
2 cars	53,226	6.15	1.45	.066	39.67	4.75	10.31
2 cars	49,807	5.72	1.70	.060	43.18	3.25	12.09
2 cars	45,816	6.76	1.20	.053	38.54	4.05	10.02
5 cars	156,738	8.00	1.50	.050	40.50	3.70	10.93
4 cars	93,910	8.09	....	....	35.78	5.00	8.95

Samples previously analyzed by the same concern showed:

Analyses of other manganese ores from Lehigh, Indian Territory.

Iron	Silicon.	Phosphorus.	Manganese.
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
2.46	0.30	0.053	51.78
3.07	.75	.026	59.55
4.92	.85	.046	40.28
1.23	1.30	.036	43.18
1.84	2,00	.053	49.34
5.53	·60	.056	53.35
....	....	.050	42.71

Analyses made by other parties showed:

Analyses of manganese ore from Indian Territory.

Iron.	Silicon.	Phosphorus.	Manganese.	Moisture.
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
2.46	0.83	0.047	46.05	Sulphur ·024
3.58	.73	.033	44.07	Sulphur ·04

All the above were the black oxide of manganese.

The following analyses were made of the carbonate ores by Rattle and Nye, of Cleveland, Ohio:

Manganese.	Phosphorus.	Manganese.	Phosphorus.	Manganese.	Phosphorus.
Per cent.	*Per cent.*	*Per cent,*	*Per cent.*	*Per cent.*	*Per cent.*
27.25	0.032	25.48	.0[illegible]3	19.15	0.049
4.42	.119	25.99	.061	13.25	.116
24.71	.066	28.68	.047	....	....

Not much work has ever been done to ascertain the full extent of these deposits. At one opening the surface soil has been removed from 2 to 6 feet in depth for a space of say 30 by 70 feet and ore taken out to a depth of say 10 feet. At another opening the surface soil is not over 2 feet deep; from this opening which is say about 20 by 100 feet, was taken 97 tons of black oxide of manganese, and about 300 to 400 tons of carbonates, large quantities of which are still in sight, not taken out.

At another opening ore is shown to be about say, from 2 to 4 feet thick. From this place about 10 tons of ore have been shipped (all black oxide of manganese), and about 50 tons remain in sight.

From the first opening mentioned there was shipped about 93 tons of black oxide, and nearly 2,000 tons of carbonates remain on the surface and in sight.

Parties are now in the field with a diamond drill and after prospecting a coal field which is only 6 miles distant from the manganese, they will more thoroughly prospect the manganese valley. On a hill, not over 300 yards from one of the openings mentioned, is found a deposit of manganese entirely different from the others; the base material being flint rock in which is found a very pure kind of black oxide of manganese in nodular form, averaging 66 per cent. manganese, 0.35 silica, 1.23 iron, and 0.023 phosphorus. How much there may be of this ore is conjectural, but the prospects are good for its being quite extensive.

Lake Superior region.—But little can be added to what is said in other portions of this report regarding the character of the manganiferous iron ores of the Lake Superior region. Strictly speaking there are no manganese mines in this district, but a number of the iron mines produce an ore sufficiently high in manganese to justify its grading, usually into three grades, sometimes into two only, one grade being iron ore proper and the other grades those containing 4 per cent. or more of manganese.

During 1892 there were produced in the Lake Superior region 147,431 tons of manganiferous iron ore, containing from 4 to 12 per cent. of manganese, valued at $331,178, or $2.25 a ton.

The production of manganiferous iron ore in the Lake Superior region since 1886, so far as the same has been ascertained, is as follows:

Production of manganiferous iron ore in the Lake Superior region from 1886 to 1892.

	Tons.
Production in 1886:	
Averaging 2 per cent. of manganese	100,000
Averaging 4 per cent. of manganese	157,000
Total	257,000
Production in 1887:	
Averaging 4 per cent. of manganese	200,000
Averaging 10 per cent. of manganese	10,000
Total	210,000

Production of maganiferous iron ore in the Lake Superior region, etc.—Continued.

Production in 1888:	
Averaging 4 per cent. of manganese	189,574
Averaging 11 per cent. of manganese	11,562
Total	201,136
Production in 1889:	
Averaging 6.74 per cent. of manganese	50,018
Averaging 9 per cent. and over of manganese	31,341
Total	81,359
Production in 1890	61,863
Production in 1891:	
Averaging from 4.68 per cent. to 17.96 per cent. of manganese	13,711
Averaging 10 per cent. of manganese	11,015
Averaging 9.68 per cent. of manganese	9,213
Averaging 5.38 per cent. of manganese	98,572
Total	132,511
Production in 1892:	
Averaging 4.893 per cent. of manganese	6,710
Averaging 5 per cent. of manganese	102,695
Averaging 8 per cent. of manganese	7,500
Averaging 9.998 per cent. of manganese	8,272
Averaging 12.028 per cent. of manganese	22,254
Total	147,431

Maine.—At Blue Hill, in Hancock county, Maine, there has occasionally been mined what is termed a silicate of manganese. It occurs in a vein 15 feet wide. The hill is a mass of contorted gneiss rock, the manganese running through it east-northeast by west-southwest. Its chief use has been as a flux at the furnace of the Katahdin iron works.

As this ore is of some interest as being a silicate of manganese, the following analyses are given:

Analyses of manganese ores from Blue Hill, Maine.

Component parts.	No. 1.	No. 2.	No. 3.
	Per cent.	*Per cent.*	*Per cent.*
Protoxide of iron	14.01	24.91	12
Protoxide of manganese	35.13	29.72	15
Alumina	7.45	3.04	....
Lime	3.49	5.02	....
Silica	35.84	35.70	39
Phosphoric acid	1.02	....	....

Maryland.—Manganese ore was at one time mined to some extent in Maryland from a deposit near Brookeville, in Montgomery county, and also from a deposit on the north side of the Potomac river opposite

Harper's Ferry. No manganese has been produced in this State for a number of years.

Massachusetts.—Pyrolusite is frequently found in connection with the limonite ores in the western part of Massachusetts, as it is so frequently found in connection with the same ores all through the Appalachian region. It is rarely, if ever, found in sufficient quantities to justify its separation for sale as manganese ore.

Missouri.—Considerable quantities of both manganese ores and manganiferous iron ores have been mined in Missouri for use in the Saint Louis furnaces in the manufacture of spiegeleisen. These ores have been derived chiefly if not entirely from what Professor Pumpelly has termed the "porphyritic" region of Pilot Knob and vicinity, and are usually found associated more or less intimately with iron ore. In 1881 some 2,000 tons of this ore were taken from one mine in this section, but since that year none has been mined on a commercial scale.

The 2,000 tons referred to were from the property of the Arcadia Mining Company, near Arcadia, Missouri. The analyses were as follows:

Analyses of manganese from Arcadia, Missouri.

Component parts.	No. 1.	No. 2.
	Per cent.	*Per cent.*
Metallic manganese	64.98	58.02
Metallic iron	2.82	3.35
Phosphorus	0.04	0.03
Silica	2.82	3.35

This ore was used in the furnaces of the Missouri Furnace Company at Saint Louis in such quantities as to give 0.75 per cent. of manganese in the iron. The analyses above given were of exceptionally rich specimens of the ore.

Montana.—Argentiferous manganese ores, similar in character to those mined in Colorado, are found in Montana. So far as has been learned, however, no ore was produced in this state in 1892 and sold as manganese ore or for any additional sum because of the manganese contained in it.

Nevada.—A small amount of manganese has been produced in Nevada, near Golconda, on the Central Pacific railroad in the valley of the Humboldt river, but the expense of getting it to market has been so great that no use has been made of it. A few tons, 13¼, are said to have been shipped a few years ago to San Francisco, but the cost of freight to market was too great to make the venture a commercial success. The deposit is not worked at present. The ore is a massive, black, glossy oxide of manganese.

New Hampshire.—Some manganese has been found associated with iron ores that were worked in this state many years ago, but manganese as a separate ore has never been produced. Some pyrolusite is said to have been found in connection with silicate of manganese in Cheshire county.

New Jersey.—The first spiegeleisen produced in the United States as a commercial product was from the residuum of the zinc ores of Sussex county, New Jersey. These ores, which we have termed manganiferous zinc ores and have quite thoroughly described elsewhere, are mined primarily for their zinc content, though they carry a considerable percentage of manganese.

The production of these ores since 1889, at which time statistics of their production were first ascertained, is given elsewhere in this report under the title "Production of manganiferous zinc ores," page 26.

North Carolina.—No manganese ores were mined in North Carolina in 1891 or 1892. The amounts reported as being mined in this state heretofore have been only for experimental purposes. According to our returns, the production for the years since 1886 has been as follows:

Production of manganese in North Carolina from 1886 to 1892.

Years.	Long tons.
1886	15
1887	14
1888	50
1889	47
1890	14
1891	....
1892	....

South Carolina.—No product of manganese in this state was reported for the years 1890, 1891, or 1892. There are quite extensive deposits of manganese and manganiferous iron ores in this State, but they are either so inconveniently located or the content of manganese is so low as not to justify the working of the mines.

The total production of manganese ore in South Carolina, so far as the same has been ascertained, is as follows:

Total production of manganese ore in South Carolina.

Years.	Tons.
1885 and 1886	300
1887	45
1888	50
1889	124
1890	....
1891	....
1892	....

South Dakota.—No manganese was mined in this State in 1892, though a small amount of manganese ore was produced there in 1891, one car load of 19 tons having been shipped from Custer county, netting at the shipping point $8 a long ton. An analysis of this ore was as follows:

Analysis of South Dakota manganese ore.

Component parts.	Per cent.
Metallic manganese	46.05
Metallic iron	3.93
Phosphorus	0.05
Silica	8.00
Moisture	4.70

The ore is stated to be in vertical veins, but development has not proceeded far enough to determine its extent.

Tennessee.—Though the first manganese produced in the United States was mined in Tennessee for use in coloring earthenware, the state has never assumed any importance as a source of manganese. The production at the mine referred to, which began in 1837 and which has never amounted to more than a few hundred pounds each year, still continues. Outside of this the total production of the State, so far as has been learned, has been but 96 tons, all of which has been mined since 1885.

Vermont.—This State, which some years ago produced considerable manganese, and which in 1888 and 1889 gave promise of being an important source of the ore in the future, has again fallen to its former insignificance, but 49 tons, worth $245 or $5 a ton, being reported as having been mined in Vermont in 1891 and none in 1892.

The production of manganese in Vermont from 1888 to 1892 is given as follows:

Production of manganese in Vermont from 1888 to 1892.

Years.	Long tons.
1888	1,000
1889	1,576
1890	0
1891	49
1892	....

Virginia.—For the first time in many years Virginia has ceased to occupy the first place among the States as a producer of manganese ores, the production of this State in 1892 being but 6,079 tons, while the production of Arkansas was 6,708 tons. If, however, to the production of manganese ore proper was added the production of manganiferous iron ores, 2,842 tons, all of which was used in the manufacture of spiegeleisen, Virginia would still maintain its front rank, having a production of manganese and manganiferous iron ores in 1892 of 8,921 tons. As is stated elsewhere, the cause of the reduction in production of manganese ores in Virginia in 1892 was the abandonment of its lease at Crimora by the American Manganese Company, limited, and the delay that was necessary before the Virginia Manganese Company, the owners of the fee, who are now working the mine, could begin the production of ore.

The production of manganese ore in Virginia in 1892 was the smallest in the history of this state since 1883, the production of that year being 5,355 tons. The largest production in any one year was in 1886, when 20,567 tons was mined. This gradually declined until 1890, when the production was 12,699 tons. It increased in 1891 to 16,248 tons and dropped in 1892 to 6,079 tons.

The production of the Crimora mine and the adjoining mine, the Old Dominion, which were worked as one from 1886 to 1890 and from which the larger proportion of the manganese ore mined in Virginia was taken, has been as follows:

Product of the Crimora mine, Virginia.

Years.	Tons.
Prior to 1869	5,684
May, 1869, to February, 1876	280
February, 1876, to December, 1878	2,326
December, 1878, to December, 1879	1,602
1880	2,963
1881	2,495
1882	1,652
1883	5,185
1884	8,804
1885	18,212
1886	19,382
1887	19,100
1888	16,100
1889	12,974
1890	11,332
1891	13,645
1892	4,389

The total production of manganese from 1880 to 1892, inclusive, in Virginia was as follows:

Production of manganese in Virginia from 1880 to 1892.

Years.	Long tons.
1880	3,661
1881	3,295
1882	2,982
1883	5,355
1884	8,980
1885	18,745
1886	20,567
1887	19,835
1888	17,646
1889	14,616
1890	12,699
1891	16,248
1892	6,079

To this should be added the production in 1892 of 2,842 tons of manganiferous iron ore carrying an average of 15 per cent. of metallic manganese of a total value of $7,986, or $2.81 a ton.

So far as explorations have been made, manganese ores have been found in Virginia over a much greater extent of territory than in any other of the United States. Virginia has more known deposits of this mineral, they are spread over a greater extent of territory, more localities have been worked, and more manganese has been raised than in any other State, and yet the greater part of the manganese has come from Crimora. The other chief producers have been in the Shenandoah valley, chiefly at the Houston mines, in Botetourt county, and at the mines of the Virginia Mining and Investment Company, in the Blue Ridge mountains, in Augusta county. The product of the two latter mines has been manganiferous iron ore instead of manganese ore proper. A small amount of very high-grade pyrolusite for use in glass-making and the manufacture of bromine has been shipped from a mine near Mount Athos, on the Norfolk and Western railroad, and in past years a number of other localities have produced considerable ore.

In Virginia, as elsewhere, deposits of manganese almost invariably accompany those of iron. Where iron ores are abundant, more or less manganese may be confidently looked for. At least eight groups of the geological formations in Virginia are iron bearing; each of these contains more or less manganese. These iron ores are found in belts or bands, generally extending across the State in a northeast and southwest direction, following the strike of the outcrops of the rocks as a rule.

In discussing the manganese deposits of Virginia it will be more convenient to arrange them in accordance with the natural divisions of the state. These divisions are: (1) Tidewater, (2) Midland, (3) Piedmont, (4) Blue Ridge, (5) Valley, (6) Appalachia, (7) Transappalachia.

Some manganese has been found in pockets of small extent in the Tidewater sections of Virginia. One deposit near City Point yielded some hundreds of tons of ore before it was exhausted, and it is reported that others have been worked. No deposits of such extent as that at Crimora can be expected in this region, though it is probable that small pockets will be found in connection with the beds of iron ore that outcrop in the bluffs along the banks of the rivers. The age of these deposits is much later than that of those found resting on the Potsdam in the Valley district, the iron ore with which it is associated being found in the Tertiary, chiefly in the Miocene.

In the Midland district of Virginia deposits of manganese become more abundant, this division, with the Valley, furnishing practically all the manganese mined in the State. The ore that has been mined is found chiefly in Campbell, Nelson, and Pittsylvania counties, though there are deposits in Spottsylvania, Louisa, Appomattox, and perhaps other counties. The deposits are found in the extreme western part of the section, well up to the base of the mountains that form the dividing line between this and the Piedmont. Indeed, it is possible that some of these deposits should be classed in the Piedmont, but as they are all situated on the same belt as Campbell county, they are classed in the Midland.

The Mount Athos mine, which probably produces the highest grade of manganese mined in the United States, is in Campbell county, near Mount Athos station, just across the line from Appomattox county, on the Norfolk and Western railroad, just where the James river turns to the north. It is one of the few deposits on the right bank of the James. This mine is sometimes known as the Leet mine.

The manganese is found in pockets associated with iron ore and also as button ore in dark-colored micaceous schist, 8 feet thick, holding some 40 per cent. of nodules, varying in size from a bean to that of an oyster.

In Nelson county several deposits of manganese have been worked quite extensively in past years, though no ore is now mined. These deposits are found in the ore belt of the James river, already described, the belt running nearly parallel to the river and about two miles from the left or northwestern bank. The manganese is in small quantities on the surface, the deposit widening as it goes down. The manganese is found in pockets, and usually in clay.

From what is known as the Cabell mine, 2 miles from Warminister depot, on the Richmond and Allegheny railroad, some 5,000 tons of manganese were taken in 1868 and 1869 by Mr. James E. Mills, who was employed by a Newcastle (England) firm, and shipped to Newcastle-on-Tyne, and who probably made the first systematic search for manganese in the United States, unless Mr. Sibert's mining in the valley of Virginia may be termed systematic. The mine has not been worked since 1871. An analysis of the ore showed 82.25 per cent. of manganese peroxide.

About half a mile southwest of the Cabell mine is a deposit known as the Bugley mine, which was worked about the same time and yielded about 2,000 tons of ore.

At Midway mills is a deposit, on the land of Mr. G. F. Simpson, which was worked in 1882 and yielded some 1,200 tons of first-class ore. The mine was worked by shaft to the depth of 165 feet, when it was drowned out. The ore above the water line is said to have shown some 70 per cent. oxide, but below the line it was much richer, 80 to 85 per cent. The entire product was marketed in Liverpool.

At the Davis mine in Nelson county, some 1,000 tons have been mined. Deposits are also reported in Appomattox and Amherst counties.

No details have been obtained concerning the manganese ores of the Piedmont and Blue Ridge districts. The deposits are small and of no commercial value.

The chief sources of the manganese in this State, and in the country, are the mines of the valley of Virginia, or, as it is usually called, the Shenandoah valley. In this valley are located the Crimora mines, that have produced as much ore as the entire country besides. The manganiferous belt lies along the western base of the Blue Ridge mountains on the eastern side of the valley. It is asserted that this belt extends 300 miles in the state, and that workable beds of manganese ore have been found in every one of the twelve valley counties that border on the western foot of the Blue Ridge.

It is along this belt that the remarkable body of iron ore accompanying the Potsdam or No. 1 formation of Rogers is found, and with this iron the manganese ores are associated. Indeed, it is in the clays formed by the decomposition of the ferriferous shales of the Potsdam that the ore is usually found imbedded. An exception to this is noted by Prof. William M. Fontaine, in his "Notes on the mineral resources at certain localities in the western part of the Blue Ridge," as occurring on the lands of Joshua Robertson, some 5 miles from Waynesboro. The ore at this point, which is psilomelane, occurs in the primordial formation in a fissure in a cracked and crushed band of the upper gray shales and flags, and has impregnated the walls, which are kaolin flags. Some 100 tons were taken from this locality in 1857 by Mr. Sibert. Prof. Fontaine is of the opinion that the origin of this manganese is similar to that of the iron ore occupying a similar geological position, viz., deposition in disturbed beds from solution in water.

Manganese mining began in this State and district as early as 1859, and Mr. Sibert, having made thorough explorations through the whole extent of the valley, opened up quite a number of deposits, and shipped the product to England for chemical purposes. Mr. James E. Mills, who was employed by a Newcastle (England) firm, also did some mining in this district, though his chief work in production was done at the Cabell mine, in the Midland district.

We have so thoroughly described the Crimora mines elsewhere that we need only refer to their occurrence in this division at the present time. In this division also is to be placed the mines of the Virginia Mining and Investment Company, which produced 2,842 tons of ore in 1892, of an average composition of 15 per cent. of metallic manganese. This valley is full of old manganese mines. Among them are the Garrison tract, which has produced ore containing as high as 53.656 per cent. of manganese, but carrying 0.327 per cent. of phosphorus; the Kimball bank, showing 7.349 per cent. of metallic manganese; the Lyndhurst deposit, from which Mr. Sibert shipped in 1859 some 250 tons of ore containing from 86.62 to 92.54 per cent. of available peroxide of manganese; the Kennedy tract, the ore showing at times 43.3 per cent. of metallic manganese, from which Mr. Sibert took in 1859 something over 100 tons of ore; the Blue bank; the Newton mine bank; the Fauber mines; the Kelly bank, and other mines in the neighborhood of the old Cotopaxi and Vesuvius furnaces. Indeed, the deposits in the Shenandoah valley are so numerous as to forbid any enumeration of them in this paper. The deposits of manganese in Virginia are thoroughly discussed in the report on manganese in the volume on the Mineral Industries in the United States at the Eleventh Census, 1890.

A word should be said, however, about the ores in that portion of Virginia known as Appalachia, which includes the broken mountainous country between the valley district and West Virginia, where quite a number of deposits of manganese ore, some quite high in manganese, and of good quality, are known to exist. Most of these are so situated with reference to transportation routes, however, that they are not available at present.

The manganese ores in this portion of Virginia are, as a rule, of a later geological age than those of the valley district. The valley ores are usually found in connection with the Potsdam No. I of Rogers' survey. Those of the Appalachia are found in the Hudson River No. III, the Clinton No. V, and especially in the Oriskany No. VII. In all cases the manganese is associated with iron ores, usually brown hematites, sometimes as a manganiferous portion of an iron ore; at others as a manganese ore. Little or no ore has been mined in this district, though at places the indications for large deposits are favorable. In the southwestern corner of Frederick county is a deposit of manganese known as the Paddy Mills manganese mine, which has produced some manganese in past years. The mine is a conical-shaped hill, covering about a square mile, and rising to a height of some 150 feet above the drainage level of the surrounding country. The ore is found in connection with the limestone and imbedded in the strata. The deposit is somewhat unreliable, being cut off by limestone. The ore is chiefly soft pyrolusite; part of it, however, is hard, running about 50 per cent. metallic manganese, 4 per cent. iron, and from 0.09 to 0.10 per cent. of phosphorus. There have been removed from this mine some 2,000 tons of ore, mostly before the war, and by very imperfect methods of mining. No shaft has gone below 50 feet, so that it is not known how large the deposit is. Should it extend downward, considerable ore might be found. The ore requires washing, for which there is plenty of water.

At Van Buren furnace, in Shenandoah county, in connection with the iron ores, a valuable and extensive deposit of manganese is found. This was at one time worked extensively, very large amounts being shipped before the war, but no mining has been done for twelve years, owing to the lack of transportation facilities, there being no railroad station nearer than Woodstock, 9 miles distant. The ore occurs in pockets, but they seem to be continuous, and can be traced over the surface for more than 3 miles. The washed ore analyzes upward of 70 per cent. manganese oxide.

Considerable attention has recently been directed to what is known as Powell's Fort manganese mines, located at Powell's Fort, in Shenandoah county, on the northeast Massanutton mountain. This mine has been worked at times for many years.

On what is known as the Guy Run estate, in Rockbridge county, 6 miles southward from Goshen Bridge station, on the Chesapeake and Ohio railroad, quite an extensive deposit of manganese has been discovered. Up to the present time but a few tons have been mined. In its general topography this estate is quite mountainous. The ores are found in the valleys. The manganese lies in close proximity to Rogers's No. VII (Oriskany) brown hematite ores, imbedded in potters' clay, which separates it from the iron ore. It is in pockets more or less persistent along the line of the ore horizon of No. VII.

In the counties of Appalachia, southward of those already named, many outcrops and other indications of manganese are found. Most of these are now too far from railways to be profitably worked.

At Panther Gap some ore has been mined, though no statement as to amount or the character of the deposit has been obtained.

In Craig county several manganese deposits have been opened, but the distance from railroads has precluded shipments. The Craig valley branch of the Chesapeake and Ohio railroad will possibly lead to the development of these ores. These deposits are stated to extend a distance of 17 miles.

Outside of the localities named above manganese is found in Giles, Pulaski, Wythe, Bland, Tazewell, and Smyth counties. It is not necessary, however, to give any description of these properties here, but those interested are referred to the report on the Mineral Industries in the United States at the Eleventh Census, 1890, already mentioned.

Imports of manganese.—The following table shows the amount of manganese, including both that classed as manganese ore and oxide of manganese, imported and entered for consumption into the United States in the years 1889 to 1892, these imports being for calander years.

Manganese imported and entered for consumption into the United States, 1889 to 1892.

Years.	Ore.		Oxide of.	
	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*	
1889	4,135	$72,391	151	$6,000
1890	33,998	509,704	156	7,196
1891	28,624	371,594	201	9,024
1892	58,364	830,006	208	10,805

FOREIGN DEPOSITS OF MANGANESE.

The foreign deposits of manganese that are large producers for shipment to the markets of the world are Chile, Russia, and Cuba. These are of sufficient importance to justify us in treating of them at length.

Chile (*a*).—Geological researches undertaken some years since by the Chilean Government developed the existence of immense deposits of manganese ores, especially in the northern provinces of the republic

a Condensed from the American Manufacturer of December 25, 1891, and July 8, 1892.

In most cases, however, these deposits are too far from the coast to be profitably worked and sent to market under present conditions, as, in addition to the cost of transportation to the coast by most expensive methods of carriage, the ore must also bear the cost of transportation to England and the United States, where it finds market, there being no local demand.

There are in Chile two manganese mining districts, known as the Coquimbo and the Carrizal. The latter is sometimes known as the Huasco. The Coquimbo district takes its name from the province in which the mines are situated, the port of shipment also being Coquimbo. Both of the names of the second district are from the ports of shipment, which are 35 to 40 miles distant from the mines. The mining district is known as Chanar Quemada, and is in the province of Atacama. Production in the latter district began in 1886; in Coquimbo, some years prior to that date.

The first attempts at mining manganese ores in Chile were made in 1881, when a bed in the province of Santiago was opened, the ore being taken to Valparaiso for shipment to England. The cost of conveying the ore to this port, however, proved an insuperable obstacle to the success of the undertaking, and it was abandoned.

After the abandonment of the Santiago mines a deposit in the province of Coquimbo was opened, and, in 1885, 4,106,045 kilograms, equal to 4,041 long tons, were exported to England, the average content of manganese being 45 to 55 per cent., averaging 52 per cent. The beds of manganese worked in the province of Coquimbo are chiefly surface deposits, requiring no expensive or scientific mining. The cost, therefore, of producing the ore is trifling; the ore runs in ridges, the tops of which are visible, the ore being extracted chiefly by crowbar and sledge. The great expense, however, is the cost of transportation, which, though the beds are worked in close proximity to the railroad, and though the ore is conveyed to a port of shipment on very liberal terms, makes it cost $5 to $7.50 (American money) per ton by the time it is placed alongside a vessel at Coquimbo. The ore from this district contains considerable peroxide, and is softer than that from the Carrizal district.

The second, and at present the only other producing district, is that know as the Carrizal, and sometimes as the Carrizal and Huasco, from the ports of shipment. The manganese mines of this district were discovered in 1886, and at the end of that year a small lot was sent to the coast to be shipped. The lode had been often assayed before this, but as it was neither copper nor silver it was not considered of any value.

The mines are situated from 35 to 40 miles from the port of Carrizal, and about the same distance from Huasco, but for most of the mines Carrizal is the shortest road to the sea.

Carrizal is situated in south latitude 28° 4′, and west longitude 71°

11′, and is connected with the manganese mine by a railway which goes in to the conchas of the principal mine; the other mines have cart roads, and are from 2 to 3 miles distant from the railway.

The manganese ore is found in nearly vertical lodes of from a few inches to about 10 feet wide, or more, but the commoner width is about 3 feet. There were heavy outcrops on the surface, forming walls or dikes 10 or more feet high. These were worked as open quarries, and many open quarries yet exist, but now the ore is usually worked underground as mines. The walls of the lode are not well formed, nor is there any natural cleavage between the ore and the walls, nor is the manganese regularly continuous for any great distance; there are sudden "faults" or disappearance of the manganese, it having been pushed to one side or other, making it difficult to find the lode again.

The ore averages 50 per cent. of metallic manganese, is hard and brittle, with a glassy fracture, and has no soft powder-like deposits as some of the Coquimbo manganese. Every pound of it must be taken out by blasting.

A production of about 15,400 tons a year, the average of the last four years, can not be regularly exceeded, for, though there is no indication of exhaustion of the mines, some of them are getting deep, which will make it more difficult and expensive to get ore every year. The low range of hills which contains these mines rises some 500 feet above the inland plain, which plain is 1,200 above sea level and 25 miles distant from the sea in a straight line to a point about half way between Carrizal and Huasco. The hill and lode run due north and south for a distance of about 7 miles. The principal mines are situated within 3 miles of the north end, then after a barren piece of about 3 miles, where no manganese crops out, there is over a mile of outcropping mines, with good ore, but capricious and much broken-up lodes. This is the south end of the mineral and is not worked at present.

No other lode of manganese rich enough to work has been discovered in north Chile.

The production of Coquimbo since 1885 and Carrizal since 1886, and the total production of Chile since 1885, in tons of 2,240 pounds, is as follows:

Production of Chilean manganese, 1885 to 1891.

	Coquimbo.	Carrizal.	Total Chile.
	Long tons.	*Long tons.*	*Long tons.*
1885	4,041	....	4,041
1886	23,701	227	23,928
1887	38,234	9,287	47,521
1888	12,132	6,581	18,713
1889	9,145	19,538	28,683
1890	23,409	24,577	47,986
1891	16,462	18,000	34,462

Twelve vessels cleared from Carrizal in 1891, carrying 18,000 tons of manganese. Of these, two were lost.

No statistics of production prior to 1885 have been obtained.

The statistics of production in 1892 are not at hand. They seem, however, to be somewhat less than in 1891. The imports of manganese ore from Chile into Great Britain in 1892 were 27,195 tons, as compared with 34,331 tons in 1891.

The following analyses of Chilean manganese are from a paper by Messrs. John and H. N. Pattinson. They are made from samples taken from cargoes of about 1,000 tons each, and may be regarded as representing the nature of the Chilean ores heretofore imported:

Analyses of Chilean manganese.

	I.	II.	III.
	Per cent.	*Per cent.*	*Per cent.*
Peroxide of manganese	69.23	55.06	66.03
Protoxide of manganese	11.92	23.05	10.39
Peroxide of iron	1.67	4.71	1.50
Oxide of lead	0.09	0.06	0.05
Oxide of copper	0.15	None.	0.14
Oxide of zinc	0.10	None.	None.
Alumina	4.21	2.80	1.60
Baryta	None.	None.	3.58
Lime	1.13	2.33	5.36
Magnesia	0.24	0.56	0.13
Potash	2.86	0.46	0.15
Soda	0.08	0.26	0.11
Silica	4.17	7.30	4.75
Carbonic acid (CO^2)	None.	0.18	2.53
Sulphuric acid (SO^3)	0.05	0.13	1.57
Phosphoric acid (P^2O^5)	0.12	0.14	0.05
Arsenic	(?)	0.15	0.04
Combined water	3.90	3.00	1.96
Total	99.92	100.19	99.94
Metallic manganese	53.00	52.66	49.79
Sulphur	0.02	0.05	0.63
Phosphorus	0.05	0.06	0.02

The analyses were made on samples dried at 100° C., at which temperature they lost, respectively, 2.47 per cent., 1.08 per cent., 0.98 per cent. of hygroscopic moisture.

No. I comes from the neighborhood of Santiago; Nos. II and III are from the vicinity of Coquimbo and Carrizal. Nos. I and II are very hard, compact, amorphous ores, of a bluish-black color, and often exhibit a conchoidal fracture; No. III, which contains more peroxide than the others, is softer and of rather a darker color. Crystals of calcium carbonate are frequently disseminated through it.

A characteristic of Chilean manganese ores is the large percentage of protoxide of manganese they contain. In Caucasian and Spanish ores there is not often more than from 1 to 2 per cent. of protoxide. It is known that manganese dioxide acts the part of the feeble acid, and when precipitated carries down with it as manganites, protoxide of manganese, baryta, lime, potash, and other bases with which it was in solution, and it is probable that in these ores the protoxide of manganese, the potash, and portions of the baryta, lime, and other bases shown in the above analyses have been precipitated in combination with the peroxide in the form of manganites.

Baryta is frequently found in other manganese ores. Some Caucasian ore contains as much as 2.04 per cent. Potash also is found in other ores, though not often in such quantities as in No. I. "We have, however," state the Messrs. Pattinson, "met with one specimen, not Chilean, which contained as much as 4.15 per cent. The silica in Chilean ore occurs sometimes as quartz and sometimes as silicate of manganese."

The percentage of phosphorus in Chilean ores is very low; a matter of great importance to the steel-maker. The amount varies to a slight extent in various cargoes, and about 0.1 per cent. has sometimes been found. No. II contains a small quantity of arsenic, which has been shown by Pattinson and Stead (Journal of the Iron and Steel Institute, 1888, Part I) not to be so deleterious an ingredient of steel as phosphorus.

No statement as to costs and prices could be obtained except those given above. The ore workings are so irregular, and the distance the ore is carried to the seaport, at which point the price would be fixed, varies so greatly, that no satisfactory average could be given. The selling price is controlled entirely by the value of the ore in England and the United States, and fluctuates not only as these values change, but with the rates of freight obtainable in sailing vessels.

Cuba (*a*).—The principal Cuban deposits of manganese are located in the province of Santiago de Cuba. The topography of that part of the country is somewhat broken. The range of mountains called the Sierra Maestra, with its highest peak towering 7,670 feet above sea level, skirts the southern coast. This great range is broken into much smaller and lower ranges of mountains or foothills, at the summit or on the flanks of which the manganese deposits are usually found. The most abundant ores are pyrolusite of a highly crystalline variety and psilomelane. Wad is also found to a large extent at some of the mines.

The mode of occurrence does not differ from that observed in other deposits. The ore is found in pockets usually embedded in clay. Sometimes these pockets contain several hundred tons of ore, forming a more or less compact mass almost entirely free from impurities. At other times the ore is found in lumps of various sizes and more or less mixed up with clay and fragments of jasper. The large lumps can be picked out by hand, but the small ones have to be wasted unless washing is resorted to.

The most extensive deposits are those forming the Ponupo group of mines, which covers an area of 752 acres.

From the Vencendora mine of this group some 6,000 tons have been taken, and pits already sunk have developed a body of at least 300,000

a Condensed from the American Manufacturer, May 27, 1892.

tons more. The ore pockets are 20 feet wide. The quality of the ore is varied, but is always of as rich a grade as pyrolusite, practically free from phosphorus, with little silica, and carrying 50 to 56 per cent. metallic manganese. The ore was mined in a very primitive way and without the aid of any machinery whatever. The transportation to the railroad station at Cristo was by means of carts and teams, which occasioned great expense and loss of time, and which, moreover, is only practicable in the dry season. The ore was sold to Carnegie Brothers & Company, of Pittsburg, Pennsylvania, and the price paid ranged from 30 to 36 cents delivered for every unit of metallic manganese, with allowances for iron, silicia, etc., which represents an average of $19 per ton. Work has been stopped pending negotiations for thec onstruction of a railroad.

At the Sultana mine explorations show the existence of some 200,000 tons of ore; at the Balkanes, 100,000 tons; in the Generala and the Serrallo, 150,000 tons, and at other mines not developed large deposits are known to exist. On the whole it has been estimated that 800,000 tons of manganese can be won in this group. The following statement as to the actual cost of producing ore in this group of mines by the primitive methods that have been in use and an estimate of the cost with improved methods and a railroad are given:

Costs for producing Cuban manganese.

Cost to the owner:		Cost to the proposed company:	
Extraction	$0.50	Extraction	$0.50
Bagging	.30	Freight, railroad to Cristo	.60
Transportation in cars to Cristo	6.00	Freight to Cuba	1.27½
Freight railroad to Cuba	1.27½	Freight to New York	2.50
Loading and unloading	.30	Administration	.50
Shipping and freight to New York	4.50	Royalty	2.50
Administration	1.00	Cost in United States	7.87½
	13.87½		

Considerable ore has been taken from the Marguerita group of mines. At the Pabelita mine, in this group, work was begun in 1889. This mine is 3,180 meters from the railroad station at Cristo, at an elevation of 180 feet. The ore is largely pyrolusite, assaying more than 50 per cent. metallic manganese. Some 15,000 tons of ore have been mined here. Quite a quantity of the ore produced is wasted for want of a washing plant. From the Marguerita mine some 300 tons have been produced; from the Balsford, 700; from the Pilar, 500 tons; the Thiers, 1,000 tons; the Fodera, 2,000 tons; and various smaller amounts from other mines. From the Boston mine some 12,000 tons have been extracted from one pocket. The dimensions of this pocket are 300 feet long, 30 feet wide, and 32 feet deep. The ore analyzes 48 per cent. to 52 per cent.

The Bueney group of mines is the smallest. It comprises the San José and Gloria, from which some 2,000 tons of a 54 per cent. to 58 per cent. manganse have been extracted. In the Magdalena group, near the Sigua Iron Company's mines, there is an abundance of rich ore. The Portello mines have not been worked to any extent.

The exportation of manganese ores from the mines near Santiago since 1888 is as follows:

Exportation of manganese ores from Santiago district, Cuba, from 1888 to 1891.

Years.	Tons.
1888	1,942
1889	704
1890	21,810
1891	21,987
Total	46,443

Russia.—The manganese mines of the Caucasian district of southern Russia have, within the past two years, assumed an importance second to none at present operated, and are probably having more effect upon the price of manganese in the markets of the world than the mines of any one district, not even excepting the celebrated Crimora mine in Virginia. These mines are near the village of Chiatura, or, as it is sometimes spelled, Tchiatoor, some 26 miles from Kwirilla station on the Trans-Caucasian railway, which runs between Baku on the Caspian and Batoum and Poti on the Black sea. The mines are situated on the west side of the Lesser Caucasus. They are found on the top of a high cliff overhanging the Kwirilla river. This river has cut its way deeply through the rock, and the overhanging cliffs on both sides show distinct deposits of manganese. A very steep and difficult road, up which no carts can be taken, leads to the mines.

The method of mining is by driving long galleries into the hillside, and over a space of more than 2 miles along the face of the cliff these galleries enter the hill. From them cross-tunnels have been excavated in every direction, but no scientific system of mining is employed. Pillars of the manganese ore are left at intervals to support the roof, but the galleries are dangerous, and expensive falls of the roof, accompanied by loss of life and limb, are by no means unusual. The ore is carried in baskets by the men down the face of the cliff, from the bottom of which it is carried on the backs of horses, mules, and camels 26 miles to Kwirilla station, whence it is sent by railroad to Poti and Batoum, and thence to Liverpool.

The ore contains about 55 per cent. of metallic manganese, and the quantity appears to be enormous. The chief drawback is the want of a good road from Kwirilla station to the mines. The government proposes to build such a road, and in conjunction with this road improvements in the navigation of the river Riom are also projected, so as to allow of floating the consignments of ore down to Poti instead of sending them by the railroad, the facilities of which are already sufficiently taxed by other freight, chiefly grain and petroleum. It is estimated that should these improvements be completed, at least 100,000 tons a year of manganese can be produced in this district, and should the Kwirilla mine become exhausted there are other deposits between Tiflis and Baku on the east side of the Lesser Caucasus, near Elizabethpol station, which would make good the deficiency. These latter deposits are near the copper mines of Messrs. Siemens Brothers, of the Dashkeson defile. At present only large lumps of ore are sent from the Kwirilla deposit, the means of transportation forbidding the carrying of the smaller ore. As a result, fully two-thirds of the manganese is wasted, though this ore in most cases is quite equal, if not superior, to that which is sent to market.

It has only been since 1880 that this region has assumed any importance as a producer of manganese. Before that the production was wholly under the control of a Greek company which shipped a few tons each year from the Caucasus to Constantinople, where it found its way to England. Now, as stated above, it is sent direct to Poti and Batoum, from whence it is forwarded chiefly to England, but also in some quantities to Austria and France. The following is the most complete statement relative to the production that we have been able to find:

Production of manganese ores in the Caucasus region of southern Russia.

Years.	Long tons.
1879	1,000
1880	9,910
1884	21,000
1885	44,447
1886	61,328
1887	77,674
1888	31,619
1889	63,295
1890	128,606
1891	90,264

No exact figures have been secured from 1881 to 1883. It is stated, however, that the export in 1881 was a little less than in 1880; it doubled in 1882 and doubled again in 1883, rising to 21,000 tons in 1884, as shown above. At the time of writing this report no statistics of production in this region for 1892 have been received. The imports of manganese from Russia into Great Britain, however, increased from 48,807 tons in 1891 to 51,854 tons in 1892.

Though the principal production of manganese in Russia is from the Caucasus, there are two other districts in which some ore is mined, the Ural and Ekaterinoslav. The Ural ores are smelted at the local furnaces, those from Ekaterinoslav at Briansk and Novorassisk. The product of manganese in Russia since 1885 is given in the following table:

Production of manganese in Russia, 1885 to 1892.

Year.	Production.
	Tons.
1885	59,400
1886	74,603
1887	57,117
1888	32,078
1889	76,836
1890	171,300
1891	110,000
1892	....

Canada.—Most of the manganese mined in Canada is from the deposits of Nova Scotia and New Brunswick, described below, and some small amounts are from time to time mined in Quebec, but the deposits are of comparatively little importance.

According to the reports on the mineral production of Canada published by the Geological Survey Department of Canada, the total production of manganese ore in Canada and the value of the same, 1886 to 1892, is as follows:

Production and value of Canadian manganese ore, 1886 to 1892.

Year.	Production.	Value.
	Tons.	
1886	1,789	$41,499
1887	1,245	43,658
1888	1,801	47,944
1889	1,455	32,737
1890	1,328	32,550
1891	255	6,694
1892	115	10,250

New Brunswick.—Two classes of manganese ore are mined in the province, one known locally as "gray ore" or "needle ore" which is pyrolusite, and the other the brown ore known as "blast-furnace ore." Throughout the Southern part of New Brunswick and in the areas underlaid with the Carboniferous limestone are very extensive deposits of manganese which have afforded considerable quantities of high class ore. The most important of these deposits is that at Markhamville, near the town of Sussex, Kings county, at which place manganese was discovered in 1862. This mine has produced some of the highest grades of manganese found in the world. It is largely used in the United States in the manufacture of glass, which use requires an ore high in manganese and as low as possible in iron. The ore occurs throughout the Carboniferous limestone in beds and pockets attaining in places large dimensions, as much as 4,000 tons having been produced from one pocket.

No regular system of mining is attempted nor is it possible, though until quite recently the workings, owing to the location of the deposits, have taken the form of drifts and open cuts. In 1890 explorations with a diamond drill located two large bodies of ore to which shafts are sunk.

In the following table are given analyses of this ore:

Analyses of high-class manganese ore from Markhamville, New Brunswick.

	No. 1.	No. 2.	No. 3.
	Per cent.	*Per cent.*	*Per cent.*
Manganese peroxide	98.70	97.25	96.62
Silica	.55	....	....
Iron	.75	....	....
Iron peroxide	....	.85	.78
Baryta and silica	Trace.	.95	.85
Water	....	Trace.	Trace.
Loss	....	.95	1.75
Total	100.00	100.00	100.00

This ore is granulated or powdered and packed in old petroleum barrels containing upwards of 1,000 pounds each. As so packed for shipment it is worth 5 cents per pound. It is sold by analysis, 50 per cent. being the standard. But little ore has been produced in this district outside of that produced at these mines.

At Jordan mountain, also near Sussex, is a deposit of manganese similar in character to that at Markhamville, which was discovered in 1882, and from which some 400 tons of ore have been taken.

On a promontory extending into the Bay of Fundy opposite St. Martins, and known locally as "Quaco head" is a calcareous shale charged with manganese, which has been worked for years in a desultory manner. It is stated that the present owners purpose systematic operations. This ore shows 57.15 to 58.20 per cent. metallic manganese with but 0.02 to 0.04 per cent. phosphorus.

At Goodland mountain is a recently opened mine that furnishes the only case in New Brunswick of a manganese deposit in appreciable quantity outside of the Carboniferous areas.

Other deposits exist but they are of such a character or have been so little developed as to have little or no importance.

Regarding exports as showing the total products, the production of manganese in New Brunswick since 1868 is as follows:

Production of manganese ores in New Brunswick, 1868 to 1892, and value of same.

Years.	Production.	Value.	Years.	Production.	Value.
	Long tons.			*Long tons.*	
1868	861	$19,019	1881	1,504	$22,532
1869	332	6,174	1882	771	14,227
1870	140	3,580	1883	1,013	16,708
1871	954	8,180	1884	469	9,035
1872	1,075	24,495	1885	1,607	29,595
1873	1,031	20,192	1886	1,377	27,484
1874	776	16,961	1887	837	20,572
1875	194	5,314	1888	1,094	16,073
1876	391	7,316	1889	1,377	26,326
1877	785	12,210	1890	1,729	34,248
1878	520	5,971	1891	....	....
1879	1,732	20,016	1892	....	....
1880	2,100	31,707			

Nova Scotia.—The manganese mines of Nova Scotia exhibit the usual variations common to this mineral in the United States which are described in previous parts of this report. Considerable wad is found. The brown hematites in various parts of the province carry considerable manganese peroxide, at times as high as 14 per cent. Pyrolusite, however, is the only ore that has been mined to any extent in Nova Scotia. Between Halifax and Windsor, near Mount Uniacke, it is found in small pockets and veins penetrating granite and in the quartzites of the auriferous Lower Cambrian of the Nova Scotia Atlantic coast. It occurs in veinlets in the granite of Musquodoboit, and as small irregular seams in the granite of Ship Harbor. In the hills south of Wolfville, in Kings county, the same ore is found in quartzites and slates, presumably of Upper Silurian age. In the Trias of the same county the ore is met in a bedded form near Cornwallis and Wolfville, and in the Triassic trap it is said to occur lining cavities, in association with zeolites, etc.

These ores are found, however, most abundantly in the Lower Carboniferous marine limestone formation. This horizon forms one of the widest spread and most strongly marked of the divisions of the Carboniferous age. It is met in Kings county, in Hants, Cumberland, Colchester, Pictou, and Antigonish, and in the four counties of the island of Cape Breton.

In the northern part of Hants county, the Carboniferous marine limestones and the underlying Lower Coal Measures are found in a series of east and west folds, shifted and broken by transverse subordinate flexures. The presence of manganese in the upper of these divisions is first observable at the mouth of the Shubenacadie river, where a dark-colored limestone underlies the gypsum, and is associated, a short distance east of the river, with red shales, carrying veins of red hematite, with manganese oxides and calcspar. The westward continuation of this horizon is noticeable again at Teny cape, where a series of these measures, extending to Walton and Cheverie, a distance of about 15 miles, contains several beds of limestone, which apparently underlie the gypsum, and may be called manganiferous. These measures carrying manganese reappear again south of Windsor, and at Douglas, 15 miles, south of Teny Cape, near the line of their junction with the pre-Carboniferous rocks. In this range of measures the manganese of Teny cape appears to be principally connected with a compact red and gray limestone, which, from the analysis already given, may be called a dolomite. At the western end of the district it occurs as veins in conglomerates and sandstones, and also in limestones in places decidedly magnesian.

The Teny Cape manganese ores were discovered about the year 1862, and have been worked intermittently since that date. The limestone band to which they seem to be principally confined is about 300 feet thick. The ore occurs in irregular nests, and in seams eroded on the bedding planes and cross fractures. It thus occurs that large masses almost entirely isolated have been met; also seams with occasional pockets, sometimes connected, but in no case, so far as ascertained, following any regular order of position or extent. The largest mass yet found was estimated to contain 180 tons of ore. Apparently the ore has been deposited at irregular intervals of time, with the associated minerals, in the openings worn by the action of water on the limestones. Specimens may be obtained showing pyrolusite cementing waterworn pieces of limestone and surrounding nodules of the bed rock which have resisted erosion. The ore is chiefly a fibrous pyrolusite, with splendent luster, based on a compact or granular ore consisting of pyrolusite, psilomelane, and manganite, the latter mineral, however, not being present in large quantity. The quality of these ores, even after the slight hand dressing they receive at the mines, is very high, and in some years they bring $125 a ton at the mine. They are prized by glassmakers for their freedom from impurities, especially of iron. This high grade of the pryolusite from the Teny Cape district will appear when, from numerous assays, it has been found to yield from 88 to 95 per cent. of available oxide. The following analyses show the general character of these ores:

Analyses of manganese ores from Teny Cape district.

	Douglas.	Cheverie.
	Per cent.	*Per cent.*
Moisture	1.660	2.05
Water of composition	3.630	....
Iron peroxide	.603	2.55
Oxygen	7.035	....
Baryta	.724	1.12
Insoluble matter	1.728	2.80
Phosphoric acid	....	1.029
Manganese oxides	84.620	....
Peroxide of manganese	....	90.15
Lime	....	Trace.
Totals	100.000	99.699

The production of manganese in Nova Scotia since 1861, so far as figures have been ascertained, is given in the following table:

Production of manganese in Nova Scotia from 1861 to 1892.

Years.	Production.	Value.	Years.	Production.	Value.
	Tons.			*Tons.*	
1861 to 1871	1,500	$10,500	1882	209	....
1872	40	1,400	1883	150	12,462
1873	131		1884	302	23,830
1874	....	....	1885	354	....
1875	7	....	1886	465	13,849
1876	16	....	1887	665	21,683
1877	97	5,335	1888	106	6,460
1878	127	6,505	1889	200	....
1879	145	7,170	1890	112	....
1880	283	14,831	1891	41	....
1881	231	....	1892	111	8,691

Great Britain.—The manganese ores of Great Britain can be divided into two classes, the oxides and carbonates. Small quantities of manganese ore in the form of psilomelane, with some pyrolusite, occur in the Lower Silurian measures in Devonshire and Cornwall and in the Midlands of England, especially in Derbyshire. Carbonates are found to a considerable extent in Merionethshire. By far the largest portion of the production of manganese in Great Britain are the carbonates from North Wales.

The ore mined in Great Britain in 1892 was from Devonshire, in which 840 tons of a fairly high grade of manganese, worth $5,082, were produced, 119 tons of a much lower grade, worth only $290, from Derbyshire, and 5,119 tons, chiefly carbonate, from Merionethshire, worth $16,088.

Some forty years ago pyrolusite and psilomelane were mined near Tavistock, in Devonshire, and Launceston, in Cornwall. These deposits were then worked chiefly as surface workings and as surface deposits are practically worked out. While ore was known to exist beneath these surface workings, it was believed for a long time that the mining would be too expensive and the content of the ore in manganese too low to admit of profitable competition with the high-grade ores cheaply mined in Chile and Russia. That this belief is not general is shown by the facts stated above, namely, that 840 tons of a fairly high grade of manganese were produced in Devonshire in 1892 by the Chillaton Manganese Company, Limited.

The deposits in the Midlands occur in different conditions, sometimes in layers a few inches thick and at others, and more generally in masses of a dark brown or blackish color, having a friable, earthy appearance, not unlike hard balls of soot. It is unctuous to the touch, and stains the fingers black when handled. It is found at various depths, some of the shafts being 80 yards deep. It appears to have been deposited in layers, for where it forms a bed it has every appearance of being a sedimentary deposit, and can be plainly seen in consecutive horizontal layers. It is found in layers varying from 6 inches to 2 feet thick, resting upon limestone blocks, the geological formation being the mountain limestone. The ore has not been used for obtaining metallic manganese, but as a mixture for paint. Nearly the whole of the ore raised in the Midlands or in Derbyshire is sold to the paint mills and converted into paint. The price at the mines is from 10 shillings ($2.42) to 12 shillings ($2.90) per ton. The following is an analysis of the Derbyshire ore, made by Mr. Wedgwood some years ago:

Analysis of manganese ore from Derbyshire, England.

Twenty-two parts of black wad gave:	
Insoluble earth, chiefly micaceous	2
Iron	9½
Manganese	9½
Lead	1
Total	22

The deposits of carbonate of manganese found in the Cambrian rocks at several places near Barmouth and Harlech are of some importance, in view of the fact that carbonate of manganese has not heretofore played an important part in the manganese market, according to Mr. Edward Halse, in a paper on "The Occurrence of Manganese Ore in the Cambrian Rocks of Merionethshire."

These rocks, which are comprised in a broad mountain tract forming an irregular oval, the longer axis being 17 miles and the shorter axis 10, consist principally of coarse quartzite, greenish gray grit, the quartz grain being sometimes interspersed with granules of feldspar. There are three manganese lodes, one running in an unbroken line for about 2 miles, in an almost true north and south direction. Two miles and a half farther north and a little to the west is another lode nearly a mile long, and a half mile still further north is a third lode about the same length. These so-called lodes were worked superficially for black oxide of manganese from about 1835 to 1840, the ore being sent to Glasgow for the manufacture of bleaching powder, and valued at 50 to 60 shillings per ton at Barmouth. The outcrop of the Barmouth deposit can be traced for 2 miles by means of these old workings. These workings are in no instance more than a few fathoms deep, the black oxide being found not to extend to any great depth. The workings, it seems, were abandoned about 1840. Sometime in 1855 it was discovered that the deposits were really the outcrops of one or more beds of impure carbonate of manganese. Mr. Halse points out that workable beds of carbonate of manganeses are found to occur in the Cambrian rocks of North Wales and are traceable for a length of 17 miles; a fact of great interest, both from a geological and an economic point of view. The only other workable bed of carbonate of manganese (rhodochrosite or diallogite) known is said to occur in the Upper Silurian rocks of Chevron, Belgium.

In the Harlech mine the bed of ore is a little over a foot thick, consisting of grit of medium grain, overlaid by a thin band of quartzite, probably metamorphosed grit. The roof proper consists of about 2 feet of very hard schistose rock, termed "blue stone" by the miners. Specimens of ore taken from the mine are seen to be formed of uniform layers, having gray, yellowish, white, greenish, and chocolate-brown colors. Fifteen cubic feet of ore weigh about a ton. The mine is 1 mile from Harlech station, the cost of cartage to the station being 9 pence per ton. The bed is very faulty, the ore of the lower grade averaging only 27 per cent. of metal. The work proving very hard, the mining operations were stopped in 1887. At the Artro mine the thickness of the vein varied from 8 to 18 inches. The cost of cartage to the station was 2 shillings 9 pence per ton, the ore being worth about 16 shillings per ton at the Llanbedr station. In the Moelfre mine the bed s remarkable for its contortions, sharp folds occurring every 2 or 3 yards, and often every 2 or 3 feet. The ore contains 4½ per cent. of iron. In the Hafodty mine the ore is of a light brown color and of low uniform quality. The percentage of manganese varies from 30 to 32 per cent., and that of silica from 18 to 19 per cent. The richest ore is where the bed is thinnest. The weight of 10 cubic feet of ore is about a ton. The ore is worth about 30 shillings per ton at Barmouth. The only other important mine is the Diphwys. The ore assays from 31 to 32 per cent. of metal.

The following is an analysis of the Merionethshire ore, as compared with the Chevron, Belgium, ore:

Analysis of the Merionethshire ore, as compared with the Chevron, Belgium, ore.

Constituents.	Merionethshire ore (analyst Mr. Holgate) dried at 212° F.	Merionethshire ore (analyst Mr. Holgate) as received.	Chevron ore (analyst M. F. Lacone) from Heid Julien.	Chevron ore (analyst M. F. Lacone) from Heid Cossin.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	....	2.499	....	....
Manganese peroxide	8.07	7.87	} 28.42	31.75
Manganese protoxide	26.72	26.05		
Iron peroxide	5.71	5.57	29.62	24.15
Alumina	10.99	10.72	3.87	4.06
Lime	4.31	4.20	3.90	2.83
Magnesia	0.62	0.60	1.15	0.88
Silica	26.67	26.00	23.22	22.01
Potash and soda	0.25	0.24	....	....
Phosphoric acid	0.074	0.072	0.55	0.46
Sulphuric acid	0.17	0.16	Trace.	0.01
Copper and lead	Nil.	Nil.	Co_2 {	Co_2 { ......
Loss on ignition, inclusive of 12.83 carbonic acid	15.70	15.31	10.63	14.51
Total	99.284	99.291	101.36	100.66
Manganese	25.8	25.05	20.48	22.87
Iron	4.0	3.90	20.73	16.90
Phosphorus	0.043	0.042	0.24	0.20

If the whole of the carbonic acid present in the Welsh ore is in combination with the protoxide of manganese, it contains 33½ per cent. of the carbonate; but doubtless there are present several per cent. of iron, magnesium, and calcium carbonates. Mr. Holgate finds there is 4 per cent. of silicate of manganese in the ore.

The ore is clearly a mechanical mixture, and seems to be made up of about 30 per cent. carbonate of manganese, 4 per cent. silicate of manganese, 40 per cent. oxides of manganese, iron as oxide (magnetite), carbonate and sulphide (iron pyrites), magnesium carbonate, etc., free silica, and 26 per cent. of clay.

If the whole of the carbonic acid in the Belgian ore is combined with protoxide of manganese, it contains 32½ per cent. of the carbonate. Hence the curious fact appears that both these deposits contain about the same quantity of the latter mineral.

The ground is set by the yard, the average price being 35 shillings; but of course it varies much. The writer is unable to give any figures with regard to the cost of getting. As the beds of ore are of only moderate thickness and quality, and as the ground has proved to be of very stubborn nature, the margin for profit can only be a moderate one.

The production of manganese in Great Britain in 1892 was as follows:

Production of manganese in Great Britain in 1892.

Districts.	Production.	Value.
	Tons.	
Derbyshire	119	$290
Devonshire	840	5,082
Merionethshire	5,119	16,088
Total	6,078	21,460

The total production of manganese ore in England and Wales since 1882 is as follows:

Production of manganese in Great Britain, 1882 to 1892.

Years.	Tons.	Value.
1882	1,548	£3,907
1883	1,287	2,976
1884	....	....
1885	1,688	....
1886	12,763	....
1887	13,777	11,110
1888	4,342	1,934
1889	8,852	6,478
1890	12,444	6,733
1891	9,476	6,213
1892	6,078	4,434

It is estimated that from 1835 to 1839 the production of manganese in Great Britain was 5,000 tons a year. In 1873 it was 8,254 tons. In 1875 there were sixteen mines in operation, which produced 3,725 tons.

New Zealand.—Manganese ore has been produced in New Zealand continuously since 1878, in which year this mineral appears for the first time among the exports from the colony. As none of the ore is consumed in New Zealand, the exports are practically the measure of the production. The largest export in any one year was in 1878, when 2,516 tons, valued at $50,413, were exported. It hardly seems possible that this can be the correct value of the ore produced, as it would make it worth about $20 a ton, a price it would hardly bring even after freight to England had been paid.

The commercial ores of New Zealand are chiefly braunite, with some pyrolusite, the latter occurring sparingly.

The statistics of production available are not complete. It is stated in the Handbook of New Zealand Mines, published in 1887, that 12,000 tons of manganese, valued at over $193,600, had been exported up to the close of 1885. Another report gives the total quantity produced up to the close of 1890 as 15,303 tons, valued at $248,248. The same remark regarding valuation can be made as is given above. The value seems especially high in view of the fact that in the details for 1890 no ore is valued above £2, 5 *s.*, which would be $12.10 a ton.

The production of New Zealand for the years for which detailed statements have been secured is as follows:

Production of manganese ore in New Zealand, 1878 to 1890.

Years.	Tons.	Value.
1878	2,516	$50,413
1879	2,140	40,356
1880		
1881	1,271	15,890
1882		
1883		
1884	318	3,911
1885	602	8,305
1886		
1887		
1888	1,085	11,635
1889	1,080	5,227
1890	1,170	12,741

France.—Small quantities of manganese are produced yearly in France, though the production has decreased in the last few years owing to the amounts imported annually from the Caucasus into France by way of Germany. These imports, according to the customs returns, amounted to 23,000 tons in 1886.

The annual production of France of late years has been in the neighborhood of 7,000 tons. Nearly three-fourths of this product was from mines of the Grand-Fillon and of Romanèche (Saone-et-Loire). The balance was from the mines of Chaillac, in the departmant l'Indre. Some 400 tons were mined in 1886 from the grant of Ferronniere and of Villerambert in the department of the Aude. The poor ore is used in the iron works for the manufacture of spiegeleisen. The better quality is sold to chemical works after being sorted and undergoing a slight preparation. The only statistics of production we have for France are for 1886, when 7,676 tons were produced.

Italy.—The only manganese ores of the Kingdom of Italy concerning which we have much information are those of Sardinia, though it is well known that both manganese and manganiferous iron ores are found in other parts of the kingdom and mined to some extent.

There are two manganese mines on the western coast of Sardinia, in the San Pietro district. The ore is both black and brown, and the seam has an average thickness of 1 foot, lying on a bed of soft, whitish clay containing trachyte, and forming the floor of the deposit. Above it is jasper, above which again comes trachyte of various colors and quantities. The best ore contains from 31 to 35 per cent. of metallic manganese and 7.13 per cent. of iron. The second grade contains about 20 per cent. of manganese and 14 per cent. of iron.

The production of manganese in Italy, so far as we have the figures, which are for 1887, 1888, 1889, and 1890, are as follows, the tons being the metric tonneaux:

Production of manganese in Italy.

Years.	Number of mines.	Production.	Value.
		Tonneaux.	*Lire.*
1887	5	4,434	113,324
1888	8	3,630	78,000
1889	5	2,203	51,801
1890	....	2,147	51,551

Germany.—No statement as to the character of the manganese ores of Germany or as to their method of occurrence has been secured, though the Prussian mining reports give quite full statistics of production and prices. The statistics of production and value of manganese ore mined in Prussia from 1881 to 1892 are as follows:

Production and value of manganese ores mined in Prussia from 1881 to 1891.

Years.	Quantity.		Value.
	Tons.	*Kilos.*	*Marks.*
1881	11,085	719	329,599
1882	4,670	525	140,606
1883	4,573	885	118,430
1884	7,750	911	179,657
1885	14,696	480	338,760
1886	25,045	496	737,773
1887	36,533	942	951,831
1888	27,307	680	613,542
1889	44,006	497	901,589
1890	40,131	236	726,785
1891	36,859	518	727,599

Belgium.—The chief center of production of manganese ores in Belgium is in the province of Liege, the ores being chiefly manganiferous iron ores carrying sufficient manganese to be of value for this metal. Manganese ores, as elsewhere, are found associated with hematite iron ores. The production, however, is not sufficient to meet the wants of the furnaces and steel works of Belgium, and considerable quantities are imported from other countries. During late years, however, the production of manganese ore in Belgium has advanced wonderfully, as will be seen from the statement of the production of manganese since 1880. The tons in this table are the metric tons of 2,204 pounds. The value is in francs.

Production of manganese ore in Belgium.

Years.	Production.	Value.
	Tons.	*Francs.*
1880	700	4,000
1881	770	4,000
1882	345	1,750
1883	820	4,100
1884	750	3,750
1885	....	....
1886	750	9,000
1887	12,750	155,850
1888	27,787	325,000
1889	20,905	248,000
1890	14,255	176,000
1891	....	....
1892	....	....

Other countries.—Manganese is found to a greater or less extent in other countries than those named, but we are without continuous details of production. In the following table are given the imports of manganese into Great Britain in 1891 and 1892:

Imports of manganese ore into Great Britain in 1891 and 1892.

Countries whence imported.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Australasia	2,062	£5,429	1,518	£4,328
Russia	48,807	157,730	51,854	162,721
Sweden	3,377	10,210	3,390	10,453
France	1,434	3,686	4,270	10,658
Italy	10	30	....	....
Portugal	3,105	10,366	4,188	12,670
Spain	2,138	6,067	11,156	32,267
Turkey	670	2,817	1,954	6,066
United States	286	858	....	....
Chile	34,331	112,526	27,195	88,952
Other countries	5,229	15,726	4,298	13,400
Total	101,449	325,445	109,823	341,515

From this table it will be seen that in addition to the countries named above Sweden, Portugal, Spain, Turkey, and the Australian colonies exported considerable quantities of manganese ore. The Swedish manganese is somewhat siliceous, but being quite free from phosphorus is in good demand for mixture with higher grade ores. The exports in 1888 were 6,089 tons. From the above table it will be noted that there were received in England from Sweden in 1891, 3,377 tons, and in 1892, 3,390 tons. This is not the entire production of Sweden, as ores went to other sections.

Portugal.—There are quite a number of manganese mines in Portugal, though the information regarding them is scanty. In 1883 it is stated that there were 90 mines of this mineral being worked in this country, the character of the ore produced being very high. The only figures of production we have for Portugal are for 1887, when 6,812 tons were produced; 1878, 6,655; 1879, 5,705, and 1881, when 9,906 tons were produced. In 1888 the product is estimated at 5,638 tons.

Spain and Turkey.—Our information regarding manganese deposits in Spain and Turkey is neither recent nor full.

ALUMINUM.

By Alfred E. Hunt.

PRODUCTION.

The product of aluminum in the United States has been as follows:

Production of aluminum in the United States.

Years.	Pounds.	Years.	Pounds.
1883	83	1889	47,468
1884	150	1890	61,281
1885	263	1891	150,000
1886	3,000	1892	259,885
1887	18,000		
1888	19,000	Total	559,130

The figures include the production of aluminum in alloys, in which form the largest share—probably at least 21,000 pounds—of the metal in 1885, 1886, and 1887 was turned out. The output of the present year, 1893, bids fair to largely exceed that of other years, and to relatively occupy the same position of increase that the last four years have shown, with the further prospect of the output being again largely increased by works at Niagara Falls, which will be built by the Pittsburg Reduction Company to utilize the power of the Niagara tunnel.

Only an estimate can be made of the total amount of aluminum made in France from the year 1855 until about 1880, but the figures from the official reports of the Minister of Public Works of France place this amount at about 70,000 pounds, and 56,000 pounds additional for the next ten years, or a total of 126,000 pounds. About 100,000 pounds was made during the two years of 1891 and 1892, or a total of 226,000 pounds.

Mr. R. L. Packard, in his admirable report attached to Census Bulletin No. 79, estimates with a reasonable degree of accuracy the English production up to and including the year 1890, at 42,000 pounds, to which will be added at least 90,000 pounds per year for the years 1891 and 1892. Very little aluminum, if any, was made in Great Britain during the year 1890. The same report places the German and Swiss production of aluminum at 43,120 pounds, up to the year 1890, the works at the falls of the Rhine not commencing operations until after the year 1890. From private data, which seems to be reasonably accurate, this concern produced 120,000 pounds of pure aluminum in the year 1890, 360,000 pounds in 1891, and 720,000 pounds in 1892, or a total of 1,200,000 pounds, which, added to the production previously made, would give 1,243,120 pounds as the product of Germany and Switzerland up to the beginning of 1893.

Tabulating the output of the world's production of aluminum as given above, we have:

The world's product of aluminum.

	Pounds.
Great Britain	222,000
France	226,000
Switzerland and Germany	1,243,120
Total European product	1,691,120
United States	559,130
Total for the world	2,250,250

or about 1,125 short tons of pure aluminum metal, of which probably just about the odd 125 tons was made in the form of aluminum bronze or ferro-aluminum alloys; so that the probable production of aluminum in the world has been about 1,000 tons up to the beginning of the year 1893.

With this record, while the statement in the last report of the years 1889–'90, that the "production of aluminum still remains small when compared with that of other metals in the arts" is still relatively true as compared to the common metals, at the same time, the output that has increased over seven times in capacity from 1889 to 1893 indicates that this statement will not be long a fact, as aluminum has already outstripped the production of nickel and bids fair to soon rank in its output with zinc and lead and copper.

Aluminum is now being sold in the markets in the form of ingots, plates, sheets, bars, shapes, wire, and castings. These are furnished by the Pittsburg Reduction Company, who are the only manufacturers of aluminum, commercially, in the United States at the time of this writing in 1893. During the year 1892 the Cowles Electric Smelting and Aluminum Company was in continuous operation at its works in Lockport, New York. Work was, however, stopped there in the early part of January, 1893. Practically all the pure aluminum which has been made in the United States has been made in accordance with the electrolytic process covered by Hall's patents. The sodium process of manufacture has never been worked on any large scale in this country.

METALLURGY.

In the commercial reduction of all the other metals from their oxides or salts, the affinity of heated carbon for the oxygen or other element in combination with the metal had been taken advantage of; but it was found, after many experiments, that not only did aluminum have a remarkable quality for withstanding the action of oxygen when the metal had once been isolated, but that also when the oxide had once been formed it was retained by the metal with such an avidity that none of the ordinary processes of reduction by the aid of heat in the presence of carbon as a reducing agent were practicable or would allow of its successful use. Stronger reducing agents, therefore, have had to be relied upon in all of the chemical processes, and metallic sodium was found to be the most available and cheapest to be used for the purpose, the sodium being used to reduce the chloride or the fluoride of aluminum or the double salts of these elements with some of the alkaline metals.

Historical.—Aluminum was first isolated in a decided and conclusive way, in which some of the physical qualities of the metal were determined, by Wöhler, in 1827, by reducing the chloride of aluminum by means of metallic potassium; this latter metal itself only having been discovered some twenty years before. This chemical process, as finally developed by H. Saint Claire Deville and others, was perfected by substituting the double chloride of aluminum and sodium for aluminum chloride and using metallic sodium as the reducing agent in place of metallic potassium. Wöhler carried on successfully the operation which Sir Humphrey Davy had outlined in 1807 and 1808; he then having succeeded in obtaining the metals barium, calcium, and magnesium from the alkaline earths by the aid of electricity.

Sir Humphrey Davy's operation he described as follows:

"By passing potassium in vapor through alumina heated to whiteness, the greatest part of the potassium became converted to potassa, which formed a coherent mass with that part of the alumina not discompounded, and in this mass there were numerous gray particles having a metallic luster and which became white when heated in the air and which slightly effervesced in water."

Very likely, the "gray particles having a metallic luster," contained an alloy of the first separated particles of aluminum. Many other laboratory experiments were carried on in a desultory sort of way from 1827 to 1855 by Wöhler, H. Saint Claire Deville, Oersted, Bunson, Tissier, and others.

Sodium processes.—To H. Saint Claire Deville belongs the honor of first manufacturing aluminum in a commercial way, along the lines which had been developed by the experiments of Davy, Oersted, and Wöhler. Aluminum chloride was used as the ore. The heated material placed in contact with molten sodium was decomposed, forming chlorides of aluminum and sodium, setting free metallic aluminum, which was retained in a fine state in the matrix of the double chloride.

This mixture was then placed in a carbon retort and highly heated in a porcelain tube with a current of dry hydrogen passing over it. The double chloride was distilled off by this means, leaving the aluminum, which was afterwards remelted and run into ingots.

Aluminum chloride is formed by treating alumina in the presence of carbon and common salt with chlorine gas in regenerative furnaces, forming a double chloride of aluminum and sodium, the reaction being as follows:

$$Al_2O_3 + 3C + 6Cl + NaCl = NaCl + Al_2Cl_6 + 3CO.$$

the double chloride thus formed being treated with metallic sodium under a flux of cryolite, giving the metallic aluminum as follows:

$$Al_2Cl_6 + 6Na = 6NaCl + 2Al.$$

H. Saint Claire Deville produced metal of remarkable purity, which gave the deserved reputation to the Société Anonyme d'Aluminium at Salindres, near Marseilles, for metal made in this way. This company enjoyed the exclusive manufacture and sale of the metal from 1855 to 1872, when, for a short time, works were started in England, under the direction of Sir Lothian Bell and his brother, who, while experimenting constantly, used the same general method as Deville. These works did not succeed commercially, and in two years (1874) stopped operations, leaving the French works of M. Pechinet, who succeeded to the management of Deville, of the Société Anonyme d'Aluminium, again as the sole manufacturer of the metal in the world upon anything like a commercial scale, until some little time after the year 1880. Since the first work of Deville, many details were improved and the process was cheapened very considerably, both by Deville himself at the French works and later at the two large English works which were started: the Aluminium Company, Limited, at Oldbury, near Birmingham, and the Alliance Aluminium Company, at New Castle-on-Tyne.

At the Aluminium Company, Limited, an American chemist, Mr. Hamilton Y. Castner, added a further step to the cheapening of allu-minum as made by the sodium process, by cheapening the production of metallic sodium, by means of an intimate admixture of caustic soda with carbide of iron, in iron retorts, the reaction being as follows:

$$6NaHO + FeC_2 = 2Na_2 + 2NaCO_3 + 6H + Fe.$$

As the cost of producing aluminum is directly proportional to this cost of metallic sodium used, the cheapening of metallic sodium by this method was a considerable step forward in the art of the manufacture of aluminum.

Mr. Carl Netto, at the New Castle-on-Tyne works of the Alliance Aluminium Company, Limited, brought out the use of cryolite, the double fluoride of aluminum and sodium, in the place of the double chloride of aluminum and sodium as used before as the material from which the aluminum was reduced, adding molten sodium to this in the same way, the aluminum being reduced and collected at the bottom of the ladles. Netto produced his metallic sodium by percolating molten caustic soda through a column of red-hot charcoal or coke, in cast-iron retorts; the caustic soda being thus reduced and the vapor of sodium condensed and the molten metal allowed to flow into settling basins exterior to the furnace; the residue, consisting chiefly of sodium carbonate, is tapped out through the lower part of the retort furnace. Each furnace produced about 100 pounds of metallic sodium per day, in the Netto process. Netto melted his cryolite in reverberatory furnaces, poured it into large crucibles, and plunged the metallic sodium into this molten bath; the reaction taking place being as follows:

$$Al_2 F_6 + 6NaF + 6Na = 2Al + 12NaF.$$

The fluorine of sodium thus formed being converted into artificial aluminum fluoride, by the addition of sulphate of aluminum and dissolving out the sulphate of sodium formed with water.

Both of these concerns, which began successful operations in the early part of the year 1888, started upon both a generous and practical scale, and bade fair to succeed, for both concerns made excellent metal and were under the management of skillful chemists; Sir Edward Roscoe being interested in the concern at Oldbury, with Mr. Castner giving his personal attention to the operations of that concern. At the New Castle works Mr. Carl Netto gave the works personal supervision, and both concerns had spent large sums of money in establishing plants on a scale sufficient to manufacture upon an economical basis. The difficulty was not only in the cost of production of the metallic sodium as the reducing agent, but also due to the fact that any reducing agent strong enough to reduce aluminum would surely reduce as well, as an impurity of the metal, any impurities in the salts used. This demanded that the chemists should use practically chemically pure materials as ores—that is, that the double chloride and fluoride aluminum salts should be practically chemically pure. This required expensive apparatus, which was rapidly corroded and ruined by the chlorine and fluorine gases used. These difficulties still remain inherent with any of the so-called cheap chemical processes for the manufacture of aluminum that have been devised within the last few years.

Grabau's method of manufacture of aluminum is a chemical process entirely, and is based upon the reduction of fluoride of aluminum with metallic sodium; the fluoride of aluminum being produced by the action of sulphate of alumina upon a mixture of fluorspar and cryolite; the cryolite being employed only at the commencement of the operation, it being reproduced in large quantities in an artificial form as a consequence of the reduction of the fluoride of aluminum; the artificially produced cryolite having the advantage of being of a much higher degree of purity than the natural mineral, which always contains spathic iron ore and quartz, from which both metallic iron and silicon are reduced and alloyed with the aluminum produced from cryolite. Very pure aluminum is produced by this process, and, it is claimed by Mr.

Grabau, at a price which will nearly compete with the production of aluminum by the now successful electrical processes. It certainly is the best development of the chemical processes for the manufacture of aluminum yet devised. The fluoride of aluminum used in the process is obtained by dissolving sulphate of alumina in water, mixing it with finely divided fluorspar, and heating to 60° C. for several hours, when a partial decomposition of the fluorspar takes place, giving sulphate of lime and aluminum fluoride. By repeating the operation several times about two-thirds of the sulphuric acid in the sulphate of alumina will be replaced by fluoride.

The result is a solution of fluo-sulphate of alumina, having a chemical formula of about: $Al_2 F_4 SO_4$, which is filtered, freed from iron by the addition of prussiate of potash, and boiled down to the consistency of a syrup. This is then mixed with finely ground cryolite to a stiff paste, giving, when dried in a basin of 112° F., a spongy mass, which is broken into pieces the size of a walnut and subjected to a dull red heat in a cast-iron vessel in a muffle-furnace. This decomposes the remaining sulphate, giving as a result pure fluoride of aluminum and sulphate of soda; the latter being washed out with boiling water with about 15 per cent. of the aluminum fluoride. The residue of 85 per cent. of the fluoride is pressed into cakes, dried, and broken up. By this method aluminum fluoride is produced in a very pure state and at comparatively low cost.

The reduction of this aluminum fluoride is made in cast-iron vessels, lined with cryolite, which is given bond with common salt water. The fluoride is heated to redness in this vessel and thereafter dropped into the reducing pot, which is also lined with cryolite, and brought into contact with an ingot of sodium, which is heated nearly to its melting point; the aluminum being covered by an asbestos cloth for its protection. The reaction is very violent. When the proportions of aluminum fluoride and metallic sodium are so chosen that only one-half of the aluminum fluoride used is reduced, the remainder combines with the fluoride of sodium formed in the reduction and produces an artificial cryolite, which, at the end of the operation, is found as a molten mass at the bottom of the pot, with the lump of reduced aluminum below it. By the aid of this process the purest aluminum that was ever made by the aid of the sodium process has been obtained—some of it produced by this process being 99.77 per cent. pure aluminum. The action on the cryolite lining of the reducing vessel is very slight. The chemical reactions involved in the process are as follows:

$$Al_2 (SO_4)_3 + 6NaF. Al_2 F_6 = 2Al_2 F_6 + 3(Na_2 SO_4)$$
$$2Al_2 F_6 + 6Na = Al_2 + 6NaF. Al_2 F_6$$

Electric processes.—During the decade after the production of the dynamo and electrical generators of currents of large quantity and low voltage—that is, from the years 1878 to 1888—a large amount of experimenting was done and many unsuccessful attempts were made to produce cheaper aluminum by the aid of the electric current, and much was learned of the chemistry of the salts of aluminum by these experiments, some of which were conducted in a large way, with the hope of obtaining economical commercial results. Most of the work was upon the basis of the electric current being used both for the purpose of melting the ore and electrolyzing it. All the workers, however, encountered the difficulty of the reduction of alumina and its high-melting point and the greater ease with which any impurities connected with the materials were reduced, thereby occasioning very expensive chemically pure reagents to be used, or the metal produced being very impure, together with the other difficulties that, when the electrolytic operation had been carried on for sometime, the bath became changed in its chemical constituents, becoming clogged and refusing to work further with uniformity and success; the metal under these conditions being of less purity and costing more than that made by the competing sodium process.

The Aluminium und Magnesium Fabrik, of Hemelingen, near Bremen, Germany, which commenced operations in the early part of the year 1887, approached nearest to successful operations of any of those attempts. Their plan, as first devised by Mr. Grätzel, was to reduce alumina in the presence of salts of magnesium, as well as those of aluminum and sodium, as a secondary operation. This concern did not succeed in making pure aluminum upon a commercial scale at a price which would warrant its going on with the business, and it dropped out of the market in the year 1890.

Mr. E. Kleiner obtained an English patent in 1886 for electrolyzing aluminum from cryolite, carrying out the ideas first called to public attention by H. Saint Claire Deville in his work on aluminum, in 1855, that an electric current passed through a molten mass of many of the salts of aluminum would, by electrolysis, reduce the metal. Many modifications of this same principle were experimented upon, but all encountered the difficulties that it took time and energy to start the electrolysis, which was soon sacrificed by the necessity of having to stop the operation due to the changes produced in the electrolyte by the electrolytic action. None of these processes had the factor of continuity absolutely necessary to economical production of aluminum by electrolysis.

Processes for producing aluminum by the aid of the electric current were used since the days of Sir Humphrey Davy: by Deville, described in his celebrated work on aluminum, published in 1855; by Gaudin in 1869; Kagensbusch in 1872; and Berthaut in 1879. Most of these investigators got so far in their experiments in producing aluminum by electricity as to obtain patents on the subject either in England or America. M. Adolph Minet developed a process at the works of the Bernard Brothers at Creile (Oise), France, which has been in operation, in a small way, ever since the year 1888. The process as described at the Paris Exposition, is to submit to the influence of the electric current a mixture of the fluoride of aluminum and sodium, together with the chloride of sodium. According to the descriptions of M. Adolph Minet he uses a mixture of cryolite and salt in the proportions of 30 or 40 per cent. of cryolite to 60 or 70 per cent. of common salt; the mass remaining molten by the heat developed by the resistance of the electric current; the bath being replenished by additions of alumina, which it is claimed dissolves freely in the free fluorides constituting the bath. Metallic aluminum is deposited at the cathode and free fluorine at the anode. The claims are that the latter at once displaces the oxide of aluminum dissolved in the bath, reforming fresh aluminum fluoride; the oxygen displaced attacking the carbon anode and being evolved as carbonic acid. The claim was also made that the sodium fluoride undergoes decomposition by the action of the electric current, yielding up its sodium by interaction with the aluminum fluoride present; thus causing the liberation of an equivalent of aluminum and reforming sodium fluoride.

Hall process.—The process of manufacture of aluminum as conducted by the Pittsburg Reduction Company is the invention of Charles M. Hall, and consists essentially in dissolving alumina in a molten bath composed of the fluoride of aluminum and the fluoride of some metal more electro-positive than aluminum; passing an electric current through the molten mass and the production of aluminum by electrolysis of the dissolved alumina; the fluorides of sodium and calcium with the fluoride of aluminum being the preferable salts used in the molten bath, although the fluorides of aluminum and sodium have been used successfully alone without the use of the fluoride of calcium, in some of their commercial work. The fluoride bath material, when melted, is almost permanent; the only loss being small mechanical lots of material sticking to the pokers and ladles and a very small loss from volatilization, when the process is working correctly. Fresh fluoride bath material is more or less impure, containing oxides of silicon and iron, in the form of quartz, sand, and spathic iron; and these metals are alloyed with the first aluminum produced in the new bath, as all of the silicon and iron are reduced before almost any aluminum is reduced, and the first metal produced contains nearly all of these impurities from the molten fluoride salts. The process is practically one of analytical accuracy, as an assay, in its production of aluminum from the ore added, as there is practically no loss of the alumina at all; almost every particle of it being electrolyzed to aluminum. As there are no slags or waste products which can contain the metal, the quantity of aluminum produced is almost exactly in accordance with the alumina added—a state of affairs not existing with the reduction of any of the other metals as now carried on, on a commercial scale. The double fluorides of aluminum and sodium as used by the Pittsburg Reduction Company are found in the native mineral cryolite, which is mined at Evigtut, near Arksut, Greenland. This mineral costs about 6 cents per pound.

The fluoride of calcium is the more common mineral, fluorspar, which is found in a reasonably pure state, in quantity, in Illinois, and costs only about $20 per ton.

In the process as carried on by the Pittsburg Reduction Company these chemicals are placed in open carbon-lined iron pots, which are arranged in series with the electric current. The pure oxide (alumina) dissolves to the extent of over 30 per cent. in the molten fluoride salts. The electric current is passed through the molten mass by the aid of carbon cylinders used as anodes, which extend down into the molten metal, these carbon anodes being attached by copper rods to the main portion of the line conducting the electric current from the positive end of the electric generating machinery. The pot itself, with its lining and the metal deposited upon the bottom, becomes the negative electrode, or cathode, and the pot is connected by copper connections to the line extending to the positive electrode in each pot. The electric current passing through the molten material causes the aluminum to be deposited by electrolysis as a molten mass at the bottom of the pot, the freed oxygen going out as carbonic oxide or carbonic-acid gas in connection with the carbon of the anode, wearing it away in proportion of a little less than an equal weight of the anode to the aluminum produced. The wear upon the walls of the pot is very small, and as the metal is tapped out from the pots each day by heavy cast iron dippers, replacing the electrolyte on the top of each ladleful of metal with the carbon rods, the operation in this way is kept continuous for many months at a time.

The fact of the alumina having become reduced to a small amount in the bath is indicated by a rise in the electrical resistance of the molten fluid to the passage of the electric current; and thus by the aid of some form of volt-meter to measure the electrical resistance of the current in its passage through each pot, the time for furnishing a fresh supply of alumina to the bath is properly told. The heat is retained in the molten bath of fluoride salts by the aid of a raft of finely divided carbon, which is kept floating upon its top, on the surface of which a fresh supply of alumina is usually kept for each further addition. The temperature of the molten bath is kept constant by the passage of the electric current through it, the resistance of the bath generating sufficient heat for this purpose. Currents of very large quantities in amperes are used and of low voltage; only sufficient pressure being required to overcome the electrical resistance of the number of pots arranged in each series, each pot requiring from six to eight volts, with the pots now in use. The Pittsburg Reduction Company had an output of between 500 and 600 pounds of aluminum per day, at the end of 1892; but was then making arrangements to increase its output considerably.

ALUMINUM ORES.

The principal sources of alumina have been the minerals cryolite, (Al_2F_66NaF) from Greenland, and bauxite ($Al_2O_33H_2O$). From both of these, alumina has been made of almost perfect purity and with a reasonable degree of cheapness. Corundum so far has proved too high-priced a mineral, as well as too difficult to work with, for the manufacture of aluminum.

Diaspore, the monohydrate of alumina ($Al_2O_3H_2O$) is a hard crystalline mineral, having a specific gravity of 3.4. It occurs as a very pure mineral for an ore of aluminum, but is not yet found in sufficient quantities, nor is it as easily worked as the softer triple hydrate.

The stalactitic modification of the triple hydrate, the mineral gibbsite, which occurs in the purest beds of bauxite, has a specific gravity of 2.4, and is a purer mineral, freer from oxide of iron, silica, and titanic acid, than bauxite. Unfortunately, it has not been found in very large masses together, although much of the purest grade of bauxite found in Georgia contains a considerable quantity of gibbsite.

Aluminite, having a chemical formula of $Al_2(SO_4)_39H_2O$, has a specific gravity of 3.66. This mineral contains from 20 to 30 per cent. of alumina in a condition to be cheaply purified by solution, filtration, and roasting. This mineral may become a cheap source of alumina in the future, as there are large beds of it in several of the western States, including one in Purgatory valley, 12 miles east of Trinidad, Colorado, and one upon the banks of the Gila river in New Mexico, near Silver City. At present, however, it is not used in the chemical manufacture of alumina, one of the chief reasons being the excessive freight charges.

Clay.—In comparison to these, the clays vary from tribasic silicates of alumina to pentacid silicates, minerals with at best 65 per cent. of alumina and 35 per cent. silica, while the more common clays contain from 50 to 70 per cent. silica and only 35 to 50 per cent. alumina. Pure kaolin contains 39 per cent. alumina, carrying about 20 per cent. aluminum, with 40 per cent. silica and 14 per cent. water. Now, as silica is much easier to reduce than alumina by all methods of reduction thus far used for the production of aluminum, this large percentage of silica must be separated from the alumina before the reduction is commenced, else a large percentage of the energy and of chemicals used in the reduction will be expended in reducing a troublesome impurity, instead of reducing the alumina to aluminum. The value of clay, therefore, as an ore of aluminum is not apparent, in comparison with the richer and purer hydrated oxides of aluminum, which have only accidental amounts of iron and silica which have to be removed before being submitted to the reducing operation.

Pure bauxite ores can be laid down in Pittsburg at a cost of not over $7 per ton at present.

There seems to be but one fact which may yet be used to advantage for the use of "fat" clays like kaolin as aluminum ores, and that is that concentrated cold sulphuric acid dissolves the alumina out of most clays, leaving the silica insoluble. This method has been experimented upon in many ways, but so far it has not produced a cheaper alumina than that produced from bauxite.

Bauxite.—Large deposits containing many hundreds of thousands of tons in several cases of bauxite have lately been discovered in the rocks of the Lower Silurian system in several counties of Georgia and Alabama, in the Tertiary area, and in the neighborhood of the older crystalline rocks, in Saline and Pulaski counties, Arkansas.

The bauxite belt of Georgia and Alabama extends in a northeasterly and southwesterly direction through Floyd, Polk, and Bartow counties, Georgia; and Cherokee, Etowah, Calhoun, Cleburne, and Talladega counties, Alabama; the belt having a length of some 75 miles and a width averaging about 10 miles. The bauxite is at the bottom of the Knox dolomite of the Lower Silurian rocks in these two States. The bauxite ores are all in sections of country which have been broken up by sharp folds and great thrust faults, in which the character of the rocks had been greatly changed, probably by intense neat. The bauxite deposits of Georgia and Alabama are all in "pockets," although the material shows more or less stratification. Bauxite occurs about as do the limonites, clays, and manganese ores with which they are closely associated, although bauxite appears to show more evidence of stratification.

The bauxite ores of Georgia and Alabama are closely associated with iron and manganese ores, having about the following composition:

Composition of manganese ore associated with bauxite, in Georgia and Alabama.

	Per cent.
Manganese	43.730
Phosphorus	0.129
Silica	0.353
Metallic iron	0.101

Composition of iron ore associated with bauxite, in Georgia and Alabama.

	Per cent.
Oxide of iron	71.36
Silica	6.73
Titanic acid	none.
Phosphorus	0.066

Several companies have been mining this bauxite within the past year; among them are the Georgia Bauxite and Mining Company, Linwood, Georgia; the Republic Mining Company, and the Southern Bauxite and Mining Company, of Piedmont, Alabama.

The average composition of the Arkansas bauxite is—

Average composition of Arkansas bauxite.

	White.	Red.
	Per cent.	*Per cent.*
Silica	10	4
Alumina	52	53
Oxide of iron	4	10
Water of hydration	30	29
Titanic acid	4	4
Total	100	100

In much of the mineral the iron runs higher, at the expense of the contained alumina.

The best mineral from Georgia and Alabama has a cream-white color and a composition about as follows:

Composition of the best bauxite from Alabama and Georgia.

	Per cent.
Silica	3
Titanic acid	4
Oxide of iron	2
Water of hydration	32
Alumina	59
Total	100

This mineral exists in very large quantities and has been mined in lots of thousands of tons already. It only needs to be incinerated lightly with soda ash to form aluminate of soda, which is dissolved and decanted off and freed from the impurities of silica, oxide of iron, and titanic acid which have not been acted upon and are insoluble in the hot water used for solution of the aluminate of soda. From this solution alumina is precipitated by passing carbonic acid formed by the distillation of carbonic acid from limestone through the solution and by agitation. The carbonic acid reforms carbonate of soda from the aluminate and precipitates the pure alumina freely. This settles at the bottom of the tank and is afterward thoroughly washed with hot water and dried and then heated for a considerable time at a high red heat to drive off the water of hydration to make the ore ready for the production of aluminum by the Hall process. This industry bids fair to be an important one for the mineral districts named in the States of Georgia, Alabama, and Arkansas.

Irish bauxite runs high in alumina, but, unfortunately, is also high in silica and titanic acid; the first quality material running as high as 8 to 11 per cent. of silica with about 6 per cent. of titanic acid, the peroxide of iron being from one-half to 1½ per cent., and in any of the mineral that is low in silica the proportion of oxide of iron runs up to considerably over 10 per cent.

As the handling of bauxite in a commercial way, and also the method of analysis of this mineral, are new in this country, the method of analysis as used by the Pittsburg Testing Laboratory, Limited, will be of interest. It is as follows:

Method of analyzing bauxite.—"Mix and fuse five-tenths of a gram of very finely powdered bauxite with 8 grams of powdered bisulphate of potassium. The fusion should be made in a thin-walled platinum crucible of about 400 cubic centimeters capacity; the cover of the crucible should fit well.

"During the first fifteen minutes the crucible should be on a platinum wire triangle over a small flame of a Bunsen burner. The burner flame should be protected from drafts by a sheet-iron chimney, and the flame at first should just touch the crucible bottom. At intervals of five minutes remove the cover carefully and give the contents of the crucible a rotating motion, holding the crucible firmly in the tongs. At the end of fifteen minutes turn up the flame till the lower quarter of the crucible is red-hot; agitate frequently as before.

"In ten minutes more turn on flame full and heat for five minutes, with shaking. Cool, add 2 grams more of bisulphate of potassium and gradually bring to a homogeneous fusion, but do not heat long enough to drive off the free sulphuric acid.

"Pour out the liquid fusion into a warmed and dry platinum dish; the cake cools and does not adhere to the dish. Place together with the crucible and cover in a 200 cubic centimeter beaker. Add 150 cubic centimeters of water. Heat to 40° C., with frequent stirring, until all soluble matter is dissolved.

"*Silica.*—Filter into two 300 cubic centimeter beakers and wash the residues. Ignite and weigh as silica. Make correction for silica if the bisulphate of potassium contained any. Also test the silica with hydrofluoric acid, and if any residue is found fuse it with a little bisulphate of potassium, dissolve in water and add it to the main solution.

"The filtrate from the silica contains the titanic acid, alumina, and oxide of iron.

"*Titanic acid.*—Add dilute nitric acid to slight precipitation, not cleared by stirring. Add dilute (1 to 3) sulphuric acid until this precipitate just redissolves. Add 4 drops of concentrated sulphuric acid to the solution and dilute to 250 cubic centimeters. Saturate with sulphurous acid gas. Heat slowly to boiling, and boil gently for three-quarters of an hour. Add a little strong sulphurous acid water occasionally to keep the iron in ferrous state.

"Filter through double filters and wash with hot water. Ignite and weigh titanic acid.

"The filtrate is boiled until free from sulphurous acid; 2 cubic centimeters of concentrated hydrochloric acid and 2 cubic centimeters concentrated nitric acid are added and the solution boiled for fifteen minutes to thoroughly oxidize the iron. It is then diluted to 250 cubic centimeters with hot water and ammonia added in slight excess. Boil gently for five minutes and then warm for five minutes more. Long boiling gives a precipitate which retains potassium salts when washed. Filter and wash thoroughly with hot water. Wash the precipitates off the filters back into the beakers, dissolve in 10 cubic centimeters concentrated hydrochloric acid and water, dilute to 250 cubic centimeters with hot water. Reprecipitate with ammonia as before. Filter on the same washed filters. Ignite (finally to highest heat of blast lamp) and weigh as oxide of iron and alumina. Fuse with carbonate of soda, boil out with water, filter, and dissolve residue in hydrochloric acid. Titrate iron with 'bichromate' and obtain alumina by difference from total weight of oxides of iron and alumina, calculating the contained aluminum from the oxide."

Imports.—The imports of bauxite into the United States in 1889 were 28,945,674 pounds; in 1890 they were 27,503,730 pounds; in 1891, due to the very large displacement of the foreign bauxite by the Georgia and Alabama products, the importation dropped to 17,936,504 pounds; in 1892 there was a further decrease to 12,804,253 pounds.

The production of bauxite in Georgia for the year 1892 was 2,000 tons; in Alabama, 7,200 tons; showing that the demand for bauxite in this country has not only largely increased but that foreign bauxite has been largely superseded by the American mineral in its use in the arts in the United States within the past two years.

Metallurgy of alloys.—Alloys of aluminum and iron or copper had been produced on a commercial scale in this country before the manufacture of pure aluminum, and to the Cowles Electric Smelting and Aluminum Company, who established works at Lockport, New York, and commenced to manufacture in 1885, belongs the honor of first putting aluminum alloys upon the American market on a commercial scale. The largest amount of these alloys was in the form of aluminum bronze (or brass), which is an alloy of aluminum with copper (or brass), and ferro-aluminum, an alloy of aluminum with iron. By the process used by them, aluminum was produced in an alloy in as rich a percentage as 10 or even 12 per cent.

The process consisted in passing an electric current of large quantity and comparatively low voltage through an intimate mixture of alumina, carbon, and pieces of copper, brass, or iron, as the character of the alloy was proposed to be, in a long metal box which was thickly lined with carbon, the electric current being supplied by two heavy carbon electrodes which were arranged to move in and out of the furnace at varying distances. At the high temperature produced by the electric arc, the carbon reduced the aluminum from the molten alumina, where it was immediately alloyed with the surrounding molten metal of copper, brass, or iron. In the operation as conducted at Lockport, horizontal furnaces with horizontal electrodes were used. Similar attempts were made in a year or two thereafter, at Neuhausen, Switzerland, under the patents of M. Pierre Heroult, who, like the Cowles Company, made aluminum alloys in his first commercial work. In his electrical apparatus, he arranged that the carbon and metal anodes were placed vertically in the boxes of contained material. Both parties obtained the high heat necessary for melting alumina by the aid and at the expense of very large electrical currents. The Heroult interests succeeded in producing at the works of the Aluminium Industrie Actien Gesellschaft, at the Falls of the Rhine, an alloy, containing as high as 40 per cent. of aluminum, although this was only done by successfully working over the alloy, and was not done in a regular commercial way.

M. Killiani, of Neuhausen, Switzerland, has patented the idea of giving the electrodes in the Heroult or other furnace for the production of aluminum a rotary motion about their axes; the idea being to prevent the formation of a solid crust upon the surface of the bath and thus permitting the addition of fresh material. This invention, however, has been entirely done away with in later practice, as being exactly against the best plan of action, which has been found to be to place an artificial crust of powdered carbon on the surface of the molten bath for the manufacture of aluminum, to retain the heat; it being found easy to charge fresh supplies of alumina through this crust by breaking its surface and stirring in the alumina.

Among the many attempts to manufacture aluminum within the past three years, the following is a list of concerns in the United States who have made many claims for successful operation, but as yet have not put any commercial amount of pure metal upon the market:

Col. William Frishmuth, of Philadelphia.

The Hartsfeld Furnace and Refining Company, of Newport, Kentucky.

M. Hirsch, of Chicago.

Dr. Emmé, of Atlanta, Georgia.

Dr. P. A. Emanuel, of Aiken, South Carolina.

Oliver Aluminum Company.

American Aluminum Company, working under the ideas of Edward Broadwell.

Northwestern Aluminum Company.

Aluminum Metal Manufacturing Company, manufacturing a material which is called "fluxal," claimed to contain aluminum, for use in steel.

Mr. Charlton, of Chicago.

PROPERTIES OF ALUMINUM.

Much erroneous data is still being published regarding the properties of aluminum. It is spoken of as having "no strength", that it "is as soft as lead", and that "its only peculiarity is its lightness," etc. A comparison of the actual results of tensile tests of aluminum shows these statements to be as markedly wrong as the other equally erroneous one that "aluminum is as strong as steel."

The properties of aluminum are:

1. Its relative lightness.

2. Its ability to resist corrosion as compared with many other metals; aluminum not being acted upon at all by sulphur fumes and being very much more slowly acted upon by moist atmosphere than most metals.

3. Its extreme malleability.

4. Its easy casting qualities.

5. Its high specific heat and heat conductivity.

6. Its relatively high electrical conductivity.

7. Its high tensile strength and elasticity, when weight for weight of the metal is compared with other metals, and especially when alloyed with a small percentage of silver, copper, or other metals and properly worked by being rolled, hammered, drop-forged, or otherwise drawn out thereafter.

8. The valuable alloys it makes with many other metals.

These properties are here treated in relative order as given above:

1. The specific gravity of pure aluminum in the cast state is 2.58; in rolled bars of large section, 2.6; in very thin sheet which has been subjected to high compression under chilled rolls the specific gravity is increased as high as 2.7. The weight of a given bulk of cast aluminum being taken as 1, wrought iron is 2.90 times heavier; structural steel, 2.95 times heavier; copper, 3.60 times heavier; ordinary high brass, 3.45 times heavier; nickel, 3.50 times heavier; silver, 4 times heavier; lead, 4.80 times heavier; gold, 7.70 times heavier, and platinum, 8.60 times heavier. Most woods that would be used for structural purposes are about one-third as heavy as aluminum. A cubic inch of aluminum weighs 0.092 of a pound.

The metal has found many new uses within the last year where this property of lightness has been of peculiar advantage, as in the reciprocal parts of many forms of machinery where the momentum is to be overcome; for valves with air brakes and other forms of apparatus where the lightness of the metal is of importance. In many places where aluminum is too soft for the purpose this difficulty can be overcome by "bushing" the bearing parts. Where a stiff material is required aluminum can often be used by adopting properly designed sections and by using aluminum which has been hardened by alloying with a small percentage of other metals or by cold-rolling, drop-forging, or otherwise stiffening it. Aluminum can be cold-rolled so as to be quite stiff, and the hardest rolled pure aluminum has about the temper of half-hard brass. If the metal be alloyed with a small percentage of other metals, as, for instance, copper, and then cold-rolled, sheets can be gotten of a temper about as hard as hard brass.

2. There are two theories by which to account for the extreme stability of aluminum in the atmosphere. The first is that a clean surface of the metal speedily becomes coated with a very thin and impenetrable film of its own oxide, which thus protects it.

This does not explain the fact that when the metal is treated with acids which would necessarily remove the thin film of oxide upon its surface it does not seem to corrode more rapidly than before; but, on the contrary, if treated skillfully with certain acid solutions it seems to be more stable and nontarnishable than when precautions have not been taken to clean off the coating of oxide from the surface of the aluminum.

The presence of a large percentage of silicon in aluminum materially detracts from its power to withstand corrosion due to atmospheric influence. Metal with 4 or 5 per cent. of silicon very soon collects a thick coating of oxide upon it. Aluminum has sometimes been produced in an alloyed state with metallic sodium. In such metal the sodium very soon oxidizes and washes out, leaving the aluminum "spongy" and porous and easily corrodible. Pure aluminum is practically not acted upon by either boiling water or steam. It is being used for a packing or gasket in steam connections to good advantage. Aluminum is not acted upon by carbonic acid or carbonic oxide or hydrogen sulphide at any temperature less than 600° F.

The metal, also, is not acted upon by most organic secretions or by most of the solutions used as germacides; and, due to this reason, it is receiving favor and considerable use for surgical instruments, suture wires, and places where subjected to carbolic acid or other antiseptic solutions.

Hydrochloric acid is the best solvent for aluminum. Strong solutions of the caustic alkalies readily dissolve it. Ammonia has a slight solvent action upon it.

Concentrated sulphuric acid dissolves aluminum on heating with evolution of sulphurous acid gas. Dilute sulphuric acid acts only slowly on the metal. The presence of any chlorides in the solution, however, allows the metal to be rapidly decomposed. Nitric acid, either concentrated or dilute, has very little action on aluminum. Sulphur has no action on it at any temperature less than a red heat.

Sea water has very little effect upon aluminum. Strips of aluminum placed upon the sides of a wooden vessel corroded less than one one-thousandth of an inch after six months' exposure to sea water. Copper sheet similarly treated was corroded to a much greater extent than the aluminum. Unfortunately, however, for the advantageous use of aluminum as a sheathing for ships barnacles seem to thrive on it, as they do upon steel sheet, and the metal would have to be specially prepared to prevent the barnacles growing upon it in actual service.

For structural purposes under water, where metal is required, aluminum has been successfully used, and is standing the effects of time and corrosion much better than wrought iron or steel, or even cast iron, under similar conditions.

Aluminum is being used for shims upon masonry foundations, due to its noncorroding properties.

As yet aluminum sheet has received only a very small use for roofing, but the prospect is that there will very soon be a very large use for the metal for this purpose, when it is furnished in sheet at a rate comparable in price to copper sheet similarly used. It is well, in this connection, however, to note that aluminum stands very high in the series as an electro-positive metal, and that when subjected, in contact with any of the other metals, to solutions which are at all corrosive, the galvanic action established is considerable and is, as usual, at the expense of the electro-positive metal, the aluminum. This fact has to be borne in mind in designing new uses for aluminum in connection with other metals, to avoid contacts that will establish galvanic couples.

Polishing.—The best polish for aluminum is that called "almeta polish," and consists of the following materials: stearic acid, 1 part; fuller's earth, 4 parts; rotten stone, 6 parts, by weight; the whole powdered very finely and run through a bolting-cloth sieve.

Aluminum will take and retain a very high polish, fully equal to that of silver. The truly distinctive and beautiful color of aluminum is best brought out in highly-polished plate. Aluminum can be polished on a buffing wheel with rouge, like brass; and for polishing any considerable quantity of sheet this, of course, is the most economical way. In the absence of special aluminum polishes, several of which are on sale, the ordinary cold-brass polish will be found quite efficient if it is ground fine enough.

Scratch brushing.—A steel scratch brush run at high speed will give a high polish to sand castings and will remove any yellowish streaks that may have been produced by too hot metal. A fine-steel scratch brush gives a most beautiful finish to sheet metal or to articles manufactured from sheet. By this means a frosted appearance is given to the metal, which effect in many cases is equal to that given by a high polish.

Dipping and pickling.—Remove the grease and dirt from the plates by dipping in benzine. To whiten the metal, leaving on the surface a beautiful white mat, the sheet should be first dipped in a strong solution of caustic potash. The solution should be strong enough to blacken the metal. The plates should then be dipped in a mixture of concentrated acids—two parts nitric acid, one part sulphuric acid; then in a solution of undiluted nitric acid; then in a mixture of vinegar and water, equal parts; then washed thoroughly in water and dried, as usual, in hot sawdust.

To polish, use a fine white polishing composition, rouge or tripoli, and a sheepskin or chamois-skin buff, although it is often polished with an ordinary rag buff.

For burnishing, use a bloodstone or steel burnisher. For hand burnishing, use either a mixture of melted vaseline and kerosene oil or a solution composed of two tablespoonfuls of ground borax dissolved in about a quart of hot water, with a few drops of ammonia added.

For lathe work, the burnisher should wear upon the finger of his left hand a piece of canton flannel, keeping it soaked with a mixture of melted vaseline and kerosene and bringing it in contact with the metal, supplying a constant lubricant. Very fine effects can be produced by first burnishing or polishing the metal and then stamping it in polished dies showing unpolished figures in relief.

In spinning or turning aluminum plenty of oil should be used to prevent the clogging of the tool and to make it cut smooth in the turning and to assist in the spinning.

3. Pure aluminum stands third in the order of malleability, being exceeded only by gold and silver. In ductility it stands seventh, being exceeded by gold, silver, platinum, iron, very soft steel, and copper. Sheets of aluminum are rolled down to 0.0005 of one inch in thickness and beaten into leaf nearly as thin as gold leaf.

Beaten aluminum leaf is now being used for decorative purposes, and notable examples of it are seen in the leading hotels of New York, and especially in the decoration of the Transportation Building at the World's Columbian Exposition. All the artistic work of the decoration of this building is made upon a base of thin beaten aluminum foil. Aluminum takes oil colors very kindly, and sheets, plaques, and foil are now being largely used in art work as well as in decorations. The use of aluminum foil has almost altogether superseded, within the last two years, that of silver foil, which had been used for the same purpose. Aluminum has also been drawn down into the very finest sizes of wire. The metal is most malleable at a temperature of between 400° and 600° F., a temperature readily discerned by noting that the metal is hot enough to char the end of a pine stick when rubbed across its face. At this temperature the metal can be drawn down between rolls with nearly as much draft upon it as with heated steel.

Aluminum is capable, with frequent annealing, of being rolled or hammered down cold.

Aluminum in thick sections is annealed by being heated in muffled furnaces to a temperature which will show a low red heat on a piece of iron or steel placed in the muffle, in the dark, which is a temperature of about 800° F. The metal should be allowed to cool gradually after being subjected to the annealing temperature.

Aluminum has been rolled into tubes successfully in this country, but we are still behind the Germans in this matter, as by the Mannesmann process aluminum tubes have been made on a very large scale and as successfully as with other metals.

4. Sound castings of aluminum can be made in either dry or "green" sand molds or in metal "chills." Aluminum should not be heated in melting much beyond its melting point, for if superheated it absorbs occluded gas to such an extent as to make unsound ingots. This is especially shown if the ingots are subsequently to be rolled. In pouring great care should be taken not to occlude air in the molten metal as it is cast and as it rises in the molds. Due to its lightness and the difficulties of forcing the occluded gases to the surface in cast-

ings, it is wise to use large feeding gates and heavy "risers" or sinking heads to produce sound castings. The shrinkage of aluminum is a little more than that of ordinary brass, being seventeen sixty-fourths of an inch to the foot. It should be melted in plumbago crucibles. The metal becomes molten at a temperature of 1,120° F., according to the researches of Prof. Roberts-Austin; 1,300° F., according to Richards' work on Aluminum.

The use of the metal in castings is now rapidly establishing one of the largest demands for it in the market.

The production of cast aluminum hollow ware has just been started as a new industry that will undoubtedly be successful. Aluminum teakettles are now on the market, and aluminum coffeepots and teapots will soon follow. Hollow-ware castings have been successfully made in the form of teakettles, with only one-sixteenth of an inch thickness of metal in the walls of the kettle, which is a remarkable evidence of the good casting qualities of aluminum. Another advantage which may be incidentally spoken of here is that these castings are more malleable than those of any other metal. Thin castings of aluminum teakettles have been hammered in and bent almost double before breaking. The Smith pressure casting process has been very successfully used for casting aluminum articles by the Passaic Art Casting Company, of Passaic, New Jersey. By this process the finest details of the engraving, chased, and repousé work are brought out in aluminum castings, with a finish equal to that of electrotypes. Molds, either of sand or of a liquid plaster-of-Paris composition, are made in as flat a shape as possible, so that they may be piled on top of each other; the gates from each mold leading to a central sprue. The effective penetration of the molten aluminum to every part of the matrix is secured by the collection and temporary detention of the entire charge of molten metal in a suitable holder above the molds, where a prompt and continuous transfer of the molten metal from the bottom of the holder to the matrix cavities is obtained by the aid of increasing the pressure at the rear and decreasing the pressure in front of the advancing stream of molten metal by means of a piston covered with asbestos, which fits closely into the cylinder above the receiver for the molten metal, the mold itself being air-tight and in connection with the vacuum tank of an air pump. A thin diaphragm of asbestos used to hold the molten metal in the receiver before it enters the mold is burst by the pressure placed upon the metal by the piston, allowing it to flow suddenly into every minute cavity of the molds. Extremely light and sharp aluminum castings, having a remarkable solidity and freedom from blow-holes, are obtained by this process.

5. The coefficient of linear expansion is very near to that of the metal tire and as tested on three-eighths inch round aluminum rods gave results of 0.00002295 per degree centigrade between the freezing and boiling points of water; that of iron being similarly 0.0000122; tin, 0.0000217; copper, 0.00001718.

The mean specific heat of aluminum is, with the exception of magnesium and the alkali metals, the highest of any of the metals. From zero to the melting point it is 0.2185; water being taken as 1 and the latent heat of fusion is 28.5 heat units.

The coefficient of thermal conductivity of unannealed aluminum is 37.96; of annealed aluminum, 38.87.

As a conductor of heat aluminum stands fourth, being exceeded only by silver, copper, and gold as follows:

Relative conductivity of aluminum, silver being taken as 100.

Silver	100.0	Tin	14.5
Copper	73.6	Iron	11.9
Gold	53.2	Steel	11.6
Aluminum, annealed	38.87	Platinum	8.8
Aluminum, unannealed	37.96	Bismuth	1.8

Due to its high specific heat and its high heat conductivity, as well as its nontarnishing qualities and its lightness, aluminum is particularly adaptable for cooking utensils, and a considerable use for the metal in this direction has begun to be established and bids fair to grow rapidly within the next few years. The prospects are that a very large tonnage of aluminum will be required for cooking utensils soon, when the people become better acquainted with the advantages of its use, and the demand will grow large enough to warrant the increased facilities and output in factories already established to manufacture cooking utensils and the building of others, so that the most approved machinery may be used and all forms of articles made, and made also at the cheaper rates occasioned by large production. There seems to be no reason why aluminum cooking utensils shall not be sold in the near future at a price certainly as low as like articles made of copper. Aluminum is far superior for this purpose to copper, which requires to be tin-lined for most culinary uses; one of the chief advantages being that, due to its high heat conductivity, local burning of the food products contained in the vessel will not occur. For covered dishes to retain the heat within the contents of the dish, aluminum is particularly well adapted.

6. The electrical conductivity of pure aluminum is 54.20; pure silver being taken as 100; aluminum in this being only surpassed in electrical conductivity by pure copper, silver, and gold. Pure gold is is 78; zinc stands next below aluminum in the table of conductivities of metals, at 29.90; iron being only 16, and platinum only 10.60 in the same scale.

Pure aluminum has no polarity and the metal of the market is absolutely nonmagnetic. These properties have, within the last year, led to its considerable use in electrical appliances, and there seems ground for believing that the demand for its use for electrical as well as astronomical and other physical instruments will be a growing one.

7. *Strength.*—Under tension, aluminum is about as strong, section for section, as cast iron, but when the fact is taken into consideration that pig iron or a similar part of wrought iron or steel would weigh, section for section, three times as much as aluminum, the relative tensile strength of the metal assumes a further importance.

The tensile strength is further increased by its being cold rolled or cold forged; and there are alloys which will not increase the specific gravity over, say 3 or 3.25, which add very considerably to the tensile strength of the metal. For sections of structural work where lightness is of importance, as in the framework and plating of torpedoes, the metal has begun to find useful application. The Pittsburg Reduction Company is now furnishing angles, plates, channels, and other sections used in structural work of aluminum, in commercial quantities, and the use of the metal in heavier sections is one of the steps forward in the development of aluminum which has lately gone into effect.

The following is a table giving the average results of many tests of commercial aluminum:

Strength of commercial aluminum.

		Pounds.
Elastic limit per square inch in tension	castings	6,500
	sheet	12,500
	wire	16,000–30,000
	bars	14,000
Ultimate strength per square inch in tension	castings	15,000
	sheet	24,000
	wire	30,000–65,000
	bars	28,000
Percèntage of reduction of area in tension	castings .15	
	sheet 35	
	wire .60	
	bars .40	
Elastic limit per square inch under compression in cylinders, with length twice the diameter		3,500
Ultimate strength per square inch under compression in cylinders, with length twice the diameter		12,000
The modulus of elasticity of cast aluminum is about		11,000,000

Aluminum in castings can readily be strained to the unit stress of 1,500 pounds per square inch in compression, and to 5,000 pounds per square inch in tension. It is rather an open metal in its texture, and for cylinders, to stand pressure, an increase in thickness over the ordinary formulæ should be given to allow for its porosity.

Taking the tensile strength of aluminum in relation to its weight, it is as strong as steel of 80,000 pounds per square inch. Comparative results in this way are tabulated below, as taken from Richards' work on aluminum.

The strength of aluminum compared with other metals.

Metals.	Weight of 1 cubic foot in pounds.	Tensile strength per square inch.	Length of a bar able to support its own weight in feet.
Cast iron	444	16,500	5,351
Ordinary bronze	525	36,000	9,893
Wrought iron	480	50,000	15.000
Hard structural steel	490	78,000	23,040
Aluminum	168	26,800	23,040

Under torsional stress in Thurston's torsional machine the metal has much lower modulus of rigidity than iron or steel, its maximum shearing stress in castings being about 12,000, and in forgings about 16,000, being about that of pure copper. The angle of torsion is about equal to that of the softest steel.

Torsional tests of aluminum.

Aluminum.	Diameter.	Moment of torsion (inch pounds).		Angle of torsion (degrees).	
		Elastic limit.	Maximum strength.	Elastic limit.	Maximum strength.
	Inch.				
Cast	0.751	....	1,114.76	....	110
Forged	.751	666.49	1,274.00	1.56	260
Cast	.980	....	2,548.00	....	72.5
Forged	.980	1,433.00	2,942.00	5.00	157.5
Cast	.625	....	478.00	....	109.3
Forged	.620	478.00	755.00	4.37	57.5
Cast	.760	1,036.00	1,115.00	2.18	36.25
Forged	.760	319.00	1,194.00	1.25	168.75

Aluminum.	Diameter.	Extension of outer fiber.			Shearing stress.		Modulus of rigidity.	Elastic resilience.
		Elastic limit.	Maximum extension.	Final extension.	Elastic limit.	Maximum stress.		
	Inch.							
Cast	0.751	....	0.166	0.1660	....	13,473	....	....
Forged	.751	0.00003	.738	.9120	8,163	15,285	843,658	8.99
Cast	.980	....	.0753	.0735	....	....	....	....
Forged	.980	.0003	.317	.4490	7,802	16,022	186,133	62.34
Cast	.625	....	.1601	.1601	....	10,133	....	....
Forged	.620	.00024	.048	.1490	10,133	16,593	434,318	18.15
Cast	.760	.00007	.0193	.0193	9,025	13,149	869,849	19.67
Forged	.760	.00002	.359	.6550	3,757	14,089	461,594	3.49

8. *Alloys of aluminum.*—Aluminum and copper form two series of valuable alloys—aluminum bronze, containing from 5 to 11½ per cent. of aluminum; and copper-hardened aluminum, containing from 2 to 15 per cent. of copper.

The 5 to 11½ per cent. aluminum bronzes are very dense, fine-grained, and strong alloys, having good ductility as compared with the tensile strength. The 10 per cent. bronze, in forged bars, will give 100,000 pounds tensile strength per square inch, with 60,000 pounds elastic limit per square inch, and 10 per cent. elongation in 8 inches.

The 10 to 11½ per cent. aluminum bronzes have a specific gravity of about 7.50, and are of a light yellow color. The 5 to 7½ per cent. have a specific gravity of 8 to 8.30. They are of a yellow color and give a tensile strength of 70,000 to 80,000 pounds per square inch, with an elastic limit of 40,000 pounds per square inch, and an elongation of 30 per cent. in 8 inches.

The melting point of 10 per cent. aluminum bronze is about 1700° F. A peculiarity of this alloy is that it is malleable at a red heat, making it more convenient to fashion it for various purposes than the other bronzes which are less easily malleable, none of the strong bronzes being malleable at a high heat.

Aluminum bronze is especially capable of withstanding acid solutions which attack most metals. Coal screens and other articles subjected to acid mine waters have been made in considerable quantities of aluminum bronze during the past two years, and are giving good satisfaction. The metal is also being used in parts of acid-making machinery with success.

A small percentage of aluminum added to Babbitt metal gives very superior results over ordinary Babbitt as a bearing metal. Mr. A. W. Cadman, of Pittsburg, has patented the use of one-half of 1 per cent. of aluminum with the ordinary tin-antimony-copper Babbitt metal. Considerable amounts of this Babbitt metal are being used in the Pittsburg district, in the hardest classes of bearings, giving very satisfactory results. A peculiarity that the aluminum gives to the alloy is good malleability, allowing it to be hammered or rolled readily into bars and shapes. Various concerns are now placing aluminum bearing metals upon the market.

Aluminum is being used regularly by many of the largest steel companies in the country. It is added to the steel in proportions of from one-half pound to several pounds of aluminum to the ton of steel, the purpose of the addition being largely to prevent the retention of the occluded gases in the steel and give thereby the production of solid ingots. Aluminum also seems to give extra fluidity to the metal which allows the making of clearer and sounder steel castings, so that in the steel casting trade it is now almost universally used. In fact, it is claimed by leading metallurgists who have watched the operation of the manufacture of steel castings, that the largest share of the remarkable development of the past few years in the quality of steel castings has been due to the regular use of aluminum. In the manufacture of open-hearth steel, aluminum as used is added in small pieces of from one-fourth to one-half pound weight to the ladle during the tapping operation. The aluminum melts instantaneously, as the temperature of the molten steel is above the melting point of aluminum and it seems to diffuse with remarkable rapidity throughout the entire contents of the ladle. The diffusion seems to be complete and there appears to be no need for special precaution for agitation of the metal for this purpose, as no indications of a want of homogeneity of the metal have been found.

A valuable alloy of aluminum and ferro-manganese has lately been covered by letters patent; it having been found that the addition of a small percentage of aluminum to ferro-manganese renders the combined carbon in the manganese alloy graphitic and throws the carbon thus separated in a graphitic state out in the molten mass in the form of a "kish." This allows the production by this means of a ferro-manganese relatively very low in combined carbon—a state of affairs which is particularly useful with the ferro-manganese used in the manufacture of low carbon steel.

Aluminum added to cast iron produces an effect similar to that produced by silicon—that is, it tends to convert the combined carbon in the iron into the graphitic state, thus causing the iron to be softer, freer from shrinkage, and lessens the tendency of the iron to "chill." A small percentage of aluminum added to white iron will thus change the character of the metal. While aluminum does not always seem to give marked advantages, when used with good gray iron, its use with inferior grades of pig iron in foundry work is marked and very satisfactory.

Mr. R. A. Hadfield, in his paper read before the October, 1890, meeting of the Iron and Steel Institute of Great Britain, in New York, gives the following table of results of the addition of aluminum and silicon to manganiferous white iron, showing the results of the aluminum and silicon to have been very closely the same.

Effect of adding aluminum to white iron.

12 per cent. spiegel iron.	Combined carbon.	Graphitic carbon.	Silicon.	Manganese.	Aluminum.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Before addition of aluminum.	4.80	None.	....	11.65	....
After addition of aluminum.	.93	3.45	1.30	11.75	3.19
Before addition of silicon....	4.10	None.	....	11.00	....
After addition of silicon.....	.43	3.40	3.73	9.50	....

The fracture was changed after addition of both the aluminum and silicon, from the usual pronounced spiegel appearance, to that of No. 3 iron.

With the exception of lead and mercury, aluminum unites forming alloys with all metals. Antimony alloys with aluminum with great difficulty. A small percentage of silver in aluminum whitens the color and hardens the metal, giving it added strength. This alloy is especially adaptable for fine instruments and apparatus, where the work is of more consequence than the increased cost by the addition of the silver. The following alloys have been found recently to be useful in the arts:

New aluminum alloys.—Nickel aluminum, composed of 20 parts nickel and 8 parts aluminum.

Rosine, composed of 40 parts nickel, 10 parts silver, 30 parts aluminum, and 20 parts tin, for jewelers' work.

A bronze composed of 60 parts (or 40 parts) cobalt, 10 parts aluminum, 40 parts (or 30 parts) copper.

Metalline, composed of 35 parts cobalt, 25 parts aluminum, 10 parts iron, and 30 parts copper.

In the Paris exhibition there was considerable importance placed to the exhibit of aluminum-Bourbounz metal, an alloy of aluminum with tin. The specific gravity of the alloy ran from 2.9 to 2.96. The special advantage of this metal was its capacity to cast in very solid shapes, the metal having very little shrinkage in castings. The analysis of this aluminum-Bourbounz metal was as follows:

Composition of aluminum-Bourbounz.

	Per cent.
Aluminum	85.74
Tin	12.94
Silicon	1.32
Iron	None.

Prof. Roberts-Austin has discovered also a beautiful alloy composed of 22 parts aluminum and 78 parts gold, which is a rich purple color of ruby tint.

An addition of 5 to 15 per cent. of aluminum to type metal composed of 25 per cent. antimony and 75 per cent. lead, makes a metal giving sharper castings, and much more durable type. To brass, the addition of aluminum gives superior strength and better anti-corrosive qualities. The addition of small quantities of aluminum to zinc has rendered the zinc much more efficient in galvanizing, giving a thinner and more tenacious and finer-looking casting.

Alloys of from ten to fifteen and even up to 25 per cent. of zinc to aluminum have been found to be much harder and stronger than pure aluminum in castings. These alloys having in addition to the zinc a small percentage of tin added have been growing in use of late for mapy purposes, a notable instance being for the parts of bicycles.

Processes for plating aluminum with other metals have been successfully produced within the past year, and metal plated with gold, silver, nickel, and even bronze are shown in the exhibit of Mr. Wetz, in the Department of Mining at the World's Columbian Exposition. The exhibit illustrates Wegner & Guehr's method of plating aluminum, which is as follows:

"The aluminum article or alloy of aluminum is first steeped in a bath of acetate of copper dissolved in vinegar, to which oxide of iron, some sulphur, and aluminum chloride has been added. After this treatment the article is brushed with a soft wire brass brush. As a result of the brushing, the metal absorbs the oxide of aluminum and fills up the pores. The article is now rinsed well in clear water and then placed in the gold, silver, copper, or other electrolytic bath to be plated in the usual manner."

It is claimed that the plating is so strong that the plated article can be bent double and then straightened without the plating showing any cracks. Aluminum, after being coated with copper or silver, has been treated by the sulphide process of "oxidizing," giving the same variegated colors as with oxidized silver.

Aluminum can be readily electrically welded, and the metal can be soldered after a fashion, but not as satisfactorily as desired. Due to the high heat conductivity of aluminum the heat of the molten solder is withdrawn so rapidly as to "freeze" it before it can flow sufficiently. There have been several solders, however, which have been used with more or less success. Mr. Joseph Richards has patented the use of a phosphor-tin solder. A German solder which has been said to give good results, is as follows: 80 parts tin, 20 parts zinc, using a flux composed of 80 parts stearic acid, 10 parts chloride of zinc, 10 parts of chloride of tin.

Pure tin has been used as a solder. It fuses at 250° C.

Also, the following alloys have been used with more or less success.

Alloys used for soldering aluminum.

Alloys.	Grains.	Fusing point.
		Degrees centigrade.
Tin	1000	280–300
Lead	50	
Tin	1000	280–300
Zinc	50	
Tin	1000	350–400
Copper	10–15	
Tin	1000	350–400
Nickel	10–15	
Tin	900	
Copper	100	
Bismuth	2–3	

The last solder in the above table is especially suitable for use with aluminum bronze.

The use of chloride of silver as a flux in soldering has been patented and has given some success in soldering aluminum, using ordinary soft solder. There are now pending in the Patent Office several solders and methods of soldering, which bid fair to further aid in this matter, but which it is manifestly improper to describe here. A pure nickel soldering bit should be used in soldering the metal, as it does not discolor the aluminum as copper soldering bits do.

A novel use of aluminum has been in the production of aluminum slate pencils, which bave had a large sale for the past few months. The soft aluminum in the form of wire, with sharpened point, is found to work very satisfactorily upon slate, as ordinary forms of slate pencils do, being much more durable and less liable to break and wear.

Aluminum has been used for sounding boards and stringed musical instruments, the qualities claimed by the patentee, Mr. Springer, of Cincinnati, being the production of a more sonorous and pleasing tone than the wooden ones in common use. Aluminum differs from the other metals in the character of its "metallic" sound. There is an elasticity capable of sympathetic vibrations uniformly throughout a wide range of tone pitch with the metal, besides the other qualities of incombustibility, impermeability to moisture, and comparative freedom from liability to injury, such as splitting, which renders it far superior to wood for sounding boards.

Aluminum has been very successfully used for horseshoes, and has been used upon the feet of several of the fastest race horses within the past year. A detachment of horses of Finland dragoons of the Russian cavalry service have been shod alternately with iron and aluminum shoes, with both fore and hind feet, and in each instance the wear after hard service for a considerable period has been less upon the aluminum than the iron shoes, and the claim was made that they preserved the feet of the horses better than the iron shoes.

Aluminum has been used lately for racing shells, and the famous racing-shell builder, Mr. Galanaugh, built a four-oared shell for the Fairmount Rowing Club, of Philadelphia, in which their champion crew lowered the record nine seconds this season, over the Schuylkill river course. The aluminum for this boat was in one sheet of about one-nineteenth inch thickness, and the weight about 50 pounds—considerably less than that of a cedar boat; the entire boat, with the exception of the outriggers, being of aluminum.

Aluminum has been used in the metallurgy of silver very satisfactorily of late, and the Roessler-Edelman process of desilverizing lead with an alloy of aluminum and zinc bids fair to be of large commercial use.

NICKEL AND COBALT.

Canada has become the principal source of nickel for the American market. In all 6,057,482 pounds were produced there in 1892, of which 1,500,000 pounds of metallic nickel contained in matte were sold to refiners in the United States. Meanwhile the domestic production amounted to 92,252 pounds, worth $50,739, so that the total supply for this country aggregated 1,592,252 pounds. This is a larger product than has been sold to the trade before. In the preceding year the United States produced 118,498 pounds. The increased product, however, reflects an increased consumption, particularly for nickel steel. This industry absorbed nearly 1,000,000 pounds.

Interest is still shown in the deposits of arsenide ores in Nevada and silicate ore near Riddles, Oregon. Although these regions show no product, they are still considered worthy of careful study among the possible sources of future supply, especially with the new process of Ludwig Mond in view. This process is being experimented with commercially at Birmingham, England, by such conservative and capable chemical engineers as Mond and his assistant, Dr. Bernhard Mohr. This process depends upon the fact discovered by Mond that carbon monoxide forms a volatile compound with nickel, from which the nickel is easily obtained by heating the compound to a temperature above 185°.

As carried out commercially, the ores are roasted until the nickel is in the form of oxide. The oxide of nickel (which may contain any number of impurities) is reduced to the metallic state by treating it with carbonic oxide or with hydrogen, or a gaseous mixture containing these gases, at a temperature between 350° and 400° C. The finely divided metal so obtained is allowed to cool to the ordinary temperature, and is then treated with carbonic oxide gas, which may be mixed with other gases, but should be free from oxygen or halogens. The nickel combines with the carbonic oxide and forms a readily volatile compound called nickel-carbon oxide, which is easily carried off by the excess of the gas employed.

The mixture of the vapor of this compound and other gases so obtained is passed through tubes or vessels in which it is heated to about 180° C., when the nickel-carbon oxide is decomposed again into nickel and carbonic oxide. The nickel separates out perfectly pure in coherent metallic masses more or less attached to the sides of the tubes or vessels in which the gas has been heated, and the carbonic oxide condensed over again to treat fresh masses of the reduced oxide. After some time the action of the finely divided nickel upon the carbonic oxide becomes less energetic. The oxide is then heated to 350° or 400° C. in a current of carbonic oxide or hydrogen and cooled down again to the ordinary temperature; by this means its energy is restored.

Impure metallic nickel obtained in any other way than the one indicated can also be treated in the same way to obtain the pure metal. The action is more rapid the more finely the nickel is divided. The impurities, even cobalt, are not acted upon by carbonic oxide and remain behind after the nickel has been volatilized.

The principal nickel ores contain nickel in combination with arsenic and sulphur, together with other metals and gangue. These ores must first be wasted to the condition of oxide and drive off the arsenic, sulphur, and other volatile materials as far as possible. By the subsequent stages the oxide of nickel is reduced to the metallic state and volatilized with carbonic oxide. In dealing with nickel ores which contain nickel oxide in chemical combination with silicic acid, arsenic acid, or other substances not removable by calcination, Mr. Mond prefers to subject such ores to such treatment as will bring the nickel speiss or matte and to subject the latter to calcination. In reducing this nickel to the metallic state hydrogen or carbonic oxide, or both, are used. If pure hydrogen alone is used a temperature of 350° C. is sufficient. If, on the other hand, diluted carbonic oxide is used a temperature of 500° C. and upward is necessary for a complete and speedy reduction.

The finely divided nickel is allowed to cool to about 50° C., which is found to be the most suitable temperature for treating it with carbonic acid. If preferred, it can be cooled to the ordinary temperature, as the compound will form at a temperature as low as 0° C. It is possible to work from this temperature up to 150° C., but it is preferable to work at the temperature of 50° C. The most suitable temperature for heating the compound in separating the nickel again is 180° to 250° C. If this range of temperature be exceeded, the nickel becomes contaminated with carbon owing to its power of absorbing carbon from carbonic oxide and forming carbonic acid, while at a temperature below 180° C. the deposition of nickel will be less rapidly and less completely effected. The nickel separates out perfectly pure when the above conditions are observed. The carbonic oxide is regenerated, and the same gases can be used over and over again to extract new supplies of metal. There are considerable advantages in thus using the same gases repeatedly, because the danger arising out of the poisonous qualities of the nickel-carbon oxide are thus almost wholly overcome, inasmuch as the gases never leave the closed apparatus in which the treatment is carried out. The plant at Birmingham for using this idea is nearly ready to begin operations. The main objections to the process would seem to be the great size of the plant necessary to provide sufficient surface capacity for extracting by means of the gas.

Prices.—In spite of the increased supply and the undoubted ability to supply much more from Canada on demand, the price has not declined very markedly. This is owing partly to the fact that the principal supply does not reach the stage of metallic nickel, but is sold as oxide for use in steel making, at about half the value for the contained nickel which this would have as metallic nickel.

IMPORTS AND EXPORTS.

Nickel imported and entered for consumption in the United States, 1868 to 1892, inclusive.

Years ending—	Nickel.		Oxide and alloy of nickel with copper.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
June 30, 1868		$118,058			$118,058
1869		134,327			134,327
1870		99,111			99,111
1871	17,701	48,133	4,438	$3,911	52,044
1872	26,140	27,144			27,144
1873	2,842	4,717			4,717
1874	3,172	5,883			5,883
1875	1,255	3,157	12	36	3,193
1876			156	10	10
1877	5,978	9,522	716	824	10,346
1878	7,486	8,837	8,518	7,847	16,684
1879	10,496	7,829	8,314	5,570	13,399
1880	38,276	25,758	61,869	40,311	66,069
1881	17,933	14,503	135,744	107,627	122,130
1882	22,906	17,924	177,822	125,736	143,660
1883	19,015	13,098	161,159	119,386	132,484
1884			*a*194,711	129,733	129,733
1885			105,603	64,166	64,166
Dec. 31, 1886			277,112	141,546	*b*141,546
1887			439,037	205,232	*c*205,232
1888			316,895	138,290	*d*138,290
1889			367,288	156,331	*e*156,331
1890	*f*566,571	260,665	247,299	115,614	376,279
1891	355,455	172,476	*g*10,245,200	148,687	321,163
1892			*h*4,068,984	426,817	426,817

a Including metallic nickel.
b Including $465 worth of manufactured nickel.
c Including $879 worth of manufactured nickel.
d Including $2,281 worth of manufactured nickel.
e Including $131 worth of manufactured nickel.
f Classified as nickel, nickel oxide, alloy of any kind in which nickel is the element or material of chief value.
g Classified as nickel and nickel matte.
h Includes all nickel imports except manufactures.

Cobalt oxide imported and entered for consumption in the United States, 1868 to 1892.

Years ending—	Oxide. Quantity.	Oxide. Value.	Years ending—	Oxide. Quantity.	Oxide. Value.
	Pounds.			*Pounds.*	
June 30, 1868		$7,208	June 30, 1881	21,844	$13,837
1869		2,330	1882	17,758	12,764
1870		5,019	1883	13,067	22,323
1871		2,766	1884	25,963	43,611
1872		1,920	1885	16,162	28,138
1873	1,480	4,714	Dec. 31, 1886	19,366	29,543
1874	1,404	5,500	1887	26,882	39,396
1875	678	2,604	1888	27,446	46,211
1876	4,440	11,180	1889	41,455	82,332
1877	19,752	11,056	1890	33,338	63,202
1878	2,860	8,693	1891	23,643	43,188
1879	7,531	15,208	1892	32,833	60,067
1880	9,819	18,457			

The imports of cobalt and cobalt ore during 1892 amounted to 1,106 pounds, worth $115, against 2,377 pounds, worth $104, in 1891.

TIN.

California produced 162,000 pounds of tin during the first half of 1892. Work at the mines at South Riverside was suspended in September. Indeed, during the last month of operations the work was diverted exploitation. The concentrator at Hill City, South Dakota, was run for about two months and accumulated about 150 tons of concentrates, part of which remains in this condition, while part has been melted and exhibited at the World's Columbian Exposition as pig tin. The Harney Peak Company gives no further reason for the stoppage of the mill than simply "financial reasons."

With about five-sixths of the world's tin supply coming from comparatively rich placers equipped with extremely cheap labor, it is little wonder that the vein tin is not worked in the United States, especially as there are good veins of tin in Australia practically untouched.

The world's supply, according to the American Metal Market, is given below.

World's supply of tin from 1880 to 1891.

Years.	English production.	Straits shipments to Europe and America.	Australian shipments to Europe and America.	Banca sales in Holland.	Billeton sales in Java.	Total.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
1880	8,918	11,735	9,177	3,756	4,735	38,321
1881	8,615	11,400	10,100	4,548	4,740	39,403
1882	9,300	11,705	10,067	4,399	4,200	39,671
1883	9,307	16,958	11,121	4,203	4,157	45,746
1884	9,574	17,548	9,337	4,193	3,600	44,252
1885	9,331	17,320	9,088	4,200	3,760	43,699
1886	9,312	19,674	8,064	4,379	4,128	45,557
1887	9,282	23,977	7,750	4,384	4,978	50,371
1888	9,241	23,855	7,975	4,430	5,220	50,721
1889	8,912	28,295	6,800	4,114	4,857	52,978
1890	9,000	27,470	6,415	5,317	5,232	53,434
1891	9,354	31,457	5,991	5,350	5,753	57,905

Prices of tin in New York, by months, from 1885 to 1892.

[Cents per pound.]

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1885	$16\frac{5}{8}$	17.45	$17\frac{3}{8}$	17.80	$18\frac{5}{8}$	$20\frac{3}{8}$	$22\frac{3}{8}$	$21\frac{1}{4}$	20.95	20.95	20.65	21.00
1886	$20\frac{5}{8}$	20.70	20.80	20.85	21.30	$22\frac{3}{4}$	$22\frac{1}{4}$	$21\frac{3}{4}$	22.20	$22\frac{1}{4}$	22.40	$22\frac{1}{4}$
1887	20.30	$22\frac{1}{2}$	22.55	$22\frac{1}{2}$	22.95	$23\frac{1}{4}$	23.35	23.30	$23\frac{1}{8}$	$25\frac{1}{3}$	31.05	$36\frac{1}{3}$
1888	36.95	36.95	36.70	32.95	21.95	18.05	$19\frac{1}{4}$	$20\frac{3}{4}$	22.95	23.35	22.70	22.10
1889	$21\frac{7}{8}$	$21\frac{1}{2}$	21.30	$20\frac{7}{8}$	$20\frac{1}{2}$	20.30	$19\frac{7}{8}$	20.20	21.30	20.80	$21\frac{3}{4}$	21.30
1890	20.95	20.87	20.39	20.13	21.52	21.53	21.17	21.62	24.00	22.60	21.07	21.21
1891	20.20	19.90	$19\frac{3}{4}$	$19\frac{1}{2}$	20.00	21.00	20.20	20.10	$20\frac{1}{4}$	20.10	20.00	19.90
1892	20.50	20.00	20.25	20.50	20.80	22.00	21.00	20.50	20.35	20.50	20.80	20.00

Imports and exports.—The following tables show the tin and tin plates imported and entered for consumption from 1867 to 1892; also the value of the exports of the manufactures of tin from 1826 to 1892:

Tin and tin plates imported and entered for consumption in the United States, 1867 to 1892.

Years ending—	In blocks, bars, or pigs, and grain tin.		Tin plates, sheets, etc.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Cwts.		*Cwts.*		
June 30, 1867..	....	$1,210,354.02	....	$6,276,136.78	$7,486,490.80
1868..	....	1,454,327.36	....	6,893,072.07	8,347,399.43
1869..	80,811	1,709,385.00	1,534,324	8,565,432.56	10,274,817.56
1870..	81,702	2,042,887.71	1,333,150	7,628,871.51	9,671,759.22
1871..	106,595	2,938,409.82	1,556,023	9,490,778.64	12,429,188.46
1872..	102,006	3,033,837.45	1,617,627	10,736,906.59	13,770,744.04
1873..	130,469	3,938,032.25	1,854,956	15,906,446.82	19,844,479.07
1874.	116,442	3,199,807.07	1,553,860	13,322,976.14	16,522,783.21
1875..	102,904	2,329,487.96	1,540,600	12,557,630.75	14,887,118.71
1876..	93,176	1,816,506.00	1,767,210	10,226,802.87	12,043,306.87
1877..	98,209	1,783,765.00	1,984,893	9,818,069.69	11,601,834.69
1878..	128,849	2,167,350.00	2,166,489	9,893,639.61	12,060,989.61
1879..	142,927	2,301,944.00	2,487,007	10,248,720.34	12,550,664.34
1880..	290,007	6,153,005.68	3,298,534	16,524,590.19	22,677,595.87
1881..	171,146	3,971,756.67	3,366,720	14,641,057.87	18,612,814.54
1882..	197,544	5,204,251.68	3,926,311	16,550,834.64	21,755,086.32
1883..	237,348	6,106,250.37	4,051,108	16,688,276.67	22,794,527.04
1884..	*a*26,081,992	5,429,184.01	*a*527,881,321	18,931,072.70	24,360,256.71
1885..	23,947,523	4,263,447.00	505,559,076	16,610,104.56	20,873,552.00
Dec. 31, 1886..	27,960,761	5,873,773.00	574,098,405	17,719,957.12	23,593,730.12
1887..	29,645,531	6,927,710.00	570,643,389	16,883,813.95	23,811,523.95
1888..	31.740,583	8,758,562.00	632,224,296	19,034,821.03	27,793,383.03
1889..	35,177,646	7,045,939.00	734,086,964	20,361,564.00	27,407,503.00
1890..	33,800,729	6,809,645.00	688,247,657	21,923,754.00	28,793,399.00
1891..	41,146,123	8,091,363.00	734,425,267	25,900,305.00	33,991,668.00
1892..	46,815,141	9,415,880.00	573,918,302	16,545,336.00	25,961,216.00

a Pounds in 1884 and following years.

Value of tin manufactures exported from the United States (a).

[Fiscal year ending September 30 until 1843; ending June 30, from 1844 to 1886; calendar years since 1886].

Years.	Value.	Years.	Value.	Years.	Value.
1826	$4,515	1849	$13,143	1871	$70,366
1827	2,967	1850	13,590	1872	67,244
1828	5,049	1851	27,823	1873	69,865
1829	1,757	1852	23,420	1874	62,973
1830	4,497	1853	22,988	1875	48,194
1831	3,909	1854	30,698	1876	48,144
1832	3,157	1855	14,279	1877	87,057
1833	2,928	1856	13,610	1878	116,274
1834	2,230	1857	5,622	1879	103,467
1835	2,545	1858	24,186	1880	144,185
1836	5,604	1859	39,289	1881	498,524
1837	10,892	1860	39,064	1882	198,608
1838	10,179	1861	30,229	1883	191,947
1839	19,981	1862	62,286	1884	166,819
1840	7,501	1863	41,558	1885	162,304
1841	3,751	1864	46,968	1886	157,724
1842	5,682	1865	106,244	1887	137,551
1843 (nine months)	5,026	1866	79,461	1888	219,000
1844	6,421	1867	40,642	1889	255,100
1845	10,114	1868	27,110	1890	262,343
1846	8,902	1869	18,994	1891	250,411
1847	6,363	1870	46,007	1892	209,429
1848	12,353				

(*a*) Classed as "tin, and manufactures of," from 1851.

ANTIMONY.

The only metallic antimony produced in the United States in 1892 was from ore mined at Lovelocks, Bernice, and Austin, Nevada, and smelted in San Francisco. The total amount of metallic antimony obtained was 150 tons, valued at $30,000. In addition to the ore smelted at San Francisco, however, there were mined 380 tons of ore which were shipped to England for smelting. The total value of this was $26,466, bringing the total value of metallic antimony and ore produced in 1892 up to $56,466. Assuming that the ore shipped would run 55 per cent. metallic contents, as claimed by producers, the yield of metal from it would have been 209 tons, which, taken at the same value as that produced in San Francisco, would have been worth $41,800, and the total metal contents of antimony ore produced in 1892 would have been 359 tons, worth $71,800.

The mines at Antimony, Arkansas, were not operated during the year, as the owners are awaiting the construction of a railroad now in contemplation. At Kingston, Idaho, the Idaho Antimony Mining Company is erecting a concentrating and smelting plant and expects to be producing metallic antimony before the close of 1893. About 7 tons of ore were taken out in the prosecution of assessment work at Thompson Falls, Montana. This was not disposed of. As previously stated, all the commercial product for the year was from Nevada, the ore being shipped to San Francisco and Liverpool for smelting. Smelting works have been erected at Lovelocks, but Mr. Francis N. Gore, superintendent, reports they were not successful. He states, however, that the output of antimony ore will be larger in 1893 than ever before.

The following table shows the production of antimony in the United States since 1880:

Production of antimony in the United States since 1880.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	50	$10,000	1888	100	$20,000
1881	50	10,000	1889	115	28,000
1882	60	12,000	1890	129	40,756
1883	60	12,000	1891	278	47,007
1884	60	12,000	1892:		
1885	50	10,000	Metallic	150	56,466
1886	35	77,000	Ore	380	
1887	75	15,000			

Prices.—The prices for antimony which ruled during 1892 were low. The year opened with quotations slightly less than in December, 1892, and gradually declined, with the exception of a little improvement in May and June, until October, the prices for September being the lowest during the year. In October and the first of November an improved tone prevailed, but prices again weakened about the first of December, and the year closed with Cookson's and L. X. each 4 cents lower than at the beginning of the year, and Hallett's showing a decline of 2 cents. The following table exhibits the range of prices during the year:

Ruling prices for antimony during 1892.

[Cents per pound.]

Kinds.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Cookson's ..	15½ to 16	15 to 15½	14¾ to 15	14¼ to 15½	15	14½	13¼	12	11½ to 11¾	12	11¾	11¼
L. X........	12 to 15	12 to 14	11¾ to 13	12¼ to 12½	12¾	12¾	12¼	11½	11 to 11¼	11¼	11	11
Hallett's....	12¼ to 12½	11¼	10¾ to 11⅛	10⅞ to 11	11½	11¼	10⅞	10¾	10 to 10¼	10⅝ to 10¾	10½	10¼ to 10⅜

Foreign sources.—Great Britian obtains her chief supply of antimony and antimonial ores from her colonies in Canada and Australia. It is reported that the antimony mines in England are becoming exhausted and are being closed down. The Canadian mines are in New Brunswick and Nova Scotia, but these have not produced any antimony since 1891, when 10 tons of ore, valued at $60, were mined. In 1892 Great Britian drew her entire supply from Australia, principally from New South Wales. The European countries producing antimony are France, Spain, Portugal, Germany, Austria, and Italy. Borneo and Japan are also important producers. Among the exhibits at the World's Columbian Exposition in Chicago those of star antimony (regulus) from California and New South Wales and of stibnite from Japan, were of especial interest. Some of the stibnite crystals in the Japanese exhibit were magnificent specimens.

Imports.—The imports of antimony continue to be largely in excess of the domestic production. Since 1867 the imports have been as follows:

Antimony and antimony ore imported and entered for consumption in the United States, 1867 to 1892.

Years ending—	Crude and regulus.		Ore.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
June 30, 1867	....	$63,919	....	....	$63,919
1868	1,033.336	83.822	....	....	83,822
1869	1.345.921	129,918	....	....	129,918
1870	1,227.429	164,179	....	....	164,179
1871	1,015 039	148,264	....	$2,364	150,628
1872	1,933,306	237,536	....	3,031	240,567
1873	1,166,321	184,498	....	2,941	187,439
1874	1,253.814	148,409	....	203	148,612
1875	1,238.223	131,360	6.460	609	131,969
1876	946,809	119,441	8,321	700	120,141
1877	1,115,124	135,317	20.001	2,314	137,631
1878	1,256,624	130,950	20.351	1,259	132,209
1879	1,380,212	143.099	34,542	2.341	145,440
1880	2.019,389	265.773	25,150	2,349	268,122
1881	1,808,945	253,054	841.730	18,199	271,253
1882	2,525,838	294,234	1,114,699	18,019	312,253
1883	3,064,050	286.892	697,244	11,254	298,146
1884	1.779,337	150,435	231,360	6,489	156,924
1885	2.579,840	207.215	215,913	7,497	214,712
Dec. 31, 1886	2,997.985	202,563	218,366	9,761	212,324
1887	2,553,284	169,747	362.761	8,785	178,532
1888	2,814,044	248,015	68,040	2,178	250,193
1889	2,676,130	304.711	146.309	5,568	310,279
1890	3,315,659	411,960	611,140	29,878	441,838
1891	2,618,941	327,307	1,433,531	36,232	363,539
1892	3,950,864	392,761	192,344	7,338	400,099

COAL.

By E. W. Parker.

INTRODUCTION.

As in the preceding report, the statistics of the production of coal in 1892 have been compiled from statements furnished by individual operators, with the exception of the output in Illinois. The report for Illinois has been extracted, by permission, from that of Col. J. S. Lord, secretary of the Bureau of Labor Statistics. The report on Pennsylvania anthracite has been prepared as heretofore by Mr. John H. Jones, of Philadelphia.

In addition to the regular statistical report, this volume contains descriptions of the coal fields of the several States, contributed by State geologists, mine inspectors, etc., or obtained from previous publications, and collated in this report.

Besides these features the usual coal-trade review has been made more complete by contributions from the secretaries of boards of trade, and exchanges at the important trade centers.

In the collection of the statistics of production particular attention has been given to ascertaining the product of the different kinds of coal; that is, in addition to the separation of the statistics of anthracite and bituminous production, statements are given showing the amount of lignite or brown coal, semi-anthracite, and semi-bituminous coals produced in the several States. It must be remembered, however, that these distinctions are not made according to a scientific system of classification, but from the statements of operators regarding the nature of their product.

THE COAL FIELDS OF THE UNITED STATES.

For convenience of description, the coal areas of the United States have been grouped into the Anthracite division and the Bituminous division.

The Anthracite division, in a commercial sense, may be said to include the anthracite districts of Pennsylvania alone, although small amounts of anthracite are mined in Colorado, Arkansas, Virginia, and New Mexico. In the New England basin the original coal beds have been metamorphosed into graphite and graphitic coal, which have special uses, although not classified by the coal trade as anthracite.

The Bituminous division includes the following coal fields: (1) The Triassic field, embracing the coal beds of the Triassic or New Red sandstone formation in the Richmond basin in Virginia, and in the coal basins along the Deep and Dan rivers in North Carolina; (2) the Appalachian field, which extends from the State of New York on the north to the State of Alabama on the south, having a length northeast and southwest of over 900 miles and a width ranging from 30 to 180 miles; (3) the Northern field, which is confined exclusively to the central part of Michigan; (4) the Central field, embracing the coal areas in Indiana, Illinois, and western Kentucky; (5) the Western field, including the coal areas west of the Mississippi river south of the forty-third parallel of north latitude and east of the Rocky mountains; (6) the Rocky Mountain field, containing the coal areas in the States and Territories lying along the Rocky mountains; (7) the Pacific Coast field, embracing the coal districts of Washington, Oregon, and California. (See Mineral Resources of the United States, 1886, for detailed descriptions.)

The following table contains the approximate areas of these coal fields, with the total product of each during 1887, 1888, 1889, 1890, 1891, and 1892:

Classification of the coal fields of the United States.

	Area.	Product in—					
		1887.	1888.	1889.	1890.	1891.	1892.
Anthracite.	*Sq. miles.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
New England (Rhode Island and Massachusetts)	500	6,000	4,000	2,000	....	500	....
Pennsylvania	470	39,506,255	43,922,897	45,544,970	46,468,641	50,665,431	52,472,504
Colorado and New Mexico	15	36,000	44,791	53,517	(*b*)	(*b*)	64,963
	985	39,548,255	43,971,688	45,600,487	46,468,641	50,665,931	52,537,467
Bituminous (*a*).							
Triassic:							
Virginia	180	30,000	33,000	49,411	19,346	17,290	37,219
North Carolina	2,700	....	....	222	10,262	20,355	6,679
Appalachian:							
Pennsylvania	9,006	30,866,602	30,796,727	36,174,089	42,302,173	42,788,490	46,694,576
Ohio	10,000	10,301,708	10,910,946	9,976,787	11,494,506	12,868,683	13,562,927
Maryland	550	3,278,023	3,479,470	2,939,715	3,357,813	3,820,239	3,419,962
Virginia	2,000	795,263	1,040,000	816,375	764,665	719,109	637,986
West Virginia	16,000	4,836,820	5,498,800	6,231,880	7,394,494	9,220,665	9,738,755
Kentucky	10,000	950,903	1,193,000	1,108,770	1,206,120	1,222,918	1,231,110
Tennessee	5,100	1,900,000	1,967.297	1,925,689	2,169,585	2,413,678	2,092.064
Georgia	200	313,715	180,000	225,934	228,337	171,000	215,498
Alabama	8,660	1,950,000	2,900,000	3,572,983	4,090,409	4,759,781	5,529,312
	61,510	55,193,034	60,966,240	62,972,222	73,008,102	77,984,563	83,122,190
Northern:							
Michigan	6,700	71,461	81,407	67,431	74,977	80,073	77,990
Central:							
Indiana	6,450	3,217,711	3,140,979	2,845,057	3,305,737	2,973,474	3,345,174
Kentucky	4,000	982,282	1,377,000	1,290,985	1,495,376	1,693,151	1,794,203
Illinois	36,800	10,278,890	14,655,188	12,104,272	15,292,420	15,660,698	17,862,276
	47,250	14,478,883	19,173,167	16,240,314	20,093,533	20,327,323	23,001,653

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

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

	Area.	Product in—					
		1887.	1888.	1889.	1890.	1891.	1892.
Bituminous—Continued.	*Sq. miles.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Western:							
Iowa	18,000	4,473,828	4,952,440	4,045,358	4,021,739	3,825,495	3,918,491
Missouri	26,700	3,209,916	3,909,967	2,557,823	2,735,221	2,674,606	2,733,949
Nebraska	3,200	1,500	1,500	} 2,222,443	} 2,259,922	1,500	1,500
Kansas	17,000	1,596,879	1,850,000			2,716,705	3,007,276
Arkansas	9,100	150,000	276,871	279,584	399,888	542,379	535,558
Indian Territory	20,000	685,911	761,986	752,832	869,229	1,091,032	1,192,721
Texas	4,500	75,000	90,000	128,216	184,440	172,100	245,690
	98,500	10,193,034	11,842,764	10,036,256	10,470,439	11,023,817	11,635,185
Rocky Mountains, etc.:							
Dakota	....	21,470	34,000	28,907	30,000	30,000	40,725
Montana	....	10,202	41,467	363,301	517,477	541,861	564,648
Idaho	....	500	400	....	....	....	....
Wyoming	....	1,170,318	1,481,540	1,388,947	1,870,366	2,327,841	2,503,839
Utah	....	180,021	258,961	236,651	318,159	371,045	361,013
Colorado	....	1,755,735	2,140,686	2,544,144	3,094,003	3,512,632	3,447,967
New Mexico	....	508,034	626,665	486,463	375,777	462,328	659,230
	....	3,646,280	4,583,719	5,048,413	6,205,782	7,245,707	7,577,422
Pacific coast:							
Washington	....	772,612	1,215,750	1,030,578	1,263,689	1,056,249	1,213,427
Oregon	....	31,696	75,000	64,359	61,514	51,826	34,661
California	....	50,000	95,000	119,820	110,711	93,301	85,178
	....	854,308	1,385,750	1,214,757	1,435,914	1,201,376	1,333,266
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	157,788,656	168,566,669	179,329,071

PRODUCT.

The total product of all kinds of coal in 1892 was 160,115,242 long tons, or 179,329,071 short tons, valued at $207,566,381. This includes colliery consumption, i. e., that portion of the product used at the mines in the work of operating, ventilating, etc., and sold or furnished to employés.

The total product of Pennsylvania anthracite coal was 46,850,450 long tons, or 52,472,504 short tons, valued at $82,442,000. In addition to this, Colorado produced 62,863 short tons of anthracite, New Mexico, 2,100 short tons, and Virginia, 657 short tons, bringing the total production of anthracite coal up to 52,538,124 short tons. It has been customary, however, to treat this comparatively small factor in the bituminous report, and the custom is adhered to in this chapter. Compared with 1891, the production of Pennsylvania anthracite shows an increase of 1,613,458 long tons, or 1,807,073 short tons, and an increase in value of $8,497,265, the output in 1891 being 45,236,992 long tons, or 50,665,431 short tons, worth $73,944,735 at the mines.

The bituminous product in 1892 (and in this is included, for sake of convenience and for comparison with the output of previous years, the product of semianthracite, semibituminous, cannel, and lignite coals, and the anthracite product of Colorado, New Mexico, and Virginia), was 113,264,792 long tons, or 126,856,567 short tons, valued at $125,-124,381. Compared with the product of 1891, which was 105,265,830 long tons, or 117,901,238 short tons, worth $117,188,400 at the mines, the output in 1892 shows an increase in tonnage of 7,996,009 long tons, or 8,955,329 short tons, and an increase in value of $7,935,981. The average price for Pennsylvania anthracite advanced from $1.79 to $1.92, and for other coals declined from $0.994 to $0.99. The average price for anthracite includes only that of the marketable product, i. e., the quantity shipped and that sold to local trade and employés. The item of colliery consumption consists principally of culm or nonmerchantable grades, and is usually reported as "estimated," no account being kept of the quantity so consumed, and the value not being included in the total. In the statement of the bituminous product, all grades are included in the value, except in a few instances where no account is kept, and in such instances no attempt has been made to estimate on either the amount or value.

The total number of employés engaged in operating the anthracite mines, that is, including superintendents, mechanics, miners, laborers, and the clerical force at the collieries, but not including those at offices at a distance, was 129,050 in 1892 against 126,350 in 1891. The average number of days worked in 1892 was 198 against 203 the preceding year.

In the bituminous mines the total number of persons employed in 1892 was 212,893, as compared with 205,372 in 1891. The average number of working days was 219 in 1892 against 223 in 1891. The grand total of employés in coal mines of the United States in 1892 was 341,943, their average working time being 212 days.

The following table exhibits the production of all kinds of coal in the United States in 1892, together with the distribution for consumption:

Coal product of the United States in 1892, by States.

States.	Loaded at mines for shipment.	Sold to local trade and used by employés.	Used at mines for steam and heat.	Made into coke.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
Alabama	3, 122, 075	37, 843	135, 627	2, 233, 767
Arkansas	513, 908	7, 450	14, 200	
California	73, 269	9, 679	2, 230	
Colorado	2, 938, 980	126, 748	55, 721	389, 381
Georgia	52, 614	250	3, 756	158, 878
Illinois (*a*)	14, 557, 655	2, 624, 821	675, 000	4, 800
Indiana	3, 088, 911	208, 220	42, 621	5, 422
Indian Territory	1, 156, 603	10, 840	18, 089	7, 189
Iowa	3, 459, 025	401, 855	57, 611	
Kansas	2, 756, 812	206, 038	44, 325	101
Kentucky	2, 620, 556	327, 985	33, 856	42, 916
Maryland	3, 385, 384	30, 955	3, 623	
Michigan	27, 200	45, 180	5, 610	
Missouri	2, 399, 605	293, 414	40, 930	
Montana	521, 521	4, 866	1, 849	36, 412
Nebraska		1, 500		
New Mexico	645, 557	8, 776	6, 997	
North Carolina	6, 679			
North Dakota	38, 000	2, 725		
Ohio	11, 995, 256	1, 411, 642	117, 486	38, 543
Oregon	31, 760	2, 353	548	
Pennsylvania bituminous	32, 425, 949	2, 207, 827	356, 779	11, 704, 021
Rhode Island (*b*)				
Tennessee	1, 448, 262	55, 452	17, 037	571, 313
Texas	241, 005	4, 460	225	
Utah	321, 431	6, 775	6, 509	26, 298
Virginia	527, 304	20, 721	6, 611	120, 569
Washington	1, 150, 865	9, 802	40, 085	12, 675
West Virginia	7, 569, 790	441, 159	49, 563	1, 687, 243
Wyoming	2, 378, 657	27, 054	96, 128	2, 000
Total	99, 415, 633	8, 536, 390	1, 833, 016	17, 041, 528
Pennsylvania anthracite	46, 926, 465	1. 168, 288	4, 377, 751	
Grand total	146, 372, 098	9, 704, 678	6, 210, 767	17, 041, 528

States.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employés.
	Short tons.				
Alabama	5, 529, 312	$5, 788, 898	$1. 05	271	10, 075
Arkansas	535, 558	666, 230	1. 24	199	1, 128
California	85, 178	209, 711	2. 46	204	187
Colorado	3, 510, 830	5, 685, 112	1. 62	229	5, 747
Georgia	215, 498	212, 761	. 99	277	467
Illinois	17, 862, 276	16, 243, 645	. 91	219½	34, 585
Indiana	3, 345, 174	3, 620, 582	1. 08	225	6, 436
Indian Territory	1, 192, 721	2, 043, 479	1. 71	211	3, 257
Iowa	3, 918, 491	5, 175, 060	1. 32	236	8, 170
Kansas	3, 007, 276	3, 955, 595	1. 31½	208½	6, 559
Kentucky	3, 025, 313	2, 771, 238	. 92	217	6, 724
Maryland	3, 419, 962	3, 053, 580	. 89	225	3, 886
Michigan	77, 990	121, 314	1. 56	195	230
Missouri	2, 733, 949	3, 369, 659	1. 23	230	5, 893
Montana	564, 648	1, 330, 847	2. 36	258	1, 158
Nebraska	1, 500	4, 500	3. 00		
New Mexico	661, 330	1, 074, 601	1. 62	223	1, 083
North Carolina	6, 679	9, 599	1. 44	160	99
North Dakota	40, 725	39, 250	. 96	216	54
Ohio	13, 562, 927	12, 722, 745	. 94	212	22, 576
Oregon	34, 661	148, 546	4. 29	120	90
Pennsylvania bituminous	46, 694, 576	39, 017, 164	. 84	223	66, 655
Rhode Island (*b*)					
Tennessee	2, 092, 064	2, 355, 441	1. 13	240	4, 926
Texas	245, 690	569, 333	2. 32	208	871
Utah	361, 013	562, 625	1. 56	230	646
Virginia	675, 205	578, 429	. 86	192	836
Washington	1, 213, 427	2, 763, 547	2. 28	247	2, 564
West Virginia	9, 738, 755	7, 852, 114	. 80	228	14, 867
Wyoming	2, 503, 839	3, 168, 776	1. 27	225	3, 133
Total	126, 856, 567	125, 124, 381	. 99	219	212, 893
Pennsylvania anthracite	52, 472, 504	82, 432, 000	1. 57	198	129, 050
Grand total	179, 329, 071	207, 566, 381	1. 16	212	341, 943

a Distribution estimated on the returns for 1889. *b* None reported.

In the following table is shown the amount of each kind of coal produced in the several States. As previously noted this classification is not based upon a scientific system, but is made up from the returns of operators, and in reply to the inquiry whether their product was classed as anthracite, bituminous, cannel, semi-anthracite, semi-bituminous, or lignite. The "block" coal of Indiana and "splint" coal of West Virginia are included in the bituminous products of those States.

Classification of the coal product of the United States in 1892, by States.

States.	Anthracite.	Semianthracite.	Cannel.	Lignite.	Bituminous.	Semibituminous.	Total.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Alabama					5, 529, 312		5, 529, 312
Arkansas		17, 500			213, 640	304, 418	535, 558
California				52, 018	33, 160		85, 178
Colorado	62, 863			590, 576	2, 746, 492	110, 899	3, 510, 830
Georgia					215, 498		215, 498
Illinois					17, 862, 276		17, 862, 276
Indiana					*a*3, 221, 414	123, 760	3, 345, 174
Indian territory					1, 192, 721		1, 192, 721
Iowa			1, 401		3, 917, 090		3, 918, 491
Kansas					3, 007, 276		3. 007, 276
Kentucky			*b*47, 270		2, 901, 043	77, 000	3, 025, 313
Maryland					32, 328	3, 387, 634	3, 419, 962
Michigan					77, 990		77, 990
Missouri			2, 486		2, 731, 463		2, 733, 949
Montana				1, 443	317, 868	245, 337	564, 648
Nebraska					1, 500		1, 500
New Mexico	2, 100	1, 295		38, 725	208, 606	410, 604	661, 330
North Carolina					6, 679		6, 679
North Dakota				40, 725			40, 725
Ohio			27, 798		13, 535, 129		13, 562, 927
Oregon				34, 661			34, 661
Pennsylvania	52, 472, 504	22, 200	25, 920		44, 747, 051	1, 899, 405	99, 167, 080
Tennessee					2, 092, 064		2, 092, 064
Texas				11, 723	233, 967		245, 690
Utah					361, 013		361, 013
Virginia	657	35, 862			200	638, 486	675, 205
Washington				293, 558	623, 012	296, 857	1, 213, 427
West Virginia					7, 600, 440	2, 138, 315	9, 738, 755
Wyoming				358, 579	661, 067	1, 484, 193	2, 503, 839
Total	52, 538, 124	76, 857	104, 875	1, 422, 008	114, 070, 299	11, 116, 908	179, 329, 071

a Includes 944, 515 tons of "block" coal. *b* Includes 21,887 tons classed as semi-cannel.

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 1892, 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; from 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; since August, 1872, bituminous coal and shale, 75 cents per ton; anthracite, free of duty. No change has been made in tariff rates since 1872, except for slack or culm, which, under act of March 3, 1883, was made 30 cents per ton. 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 anthracite being the greater. 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 1892.

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

Coal of domestic production exported from the United States, 1867 to 1892.

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

WORLD'S PRODUCT OF COAL.

In the following table, the product of coal in the principal countries is given for the years nearest to the one under discussion for which figures are obtainable. In each instance the year for which the product is given is named. Long tons of 2,240 pounds are used in giving the product of Great Britain, short tons of 2,000 pounds for the United States, Canada, and Japan, and metric tons of 2,204 pounds for all continental countries.

The world's product of coal.

Countries.	Tons.
Great Britain (1892)	181, 786, 871
United States (1892)	179, 329, 071
Germany (1892)	(*a*)94, 196, 000
France (1892)	(*b*)26, 064, 073
Belgium (1891)	19, 675, 644
Austria (1890)	(*b*)9, 926, 000
Russia (1889)	5, 943, 408
Canada (1890)	3, 117, 661
Japan (1890)	2, 608, 284
Sweden (1888)	300, 000
Spain (1891)	1, 314, 147
Italy (1889)	390, 320
Total	524, 651, 479
Percentage of the United States	34

a Includes 20, 555, 000 tons lignite.
b Exclusive of lignite.

COAL-TRADE REVIEW.

The year 1892 was one unprecedented in the history of the coal trade. The production exceeded that of any previous year, the total output of all kinds of coal being 160,115,242 long tons or 179,329,071 short tons, being 9,609,288 long tons or 10,762,402 short tons more than in 1891. The remarkable feature of the year's trade was, however, not the increase in production, which was practically the same as that of 1891 over 1890, and exhibits only a natural and healthy increase. The matter of greater interest was the advance in prices on anthracite in Pennsylvania, the average price per long ton rising from $1.79 in 1891 to $1.92 in 1892. The advance was not due to greater activity in anthracite mining, but was the result of combination among the producing companies and transportation lines in self-interest and protection. The advance by the producers was followed by further advances by the initial freight lines for carriage, and the retail coal exchanges combining in turn advanced their rates in still greater proportion.

The average price of bituminous coal in 1892 was practically the same as in 1891, about 99 cents per short ton. It is probable, however, that the returns for 1893 and subsequent years will show a decline unless steps be taken to control the production. A spirit of rivalry exists between different sections to outstrip each other in the aggregate tonnage produced and is almost certain to lead to an overproduction, a decline in values, and eventually prove disastrous to the trade. The producers of "Cumberland" coal in Maryland and West Virginia foresaw this condition in the early part of 1892, and rather than cut prices in an unwise strife for trade curtailed their output, the product in Maryland being nearly 12 per cent. less than in 1891.

In comparing the trade of 1892 with that of 1891 it is seen that in eighteen States production increased and in eleven States the output decreased. There was no surprising increase in the output of any one State, and the only new development of extra interest was in the Clinch Valley district of Virginia, which is fully discussed under that State. The States and Territories whose production showed an increase in 1891 were: Alabama, Georgia, Illinois, Indiana, Indian Territory, Iowa, Kansas, Kentucky, Missouri, Montana, New Mexico, North Dakota, Ohio, Pennsylvania, Texas, Washington, West Virginia, and Wyoming. Maryland's output was decreased for reasons already mentioned. Tennessee suffered from the convict riots and strikes, and her output was decreased about 16 per cent. With the exception of Tennessee the trade was not seriously affected by strikes, the decrease in the output of the other States being comparatively small, and due in the most part to mild weather. It will be noted that the winter of 1892, while severe in the Eastern states, was a mild one in the West and that Arkansas, California, Colorado, Michigan, Oregon, and Utah are among the States whose product decreased.

In the effort to make the review of the coal trade more comprehensive and interesting, requests were made of the secretaries of coal exchanges, boards of trade, etc., for brief reports on the coal trade of their respective cities. These requests have met with generous responses and the writer desires to express here his grateful acknowledgments.

Boston, Massachusetts.—Mr. Elwyn G. Preston, secretary of the Boston Chamber of Commerce, has kindly prepared the following comprehensive review of the coal trade of that port in 1892:

"The receipts of coal at the port of Boston for the past ten years have been as follows:

Coal receipts at Boston, Massachusetts, for ten years.

Years.	Domestic.		Foreign.	Total.
	Anthracite.	Bituminous.		
	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

"The amounts given above include coal received at this port which is forwarded to interior New England points, and which last year amounted to 867,734 tons, or about 28 per cent. of the total receipts.

"This would place the coal consumption of the city of Boston, exclusive of the small amount of coal that comes to this city by rail, at 2,217,481 tons. It will be noticed that the increase of 125,000 tons in the receipts of anthracite coal was more than offset by the decrease in bituminous, so that there was a net falling off in the receipts of about 30,000 tons for the year. This is explained partly from the fact that the receipts in 1891 were extraordinarily large, but more particularly by the fact that the extension of the Philadelphia and Reading system into this territory by way of the Poughkeepsie bridge route has operated to divert a large amount of coal destined to inland points from the water routes to this all-rail route.

"The opening of 1892 found the trade in a lifeless condition, with no demand for either anthracite or bituminous coal. Stove coal was quoted at $3.75 per ton, with other grades in proportion, but prices were merely nominal, and what few sales were effected were governed largely as to price by individual circumstances. Prices began to stiffen in the early spring under the influence of the Philadelphia and Reading coal deal, and graded up until August, when the final advance to $4.75 free on board, New York, was made, with other prices advancing accordingly.

"The same apathy that marked the anthracite trade early in the year was apparent in the bituminous trade. In March and April, however, trade began to pick up and continued fair during the summer months, with a general strengthening tendency toward the close of the year.

"As a whole, the year has been a profitable one to the trade in this vicinity. There has been no lack of carriers at any time, with rates from Philadelphia and Baltimore ranging all the way from 95 cents per ton in January and December down to 55 cents in August.

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

Coal receipts at Boston, Massachusetts, during 1892, by months.

Months.	Domestic.		Nova Scotia.	Total.
	Anthracite.	Bituminous.	Bituminous.	
	Tons.	*Tons.*	*Tons.*	*Tons.*
January	115,604	42,332	....	157,936
February	95,956	42,592	....	138,548
March	178,142	52,319	....	230,461
April	224,014	67,719	405	291,733
May	230,083	82,739	....	313,227
June	220,511	84,700	....	305,211
July	215,268	72,790	....	288,058
August	191,854	101,341	816	293,195
September	203,642	95,654	....	300,112
October	180,618	105,138	195	285,951
November	149,862	82,854	....	232,716
December	158,430	89,637	....	248,067
Total	2,163,984	919,815	1,416	3,085,215

"It may be noted as a fact of some interest that the imports of coal from Nova Scotia, never large, have fallen off steadily until last year there was practically none received at this port. Now, however, that the Cape Breton county coal fields have passed into the hands of Mr. H. M. Whitney and his associates, new and improved machinery will be employed, both increasing the output and reducing the cost of mining per ton over the primitive methods hitherto employed, and it is expected that as a result more of this coal will eventually find its way into this market in competition with the product from the Pennsylvania mines."

Baltimore, Maryland.—The coal received at Locust Point for the Baltimore market includes Cumberland, Georges Creek, Myersdale, and the gas coal from the West Virginia mines on the line of the Baltimore and Ohio railroad, and that from the Youghiogheny mines in Pennsylvania on the line of the same road, for local use and for northern shipment. Although the bulk of the coal received in Baltimore comes by the Baltimore and Ohio railroad, the receipts over the Northern Central are not inconsiderable. The receipts over the Baltimore and Ohio in 1892 were 1,978,967 tons, and by the Northern Central 896,272 tons. Of the latter 300,000 tons is anthracite. In addition to the above about

250,000 tons of anthracite are received annually by the Susquehanna canal, and a comparatively small amount of bituminous coal is received over the Baltimore and Potomac railroad.

The three railroads have carried to Baltimore annually since 1883 the following quantities:

Coal receipts at Baltimore.

Years.	Via Baltimore and Ohio railroad.	Via Northern Central railroad.	Via Baltimore and Potomac railroad.
	Tons.	*Tons.*	*Tons.*
1883	1,618,416	693,494	
1884	2,510,389	767,381	
1885	2,238,097	850,303	
1886	2,313,783	818,863	
1887	2,167,007	765,082	15,338
1888	2,300,000	680,962	16,500
1889	2,000,000	666,972	7,139
1890	2,090,911	735,912	10,000
1891	2,296,735	916,086	
1892	1,978,967	896,272	

Foreign shipments of coal from Baltimore.

Years.	Tons.	Years.	Tons.
1883	63,526	1888	33,386
1884	50,289	1889	27,750
1885	71,527	1890	37,190
1886	64,477	1891	122,818
1887	54,455	1892	46,134

Buffalo, New York.—Mr. William Thurstone, secretary of the Buffalo Merchants' Exchange, has kindly contributed the following review of the coal trade of that city:

"The anthracite coal trade of Buffalo for the year 1892 was generally satisfactory to producers, although during the latter half prices were advanced to figures that were anything but satisfactory to consumers. Consumption was about as large in volume in 1891 as in 1892, and would have been greater but for the fact that the introduction of natural gas for fuel purposes from Canada materially affected the domestic trade over a large part of the city, especially in the best resident locality. The extraordinary influx of population and the addition of numerous manufacturing industries would also have increased consumption, but that was counterbalanced by the larger demand for natural gas fuel. About 300,000 short tons were used by families nevertheless.

"The changes in the general policy and workings of the anthracite coal trade inaugurated about eighteen months since made numerous changes in the management thereof, but without any curtailment in the volume of business, as all shipping docks and trestles were in continuous use.

"Car service was much improved during 1892, and complaints of want of cars were reduced to a minimum.

"The total receipts of anthracite coal in 1892 by rail and canal were 4,804,760 short tons; bituminous, by rail, 2,627,441 short tons; and Blossburg, by rail, about 25,000 short tons. The total exports of coal by lake were 2,822,330 short tons; bituminous, by lake and canal, 54,216 short tons, and Blossburg, by lake, about 5,000 short tons.

"Bituminous coal was in good demand all the year. Manufactories ran on full time and the requirement for propellers, tugs, etc., was large. The range of prices, delivered to manufactories, propeller lines, tugs, etc., was from $1.75 to $2.75 per short ton in car lots according to description, size, etc. It is estimated that about 3,500 short tons were consumed for family use, bringing from $4 to $6 per short ton, delivered. Bituminous coal was steady in price as a rule. Dealers and producers working in harmony prevented the market from being overstocked at one time and bare at another. Wholesale and retail prices of anthracite are given in the annexed tables. They show the days on which the changes were made. Also all figures as compiled for the Buffalo Merchants' Exchange by its secretary are given.

"The shipping docks and coal pockets at Buffalo number seven, with an average daily shipping capacity of 27,500 tons and average capacity of pockets of 36,800 tons.

"Outside the city limits at Cheektowaga is the stocking coal trestle of the Delaware, Lackawanna and Western railroad, with a capacity of over 100,000 tons storage. Also at the same place the Lehigh Valley railroad has its trestles and stocking plant of 175,000 tons storage capacity, with a shipping capacity of 3,000 tons daily, and has nearly completed a transfer trestle for loading box cars, with a capacity of 100 cars daily. And at the same point the Erie railroad has a stocking plant, with an average daily capacity of 1,000 tons and storage capacity of 100,000 tons. The Lehigh Valley railroad has a 160-pocket trestle at Cheektowaga, 1,000 feet long, with a storage capacity of 300,000 tons and a daily shipping capacity of 5,000 tons. The structure is covered with an iron roof; four Brown hoists are in operation. The company has also, at the foot of Georgia street, in the city, a large trestle and pocket for the convenience of the retail trade, and in connection with their docks, with a capacity of 2,000 tons. The Buffalo, Rochester and Pittsburg railroad has terminals on Ganson and Michigan streets, fronting on the Blackwell canal, with a water frontage of 1,100 feet; also a town delivery yard, with a hoisting plant for loading and coaling vessels.

"The facilities for rapid handling of coal at this port are well known. The increase in the size of the propellers and steam barges is noteworthy. The favorable location of this port is well known to the coal trade generally, as miners are assured of ample steamer shipping facilities by lake to the West, the Northwest, and to Canada, at all times during the season of navigation.

"The following were the circular wholesale prices of anthracite coal per 2,240 pounds during 1892:

Anthracite wholesale circular prices.

Dates.	Free on board vessels at Buffalo.				On cars at Buffalo or Suspension Bridge.			
	Grate.	Egg.	Stove.	Chestnut.	Grate.	Egg.	Stove.	Chestnut.
Jan. 1	$4.80	$4.90	$4.90	$4.90	$4.50	$4.60	$4.60	$4.60
Mar. 24	4.55	4.55	4.55	4.55	4.25	4.25	4.25	4.25
May 2	4.80	4.80	4.80	4.80	4.50	4.50	4.50	4.50
June 1	4.80	5.05	5.05	5.05	4.50	4.75	4.75	4.75
July 1	5.05	5.30	5.30	5.30	4.75	5.00	5.00	5.00
Sept. 1 to December 31	5.35	5.60	5.60	5.60	5.05	5.30	5.30	5.30

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

Anthracite retail prices.

Dates.	Grate.	Egg.	Stove.	Nut.	Pea.	Blossburg.
Jan. 1	$5.00	$5.00	$5.00	$5.00	$3.75	$4.00
May 2	5.00	5.00	5.00	5.00	4.00	4.00
June 1	5.00	5.25	5.25	5.25	4.00	4.00
July 1	5.25	5.50	5.50	5.50	4.00	4.00
Sept. 1 to Dec. 31	5.50	5.75	5.75	5.75	4.25	4.00

"The range of prices during 1892 for bituminous, delivered to manufacturers, gas works, propeller lines, tugs, etc., was from $1.75 to $2.75 per short ton, in car lots, according to description; the price at retail, for choice for family use, was from $4 to $6 per short ton delivered.

"The shipping docks and coal pockets at this port are:

Shipping docks and coal pockets.

Names.	Average shipping capacity, daily.	Average capacity of pockets.
	Tons.	*Tons.*
Western New York and Pennsylvania railroad	2,500	3,000
Delaware and Hudson Canal Company	3,500	5,000
Delaware, Lackawanna and Western railroad	3,000	4,000
Reading (Lehigh) docks, Nos. 1 and 2	6,000	12,000
Erie docks (New York, Lake Erie and Western railroad)	2,500	3,000
Pennsylvania Coal Company	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

Lake shipments of anthracite coal from Buffalo.

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

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

"The principal points to which coal was shipped from Buffalo by lake during the past seven years are shown in the following table, together with the tonnage for each year:

Clearances of coal at Buffalo for seven years.

Destination.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Chicago	642, 135	784, 462	1, 023, 649	988, 750	952, 280	957, 805	1, 179, 635
Milwaukee	376, 615	376, 876	549, 831	497, 895	451, 550	508, 140	715, 975
Duluth	157, 420	165, 798	282, 106	160, 430	199, 230	257, 625	318, 580
Superior	65, 090	96, 746	120, 000	112, 450	127, 300	162, 075	200, 680
Toledo	55, 290	84, 563	83, 850	52, 725	96, 230	64, 620	102, 585
Gladstone			39, 575	36, 520	30, 215	35, 170	52, 500
Racine	25, 263	16, 565	29, 695	33, 410	29, 130	30, 510	34, 020
Detroit	31, 090	40, 203	35, 330	31, 890	40, 065	24, 560	22, 500
Green Bay	23, 870	29, 446	26, 345	25, 050	22, 380	29, 015	35, 300
Other places	156, 439	140, 020	179, 525	142, 216	131, 390	295, 375	190, 555
Total	1, 531, 212	1, 734, 479	2, 369, 906	2, 081, 336	2, 079, 770	2, 365, 895	2, 852, 330

Cleveland, Ohio.—The following report on the coal trade of Cleveland has been furnished by Mr. Ryerson Ritchie, secretary of the chamber of commerce:

"The price of bituminous coal at the close of the year's trade in 1892 was unchanged from the prices ranging at the close of the preceding year. In anthracite coal a slight change had taken place in each of the four grades, as shown by the following table:

Prices of coal at Cleveland, Ohio, in 1891 and 1892.

Kinds of coal.	Price per ton. 1891.	Price per ton. 1892.	Kinds of coal.	Price per ton. 1891.	Price per ton. 1892.
Bituminous:			Bituminous—		
Massillon	$2.40	$2.40	Coshocton	$2.10	$2.10
Palmyra	2.75	2.75	Hocking	1.90	1.90
Pittsburg	2.10	2.10	Anthracite:		
Salineville	1.70	1.70	Grate	5.25	5.18
Kentucky cannel	4.75	4.75	Egg	5.50	5.40
Goshen	1.85	1.85	Stove	5.50	5.40
Sherodsville	1.70	1.70	Chestnut	5.50	5.40
Osnaburg	1.80	1.80			

"Phenomenal and gratifying as was the coal trade of 1891, the showing for the following year brought still more satisfactory results. There was a steady increase both in the receipts and shipments by rail and water. From 2,838,586 tons of bituminous coal received in 1891, the returns for 1892 show the receipts to have been 3,651,080 tons, or nearly 30 per cent. increase. There was a corresponding increase both in anthracite coal and coke. The total shipments for 1891 amounted to 2,501,474 tons; those of 1892 reached the unprecedented figure of 2,889,360 tons, or a gain of 387,886 tons. The heaviest rate of increase was made in the shipments of bituminous coal by lake, the total number of tons advancing from 1,525,000 in 1891 to 1,728,831 in 1892, or 203,831 tons. In 1891 there was a falling off in the receipts of both anthracite coal and coke, brought about by the lively demand for bituminous coal by the local trade. This was offset in 1892 and both of these show an increase in the amount received as large in percentage as that of bituminous.

"The coal and coke receipts and shipments at Cleveland for the past six years are shown by the following table:

Coal and coke receipts and shipments for Cleveland since 1887.

	1887.	1888.	1889.	1890.	1891.	1882.
Receipts:	*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
Anthracite	176,769	181,551	160,000	205,856	201,927	259,150
Coke	114,924	124,827	150,000	194,527	189,640	351,527
Total	1,746,437	2,044,159	1,910,000	1,960,591	3,230,153	4,261,757
Shipments:						
Anthracite by rail	20,296	29,735	25,000	29,056	34,910	50,742
Bituminous by rail	294,453	677,733	600,000	785,526	941,564	1,109,787
Bituminous by lake	703,506	1,000,000	1,100,000	1,200,000	1,525,000	1,728,831
Total	1,018,255	1,707,468	1,725,000	1,814,582	2,501,474	2,889,360

"In the clearances for the Cuyahoga district for the past year there has also been a considerable increase in the total number of tons, advancing from 2,635,461 tons in 1891 to 2,957,988 tons in 1892. The district includes the ports of Cleveland, Ashtabula, Fairport, and Lorain. The following comparative table will show the clearances for the district for the past six years:

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

Years.	Tons.	Years.	Tons.
1887	1,433,035	1890	2,328,663
1888	1,855,260	1891	2,635,461
1889	2,020,996	1892	2,957,988

Toledo, Ohio.—The following review of the coal trade of Toledo is from the annual report of Mr. Denison B. Smith, secretary of the Toledo Produce Exchange:

"In the report of the commerce for 1891 it was stated 'that the occurrence of three consecutive winters of mild temperature in our country furnishes sufficient reasons for the falling off in receipts for that year.' It affords a no less potent and sufficient reason for a like deficiency in the movement hence for 1892. While the demand for coal over the period named was decreasing, the facilities for its production have increased, and if the present winter should be marked by a return to previous low temperature we shall doubtless witness a great increase in the movement at all points. Toledo will forever maintain her claim upon any increase of traffic in this cheap fuel. Her water channel now admits the largest ships that float the lakes. Her harbor, along some of the coal docks, has recently been thoroughly dredged, and these improvements point to freight rates so low as to inevitably concentrate here a largely increased commerce in coal.

"Our table below exhibits the movement here for seven years:

Coal receipts at Toledo since 1886.

	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Wabash railroad	12,598	9,637	10,375	8,586	3,620	600	500
Lake Shore and Michigan Southern railway	165,382	206,099	201,064	35,693	20,592	8,872	43,252
Cincinnati, Hamilton and Dayton railroad	8,198	11,741	37,831	51,746	25,753	35,356	82,053
Pennsylvania Company	201,427	330,020	339,750	234,675	214,765	172,325	92,894
Michigan Central railroad	9,594	13,864	16,504	19,935	3,152	524	420
Columbus, Hocking Valley and Toledo railway	1,039,200	955,620	1,358,025	923,745	931,716	604,039	394,895
Toledo, Ann Arbor and North Michigan railway	1,910	552	24,700	96			
Toledo, St. Louis and Kansas City railroad	3,828		1,359	3,287	8,420	6,891	5,041
Toledo and Ohio Central railway	404,684	590,000	637,000	706,950	820,049	300,429	450,000
Lake	87,120	117,921	140,963	90,282	133,813	83,800	112,199
Wheeling and Lake Erie railway	391,086	454.813	755,155	763,055	853,940	1,007,042	1,080,000
Toledo, Columbus and Cincinnati railway	15,832	5,446	2,014	2,210		35,064	30,000
Cincinnati, Jackson and Mackinaw railroad			45	54	65		101
Total	2,340,859	2,695,810	3,423,780	2,838,314	3,021,886	2,754,943	2,291,355

Chicago, Illinois.—The following table shows the receipts of coal at and shipments from Chicago during 1891 and 1892, as collected and compiled by the bureau of coal statistics:

Coal and coke receipts at Chicago, Illinois, in 1891 and 1892.

Months.	Anthracite.							
	By lake.		By rail.		Total.		1892.	
	1892.	1891.	1892.	1891.	1892.	1891.	Increase.	Decrease.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January	....	....	29,406	24,943	29,406	24,943	4,463	....
February	....	....	20,816	27,122	20,816	27,122	....	6,306
March	....	....	31,419	16,889	31,419	16,889	14,530	....
April	63,708	10,736	38,009	33,192	101,717	43,928	57,789	....
May	121,113	173,288	30,113	26,971	151,226	200,259	....	49,033
June	209,142	142,455	43,516	32,024	252,658	174,479	78,179	....
July	167,123	175,826	64,358	43,794	231,481	219,620	11,861	....
August	157,711	164,367	53,436	52,723	211,147	217,090	....	5,943
September	169,385	149,983	83,611	70,844	252,996	220,827	32,169	....
October	249,792	155,805	69,911	77,314	319,703	233,119	86,584	....
November	239,709	193,107	93,465	68,894	333,174	261,501	71,673	....
December	97,554	144,780	91,766	69,328	189,320	214,108	....	24,788
Total	1,475,237	1,310,347	649,826	543,538	2,125,063	1,853,885	271,178	....

Months.	Pennsylvania.				Ohio.			
	1892.	1891.	1892.		1892.	1891.	1892.	
			Increase.	Decrease.			Increase.	Decrease.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January	25,842	17,309	8,533	....	44,950	27,698	17,252	....
February	23,844	26,395	....	2,551	31,852	29,328	2,524	....
March	26,488	25,459	1,029	....	35,113	30,012	5,101	....
April	29,633	26,595	3,038	....	34,669	30,822	3,847	....
May	27,144	21,477	5,667	....	42,253	31,685	10,568	....
June	38,346	26,326	12,020	....	55,800	37,145	18,655	....
July	34,906	27,123	7,783	....	51,400	40,460	10,940	....
August	28,435	24,079	4,356	....	38,321	30,134	8,187	....
September	32,445	30,035	2,410	....	60,924	40,833	20,091	....
October	31,714	25,462	6,252	....	57,438	51,524	5,914	....
November	41,329	52,729	....	11,400	109,339	81,725	27,614	....
December	54,318	36,949	17,369	....	97,842	64,683	33,159	....
Total	394,444	339,938	54,506	....	659,901	496,049	163,852	....

Months.	West Virginia and Kentucky.				Illinois.			
	1892.	1891.	1892.		1892.	1891.	1892.	
			Increase.	Decrease.			Increase.	Decrease.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January	10,752	10,277	475	....	128,026	136,786	....	8,760
February	8,651	9,758	....	1,107	116,012	135,505	....	19,493
March	6,696	10,076	....	3,380	144,769	166,086	....	21,317
April	9,842	12,374	....	2,532	133,047	157,948	....	24,901
May	11,575	10,081	1,494	....	119,157	75,976	43,181	....
June	13,260	10,935	2,325	....	150,381	127,914	22,467	....
July	10,831	8,704	2,127	....	114,381	96,546	17,735	....
August	13,432	9,472	3,960	....	146,030	103,921	42,109	....
September	15,735	8,173	7,562	....	191,359	137,547	53,812	....
October	13,474	10,300	3,174	....	168,826	184,976	....	16,150
November	25,238	22,240	2,998	....	204,269	181,402	22,867	....
December	24,785	18,439	6,346	....	206,223	190,011	16,212	....
Total	164,271	140,829	23,442	....	1,822,380	1,694,618	127,762	....

Coal and coke receipts at Chicago, Illinois, in 1891 and 1892—Continued.

Months.	Indiana.				Coke.			
	1892.	1891.	1892.		1892.	1891.	1892.	
			Increase.	Decrease.			Increase.	Decrease.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January	102,750	118,614	....	15,864	73,623	64,207	9,416	....
February	111,980	113,705	....	1,725	64,420	47,118	17,302	....
March	146,038	157,541	....	11,503	49,317	46,770	2,547	....
April	134,076	164,652	....	30,576	47,911	27,181	20,730	....
May	118,999	55,213	63,786	....	47,416	31,143	16,273	....
June	133,173	133,090	83	....	63,417	49,318	14,099	....
July	116,104	101,873	14,231	....	53,316	49,355	3,951	....
August	138,109	132,730	5,379	....	62,627	56,184	6,443	....
September	145,403	139,640	5,763	....	86,297	72,096	14,201	....
October	151,182	130,427	20,755	....	83,467	74,637	8,830	....
November	162,537	25,595	136,942	....	103,109	87,993	15,116	....
December	125,820	32,040	93,780	....	81,516	86,319	....	4,803
Total	1,586,171	1,305,120	281,051	....	816,436	692,331	124,105	....

Coal and coke shipments from Chicago.

Months.	Anthracite.				Bituminous and coke.			
	1892.	1891.	1892		1892.	1891.	1892.	
			Increase.	Decrease.			Increase.	Decrease.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January	38,557	29,784	8,773	....	73,629	76,193	....	2,564
February	18,127	19,014	....	887	44,835	39,243	5,592	....
March	38,612	32,994	5,618	....	61,236	50,012	11,224	....
April	16,319	18,722	....	2,403	59,466	73,119	....	13,653
May	16,833	9,728	7,105	....	49,557	32,212	17,345	....
June	35,643	40,741	....	5,098	57,889	53,914	3,975	....
July	53,221	49,334	3,887	....	57,819	64,274	....	6,455
August	79,332	81,247	....	1,915	71,058	64,896	6,162	....
September	103,447	93,827	9,620	....	91,005	74,012	16,993	....
October	84,919	98,773	....	13,854	89,204	86,327	2,877	....
November	106,353	81,218	25,135	....	97,678	62,739	34,939	....
December	68,579	51,327	17,252	....	62,306	60,405	1,901	....
Total	659,942	606,709	53,233	....	815,682	737,346	78,336	....

Milwaukee, Wisconsin.—Mr. William J. Langson has kindly furnished the figures for 1892 in the following tables showing the tendency of the coal trade in Milwaukee for a series of years:

Receipts of coal at Milwaukee for eight years.

	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
By lake from—	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Buffalo	392,003	395,971	464,972	631,263	542,167	510,598	659,388	819,570
Erie	50,915	41,847	61,222	74,610	47,862	46,378	55,202	65,190
Oswego	10,043	....	1,153	1,348	....	2,408	17,022	26,177
Cleveland	126,741	91,997	78,259	98,631	89,071	135,413	143,776	132,051
Ashtabula	35,360	11,096	38,881	23,105	48,599	24,671	22,726	30,549
Black River	5,549	....	....	....	....	....	....	....
Lorain	19,452	12,417	11,757	13,533	15,367	15,351	3,983	....
Sandusky	19,307	57,412	46,606	19,733	51,816	26,193	10,692	19,039
Toledo	31,875	69,079	14,115	38,452	71,516	59,305	53,644	12,229
Charlotte	19,491	31,744	2,781	14,292	22,526	6,120	10,013	55,909
Fairport	....	....	10,517	30,253	5,552	11,100	5,775	5,359
Ogdensburg	....	....	....	7,700	4,953	7,026	5,179	18,134
Huron, Ohio	....	....	....	8,244	7,726	9,720	12,307	12,173
Other ports	....	2,679	4,331	....	588	*a* 49,375	*a* 6,949	19,485
Total by lake	710,736	714,242	724,594	961,164	907,743	903,658	1,006,656	1,210,865
By railroad	65,014	45,439	118,385	161,079	72,935	92,999	149,377	163,549
Total receipts	775,750	759,681	842,979	1,122,243	980,678	996,657	1,156,033	1,374,414

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

Shipments of coal from Milwaukee for the past ten years.

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

Shipped by—	1888.	1889.	1890.	1891.	1892.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Chicago, Milwaukee and Saint Paul railway	283,269	258,281	378,090	406,455	252,168
Chicago and Northwestern railway	107,193	97,207	103,279	114,847	163,063
Wisconsin Central railroad	12,624	11,727	15,929	14,449	14,930
Milwaukee, Lake Shore and Western railway	16,146	25,413	5,884	7,998	11,041
Milwaukee and Northern railroad	34,480	20,556	19,386	26,723	27,185
Lake	125	224	50	416	757
Total	453,837	413,408	522,618	600,888	469,144

Receipts of coal at Milwaukee by lake and rail annually for thirty years, from 1862 to 1892, inclusive.

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

Saint Paul and Minneapolis, Minnesota.—No reliable information regarding the amount of coal received is obtainable. Wholesale prices to dealers at Saint Paul and Minneapolis at the close of 1891 and 1892 were as follows:

Prices of coal at Saint Paul and Minneapolis, Minnesota, in December, 1891 and 1892.

Kinds of coal.	1891.	1892.
Anthracite:		
Grate, egg, stove, and nut	$6.60	$7.35 to $7.60
Pea	4.75	5.50
Bituminous:		
Pittsburg	4.75	3.85
Youghiogheny	4.75	4.45
Kincaid	4.50	....
Mansfield	4.75	4.45
Hocking	4.50	4.20
Wheeling Creek	4.50	....
Raymond, W. Va., splint	....	4.65
Smithing:		
Briar Hill	5.25	5.25
Cumberland	5.25	5.25
Blossburg	5.25	5.25

Duluth, Minnesota.—The following is from the annual report of Mr. George E. Welles, secretary of the Duluth Board of Trade:

"Though the fourth of a series of somewhat mild winters left piled on the head of the lakes storage docks a large quantity of both hard and soft coal, the receipts for the year 1892 have been nearly 200,000 tons greater than ever before. This was due to the growing railway, manufacturing, and retail demand in the district tributary to Duluth, and to the fact that nearly all of the coal companies had not overestimated the business of the preceding winter, and were well cleaned out by the opening of the season of navigation. As usual, freight rates from Ohio ports were low, averaging through the season about 35 cents per ton, and this aided in increasing the supply.

"In the early part of the summer the coal combination of the Philadelphia and Reading road caused the absorption, by the Philadelphia and Reading Coal and Iron Company, of the business of the Silver Creek and Morris Coal Company, and this company will probably soon be a large receiver at the head of the lake. The old Saint Paul and Pacific Company's docks on Connor's point were bought during the year by the Saint Paul and Western Coal Company, and a moderate quantity received thereon. By the Youghiogheny and Reading Company, which leased the Northern Pacific coal dock at Old Superior, the first cargoes of coal were landed on that end of the bay. By the exertions of local capitalists and the Duluth Transfer road, the Pennsylvania and Ohio Coal Company was located, in the latter part of the season, on the Duluth side of the bay, above Rice's point, it being the first enterprise of the kind to be placed on the northern side of the upper bay. The Consolidated Land Company of Old Superior also located a dock for the Northwestern Fuel Company on Allouez bay.

Several other coal-dock projects, for both sides of the bay, are in progress as the year closes, and are likely to be brought to successful issue soon. It will be seen, therefore, that there has been an unusual activity in the placing of new docks and in strengthening weak concerns in 1892, the result of which will be seen in receipts for 1893 that will doubtless exceed 2,000,000 tons.

"The receipts, by companies, in tons for the past year are as follows:

Receipts of coal at Duluth, Minnesota, in 1892, by companies.

Companies.	Tons.
Northwestern Fuel Company	640,000
Ohio Coal Company	375,000
Lehigh Coal and Iron Company	370,000
Pioneer Coal Company	250,000
Philadelphia and Reading Coal and Iron Company	150,000
Youghiogheny and Reading Coal Company	90,000
Saint Paul and Western Coal Company	90,000
Total	1,965,000

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

Coal receipts at Duluth, Minnesota, and Superior, Wisconsin.

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

Cincinnati, Ohio.—Receipts of coal at Cincinnati in the past eleven years have been as follows. The years are the fiscal years adopted by the Chamber of Commerce and end August 31:

Coal receipts at Cincinnati, Ohio.

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

The Survey is indebted to Col. S. D. Maxwell, formerly superintendent of the Cincinnati Chamber of Commerce, for interesting information relating to coal receipts at Cincinnati prior to 1891. Mr. Charles B. Murray, the present superintendent, has kindly furnished the figures for 1891 and 1892. The following table shows the annual receipts in bushels for the fiscal years ending August 31, from 1871 to 1892.

Receipts of coal at Cincinnati for twenty-one years.

Years.	Pittsburg (Youghiogheny).	Kanawha.	Ohio River.	Canal.	Anthracite.	Other kinds.	Total.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1871-'72	19,254,716	....	*a*10,359,906	1,104,003	72,171	....	30,790,796
1872-'73	24,962,373	....	*a*11,075,072	1,162,052	75,000	....	37,274,497
1873-'74	24,014,681	....	*a*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-'92	41,299,170	18,865,325	704,821	....	1,207,584	13,311,416	75,388,316

a Including Kanawha coal.

Saint Louis, Missouri.—The following review of the coal trade of Saint Louis in 1892 has been furnished by Mr. James Cox:

"The marked activity in the manufacturing interests of this city caused an unprecedented demand for coal and coke during the year 1892. Throughout the entire year factories were being run on full time, and frequently in double shifts, and furnaces and boilers were worked to their fullest capacity. As a result there was an increase in the demand for and receipts of coal of over 15 per cent. The total for 1892 was 82,302,000 bushels, as compared with 72,000,000 in 1891 and about 69,500,000 in 1890. Both the Jacksonville and Southeastern and the Saint Louis and Eastern railroads hauled in immense quantities of coal on practically new coal routes, while the Louisville and Nashville, the Louisville, Evansville and Saint Louis, and the Mobile and Ohio roads all reported heavy increase in shipments. These railroads' facts and figures indicate increased shipments from the southern Illinois coal fields; and it is also to be noted that the Missouri Pacific increased its coal shipments into Saint Louis over thirty fold, while the Saint Louis, Iron Mountain and Southern railroad showed an increase of 50 per cent. Both of these roads run across and through Missouri, where the coal mines were unusually active last year.

"During 1892 the Saint Louis municipal assembly considered ordinances for the suppression of smoke, and these became laws early in 1893. With a view to meeting the difficulty and doing away with smoke in advance of legislation there was a great increase in the demand for anthracite coal in spite of the increase in price. Between 1887 and 1891 the average receipts were about 130,000 tons per annum, varying from 121,000 to 139,000. In 1892 the total was 187,327 tons, with the principal activity during the latter months of the year. There was also a marked increase in the receipts of coke, the number of bushels received in 1891 being 7,000,000 bushels of 40 pounds, while the total of 1892 was about 9,000,000.

"The shipments of coal from Saint Louis showed a steady increase by rail and a nominal decrease by river.

"Saint Louis still has a record of very cheap coal for manufacturing purposes, bituminous coal of excellent steam-producing quality having been delivered in factories during the year at prices varying from $1.25 to $2.50 per ton, the last-named price having been fairly general for residence purposes. Prices generally increased somewhat during the winter months and were quoted at the end of the year as follows:

Prices of coal at Saint Louis at the close of 1892.

Kinds of coal.	Per ton.
Ava	$1.60
Percy	1.75
Royal	1.87½
Dryden (steam)	1.75
Dryden (lump)	2.12½
Jupiter (lump)	1.80
Jupiter (steam)	1.60
Jupiter (nut)	1.10
Big Muddy (lump)	2.00
Big Muddy (nut)	1.37½
Illinois standard	1.25
Anthracite	7.75
Anthracite (grate)	7.50
Piedmont smithing *a*	4.50

a Delivered in Saint Louis.

"There was no material change in the price of coke during the year, Connelsville foundry coke selling at $5.65 per ton in Saint Louis and New River at $5.55, about the same as at the beginning of the year.

"Taken as a whole the coal trade of 1892 was both prosperous and active. During the cold spell there was some talk of a coal famine and an absence of the necessary supplies, but there was never any actual difficulty nor any necessity to delay orders more than a couple of days."

Mobile, Alabama.—Mr. A. C. Danner, president of the Mobile Coal Company, has kindly furnished the figures for 1892 in the following table, and also contributed the appended remarks on the coal trade of that city:

Receipts of coal at Mobile, Alabama, for ten years.

Years.	Alabama coal.	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	*a*70,298	1,500	71,798

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

"The total receipts in 1892 show an increase of 18,756 tons over 1891. This increase was caused largely by a greater consumption of bunker coal. The increased depth of water at the wharves of Mobile, by the dredging going on under the appropriations in the river and harbor bill, has caused more steamers to come here for business, and they have taken considerably more coal than heretofore. In all cases Alabama coal has been found to be very satisfactory to those steamers. Many of them are foreign steamers and all get good results from the use of Alabama coal.

"There was in 1892 an increase in coal shipments from here. This coal was sent mainly to Texas and Mexico, and it has given satisfaction everywhere. There is every indication that the continuous increase in the receipts of Alabama coal here will keep up and increase in still larger proportion. As it becomes cheaper, more and more is called for, it having passed out of the experimental stage as to quality. The Government engineers are now constructing locks and dams in the upper Warrior river, above Tuscaloosa, with the view of giving direct water navigation the year round from certain coal beds to Mobile. When this work is completed, if it prove to be a success, coal will be greatly cheapened here. Indeed, Mobile will then be the cheapest coal market on the seaboard in the United States, and will become a very large coal port.

"Good coke is now being made from Alabama coal, and several cargoes of it have been shipped through Mobile to Mexico to be used by the smelting furnaces there."

San Francisco, California.—The following review of the San Francisco coal trade is furnished the trade by Mr. J. W. Harrison of that city:

"The consumption of coal this year as compared with last shows an apparent falling off of about 109,000 tons, but it must be remembered we commenced this year with excessive stocks on hand, probably 50,000 tons more than there is in yard to-day. Low prices have ruled throughout the year; in fact the average quotations have been the lowest on record, and under ordinary circumstances such low-priced fuel should have made our large manufacturing interests very profitable, but unfortunately general business in that line has been below the average. The importers of foreign grades have been the principal sufferers, as there have been losses made in every cargo of British and Australian which has arrived unsold, notwithstanding the rates of freight paid for the carriage of the coal have been exceptionally low. The market is now recovering somewhat, with every evidence of further strengthening, as this is assuredly not a seductive port for vessels to seek with the present low charter rates for grain now ruling, and the prospects of any marked improvement seem very remote. If the present administration should abolish the duty on coal, this would lead to an increase of consumption.

"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 of coal at San Francisco in 1892.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Australian (gas)	6.50	6.25	6.25	6.00	5.87	5.75	5.75	5.87	6.00	6.12	6.25	6.25
English steam	6.25	6.25	6.12	6.00	6.00	6.00	6.00	6.00	6.12	6.25	6.37	6.37
Scotch splint	6.25	6.25	6.25	6.25	6.00	6.00	6.00	6.25	6.25	6.50	7.00	7.00
West Hartley	7.00	7.00	7.00	7.00	6.75	6.50	6.50	6.75	7.00	7.00	7.50	7.50

"The various sources from which supplies have been derived are as follows:

Sources of coal consumed in California.

Sources.	1890.	1891.	1892.
	Tons.	*Tons.*	*Tons.*
British Columbia	441,759	652,657	554,600
Australia	194,725	321,197	314,280
English and Welsh	35,662	168,586	210,660
Scotch	1,610	31,840	24,900
Eastern (Cumberland and Anthracite)	32,550	42,210	35,720
Franklin, Green River and Cedar River	216,760	178,230	164,930
Carbon Hill and South Prairie	191,109	196,750	218,390
Mount Diablo and Coos Bay	74,210	90,684	66,150
Japan, etc	13,170	20,679	4,220
Total	1,204,555	1,702,833	1,593,850

"To insure a correct statement of the consumption of the State, all the arrivals (by water) at San Pedro and San Diego, amounting to 158,600 tons, have been included.

"The above figures show a marked falling off in our British Columbia imports this year; the low prices ruling caused a partial suspension of shipments, as they were unable to profitably compete with the low prices for Australian and English cargoes. Importers are not solicitous to make contracts for future delivery unless they are paid full figures, as last year's experience is still fresh in their memory, and they are not liable to hazard shipments unless sales are made prior to loading."

DETAILED STATISTICS BY STATES.

In the following pages a detailed statement will be found of the coal output in the different States, by counties, with the distribution of the product for consumption. In the tabulated statements the amount quoted as "made into coke" includes only the portion of the product coked by the operators themselves. It frequently occurs that coal is shipped to distant points and made into coke by the purchasers. Under such conditions the amount coked does not come within the scope of this report, but appears in another chapter on the manufacture of coke by Mr. Jos. D. Weeks.

In the report for 1891, the names of the railroads or water courses over which the product of each county was shipped were published. The changes in transportation routes within the year have been insignificant and this feature has been omitted from the present chapter. The tables showing the production in each State and county have been carried forward and the statistical report has been supplemented by contributions on the coal fields of several of the States by State geologists and others.

ALABAMA.

Total product in 1892, 5,529,312 short tons; spot value, $5,788,898.

The amount of coal produced in Alabama in 1891 was 4,759,781 short tons, valued at the mines at $5,087,596, showing an increase in the product of 1892 of 769,531 short tons, or 16 per cent. in quantity, and $701,302, or 14 per cent. in value. Jefferson county, the first in producing importance, increased from 2,905,343 tons in 1891 to 3,399,274 tons in 1892; Walker, second, from 980,219 tons to 1,103,612 tons; Bibb, third, from 619,809 tons to 793,469 tons; and Tuscaloosa, from 142,184, to 168,039 tons. Saint Clair and Shelby counties each had decreased outputs.

During the year a number of new mines were opened and new drifts started in old mines, and increased business in the future may be looked for. The principal incident in the industry during 1892 was the absorption of the DeBardeleben Coal and Iron Company and the Cahaba Coal Mining Company by the Tennessee Coal, Iron, and Railroad Company of Nashville, Tennessee.

The following table exhibits the coal production of Alabama in 1892, by counties, together with the distribution and value. All of the output is classed as bituminous:

Coal product of Alabama in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Bibb	637,656	1,732	22,806	131,275	793,469	$860,509	$1.08	290	1,500
Jefferson	1,415,569	15,450	98,606	1,869,649	3,399,274	3,504,925	1.03	289	5,860
Saint Clair	20,000	350	600	4,000	24,950	27,445	1.10	200	75
Shelby	27,968	....	....	....	27,968	73,092	2.61	225	150
Tuscaloosa	112,395	4,195	4,463	46,986	168,039	179,130	1.06	261	281
Walker	908,487	4,116	9,152	181,857	1,103,612	1,125,797	1.02	217	2,209
Small mines	....	12,000	....	....	12,000	18,000	1.50	....	....
Total	3,122,075	37,843	135,627	2,233,767	5,529,312	5,788,898	1.05	271	10,075

The following table shows the annual output of the State since 1870, with the exception of 1871 and 1872, for which years no figures are obtainable:

Annual coal product of Alabama since 1870.

Years.	Short tons.	Value.	Average price per ton.
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
1890	4, 090, 409	4, 202, 469	1. 03
1891	4, 759, 781	5, 087, 596	1. 07
1892	5, 529, 312	5, 788, 898	1. 05

Distributed by counties, the product of Alabama for the past four years is shown in the following table, together with the increase or decrease in 1892:

Coal product of Alabama, by counties, since 1889.

Counties.	1889.	1890.	1891.	1892.	Increase in 1892.	Decrease in 1892.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Bibb	500, 525	521, 811	619, 809	793, 469	173, 660	
Jefferson	2, 437, 446	2, 665, 060	2, 905, 343	3, 399, 274	493, 931	
Saint Clair	40, 557	33, 653	66, 096	24, 950		41, 146
Shelby	84, 833	25, 022	34, 130	27, 968		6, 162
Tuscaloosa	16, 141	65, 517	142, 184	168, 039	25, 855	
Walker	488, 226	767, 346	980, 219	1, 103, 612	123, 393	
Small mines	5, 255	12, 000	12, 000	12, 000		
Total	3, 572, 983	4, 090, 409	4, 759, 781	5, 529, 312	*a* 816,839	47, 308

a Net increase, 769,531 short tons.

Bibb county.—Bibb county ranks third in the State as a coal producer, having an output in 1892 of 793,469 short tons, worth $860,509 at the mines. Compared with 1891, when the product was 619,809 short tons, worth $724,094, there was an increase of 173,660, or a little over 28 per cent. in amount, and of $136,415, or 19 per cent. in value. The average price per ton decreased from $1.17 in 1891 to $1.08½ in 1892. The following table shows the annual output of Bibb county since 1886:

Coal product of Bibb county, Alabama, since 1886.

Years.	Short tons.	Value.	Average price per ton.
1886	199, 206		
1887	230, 000		
1888	(*a*)		
1889	500, 525	$604, 230	$1. 20
1890	521, 811	574, 419	1. 10
1891	619, 809	724, 094	1. 17
1892	793, 469	860, 509	1. 08½

a Not published by counties.

Jefferson county.—The output of coal in Jefferson county increased from 2,905,343 short tons, valued at $3,024,723, in 1891, to 3,399,274 tons, worth $3,504,925, in 1892, a gain of 493,931 short tons, or 17 per cent. in amount, and $480,202, or 16 per cent. in value. The average price per ton in 1892 was $1.03 as compared with $1.04 in 1891. Jefferson county is by far the largest producer in the State, having an output more than three times that of Walker county, which ranks second, and yielding more than 60 per cent. of the State's total. Of the product of Jefferson county in 1892, more than 50 per cent., or 1,869,649 short tons, was converted into coke, the most of which was consumed at the iron furnaces at Bessemer and Birmingham.

Coal product of Jefferson county, Alabama, since 1886.

Years.	Short tons.	Value.	Average price per ton.
1886	1, 238, 114		
1887	1, 384, 000		
1888	(*a*)		
1889	2, 437, 446	$2, 618, 777	$1. 07
1890	2, 665, 060	2, 669, 226	1. 00
1891	2, 905, 343	3, 024, 723	1. 04
1892	3, 399, 274	3, 504, 925	1. 03

a Not reported.

Saint Clair county.—The coal product of Saint Clair county in 1892 was 24,950 short tons, having a spot value of $27,445. Compared with the preceding year this indicates a decrease of 41,146 short tons, and $47,978. One of the largest mines was idle until December, which accounts for the decreased output.

Coal product of Saint Clair county, Alabama, for six years.

Years.	Short tons.	Value.	Average price per ton.
1886	71, 950		
1887	53, 000		
1889	40, 557	$50, 518	$1. 25
1890	33, 653	39, 855	1. 18
1891	66, 096	75, 423	1. 14
1892	24, 950	27, 445	1. 10

Shelby county.—Shelby county produced 27,968 short tons in 1892 against 34,130 in 1891, a decrease of 6,162 short tons. The value decreased from $88,678 in 1891 to $73,092 in 1892, a loss of $15,568. The average price per ton realized for the product was practically the same in both years.

Coal product of Shelby county, Alabama, for six years.

Years.	Short tons.	Value.	Average price per ton.
1886	52,000	....	....
1887	54,153	....	....
1889	84,833	$152,166	$1.79
1890	25,022	62,550	2.50
1891	34,130	88,678	2.60
1892	27,968	73,092	2.61

Tuscaloosa county.—The total product of Tuscaloosa county in 1892 was 168,039 short tons, valued at $179,130. This shows an increase over the product of 1891 of 25,855 short tons and $32,094. The average price per ton advanced from $1.03 to $1.07.

Coal product of Tuscaloosa county, Alabama, for six years.

Years.	Short tons.	Value.	Average price per ton.
1886	7,363	....	....
1887	9,000	....	....
1889	16,141	$19,796	$1.23
1890	65,517	68,795	1.05
1891	142,184	147,036	1.03
1892	168,039	179,130	1.07

Walker county.—Walker county stands second in importance of coal production, having something over 20 per cent. of the total output of the State. Its product in 1892 was 1,103,612 short tons, worth $1,125,797 at the mines, an increase over 1891 of 123,393 short tons, or 12½ per cent. in quantity and of $117,155, or 11½ per cent., in value. The average price per ton declined from $1.03 in 1891 to $1.02 in 1892.

Coal product of Walker county, Alabama, for six years.

Years.	Short tons.	Value.	Average price per ton.
1886	179,350	....	....
1887	222,000	....	....
1889	488,226	$506,726	$1.04
1890	767,346	768,624	1.00
1891	980,219	1,008,642	1.03
1892	1,103,612	1,125,797	1.02

THE COAL MEASURES OF ALABAMA.

[By Eugene A. Smith, University of Alabama.]

Professor Tuomey long ago named the coal fields of Alabama from the rivers which drain them, the Coosa, the Cahaba, and the Warrior. Lookout mountain, though its draining streams flow into the Coosa river, is quite distinct in all its features from the Coosa field, and much more closely related to the Plateau region of the Warrior field, though differing in having a much deeper synclinal. It is, in consequence, usually considered in connection with the Warrior field.

The aggregate area of Coal Measures in Alabama is about 8,660 square miles, and this is distributed between the several fields as follows:

Area of the Alabama coal fields.

Fields.	Square miles.
Warrior field:	
Plateau region	2,275
Basin regiou	4,955
Lookout mountain	580
Cahaba field	435
Coosa field	415
Total	8,660

While all the strata of the Coal Measures in Alabama were probably deposited in a continuous body, the whole area has since the deposition been greatly modified by the action of two sets of forces. The first of these forces, acting from the southeast, compressed it into much narrower limits than it originally occupied by throwing it into a series of crests and troughs running approximately parallel with the coast line of the Atlantic. The relatively greater intensity of the compressing forces along the eastern border of our coal area is shown by the fact that there the folds are unsymmetrical, lapped over towards the northwest, and in many cases faulted and overthrust in the same direction.

This has caused the basins of the Coosa and Cahaba fields to be practically monoclinal, for the axis of the synclinal in each lies close to its southeastern edge, and for a very similar reason the prevailing dip of the strata in the separating anticlinals is also to the southeast. Towards the northwest the folds become progressively more open, symmetrical, and less faulted, and there is a far greater proportion of flat measures.

As is the case elsewhere in the Appalachian region, the crests of the compressed and faulted anticlinals have been removed by denudation, and their places are now occupied by valleys which separate the synclinals of the several fields above named. In these valleys the older geological formations down to the Cambrian are exposed.

The second of these deforming forces acted approximately at right angles to the first. By it the strata were thrown into a series of wide open folds or waves, much more symmetrical and less faulted than those produced by the first-named force. By reason of these cross folds a number of subordinate basins have been formed within the limits of each of the great divisions enumerated above; and by a warping of the strata on a much larger scale the Coal Measures have been, towards the northeast, uplifted high above the general drainage level in what we have termed the "plateau region," while towards the southwest, in what is known as the "basin region," they are at and below the drainage level. These distinctions apply more particularly to the Warrior field, though differences in the elevation of the measures as a whole, and in their thickness in the northeastern and southwestern parts, respectively, of the other fields, are sufficiently well marked. In view of these explanations it might be anticipated that we should find many points of resemblance in the structure of these different fields, which were originally one, and which have been disconnected through the agencies of the same forces; and, on the other hand, many points of difference due to nearness to or remoteness from the place of origin of the compressing force. Some of the most obvious of these points of resemblance and difference are the following:

1. Each of these fields is long and narrow in its northeastern part and widens out towards the southwest. The Warrior field shows the greatest amount of widening and the Coosa the least.

2. In the long and narrow parts the Coal Measures, especially in the Lookout mountain and in the plateau region of the Warrior field, are in great part above drainage level, or a large proportion of these measures has been removed by denudation.

3. The axis of the synclinal of each of the basins lies close along its southeastern border, and this feature is most pronounced in the case of the Coosa and Cahaba fields and least in the Warrior. In Blount mountain, lying within the limits of the plateau region of the Warrior field, we find the axis of the synclinal lying along the northwestern edge of the basin, because of a peculiarity of structure to be explained in another place.

4. Each field has an overthrust fault along its southeastern border, and the Coal Measures along that border are generally either vertical or have been overturned toward the northwest. This peculiarity is again least pronounced in the plateau part of the Warrior field, and most so in the Coosa; and here again the Blount mountain forms an exception in having its fault and vertical measures along its northwestern border.

5. The wider part of each field is split by a fault running northeast and southwest approximately parallel with the longer axis of the field, In the Coosa field this fault has the greatest amount of displacement. for by it the strata of the sub-Carboniferous are brought up between the two parts of the field thus separated. In the Cahaba field the displace-

ment is less, and only Coal Measures are brought to the surface, while in the Warrior field the fault shows the smallest amount of displacement. It marks the line of division between the Little Basin and main basin of the Warrior field.

6. In all three fields we find the greatest thickness of Coal Measures in the wide basin part of the field, and in general along or nearer to the southeastern border, and the exception to this rule also is found in the Blount mountain division of the Warrior field, where the greatest thickness is along the northwestern border.

7. The coal from the different fields varies very considerably in general appearance and texture. That from the Coosa and Cahaba fields is tough, gnarly, showing very little disposition to cleave, while the Warrior coal has almost invariably a distinct cubical cleavage, and mines out in large square blocks, in striking contrast to the irregularly rounded lumps brought from the mines of the two other fields. It is quite probable that elaborate chemical investigations will show a corresponding difference in the chemical composition of the coal from the three fields, as a consequence of the varying degree of pressure, amount of folding, faulting, and of movement generally to which these diferent areas have been subjected.

To this general account of the Coal Measures, as a whole, may be added a few particulars concerning the individual fields.

The Coosa field.—This is a long, narrow field extending from northeast to southwest about 60 miles, with an average width of 5 or 6 miles. Near its southwestern end it is doubled by a fault that brings up to the surface strata of sub-Carboniferous age. Each of these two parts of the field is an unsymmetrical synclinal with the axis of the synclinal along its eastern or southeastern edge, and in consequence of this, over the greater part of each basin the prevailing dip of the strata is to the southeast. In the thickest part of each of these divisions, *i. e.* along the axis of the synclinal, there are about 2,000 feet of Coal Measures, including a number of coal seams, three at least of which are 3 feet and upwards in thickness. The only systematic mining as yet done in this field has been in the northeastern end of the longer part, at Ragland, near the extreme northeastern end of the field, and at Broken Arrow or Coal City, 12 miles distant, towards the southwest. At Ragland the seam averages 32 inches and yields a good coke on washing. At Coal City the seam is thicker, 42 inches, perhaps, on an average, with local increase up to 9 feet.

In the shorter and more easterly portion of this field there are known to be at least four good seams of coal. One of these shows a thickness of 9½ to 10 feet and another something over 3 feet. Comparatively little has as yet been done towards the systematic investigation of this field, though the State Geological Survey has very recently undertaken it.

The Cahaba field.—This field has been quite thoroughly examined by Mr. Joseph Squire, of Helena, whose report and fully detailed map have been recently published by the Alabama Geological Survey. It is about 68 miles in length, with a width that varies from 3 or 4 miles in the narrow northeastern part to 15 or 20 miles in the wide part, southwest of the line of the Louisville and Nashville railroad.

The southeastern and southern boundaries of this field are made by a great fault, which brings up the strata of the Cambrian to the level of the Coal Measures. In the narrow upper part of the field the axis of the synclinal is along the southeastern border, and most of the strata have, in consequence, a southeasterly dip. In the wider part, on the other hand, we have much more complication, as well as variety, for in addition to the boundary fault another fault splits the field down its center, and still another fault crosses the southernmost portion from Montevallo westwards for a distance of about 8 miles. Between this fault and the fault that makes the southern boundary of the field at this place a strip of the Coal Measures, about a mile in width and 7 or 8 miles in length, has been completely overturned, so that the strata dip back at an angle of 60 degrees. It is along the border of this area of overturned measures that we find Cambrian shales resting directly upon a seam of coal. This has been described and illustrated by photographic views in Mr. Squire's report. Two other faults have been followed across part of the lower field, and in addition to these faults there have been minor undulations with their axes approximately across the general trend of the field. These undulations and faults have produced the shallow synclinals and flat measures of the various basins into which Mr. Squire has subdivided this field, and of which he enumerates eleven, besides the overturned measures.

The Measures of the Cahaba field have an aggregate thickness of over 5,000 feet, according to Mr. Squire, and include something over fifty seams of coal, of which about sixteen are 2½ feet and upwards in thickness. All the seams of workable size, with one exception, the Gould seam, occur above the middle of the series, most of them being within 1,200 feet of the top of the measures. Active mining has been carried on in a few places only, and upon seven or eight seams. The first, and for many years the only, mining done in this field was in its extreme southwestern end along the Cahaba river, and in the vicinity of Montevallo. Later, when the Louisville and Nashville road was built across the field, many mines were opened along its line in the vicinity of Helena. Next, along the Georgia Pacific road, in the upper part of the field at Henry Ellen, and, lastly, in the lower end of the field again, in the Blocton and Gurnee regions.

About Helena, where mining in past years was most active, a great many test openings were made, and the following seams have been more or less worked. In enumerating these they are given in ascending order: The Wadsworth, Buck, Blackshale, Moyle, Little Pittsburg, Conglomerate, and Helena. The Buck and Blackshale here are distinct seams, but to the northeast, at Henry Ellen, they constitute a large double seam, known as the Mammoth. Some of these seams have received other names in the lower part of the field. Thus the Wadsworth is known also by the names Big Vein and Cahaba; the Buck seam is known as the Clarke in the Dailey Creek basin about Gurnee, and Blackshale, in the Dailey Creek and Blocton basins, has the names Gholson, and Woodstock; and the Conglomerate seam in these same regions is called the Thompson and the Underwood seam. At Montevallo a still higher seam, having the name of Montevallo, has been worked for many years for domestic use. At the present time the mining is practically confined to four localities, viz: Helena, in the upper part of the field on the Wadsworth seam, and Montevallo, Gurnee, and Blocton in the lower end. At the two places last named the Woodstock or Gholson or Blackshale and the Underwood or Thompson or Conglomerate are the two seams that yield all the coal, so that practically all the coal now mined in this field comes from four seams—the Montevallo, the Wadsworth, the Mammoth, which southward divides into two (Buck and Blackshale), and the Thompson seams. Coke is made on a large scale at Blocton. An interesting account of the early history of coal mining in this field is given by Mr. T. H. Aldrich in the writer's report for 1875, and a detailed map already referred to showing the several basins of this field and their lines of outcrop has been published by the Alabama Geological Survey with Mr. Squire's report on the Cahaba coal field.

The Warrior field.—This is by far the largest and most important of the coal areas of Alabama. In it the distinction between basin and plateau, already referred to, is most clearly seen. The approximate limit between the two lies some miles to the northeast of the line of the Louisville and Nashville railroad.

In the Plateau region, as a rule, the synclinals are very shallow and somewhat symmetrical, with exceptions to be noted below, while in the Basin region, as is the case also with the Coosa and Cahaba fields, the axis of the synclinal is much closer to the southeastern border than to the northwestern, so that the greatest thickness of the measures is to be found there; and since the measures as a whole sink towards the southwest, the full series of strata occurs east of Tuscaloosa, near the extreme southeastern end of the field. Here, according to Mr. McCalley, who has been engaged upon the examination of the Warrior field for many years, the aggregate thickness of the measures is something over 5,000 feet and the number of included coal seams over fifty.

A part of the Plateau region makes a very marked exception to the usual order of things as stated above. This is the portion known as the "Blount mountain," lying between Murphrees valley and the great Coosa valley. The eastern border of Blount mountain, like that of the Sand mountain, which is its continuation towards the northeast, is a high bold escarpment capped with Coal Measures, but with sub-Carboniferous strata forming the mountain sides. While the main mass of the Sand mountain is a shallow synclinal, with a thin mantle only of the lowermost strata of the Coal Measures, nearly the whole thickness of the measures has been preserved in the Blount mountain, by reason of its synclinal having been *thrust under* the anticlinal of Murphrees valley, thus bringing the uppermost strata of the coal down to the level of the present drainage. This area is therefore the reversed image of the Cahaba and Coosa field. It is an unsymmetrical synclinal with the axis at the extreme northwestern border, *i. e.*, close to the edge of Murphrees valley. The structure is in consequence apparently monoclinal with northwest dips, and the greatest thickness of the strata is along the northwestern edge, all in direct contradistinction to what we notice in the other fields.

In the other parts of the Plateau region, with another partial exception in the Barry mountain region, lying between Murphrees and Browns valleys, the conglomerates which characterize the lower part of our Coal Measures lie near the surface, and the only coal seams occurring are the interconglomerate and subconglomerate ones. Fortunately these lower seams, which in the Basin regions of the several fields are quite thin and of no economic value, thicken up in the Plateau region and become in places of considerable importance. The best of these seams, and the one most often of workable thickness in northern Alabama, is that which occurs below the lower conglomerate, best known as the Ætna seam, while the seam between the upper and lower conglomerates, known in Tennessee as the Sewanee seam, is next in importance. Neither of these is mined to any extent at this time in Alabama, though both have been in the past.

The basin of the Warrior field like those of the Coosa and Cahaba is not a simple basin with uniform dips, but has its symmetry disturbed by faults and undulations that run both parallel with and across its longest dimension. The two most important of the first named are—

1. The great anticlinal arch of Browns valley, the continuation of the Sequatchee fold of Tennessee running down between the two branches of the Warrior river. This arch, while practically unbroken in the basin, has had most of the strata of the Coal Measures removed from it by denudation. Below the junction of the two Warrior rivers, this anticlinal appears to sink below the general level and the two synclinals which it separates further north merge into one.

2. A thrust fault, beginning at a point nearly west of Bessemer, and running down to Vance's station of the Alabama Great Southern railroad, cuts off what is known as the Little Basin, which is about 20 miles long and 4 or 5 miles in width.

In this basin the great Blue Creek mines have been opened at Adger, Johns, Sumter, etc., by the De Bardeleben company, now merged into the Tennessee Coal and Iron Company. The fault which separates the

Little Basin from the main basin of the Warrior is analogous to the interior fault of the Cahaba field and the fault that divides the Coosa field.

In other parts of the Warrior basin there are minor faults which become evident upon mining, and which are sometimes the cause of trouble. The displacement in these faults is usually not more than 150 feet.

Other disturbances of the regularity of the strata, not accompanied by faulting, but which make it impossible to follow the outcrop of a coal seam by its level, are not uncommon. In the Tuscaloosa district for instance, there is a case in which a coal seam rises nearly 300 feet within the distance of 1 mile. In the early exploration of this field these great differences of level in the same seam have made the identification of the seams a matter of great difficulty.

In the Basin region, where at the present time the greater part of the mining is done, about seven seams are worked. These in descending order are the following: The University, Peterson, Pratt, Newcastle, Jefferson, Black Creek, and Warrior. Two other seams, the double seam, and a large shaly seam near the Newcastle, have also lately been opened. Of these the Pratt seam furnished in 1892 about 50 per cent. of the total of about 5,530,000 tons of coal mined in Alabama, and the Newcastle about 25 per cent. Of the remaining 25 per cent. the two seams of the Cahaba field furnished over 15 per cent., while 10 per cent. was furnished by all the other seams of the Warrior field. While the Pratt seam is now in the lead, it is probable that the Newcastle, by reason of the vast territory which it underlies, will in the future be our most important seam. This seam, though somewhat shaly, yields upon washing a first-class coke, and many new openings are made upon it each year.

For many years the only coal mining in this field was done in the immediate vicinity of the Warrior river and the coal floated down to Mobile in barges. With the building of the Louisville and Nashville road openings were made along its line at Newcastle, Morris, and Warrior stations. Next the Pratt seam was opened near Birmingham, and when the Georgia Pacific railroad was built through Jefferson and Walker counties many new mines were started in these counties. The extension of the Mineral branch of the Louisville and Nashville railroad down the Little Basin afforded finally an outlet to the coal of Blue Creek and the regions about Tuscaloosa.

An account of the early mining in this field by Mr. Aldrich, given in the writer's report for 1875, has already been referred to, and a detailed report on the Warrior field published in 1886, and upon the Plateau region of this field published in 1892, both by Mr. McCalley, contain most of the information upon this area that was available up to the date of their publication. Investigations are being now actively pushed by the State Geological Survey, and in a few years we shall probably be in condition to map accurately the areas underlain by all the workable seams and to give a correct section of the measures, together with identifications of the equivalencies of the seams of the different fields.

The fullest returns for the year 1892 place the output of the Alabama mines at 5,529,312 tons, against 4,759,781 tons in 1892.

ARKANSAS.

Total product in 1892, 535,558 short tons; spot value, $666,230.

The returns from Arkansas indicate a decrease in the amount of coal mined in 1892 as compared with 1891 of 6,821 short tons, but an increase in value of $18,670, the product in the preceding year being 542,379 short tons, with a spot value of $647,560. The average price per ton increased from $1.19 to $1.24. The number of men employed in 1892 was 1,128, who worked an average of 199 days, against 1,317 men for an average of 214 days in 1891.

The following table shows the coal production of Arkansas in 1892, by counties, with the distribution and value:

Coal product of Arkansas in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	Used at mines for steam and heat.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Johnson	89,110	950	1,900	91,960	$122,486	$1.33	203	210
Pope	12,000	500	5,000	17,500	40,500	2.31	288	75
Sebastian	412,798		7,300	420,098	491,244	1.17	190	843
Small mines		6,000		6,000	12,000	2.00		
Total	513,908	7,450	14,200	535,558	666,230	1.24	199	1,128

The coals of Arkansas are classed as bituminous, semi-bituminous, and semi-anthracite. The latter term is sometimes carelessly applied to all Arkansas coals. The physical appearance of the different varieties is similar, which, together with the fact that they merge into each other by almost insensible gradations, has rendered confusion in nomenclature excusable. To the eye they all present more or less the appearance of soft bituminous coal with a cuboidal fracture. There is little or no approach to the hard, glistening anthracite with the semi-conchoidal fracture. Still, upon the basis of fuel ratio and mode of burning, there are some which deserve to be classed as semi-anthracite. Most of the others are of the semi-bituminous variety and even those classed as bituminous are so near the border line as not to have the characteristics of that coal at all pronounced. According to the classification made by the operators, and upon which this report is based, the production of the different varieties in 1892 was as follows:

Product of the different varieties of coal in Arkansas in 1892.

Varieties.	Short tons.
Bituminous	207,640
Semi-bituminous	304,418
Semi-anthracite	17,500
Total (*a*)	529,558

a Exclusive of estimated output of country banks.

According to Dr. J. C. Branner, the coals of Arkansas should be classed as bituminous and semi-anthracite. A report on the coal fields of the State, by Dr. Branner, will be found on page 43.

The following table exhibits the total coal product of Arkansas since 1887, by counties:

Coal product of Arkansas since 1887, by counties.

Counties.	1887.	1888.	1889.	1890.	1891.	1892.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Johnson	81,900	106,037	105,998	89,000	80,000	91,960
Pope	8,200	10,240	6,014	4,000	5,000	17,500
Sebastian	39,500	160,594	165,834	300,888	451,379	420,098
Small mines			(*a*) 1,688	6,000	6,000	6,000
Total	129,600	276,871	279,584	399,888	542,379	535,558

a Product of Franklin county according to the Eleventh Census.

According to the Tenth Census (1880) the output of coal in Arkansas was 14,778 short tons, worth at the mines $33,535. In 1882, according to the reports made to the Geological Survey, the product was only 5,000 short tons, no statistics being obtained for 1881. Since 1882 the annual production has 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 employés.
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

Johnson county.—The coal product of Johnson county in 1892 was 91,960 short tons, valued at $122,486, against 80,000 short tons, worth $112,000, in 1891, a gain of 11,960 short tons in quantity and of $10,486 in value. The average price per ton declined from $1.40 to $1.33. The total number of employés in 1892 was 210, and the mines were active an average of 203 days, against 185 men and 193 days' activity in 1891. The product is classed as semi-bituminous.

Coal product of Johnson county, Arkansas, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Total number of employés.
1887	71,900				
1888	106,037				
1889	105,998	$156,067	$1.48		(a) 172
1890	89,000	130,927	1.47	215	215
1891	80,000	112,000	1.40	193	185
1892	91,960	122,486	1.33	203	210

a Including Pope county.

Pope county.—Pope county produced 17,500 short tons of semi-anthracite coal in 1892, worth $40,500 at the mines, against 5,000 short tons, valued at $15,000, in 1891, an increase of 12,500 tons, and $25,500, the average price per ton decreasing from $3 to $2.31. The labor statistics show 75 men employed for an average of 288 days in 1892, against 40 men for 100 days the preceding year. The output of Pope county is used chiefly in Little Rock and Fort Smith for domestic purposes.

Coal product of Pope county, Arkansas, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Total number of employés.
1887	8,200				
1888	10,240				
1889	6,014	$11,491	$1.91		(a)
1890	4,000	8,000	2.00	200	40
1891	5,000	15,000	3.00	100	40
1892	17,500	40,500	2.31	288	75

a Included in Johnson county.

Sebastian county.—Sebastian county is credited with an output of 207,640 short tons of bituminous and 212,458 short tons of semi-bituminous coal in 1892, making a total of 420,098 short tons. The aggregate value was $475,084. The product in 1891 was 451,379 short tons, worth $508,560, indicating a loss in 1892 of 31,281 short tons in quantity and of $17,316, the loss being in part compensated for by an increase in the average price realized per ton from $1.13 to $1.17. The statistics of production in the past six years have been as follows:

Coal product of Sebastian county, Arkansas, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Total number of employés.
1887	39,500				
1888	160,594				
1889	165,884	$224,153	$1.35		505
1890	300,888	363,668	1.20	214	683
1891	451,379	508,560	1.13	222	1,092
1892	420,098	491,244	1.17	190	843

THE COAL FIELDS OF ARKANSAS.

[By J. C. Branner.]

Geology of the coal regions.—The workable coal beds of Arkansas lie entirely within the drainage area of the Arkansas river. The relief of the country is, in most respects, like that of other sections of similar geologic age in the Appalachian coal fields in Pennsylvania, West Virginia, and Kentucky, but it lies at a somewhat lower level. Along the Arkansas river there are alluvial lands in places 2 or 3 miles wide. These alluvial deposits rest upon older beds of water-worn and oxidized materials that rise on the margins of the valley to terraces that are considerably higher than the bottoms. The great body of the coal area is hilly or mountainous, and the rocks are the sandstones and shales so common in the Coal Measures in other parts of the United States. These sandstones and shales have been more or less folded throughout the entire coal area of the State; in some places the folds are very sharp, while in others the rocks have been but little disturbed. There are also some faults that play an important part in the determination of the coal's distribution, and consequently in that of the value of the land. Erosion has developed over the entire area a characteristic and, at first sight, complicated topography. These topographic features are of great practical value in working out the details of geologic structure and in locating and following the coal beds.

In those districts in which the horizontality of the beds has been but little disturbed there is a bench-and-bluff topography; the topography of the Boston mountains, Magazine mountains, Spring mountain, Petit Jean mountain, and Mount Nebo belong to this type.

In those parts of the region in which the strata have been thrown into well-defined folds, the sandstones withstanding the weathering influences and the shales yielding more readily, a relief or type of topography has been developed that resembles somewhat the grain of wood. This grained variety of topography is well developed in the vicinity of Greenwood, Huntington, Jennings Hill, Waldron, and immediately west of Petit Jean mountain. (*a*)

The age of the coals.—The paleontology of the Arkansas Carboniferous beds has not yet been studied thoroughly, but so far as the evidence of the age of the rocks has been accumulated it points to the following general conclusions:

First, the lower beds of the Arkansas coal-bearing rocks belong to the true Coal Measures, and are not subconglomerate as has been stated. (*b*)

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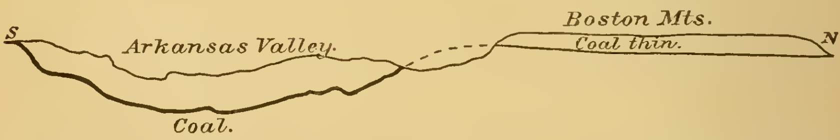
a A paper by Arthur Winslow published in Volume II of the Bulletins of the Geological Society, pages 225–242, contains good descriptions of the physical features of the coal region of Arkansas, and a small map showing the positions of the folds, so far as they had been worked out in 1890.

b Owen thought the coal of Arkansas was below the Conglomerate bed that usually occurs at the base of the Coal Measures. Second Report of a Geological Reconnoissance of Arkansas, 1860, pp. 10, 18, 91, 298, 301, 308, 316, etc.

Second, that the upper beds (in Scott, Sebastian, and Crawford counties, and extending into Indian Territory) are probably Permo-Carboniferous, equivalent to the Permo-Carboniferous beds of Kansas and Nebraska. It also seems probable that Permian beds analogous to those of Texas may yet be identified in the upper strata of the Poteau mountains, for above the beds regarded as Permo-Carboniferous there is a thickness of more than a thousand feet of rocks that has not been examined for fossils.

The coal area.—There has been more or less misapprehension in the public mind regarding the coal area of the State of Arkansas—a misapprehension arising largely from the confusion of Carboniferous formations, Coal Measures, workable coals, and the Tertiary lignites or brown coals. The Carboniferous formations of the state cover an area of 19,260 square miles, the Coal Measures cover an area of 14,700 square miles, while the area of workable coal so far as known covers an area of 1,620 square miles. The last area does not include the total area of the coal horizon, for the reason that the coal horizon does not always contain coal of commercial value. If this horizon were included it would embrace a large part of the Boston mountain area and about 100 square miles in and about Magazine mountain—indeed it would include very nearly all of the area given above as belonging to the Coal Measures.

The following sections show the general relation of the coal basin of the Arkansas valley to the Boston mountain region.



IDEAL SECTION ACROSS THE BOSTON MOUNTAINS AND PART OF THE ARKANSAS VALLEY.

In the Boston mountain region the coal bed is very thin, and often it is not present at all; in a few cases, however, it has been mined in a very small way for blacksmithing purposes. It is not probable that coal of any economic importance will be found in or north of the Boston mountains; the most important coal beds thus far known north of the Boston mountains are those in the Lower Carboniferous rocks in Washington county. These beds are worked for local consumption near Fayetteville.

In the coal region proper the beds of coal vary considerably both in character and thickness; a bed that is not workable at one point often becomes a valuable one a few hundred feet away and *vice versa*.

But little testing with the diamond drill has been done in the coal fields of Arkansas, and the only holes known to have been put down in anything like a systematic manner have been bored in Sebastian county, in the neighborhood of the Jenny Lind mines.

The working out of the structural geology in parts of Logan county shows that in the neighborhood of Paris there are at least six different beds of coal, though some of them are only a few inches in thickness. The lack of railway transportation, however, has thus far prevented the development of the coal deposits of Logan county, as it has of many other portions of the State.

The accompanying map shows the distribution in Arkansas of the coal-bearing horizon of the rocks known to geologists as the Coal Measures, and also of those belonging to the Carboniferous age. The distinctions between these geologic divisions must be borne in mind in order to prevent misconception regarding the extent of the coal deposits of the State.

Adaptability of Arkansas coals.—Arkansas coals are generally classed in trade as semianthracite and bituminous, and these distinctions are understood in such a way as to answer present purposes. The different varieties of coal found in Arkansas are adapted to such different purposes that these adaptabilities should always be kept in mind by those who use them. Those known as semi-anthracites are especially well adapted to domestic uses, while the softer coals serve better for steam making. The great advantage of the semi-anthracites from the Eureka and Ouita mines lies in the ease with which they ignite as compared with true anthracite, and their burning with but little flame or smoke. The bituminous coals ignite more readily and burn more rapidly. Many of them when ignited open slowly with the appearance of intumescence; this exposes an unusually large surface to the flames and makes a very fierce fire.

The experiments made by the Geological Survey of Arkansas to determine the steaming qualities of the coals showed that the three coals tested, namely, those from the Huntington, Coal Hill, and Jenny Lind mines produced more steam to the pound of combustible than the Pittsburg coal—in one case the Arkansas coal producing 15.3 per cent. more steam. The same experiments also showed that in order to get the best results the Arkansas coals require grates that will not allow the loss of coal through the grate bars.(*a*)

Brown coals or lignites—No mention has hitherto been made of the brown coals or lignites. The approximate area of the State covered by coals of this kind is about 720 square miles. They are confined to the Tertiary area of the State and reach their greatest thickness in Ouachita and Union counties, but they occur also in Dallas, Hot Spring, Saline, Grant, Calhoun, Ashley, Drew, Columbia, Nevada, Hempstead, Miller, Lafayette, Bradley, and Cleveland counties. They occur also in the counties along Crowley's ridge.

These lignites have been mined only in Ouachita county; the demand for them is limited, owing to the cheapness and excellence of the true coals.

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a For full results of these tests, see Annual Report of the Geological Survey of Arkansas for 1888, Vol. III, pp. 60 et seq.

The following analyses of Arkansas lignites, made by the State Geological Survey under Dr. Branner, show them to be of unusually good quality:

Partial analyses of Arkansas lignites.

Localities.	Water.	Volatile matter.	Fixed carbon.	Sulphur.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Van Sickle mine, Stephens, Ouachita county.	30.58	31.09	28.56	0.65	9.10
	....	44.80	41.15	.94	13.11
	12.45	39.00	35.53	.56	12.45
Beach drift, Ouachita county	14.47	34.15	33.82	2.99	14.55
Camden Coal Company's Drift	16.75	40.67	35.12	.81	6 64

The experience of the Arkansas Survey with the lignites shows that samples fresh from the mines contain more than twice as much water as they do when allowed to air-dry for about one month.

CALIFORNIA.

Total product in 1892, 85,178 short tons; spot value, $209,711.

The output of coal in California has decreased annually since 1889. The product in 1892 was less than that of 1891 by 8,123 short tons; the value, however, increased $4,809. The falling off has been due chiefly to increased importations, the market being supplied by coal from British Columbia and Australia, with some from Oregon and Washington. Of the product in 1892, 33,160 short tons are classed as bituminous, and 52,018 short tons as lignite. The average price per ton received by operators for bituminous coal ranged from $2.90 to to $4.02; that for lignite from $1.50 to $2.41, the average for the State being $2.46 against $2.20 in 1891.

The following table shows the output in 1892 by counties, together with the distribution and value:

Coal product of California in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	Used at mines for steam and heat.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Amador	25,118	500	....	25,618	$38,427	$1.50	284	26
Contra Costa	39,424	336	1,680	41,440	114,250	2.76	164	110
Fresno	5,400	4,780	550	10,730	39,855	3.71	297	32
Monterey	336	224	....	560	2,250	4.02	80	7
San Bernardino	2,991	3,839	....	6,830	14,929	2.18	230	12
Total	73,269	9,679	2,230	85,178	209,711	2.46	204	187

The total output since 1883 has been as follows:

Coal product of California since 1883.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Total number of employés.
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

Amador county.—The total product in 1892 was 25,618 short tons, worth $38,427, against 29,502 short tons, valued at $48,803, in 1891, and 33,610 short tons, valued at $55,515, in 1890, indicating a decrease in 1892 as compared with 1891 of 3,884 short tons, or 13 per cent. The statistics of production for the past four years have been as follows:

Coal product of Amador county, California, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	40,900	$75,075	$1.84		57
1890	33,610	55,215	1.64	291	47
1891	29,502	48,803	1.65	284	34
1892	25,618	38,427	1.50	284	26

Contra Costa county.—Contra Costa county produced 41,440 short tons of coal in 1892, valued at $114,250, against 56,335 short tons, valued at $136,600 in 1891, showing a decrease of 14,895 short tons and $22,350. There was an increase in the average price per ton, however, from $2.42 to $2.76. Of the total product 28,000 short tons were classed as bituminous and 13,440 tons as lignite.

Coal product of Contra Costa county, California, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	64,945	$161,190	$2.48		149
1890	66,974	193,804	2.89	305	247
1891	56,335	136,600	2.42	260	162
1892	41,440	114,250	2.76	164	110

Fresno county.—The output of coal in Fresno county in 1892 was 10,730 tons, valued at $39,855. This is largely in excess of the output in 1891, when only 180 tons were produced, and considerably more than that of either 1889 or 1890, when the product was 8,100 tons and 5,000 tons, respectively. The small product in 1891 was due to the fact that the mine which produced the greater part of the coal in 1889 and 1890 was idle in 1891, and the new mine credited with the entire product of 1891 was just opening up.

Both of these mines were operated in 1892. The product of 1892 is returned as bituminous, and was sold principally for local consumption.

Coal product of Fresno county since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	8,100	$17,859	$2.20	....	21
1890	5,000	20,000	4.00	312	30
1891	180	360	2.00	90	18
1892	10,730	39,855	3.71	297	32

Monterey county.—A total output of 560 short tons, valued at $2,250, is reported from Monterey county, against 1,000 short tons, worth $5,000 in 1891. The coal is classed as bituminous, 60 per cent. of it being shipped and 40 per cent. used locally.

Coal product of Monterey county, California, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	672	$3,600	$5.36	....	17
1890	125	1,000	8.00	....	30
1891	1,000	5,000	5.00	50	30
1892	560	2,250	4.02	80	7

San Bernardino county.—In 1892 San Bernardino county produced 6,830 short tons of lignite, worth $14,929, an average of $2.19 per ton. In 1891 the output was 6,284 short tons, valued at $14,139, an increase of 546 tons and $790, but showing a decline of 7 cents per ton on the average price realized.

Coal product of San Bernardino county, California, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	5,203	$13,008	$2.50	....	12
1890	5,000	13,000	2.60	216	10
1891	6,284	14,139	2.25	249	12
1892	6,830	14,929	2.18	230	12

THE COAL DEPOSITS OF CALIFORNIA.

[By H. W. Turner.]

So far as known to the writer, the coal deposits of California that are of economic value occur entirely in deposits of Tertiary age. As a general rule the older the formation is in which the coal occurs, the more valuable is the coal.

The oldest Tertiary (Eocene) rocks, the Tejon formation, has thus far in California produced much the largest quantity of coal. The Tejon formation in central California consists chiefly of white sandstone, with subordinate amounts of shale. The rocks of this age contain numerous characteristic fossils, among which *Turritella uvasana* and *Meretrix uvasana* are common. The Monte Diablo, the Corral Hollow, and the Livermore coal fields all belong to the Eocene or Tejon formation. Of these the first has produced much the most coal.

The Corral Hollow mines, long since suspended, are in a disturbed district, some of the coal seams now standing vertical, according to Mr. W. A. Goodyear, (*a*) and the structure of the region is further complicated by faulting, so that it is difficult and expensive to follow the coal seams.

The same is true of the Livermore district which lies near the head of Corral Hollow, and may be considered a part of the Corral Hollow district. The coal seams of the Livermore district are large and the coal appears to be of as good quality as that at Monte Diablo, but although considerable work has been done within the last few years, no large amount of coal has been produced.

Coal occurs in the Tejon formation on the southwest slope of Monte Diablo or on the opposite side of the mountain from the producing coal mines. It also occurs near New Ionia in Fresno county, on the Tejon ranch in Kern county, and it is probable that many of the localities from which coal is reported in southern California are in the Tejon formation.

The only other formation that has produced much coal occurs along the foothills of the Sierra Nevada. Being well developed about Ione, in Amador county, this has been designated on the geological maps of California as the Ione formation. It is thought to be late Miocene in age. The formation consists of clay and sandstone, with coal seams, and some iron deposits. The sandstone, both white and red, is quarried and used for building stone, and the clay is quarried extensively for pottery at Lincoln, in Placer county, at Carbondale, in Amador county, and Valley Springs, in Calaveras county.

Coal has been found in the Ione formation at many points in the Ione valley, and near Carbondale, in Buckeye valley. Smaller amounts of coal have been found near Sancho Plana, in Amador county, and croppings of Coal Measures, similar to those at Ione, are said to occur in the low foothills of the Sierra Nevada, in Stanislaus county. Coal has been mined also in a small way at Lincoln, near the pottery clay deposits. According to the Eighth Annual Report of the State Mineralogist of California, pp. 110–112, there are three coal seams underlying Ione valley, of which the lowest is from 9 to 15 feet in thickness.

Coal has been reported from many places in the vicinity of Eel and Mad rivers, in Mendocino county, and, according to Mr. Goodyear, the

(*a*) Geol. Calif., vol. II. Appendix p. 36–38.

coal seams are large; but the country is too much disturbed to make it likely that mining can be carried on with much profit.

Coal is said to occur at the following localities, a few only of which have thus far been productive:

Solano county.—Northeast side of Vaca valley, on the Marshall ranch, Suisun creek in the American canyon.

Yolo county.—Near the head waters of Cottonwood creek and other localities.

Trinity county.—Cox's bar; Hay Fork valley; Hyampose valley.

Stanislaus county.—Thirteen miles northeast of Newman's on D. Hoge's ranch.

Santa Clara county.—San Benito creek on the ranch of Mills & Lux; at the head waters of Uvas creek; also due east of Milpitas in the Mount Hamilton range.

San Mateo county.—Deer and Corte Madera creeks.

San Joaquin county.—Lone Tree creek.

Merced county.—Between Bear creek and the Merced river.

Los Angeles county.—Fulton Wells.

Orange county.—Santa Clara and other mines on Santiago creek.

Other localities are noted in the table of analyses.

So far as known to the writer, no workable deposit of anthracite coal has been found in any portion of the State.

The following table of analyses has been compiled chiefly from the report on coals by Prof. S. F. Peckham in the appendix to Vol. II, Geology of California, and the reports of the State Mineralogist of California.

Analyses of California coals.

Localities.	Water.	Volatile combustible material.	Fixed carbon.	Ash.	Analysts.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	
Monte Diablo:					
Black Diamond mine	13.015	42.15	34.235	10.600	S. F. Peckham.
Do	13.08	42.93	38.855	5.135	Do.
Clark bed	11.64	45.67	34.555	8.195	Do.
Union mine	11.56	47.365	34.43	6.645	Do.
Corral Hollow	15.015	41.435	30.805	12.745	Do.
Livermore dist., Summit mine.	16.00	41.75	34.00	8.25	W. D Johnston.
Panoche Pass, Fresno county.	13.73	31.73	31.54	23.00	Hanks.
Tejon Pass, Kern county	10.47	34.60	44.86	10.07	Do.
Santa Clara mine, Los Angeles county.	7.87	29.93	49.53	12.67	Do.
Cajon Pass, San Bernardino county.	9.67	27.67	49.53	16.13	Do.
McIntosh Cheney mine, San Diego county.	20.00	32.26	27.74	20.00	Do.
Cienegadel Gabian ranch, San Benito county.	18.40	31.15	30.00	20.45	Do.
Elsinor coal field, San Diego county.	2.65 to 19.00	41.00 to 46.50	7.40 to 28.65	11.85 to 45.70	Price and Johnston.
Livermore district	18.08	39.30	35.61	7.01	Thomas Price.
Do	20.78	31.00	42.46	5.70	Do.
Ione Valley	4.00	39.90	13.10	46.00	Edward Booth.
Eel river, Mendocino county	8.14	45.54	38.67	7.66	Peckham.
Do	8.595	47.315	37.485	6.605	Do.
Do	8.555	48.51	37.88	5.055	Do.
Shasta county, near Redding	9.50	37.50	46.25	6.75	

COLORADO.

Total product in 1892, 3,510,830 short tons; spot value, $5,685,112. Previous to 1891 the information regarding the output in Colorado, as well as for the other States and Territories of the Rocky Mountain division, was obtained by Mr. F. F. Chisolm, whose headquarters were in Denver. For 1891 the output was reported by Mr. John McNeil, State inspector of coal mines. In 1892, however, the statistics were collected by direct correspondence with operators, and it is exceedingly gratifying to be able to state that at the time of going to press only one operator out of a total of nearly 75, representing nearly 100 mines of commercial importance, has failed to furnish a statement.

The returns show a total product but little different from though slightly less than that of 1891, while the total value indicates a gain of $885,112. It is but fair to state, however, that the valuation of their product was not reported by two or three of the larger operators, and the estimated value placed thereon may have been more than that actually received. The actual decrease in the output of the State was 1,802 short tons. The production by counties and according to the distribution for consumption was as follows:

Coal product of Colorado in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Arapahoe	....	654	....	....	654	$1,308	$2.00	150	2
Boulder	465,004	58,459	22,100	....	545,563	744,515	1.36	193	1,128
Delta	....	200	....	....	200	300	1.50	100	2
Douglas	....	200	....	....	200	200	1.00	80	3
El Paso	23,014	....	....	....	23,014	28,768	1.25	200	40
Fremont	480,803	39,915	18,169	....	538,887	1,037,152	1.92	195	1,040
Garfield	267,335	....	....	10,459	277,794	555,588	2.00	248	423
Gunnison	141,944	....	....	83,316	225,260	413,383	1.84	259	368
Huerfano	541,733	....	....	....	541,733	1,083,466	2.00	253	947
Jefferson	7,018	12,501	1,700	....	21,219	41,943	1.90	233	50
La Plata	80,160	1,160	180	....	81,500	143,698	1.76	288	124
Las Animas	863,342	8,599	4,022	295,106	1,171,069	1,433,897	1.22	246	1,450
Mesa	2,000	2,500	50	500	5,050	12,500	2.48	125	12
Montezuma	....	30	....	....	30	45	1.50	15	3
Park	66,027	495	9,500	....	76,022	183,213	2.40	266	140
Rio Blanco	....	100	....	....	100	100	1.00	40	2
Routt	....	330	....	....	330	626	1.90	27	9
Weld	600	1,605	....	....	2,205	4,410	2.00	300	4
Total	2,938,980	126,748	55,721	389,381	3,510,830	5,685,112	1.62	229	5,747

The coals of Colorado include lignite, bituminous, semi-bituminous, and anthracite. The last mentioned is mined exclusively in Gunnison county, while all of the semi-bituminous product is obtained from Fremont county. The total product of the different varieties in 1892 was as follows:

Varieties of coal produced in Colorado in 1892.

Varieties.	Short tons.
Lignite	590,576
Bituminous	2,746,492
Semi-bituminous	110,899
Anthracite	62,863
Total	3,510,830

In importance of coal production, Las Animas county ranks first, with a total of 1,171,069 short tons in 1892, more than double that of Huerfano county, which comes second, and nearly one-third the entire output of the State. Huerfano county jumps from fourth to second place, Fremont and Boulder counties falling from second and third places to third and fourth. The product of each of these three counties exceeded half a million tons and the difference between the highest and lowest was less than 14,000 tons.

The following table exhibits the production, by counties, since 1887, with the increases and decreases in 1892 as compared with 1891:

Coal product of Colorado since 1887, by counties.

Counties.	1887.	1888.	1889.	1890.	1891.	1892.	Increases in 1892.	Decreases in 1892.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Arapahoe	16,000	1,700	823	700	1,273	654		619
Boulder	297,338	315,155	323,096	425,704	498,494	545,563	47,069	
Dolores	1,000	200		800	3,475			3,475
El Paso	47,517	44,114	54,212	25,617	34,364	23,014		11,350
Fremont	417,326	438,789	274,029	397,418	545,789	538,887		6,902
Garfield	30,000	115,000	239,292	183,884	191,994	277,794	85,800	
Gunnison	243,122	258,374	252,442	229,212	261,350	225,260		36,090
Huerfano	131,810	159,610	333,717	427,832	494,466	541,733	47,267	
Jefferson	12,000	9,000	10,790	10,984	17,910	21,219	3,309	
Las Animas	506,540	706,455	993,534	1,154,668	1,219,224	1,171,069		48,155
La Plata	22,880	33,625	34,971	43,193	72,471	81,500	9,029	
Mesa		300	1,100	1,000	5,000	5,050	50	
Park	23,421	46,588	41,823	49,594	52,626	76,022	23,396	
Pitkin	4,000	28,113		74,362	91,642			91,642
Weld	39,281	28,054	28,628	46,417	22,554	2,205		20,349
Routt			1,491	705		330	330	
Larimer			100	1,500				
Douglas	3,500	400	260	700		200	200	
San Miguel			1,800	1,500				
Delta			1,357	775		200	200	
Montezuma			816	238		30	30	
Rio Blanco			2,900	200		100	100	
Total	1,795,735	2,185,477	2,597,181	3,077,003	3,512,632	3,510,830		(a) 1,802

a Net decrease.

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 1877 being given by counties and subsequently by districts:

Coal product of Colorado from 1864 to 1892.

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	
	Northwestern division	1,064	
	Unreported mines	50,000	
			437,005
1881	Northern division	156,126	
	Central division	174,882	
	Southern division	269,045	
	Northwestern division	6,691	
	Unreported mines	100,000	
			706,744
1882	Northern division	300,000	
	Central division	243,694	
	Southern division	474,285	
	Northwestern division	43,500	
			1,061,479
1883	Northern division	243,903	
	Central division	396,401	
	Southern division	501,307	
	Northwestern division	87,982	
			1,229,593
1884	Northern division	253,282	
	Central division	296,188	
	Southern division	483,865	
	Northwestern division	96,689	
			1,130,024
1885	Northern division	242,846	
	Central division	416,373	
	Southern division	571,684	
	Northwestern division	125,159	
			1,356,062

Coal product of Colorado from 1864 to 1892—Continued.

Years.	Localities.	Product.	
		Short tons.	
1886	Northern division	260,145	
	Central division	408,857	
	Southern division	537,785	
	Northwestern 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
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	508,454	
			3,510,830

NORTHERN DIVISION.

Arapahoe county.—The product of Arapahoe county is from one mine at Scranton, operated by the Colorado Eastern Railway Company. The coal is bituminous, and is consumed by the railroad company's locomotives.

Coal product of Arapahoe county, Colorado, since 1886.

Years.	Short tons.
1886	11,000
1887	16,000
1888	1,700
1889	823
1890	700
1891	1,273
1892	654

Boulder county.—This county produced 518,313 short tons of lignite coal in 1892, valued at $701,862, against 498,494 tons in 1891. The increase was 19,819 short tons. Although the coal is of the lignite variety, and, consequently, inferior in quality to that in the southern and western portions of the State, its proximity to Denver, and excellent facilities for transportation create a good demand.

Coal product of Boulder county, Colorado, since 1886.

Years.	Short tons.	Years.	Short tons.
1886	220,287	1890	425,704
1887	297,338	1891	498,494
1888	315,155	1892	518,313
1889	323,096		

Jefferson county.—The total product of Jefferson county in 1892 was 21,219 short tons, worth $41,943, or $1.90 per ton at the mines. The amount mined in 1891 was 17,910 short tons, showing an increase of 3,309 in 1892. The coal is lignite, and supplies a local trade, and that of adjacent towns.

Coal product of Jefferson county, Colorado, since 1886.

Years.	Short tons.	Years.	Short tons.
1886	9,928	1890	10,984
1887	12,000	1891	17,910
1888	9,000	1892	21,219
1889	10,790		

Larimer county.—No product has been reported from Larimer county since 1890.

Routt county.—A small amount of coal is mined in Routt county annually to supply ranchmen and miners in the vicinity. There are no railroad facilities and the county is sparsely settled. The amount of coal mined in 1892 was 330 short tons, which sold for $626. Seventy-five tons were reported as lignite, the remainder being bituminous. No coal was reported from this county in 1891.

Coal product of Routt county, Colorado, since 1889.

Years.	Short tons.	Years.	Short tons.
1889	1,491	1891	....
1890	705	1892	330

Weld county.—The output of Weld county decreased from 22,554 short tons in 1891 to 2,205 short tons in 1892. The principal mine in the county, the Mitchell, owned by the Colorado Fuel and Iron Company, was idle throughout the year, and two other mines of small importance were closed. Of the two mines worked, the output of one is reported as lignite and the other bituminous, and they are so taken in the table showing the output by varieties. It is probable, however, that all should be called lignite, uniformly with the other northern Colorado coals.

Coal product of Weld county, Colorado, since 1886.

Years.	Short tons.	Years.	Short tons.
1886	20,450	1890	46,417
1887	39,281	1891	22,554
1888	28,054	1892	2,205
1889	28,628		

CENTRAL DIVISION.

Douglas county.—Mining in Douglas county is carried on upon a very small scale to supply a limited local demand. The coal is classed as bituminous, 200 tons being produced in 1892.

No coal was reported from this county in 1891.

Coal product of Douglas county, Colorado, since 1887.

Years.	Short tons.	Years.	Short tons.
1887	3,500	1890	700
1888	400	1891	....
1889	260	1892	200

El Paso county.—The product in 1892 was 23,014 short tons, having a spot value of $28,768. In 1891 the output was 34,364 short tons, indicating a decrease of 11,350 tons in 1892. The coal is a rather inferior lignite.

Coal product of El Paso county, Colorado, since 1886.

Years.	Short tons.	Years.	Short tons.
1886	53,000	1890	25,617
1887	47,517	1891	34,364
1888	44,114	1892	23,014
1889	54,212		

Fremont county.—Fremont county ranks third as a coal producer in 1892, the total output being 538,887 short tons, valued at $1,037,152. The product in 1891 was 545,789 short tons, showing a decrease in 1892 of 6,902 short tons. Of the product in 1892, 427,988 tons are reported as bituminous and 110,899 tons as semi-bituminous. The principal mines are operated by the Cañon City Coal and Coking Company, the Colorado Fuel and Iron Company, and the United Coal Company.

Coal product of Fremont county, Colorado, since 1886.

Years.	Short tons.	Years.	Short tons.
1886	332,024	1890	397,418
1887	417,326	1891	545,789
1888	438,789	1892	538,887
1889	274,029		

Park county.—Como No. 5, operated by the Union Pacific Coal Company, continues to be the only producing mine. The output in 1892 was 76,022 short tons, against 52,626 short tons in 1891, an increase of 23,396 tons. The product is a good bituminous coal.

Coal product of Park county, Colorado, since 1886.

Years.	Short tons.	Years.	Short tons.
1886	23,823	1890	49,594
1887	23,421	1891	52,626
1888	46,588	1892	76,022
1889	41,823		

SOUTHERN DIVISION.

Dolores county.—No product was reported from Dolores county in 1892.

Huerfano county.—All of the producing mines of Huerfano county are controlled by the Colorado Fuel and Iron Company. The output in 1892 was 541,733 short tons, being an increase over the product of 1891 (494,466 short tons) of 47,267, and bringing the county from fourth place to second, which rank it held in 1889 and 1890. The entire product is bituminous.

Coal product of Huerfano county, Colorado, since 1886.

Years.	Short tons.	Years.	Short tons.
1886	89,913	1890	427,832
1887	131,810	1891	494,466
1888	159,610	1892	541,733
1889	333,717		

La Plata county.—The annual product of La Plata county has shown a continuous increase since 1886, the output in 1892 (81,500 short tons) being 9,029 short tons in excess of that of 1891, when 72,471 tons were produced. All of the coal is bituminous, the price per ton ranging from \$1.62½ to \$3, the average being \$1.76.

Coal product of La Plata county, Colorado, since 1886.

Years.	Short tons.	Years.	Short tons.
1886	18,166	1890	43,193
1887	22,880	1891	72,471
1888	33,625	1892	81,500
1889	34,971		

Las Animas county.—Las Animas is by far the most important coal-producing county in the State, yielding over 30 per cent. of the State's total, and having more than double the output of Huerfano county, which ranks second. The product, which is altogether bituminous coal, was in 1892 1,171,069 short tons, a decrease, as compared with 1891, when the tonnage was 1,219,224, of 48,155 short tons.

Coal product of Las Animas county, Colorado, since 1886.

Years.	Short tons.	Years.	Short tons.
1886	429,706	1890	1,154,668
1887	506,540	1891	1,219,224
1888	706,455	1892	1,171,069
1889	993,534		

WESTERN DIVISION.

Delta county.—A small amount of bituminous coal is mined in Delta county to supply a limited local demand. The output in 1892 was 200 short tons, which sold for $1.50 pèr ton. No product was reported in 1891.

Coal product of Delta county, Colorado, since 1889.

Years.	Short tons.	Years.	Short tons.
1889	1,357	1891	....
1890	775	1892	200

Garfield county.—Garfield county produced in 1892 277,794 short tons of bituminous coal, valued at $555,588. This was the largest output in the history of the country, the largest previous product being in 1889, when 239,292 tons were obtained. The coal is of good quality, and of the product in 1892 10,459 tons were coked. The output in 1891 was 191,994 tons, the increase in 1892 being 85,800 short tons, or about 45 per cent.

Coal product of Garfield county, Colorado, since 1887.

Years.	Short tons.	Years.	Short tons.
1887	30,000	1890	183,884
1888	115,000	1891	191,994
1889	239,292	1892	277,794

Gunnison county.—The output of coal in Gunnison county in 1892 was 225,260 short tons, 62,863 tons of which were anthracite and 162,397 tons bituminous. Of the bituminous product 83,316 tons were made into coke.

Coal product of Gunnison county, Colorado, since 1886.

Years.	Short tons.	Years.	Short tons.
1886	159,951	1890	229,212
1887	243,122	1891	261,350
1888	258,374	1892	225,260
1889	252,442		

Mesa county.—A total output of 5,050 tons of bituminous coal is reported for 1892, being 50 tons more than in 1891.

Coal product of Mesa county, Colorado, since 1888.

Years.	Short tons.	Years.	Short tons.
1888	300	1891	5,000
1889	1,100	1892	5,050
1890	1,000		

Montezuma county.—The coal of the La Plata beds outcrops in several places in Montezuma county and a small amount is mined near the town of Cortez to supply a local demand. The amount reported in 1892 was only 30 tons and no product was reported in 1891.

Pitkin county.—The only producing mine in this county is the Spring Gulch colliery operated by the Grand River Coal and Coking Company. The mine was idle during the entire twelve months of 1892. The coal makes an excellent coke for blast furnace use and most of the product is so consumed.

Coal product of Pitkin county, Colorado, since 1887.

Years.	Short tons.	Years.	Short tons.
1887	4,000	1890	74,362
1888	28 113	1891	91,642
1889	....	1892	....

Rio Blanco county.—Only a small amount of coal is mined in Rio Blanco county, to supply the local trade at Meeker. The product in 1892 was 100 short tons, none being reported in 1891.

San Miguel county.—No production of coal in San Miguel county was reported in either 1891 or 1892, the prophecy made in the report for 1889–'90 that the introduction of other coal through the completion of the Denver and Rio Grande Southern railroad would stop the domestic production seeming to have been fulfilled.

COAL FIELDS OF COLORADO.(a)

[By R. C. Hills.]

INTRODUCTION.

The coal fields of Colorado have an aggregate area of about 18,100 square miles, exclusive of certain portions of the Measures which, for reasons subsequently referred to, presumably do not contain coal beds of workable thickness. While the productive Measures throughout

a Abstract of a series of papers intended for contribution to the Proceedings of The Colorado Scientific Society, but not yet completed.

the State are, in the main, of the same age, they are not continuous, but are separated by areas of maximum erosion and by the Rocky mountain ranges into six entirely independent fields, viz., Raton, South Platte, North Park, Grand River, Yampa, and La Plata—besides three small, but important districts hereafter mentioned, and a limited area of the coal-bearing Dakota Cretaceous in southwestern Colorado. Of the six fields above designated, the first three lie east of the main range and the last three to the west of it. For convenience, these will sometimes be referred to as the Eastern and Western groups, repectively.

The Measures of Colorado afford nearly every variety of coal, from a typical semi-lignite to an equally typical anthracite; though, of the latter, only the most inferior portion has yet been placed upon the market. The bulk of the coal mined is of the kind known as "domestic"—a slightly-caking variety approaching in composition and appearance the European "splint" and "cherry." This coal finds a ready market in Nebraska and Kansas, as far east as Missouri river points. Texas and South Dakota also purchase large quantities of this kind of fuel. The coking coal, of which there is an abundant supply, is mined, principally, for locomotive use; the "slack" being made into coke and sold to the various metallurgical establishments of the Cordilleras, as far north as Montana and as far south as central Mexico. The anthracite is quite limited in quantity, and the aggregate area will not exceed 8 square miles, if as much. It is sold throughout the region west of the Missouri river to the Pacific coast; but the demand is not great, owing to the remarkable excellence and relatively low price of the dry, soft coals.

The fields of the Eastern group are by far the most accessible to the principal markets; in fact, the steep grades and long haul over the range seriously handicap the colliery products of the Western fields, so that little but coke and anthracite can be transported to the markets on the Atlantic slope. Nevertheless, these fields are already accessible, west through Utah to the undeveloped mining region of the Great basin, and will shortly have an outlet south into New Mexico and Arizona, and before many years a northern outlet through Wyoming into the prairie region.

THE COAL-BEARING LARAMIE.

Age of the 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 Upper Cretaceous age. Indeed, of the 18,100 square miles above credited to Colorado, all but 150 square miles referable to the Dakota may, without involving any serious error in the estimates, 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 and the prairie States, it being preeminently the coal-bearing formation throughout the country west of the one hundred and fifth meridian.

Geographical range of the Laramie.—This group has been, as yet, but imperfectly defined, notwithstanding that it has attracted more attention and invited more discussion than any other Rocky mountain group of equal geographical extent. Theoretically, it is limited below by the Montana group of the marine Cretaceous; and above by the base of the Wasatch Eocene. In Colorado, however, it is not always possible to determine, satisfactorily, where the Montana ends and the Laramie begins. This is noticeably the case at certain points along the northwestern border of the Grand river field, where Laramie shells, such as *Corbula*, *Ostrea*, *Corbicula*, and *Unio* are found at the base of the lower series of workable coal seams, and *Inoceramus*, *Cardium*, and *Halymenites* towards the summit, indicating that the transition from marine to brackish water conditions was marked in places by alternations of these conditions. Under such circumstances it seems advisable to make the base of the workable Measures coincide with the base of the Laramie, and thus include in one group what is stratigraphically a continuous series of coal-bearing beds.

The upper limit of the group, is, if anything, less clearly defined than the lower; it being a recognized fact, to which attention has been called by Dr. C. A. White (*a*) that in certain localities the change from Laramie to Eocene sediments is gradual, or such as might be expected to occur were the material derived throughout, from the erosion of neighboring Archæan areas and deposited in shallow, fresh-water basins.

It is only in Colorado that the stratigraphical relations of the Laramie have been studied in sufficient detail to determine where the line should be drawn between this group and the beds succeeding it, which are either transitional or very early Eocene. Here it has been shown that there are two well-defined terranes, separating unconformably the true Laramie below from the Wasatch Eocene above. The relation of these beds (post-Laramie) to the groups just mentioned, and to the post-Cretaceous movement, has been discussed elsewhere by the writer (*b*) and very fully by Dr. Whitman Cross, (*c*) who has carefully investigated the subject in its stratigraphical and paleontological aspects. These discussions emphasize the fact that the sediments (Arapahoe beds, Ohio Creek beds) immediately succeeding the Laramie are not like the latter, wholly composed of Archæan débris; but contain material derived from all earlier sediments, as low as the Carboniferous, thus indicating great elevation, at least equal to the aggregate thickness of these sediments along the Rocky mountain axis.

a Amer. Jour Sci., Third Series, Vol. XXXV, p. 438.

b Orographic and Structural Features of Rocky Mountain Geology. Proc. Colo. Sci. Soc., Vol. III, pp. 388–397. 1890.

c Post-Laramie Deposits of Colorado. Amer. Jour. Sci., Vol. XLIV, pp. 27–31. July, 1892. Post-Laramie Beds of Middle Park. Bul. Col. Sci. Soc., Oct. 3, 1892.

Isolated areas of these beds are found in the Denver basin, at Cañon City in Fremont county, on Ohio creek in Gunnison county, and on the Pi-ce-ance in Garfield county. They are overlaid by highly characteristic, tufaceous, sandstones and conglomerates (Denver beds, Ruby beds, Middle Park beds, Animas beds) extensively developed along the mountain border, but thinning out beneath the Wasatch Eocene wherever the latter succeeds them. It is worthy of remark that similar tuffs have been described as occurring conformably at the top of the Laramie in Montana. (*a*) From all that is now known in relation to the post-Laramie terranes, it appears most consistent with the structural and floral evidence, to regard the base of the Arapahoe, Ohio creek, and equivalent beds as defining the upper limit of the Laramie group in Colorado.

Causes effecting the alteration of Laramie coals.—In no other coal fields of the world can there be shown such wide variations in the character of the coal within such narrow limits as are seen in Colorado, where, in a fractional portion of one field alone, we may find every stage of alteration represented, from lignite to anthracite. The conditions associated with the occurrence of the several kinds of coal in this region offer a simple explanation of the presence of lignite in measures which near by in the same field may contain all the varieties resulting from the alteration of this substance. The Laramie coals being much more recent than those of Carboniferous age, the slow operation of the causes which have produced the partial or complete alteration of the latter, would hardly have sufficed to advance the former beyond the lignite stage. But in the Rocky mountains enormous quantities of eruptive material were, from time to time, intruded into the Measures on the laccolite principle, as vast irregular bodies of mountain dimensions. As a result chemical activity was greatly increased through elevation of temperature in adjacent areas of measures, sufficiently so in local instances to carry the alteration to completion.

Eruptive occurrences directly associated with the coal-bearing formation are more numerous in Colorado and northern New Mexico than elsewhere, being almost entirely wanting in eastern Utah, Wyoming, and Montana. The magnitude of the eruptive bodies and their structural form indicate in a general way the degree of alteration attained by the coals of adjacent Measures. Thus in Colorado there are large deposits of coking coal in the districts nearest to the principal eruptive centers, and enormous areas of semi-coking coal in districts somewhat removed from these centers, while anthracite occurs only in a few localities where the Measures are in immediate contact with the eruptive bodies or sufficiently near to have suffered alteration, and lignite where such bodies are of very small size or entirely wanting. The degree of alteration produced seems to have depended as much on the mode of

a The Cinnabar and Bozeman Coal Field of Montana. By Walter Harvey Weed. Bul. Geol. Soc. Am., Vol. II, pp. 349–364.

occurrence of the neighboring eruptive mass as upon its magnitude—that is, certain structural conditions are associated with the presence of certain kinds of coal. In the case of coking coal and anthracite the association of what is known as Henry mountain structure, or a modified form of it, seems to be essential. This type of structure results from the uplifting of the strata into the form of a flat dome by the intrusion, more or less comformably, of a lense shaped body of lava. Such an occurrence constitutes a typical laccolite, though few laccolites possess this characteristic development, and the principle upon which they are formed gives rise, under different conditions, to many modified examples. Thus, the sheet-like intrusion, owing to the manner of origination, may be regarded as an extreme form of this type, the opposite extreme being represented by the beehive laccolite, which is bounded by steep, sometimes vertical sides. The former result from intrusions of highly fluid lavas of basaltic composition; the latter, from the intrusion of plastic, acid lavas, such as porphyry, diorite, and porphyrite. Since the large majority of these bodies consolidated in the soft, shaly beds underlying the Laramie, and under very similar conditions, it is evident that the degree of fluidity possessed by the magma at the time of eruption had much to do in determining the form of the laccolite.

The position of an eruptive body with reference to the Coal Measures is of the utmost importance. Vast extravasations of lava, such as that of the Raton mountains or of Grand and Tongue mesas, can be shown to have exercised but little direct influence in promoting alteration in adjacent districts. The intrusive bodies alone are responsible for the important changes that are to be credited to eruptive activity, which fact will appear more fully as the several coal fields are described.

Outside of the districts, where alteration is clearly attributable to the presence of eruptive bodies, there are broad areas wherein it is evident that causes not necessarily connected with igneous activity have been instrumental in advancing alteration beyond the lignite stage. These causes were: (1) Great accumulation of post-Laramie and Eocene sediments on the subsiding Coal Measures, inducing chemical changes by elevation of temperature, so that beneath the great Eocene lake deposits the lower coal seams may for long periods have been subjected to a temperature approaching the boiling point of water; (2) flexing and mountain making of a pronounced character whereby, in addition to elevation of temperature, a certain amount of shearing movement took place along the coal seams; producing, under the enormous pressure of thousands of feet of overlying rock, what may be termed "kneading" of the coal and consequent reduction in microporosity or, what amounts to the same thing, decrease in moisture capacity. The evidence afforded by numerous ultimate analyses of Rocky mountain coals indicates that changes in texture and composition go hand-in-hand—that is, decrease in microporosity is usually associated with an increase in carbon and decrease in oxygen, with a corresponding developement of the coking property, more or less pronounced as the case may be. Nevertheless numerous exceptions can be cited where the two kinds of alteration have not advanced equally. For instance the coal of Carbon, Wyoming, is essentially a lignite in composition, but lacks the hygroscopic features of that substance. It occurs in a region where the measures are much folded and faulted but were never deeply buried, hence the alteration was mostly of a physical nature. On the other hand the Newcastle coal of Wyoming, with pronounced coking qualities, has five times the moisture usually observed in coals of this character. It occurs in the Dakota Cretaceous, was at one time buried under later Cretaceous and Tertiary sediments, but is still in undisturbed position in a region that has rarely been subjected to spasmodic dynamic movement. In this case the alteration was mostly of a chemical nature; and the fact that in places the weathered outcrop is resolved into a mat of carbonized stems and leaves is conclusive evidence that the body of the coal has never been affected by "kneading" or crushing overthrust movement. The upturned and faulted measures of the Northern Colorado field yield a lignite, which differs from the product of the comparatively undisturbed portion only in this, that the latter contains about 50 per cent. more moisture—the thickness of the measures and later accumulations having been originally about the same throughout the productive area. It is true, that in certain localities in the Rocky mountains where the measures have been steeply upturned, little, if any, alteration seems to have resulted from it. But in such cases it can generally be shown either that the flexing was not accompanied by shearing along the coal seams, or else that the overthrust movement was confined to intervening soft shaly beds.

FIELDS OF THE EASTERN GROUP.

THE RATON FIELD.

Geographical extent in Colorado.—The Raton coal field—so named from the Raton mountains which it includes—is situated partly in Colorado and partly in New Mexico. The present description will be confined to the Raton field in Colorado.

The boundaries of the field as below defined coincide for the most part with the outcropping basal sandstone of the Laramie beds, though towards the northern and eastern margins the limits are less strongly marked. This is owing to the fact that the productive areas are not always coextensive with the coal-bearing formation, which in certain localities may be practically barren owing to the existence of unfavorable local conditions during the coal-forming period. There are two instances of this kind in the Raton field. In the Huerfano river region the workable coal is reduced to a single bed, which thins out rapidly to the northwestward, so that in the Huerfano basin the Laramie is no longer coal-bearing. The same is true of the eastern extremity of the field near the New Mexico line, where the workable coal gradually decreases in thickness until the measures cease to be productive, while beyond lies a considerable area of Laramie beds which up to the present time has not been shown to contain coal of economic value. It is an interesting fact that in all the coal fields of this State there are districts in which quite a number of seams will develop "high" coal, and other districts near by in which only "low" coal will be developed, or, as in the cases just cited, none at all, indicating the permanency of local conditions throughout the coal-forming period. The transition from the productive to the nonproductive measures is gradual, consequently it is largely a matter of judgment where the line separating the two should be drawn. The general form of the Colorado portion of the field resembles a scalene triangle, having the State line for the shorter base and the longest side to the eastward. On the western margin of the field the workable coal extends northward to the base of Veta mountain, beyond which explorations have failed to develop seams of any importance. On the eastern border nothing of economic value has been discovered north of the Coal cañon exposures just south of the Huerfano river, while at the extreme eastern extension of the field, near the New Mexico line, the utmost limit of known productive measures will coincide very nearly with the 104th meridian. Taking the state line from this point west to the opposite border of the field as the southern boundary, and a line drawn from Coal cañon to the south base of Veta mountain as the northern boundary, the area between the eastern and western outcrops, as computed by 40-acre subdivisions, approximates 1,330 square miles.

Allowing that 30 square miles of measures has been destroyed by eruptive intrusions, there remains 1,300 square miles of territory which may be assumed to contain coal seams of workable thickness, both accessible and inaccessible, considered in the light of existing methods of mining engineering.

Stratigraphical features.—The general characteristics of the Laramie have already been considered, and in relation to it only points of local significance will be mentioned here.

The Laramie sandstones on all sides of the field rest with apparent conformity on the beds of the marine Cretaceous, although the line of demarkation is seldom clearly defined. Shaly strata, often abounding in marine shells, predominate a few hundred feet below the Coal Measures, but in ascending order soon give place to thin-bedded sandstones, which in turn graduate into a persistent bed of massive sandstone from 90 to 120 feet thick, directly underlying the shale floor of the lower coal bed and regarded by all observers as the base of the Laramie group.

In the southern half of the area the Coal Measures are in direct contact with the basalt overflow of the Raton mountains, and are therefore clearly defined and about 3,000 feet in thickness. In the northern half of the area the upper sandstones of the measures graduate into the Poison Cañon beds, or lowest division of the Huerfano Eocene series, which aggregates in the Huerfano basin as much as 7,000 feet of strata. The thickness of the Laramie on the Cuchara river is estimated at about 4,500 feet—the greatest development anywhere observed east of the mountains.

Eruptive occurrences.—Of the eruptive bodies situated within the limits of the field the most prominent are the great Spanish peaks and Silver mountain laccolites, and the overflow of the Raton mountains near the New Mexico line. The Spanish peaks are centrally situated with respect to the Colorado portion of the field, though close to the western border, and Silver mountain near the northwestern extremity. Each of the laccolites has its own system of radially arranged dikes, which are both numerous and prominent. Other laccolites of almost equal prominence—Veta mountain and Sheep mountain—occur just outside the western limit of the field.

The earlier eruptions consisted mainly of quartz-porphyrites, hornblende-porphyrites, augite-mica-porphyrites, and augite-mica-diorites; while those of a later period consisted chiefly of olivine-bearing rocks, basalts, and dolerites. The older eruptives form the laccolitic mountain bodies and appear as dikes intersecting the Coal Measures and Eocene strata, and as sheets comformable with the stratification of the sedimentaries. The more recent likewise occur as dikes and interbedded sheets or "sills," and as the material of the Raton overflow. All the laccolites referred to expand in the soft shales of the marine Cretaceous, and by far the greater number of interbedded sheets outcrop at the same horizon, though the presence of two or more of these sheets in the shaly beds of the productive measures is a constant feature.

The dikes, traversing the Raton field, are the most numerous of the several forms of the eruptive occurrences. With but two or three exceptions, they are not deep seated, but merely extend down to the "sill" or laccolite, which, at the time of intrusion, fissured the overlying measures and discharged part of its volume into the opening to form the dike. In this manner the greater portion of the Raton field has been affected by past eruptions, and the entire area of the Colorado portion rests upon a system of sheets and intrusions, and is gridironed by the numerous dikes originating with them. The type of structure so characteristic of this field appears to some extent in the Grand river and Yampa fields, and in the fields of Washington as described by Mr. Bailey Willis.(*a*)

Flexures and displacements.—The earliest dynamic disturbances which require consideration here are those which accompanied the post-Cretaceous revolution, when the old-time land mass of the Wet mountains, together with the Sangre de Cristo were elevated into parallel mountain ranges. By this movement the Laramie beds of the entire western border of the field were tilted up along the eastern flank

a Tenth Census Reports, Vol. xv. Mining Industries of the United States, pp. 759–771.

of the Sangre de Cristo, while on the opposite side of the field a broad anticline was produced by the prolongation southward of the Wet mountain axis of upheaval. Between this anticline and the base of the Sangre de Cristo there was thus formed a long, synclinal trough gradually flattening to the southward. This trough became the Eocene lake basin of the Huerfano, and received an abundance of fresh-water sediments during the early Tertiary.

The second epoch of disturbance appears to have coincided with the period of eruptive activity, which must have been subsequent to the close of the Huerfano Eocene, since the sediments of the latter are upturned and intersected by eruptive bodies. While these disturbances were in progress, the Wet mountains and Sangre de Cristo were again uplifted, and the Coal Measures underwent additional flexing along the old lines of movement. The interval which elapsed between the first and second epochs of disturbance was at least as great as the time required for the disposition of the 7,000 feet of sediments represented in the section of the Huerfano Eocene.

As a result of the flexing produced by the movements just described, the measures along the western border are tilted from 25 degrees to 85 degrees east, according to the extent that erosion has advanced the fold. The measures of the eastern border are inclined from 3 degrees to 17 degrees in the opposite direction; while in a broad belt along the synclinal axis are measures in nearly horizontal position.

A further result of these movements is seen in the fault displacements, which are in places quite numerous, the most prominent ranging from 70 to 80 feet. Apparently these faults have no connection with the dikes, for in no instance has it been shown that a dike plane is a plane of vertical displacement, and no matter of what thickness a dike may be, mine workings can be extended through it without change of grade.

Number of coal seams.—For convenience sake, the measures may be divided into two groups—upper and lower—both of which contain, throughout their extent, a workable thickness of coal in some one seam of the section. These groups are usually separated by a barren zone of about 700 feet. The lower group is productive throughout the field; the upper group, only in the southern portion.

The number of seams which a district may develop will not be a constant quantity. In the Rouse district of Huerfano county, no less than 25 distinct seams of 4 inches and upward were reported in boring a distance of 800 feet in the Lower Measures, or from the surface to the top of the basal sandstone. In the Road Cañon district of Las Animas county, 25 seams were passed through in boring 550 feet, though in a second bore about 1 mile to the north only 15 seams were found. These borings were also confined to the Lower Measures. But a third bore, designed to explore a portion of the upper group, developed 13 seams in a distance of 290 feet. As there is not less than 500 feet of coal-bearing beds above the top of this bore, it is evident that there are many other small seams that would be recorded in a complete section. Further south, in the Trinidad district, the Lower Measures were found to contain as many as 15 seams in a bore hole 525 feet deep. It thus appears that the entire section of the Laramie probably contains 40 or more coal seams of varying thickness. This section, embracing the Upper and Lower Productive Measures, usually contains from four to five seams of workable thickness—3 feet and upward—from two to three in the Lower Measures, and generally two in the upper. These will be further considered in connection with the districts to be described.

Irregularities of the coal beds.—In this field, more than any other in Colorado, there is a noticeable want of uniformity in the character of the individual strata composing the Measures, and a corresponding absence of continuity in the thickness of the seams of coal. Even the lower and most persistent bed is, in the southern portion, split into two distinct seams, separated by a variable thickness of shale. Nevertheless, this bed usually affords a workable thickness of coal throughout the eastern portion of the field, and is, in fact, the only one that can be considered identifiable with any degree of certainty in two or more districts. This remarkable irregularity is shown in all the diamond drill borings undertaken by the writer. It is true that in each case a series of shales alternating with thin-bedded and massive sandstones and numerous seams of coal will be presented. Yet in few instances will it be found that, excluding the lower seam, a workable coal bed in one district is sufficiently persistent to be recognized in another, so frequently do the seams rapidly expand to a workable size and as rapidly thin down again or entirely disappear.

Character of the coal.—The Colorado portion of the field is included in the present counties of Huerfano and Las Animas, the east and west dividing line between the two being about midway between the New Mexico boundary and the northern extremity of the field. However, by far the larger part of the area lies south of the aforesaid line and in Las Animas county. The coal of the Huerfano county districts is altogether of the semi-coking kind known as "domestic," though the same product is much used as a steam fuel. There is also a limited quantity of domestic coal in Las Animas county south of the line, but the bulk of it is a true coking coal. The transition from one kind to the other 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 by the ordinary beehive process. The coals of the Upper Measures are, if anything, more superior for coke making than those of the lower, and with proper manipulation will yield a most excellent product.

Trinidad district.—This district is situated near the southern extremity of the eastern border of the field and embraces the region immediately tributary to Trinidad, the county seat of Las Animas county. This has been for years, and is yet, the most important coking coal district in the State. It includes the mines of Sopris, Engleville, Starkville, and Gray Creek, of which the largest producers are Sopris and Engleville, the former yielding daily from 1,500 to 1,700 tons and the latter from 1,000 to 1,200 tons of all sizes during the winter months. There are 222 beehive ovens in operation at Sopris and 250 at El Moro, 4 miles from Engleville. There are also 80 ovens in operation at Starkville, and 100 in course of construction at Gray Creek. The producing mines have from 4 to 8 feet of coal in the seams worked, though so far as known no two of them are located on the same seam.

The inclination of the beds in this district is very slight, and most of the coal is mined above water level. The mining price is 50 cents per ton of "run-of-mine" coal. As usual in this field, the Measures are traversed by dikes, and for several miles along the outcrop the workable coal has been 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 toward the southern boundary of the district that the Upper Measures appear; explored and shown to contain two workable seams of coal, but not yet rendered productive.

Road cañon district.—This district lies immediately north of the Trinidad district, and includes the mines in Tingley cañon, Road cañon, Cañon de Agua and Aguilar, all of which are located along the eastern outcrop in the order given, from south to north, and are reached by spurs from the Fort Worth and Denver railway. Only the Lower Measures are worked, though the upper series has been explored and shown to contain two workable seams. The Lower Measures afford three workable seams, but never more than two are available owing to the presence of intrusions, which in one place will have destroyed one seam and a few miles away another. At present, however, operations are confined to the lower, or Berwind seam, and the second, or Victor seam, 60 feet higher in the Measures. The Berwind mine, in Road cañon, is on the Berwind seam. The remainder are probably on the Victor seam; though there is no certainty on this point, as between the Victor mine in Cañon de Agua and the Forbes mine in Tingley cañon, this seam has been destroyed by intrusions. The thickness of coal mined ranges from 4 to 7 feet, and the mining price is 50 cents per ton for "run-of-mine" coal. The slack from Berwind is coked at El Moro; Victor slack is coked near the mine, where there is a bank of 100 beehive ovens.

The Measures of the southern portion of the district are but slightly inclined toward the southwest. In the northern portion the inclination of the outcrop is as high as 15 degrees, in places nearest to the anticlinal axis, but the beds soon flatten out in the direction of the synclinal north-and-south trough of the body of the field.

Rouse district—This is the most southern of the Huerfano county districts, and includes the mines at Rouse and Santa Clara, which are reached by short spurs from the Denver and Rio Grande railway. The Santa Clara mine is opened, but not equipped, except for pumping; while the Rouse mine is equipped for a capacity of 3,000 tons daily. Only the Lower Measures are present in Huerfano county. The seam mined at Rouse is what is known as the Rouse-Cameron seam, which ranges from 4 to 6 feet in thickness. The same seam is opened at Santa Clara, where it is about 5 feet thick. Above this seam about 35 to 40 feet is a second, known as the Walsen, which is usually about 7 feet thick on the Santa Clara tract, but only 5 feet thick at the south end of the Rouse tract, and over the main body of this tract is destroyed by an intrusion of lava. About 75 feet higher in the Measures there is a third seam, which in places expands to a thickness of 4 feet. Dikes are in some places exceptionally numerous, entailing considerable dead work in driving through them. This objectionable feature is to some extent counterbalanced by the superiority of the coal in the areas affected by this form of eruptive intrusion. There are no faults parallel with the dikes or coinciding with them; yet they are frequently encountered extending in other directions; generally, especially where the displacement is considerable, rudely parallel with the trend of the mountain uplift. The inclination of the beds is usually less than 7 degrees southwesterly, and water is encountered at about 1,000 feet from the outcrop. The mining price is 70 cents per ton of lump coal, nothing being allowed for what passes through a 1½-inch bar screen.

Walsenburg district.—This district includes the mines that are tributary to Walsenburg, the county seat of Huerfano county, and is at present the most northerly district in the Raton field. The producing mines are the Cameron, Walsen, Robinson, and Pictou. Other mines are being opened, but are not yet equipped. There are at least four workable coal seams present in the Walsenburg section, though only three are mined, viz., Cameron-Maitland, Walsen-Lennox, and Robinson, the last being the uppermost of the three. The Pictou workings are on the two first mentioned. The seams worked are from 4½ to 7½ feet thick, except in the Cameron mine, where as low as 39 inches of coal has been mined on account of its excellent qualities. The inclination of the beds is from 5 to 6 degrees southwest. There are a number of dikes traversing the district, but intrusive sheets have not been encountered and fault displacements are rare. The producing mines have each a capacity of about 500 tons daily of coal of all sizes, mostly mined below the level of the Cuchara river, and therefore in wet ground.

Important nonproducing districts.—There are two districts which have been sufficiently explored to demonstrate the existence of thick workable coal, in each case equal in extent to any of the producing areas, but which have not yet been rendered available by railway extension. Both these districts are situated in Las Animas county on the drainage of the Purgatoire river. The first embraces the highly inclined Measures of the lower series along the western border of the field, where there are two seams of excellent coking coal that have been opened up at intervals of one-half mile or such a matter from the State line north to within a short distance of the Spanish peaks. The second district lies about 12 miles to the east of the first. Here there are two seams in the Upper Measures, the lower one of which expands to a thickness of from 5 to 8 feet in the territory embracing Smith's and Zarcilla cañons, while the upper one expands to about the same thickness in the next township west. These seams have but slight inclination and the Measures are not traversed by dikes; but intrusive sheets are continuous and in places jump up into the coal, so as to destroy it or transform it into natural coke. More or less disturbance of the strata has resulted from these intrusions, and there is everywhere evidence of former horizontal movement and overthrusting. Were it not for the effects of past disturbances, these localities would afford the most extensive and important continuous area of workable coking coal in the field, as the underlying Lower Measures, which no doubt contain thick coal in one or more seams, can be reached by shafts from 600 to 1,000 feet deep. As it is, there is a strong probability that both these districts will be rendered accessible by railway extension in the near future.

CAÑON CITY DISTRICT.

Position and extent.—This district is situated near Cañon city, the county seat of Fremont county, and embraces the whole of an isolated area of 54 square miles of Laramie Measures, of which about two-thirds contains coal of workable thickness. Included within its boundaries are the producing mines of Coal Creek, Rockvale, Williamsburg, Brookside, and Chandler Creek, together with several less important properties on the outskirts of Cañon City. All of these mines are reached by spurs from the Denver and Rio Grande or Atchison, Topeka and Santa Fe railways. The western boundary of the district is defined by the base of the northern extension of the Wet mountain range, which, near by, is traversed by the Royal gorge of the Arkansas river. Situated adjacently on the east is the Florence oil district, which stretches along a gentle north-and-south anticline in the Montana beds. The valley of the Arkansas on the north and Newland creek on the south form the other two boundaries of the district.

Geological features.—The maximum thickness of the Laramie, measured at Alkali Gap, does not exceed 1,200 feet, and in the body of the field the Measures aggregate only from 700 to 900 feet of strata. As usual, on the eastern side of the mountains, the uppermost beds are decidedly conglomeritic. They are overlaid by remnants of pebble beds and tuffs which are probably the equivalent of the post-Laramie of the Denver basin. Along the base of the Wet mountains the Measures are steeply inclined towards the east, in places standing in nearly vertical position; but they soon flatten out so that the body of the Measures is in nearly horizontal position, with the exception of a slight westward inclination along the eastern border, where the beds come within the influence of the anticline already referred to. Fault displacements are rare, and there is a total absence of dikes and other forms of lava intrusions, such as are common in the Raton field, the few occurrences of this character in the neighborhood being situated outside the limits of the productive area.

Features of the coal seams.—The workings, borings, and outcrop excavations show the presence of as many as 16 seams 4 inches thick and upwards. Of these the lower or Cañon city seam is the most persistent, having been developed in all the borings of the eastern half of the field, and in the southern portion appears to extend to the western outcrop. This seam ranges from 4 to 5 feet in thickness, exclusive of a middle band of shale, which is present along the eastern border. About 50 feet higher there is a smaller seam, locally known as the Walsen, under the erroneous impression that it corresponds to the seam of that name in the Walsenburg district. The workable area on this seam is restricted to the Coal creek and Oak creek localities, and it can not be identified in the western part of the field. The workings of the Chandler Creek mine, which are near the western outcrop, are on a seam from 4 to 5 feet thick, which is evidently a local expansion of one of the higher seams, though along the same outcrop there are seams of low coal at a much lower level, as shown in the openings at Alkali Gap and Upper Oak creek.

The coal from this district possesses such excellent qualities as a domestic fuel that it has a great reputation in the prairie States and is regarded as the type of this kind of coal. In burning it exfoliates but does not coke, though when powdered and ignited in a crucible it forms a slightly coherent mass.

SOUTH PLATTE FIELD. (*a*)

Geographical extent.—This field consists of a continuous strip of Laramie Measures, about 40 miles wide, beginning at Franceville and extending thence northward along the eastern base of the Colorado range nearly to the Wyoming line. It does not include the entire area of Laramie beds east of the outcrop line, nor yet more than a portion of

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a This was previously known as the northern Colorado field, though the term was usually restricted in its application to the districts of Boulder and Jefferson counties. The name originated at the time when mining operations were confined to this field and the southern Colorado districts, but is no longer tenable, since there are two other distinct coal fields in northern Colorado. The designation here employed is thought to be the most appropriate, as at least eight-tenths the area of the field is drained by the South Platte river.

the immense tract in northeastern Colorado, represented as coal land on Hayden's Economic Map. Here again one is confronted with the necessity of establishing a line between what is really entitled to be considered coal land, whether or not the coal is prospectively accessible, and adjacent areas of barren or worthless Measures; and since the change from one class to the other is gradual and takes place at a considerable depth from the surface, there is room for honest difference of opinion as to where this line should be drawn. The limit suggested by the writer, viz., a line 40 miles east of the outcrop, and having the same contour, will, it is thought, liberally define the extent of the coal-bearing formation that will contain workable coal. This assumption is based upon the fact that while the eastern outcrop of the Laramie, near the State line, is not coal-bearing, thin beds which may eventually be worked for local consumption, are exposed at both northern and southern extremities of the field, about 40 miles from the western margin. The field, as thus defined, has a superficial extent of about 6,800 square miles, of which area less than one-sixteenth can at present be regarded as accessible. This area will include the districts of Erie, Lafayette, Louisville, Marshall, Golden, and Franceville, together with other but less important districts where mines were formerly in operation.

Geological features.—The thickness of the Laramie in the South Platte field ranges from 1,000 to 1,200 feet. It differs from the same formation in the Raton field in this, that the conglomeritic sandstones, which in the latter predominate toward the top, are represented in the former largely by clay shales. As usual, however, the workable coal seams are mostly contained in the lower half of the Measures and the upper shaly portion is not, economically considered, coal-bearing.

The beds along the western border are steeply upturned against the base of the range but flatten out rapidly to the eastward, though there are gentle undulations traversing the body of the field parallel with the range axis.

The inclination of the outcrop depends on the extent to which the strata involved in the principal flexure have been removed by erosion. All of the exposed outcrop north of Boulder is but slightly inclined, but south of this point the inclination soon reaches a high angle, the beds being often nearly vertical in position and in places overturned. Along the southern extremity, however, the Measures on the margin have a regular northern dip of from 7 to 9 degrees.

Faults are very numerous and complicated in the districts north of Denver, the amount of displacement being often sufficient to prevent the extension of mine workings across the fault plane.

The eruptive occurrences within the limits of the field consist of the small basalt overflows capping the mesas, near Golden, and a number of small patches of rhyolitic tuff, near Castle rock. There is also a prominent dike at Valmont, near Boulder, outcropping in the Montana beds just west of the Laramie border.

Features of the coal seams.—So far as known there are from one to four workable seams in this field—from two to four in the Denver basin and southern portion, and one in the northern area. This includes a seam of impure coal which occurs in the upper shaly beds near Sand creek, and also on the Bijou. These seams vary from 3 feet to 16 feet in thickness—the greatest development being in the central portion of the field.

In composition, the coal is essentially lignitic, though possessing important local variations, and in its black, lustrous appearance, when freshly mined, does not resemble the lignites of Europe and elsewhere. But it slacks rapidly on exposure to the air, as do all Rocky Mountain lignitic coals whenever the moisture contents exceeds 8 units, and is therefore not adapted for storage, or for transportation to the prairie States. The best qualities are produced from the mines in the highly-faulted Measures of Boulder county, where a sufficient amount of alteration has been effected by the disturbances to decrease the normal capacity for moisture and at the same time increase the percentage of carbon. The upturned Measures furnish a more inferior coal—that is, the moisture is higher and the carbon lower—but, nevertheless, when compared with the lignite of the body of the field, it is seen to have been materially altered by the movement attending the upturning of the beds and elevation of the Colorado range. That this elevation was gradual and not capable of inducing an extensive alteration of the coals in the adjacent Measures is made evident by the structure of the region; for the South Platte river traverses the range referred to, and if the elevation had exceeded the cutting power of the stream the South Park drainage would have been deflected south into the Arkansas.

The most lignitic coal produced in the field is that from the southern area, though this is much superior in all other respects to that contained in the upper shaly portion of the Measures. On account of the moisture contents of South Platte coals, their use is confined to the home markets, where, on account of their cheapness, they find a readier sale for domestic purposes than some other fuels of much higher calorific power.

Franceville district.—This district is situated in El Paso county, at the most southern extremity of the field, and where the measures are inclined from 7 to 9 degrees northward. It contains the producing mines of Franceville, located on a spur of the Fort Worth and Denver branch of the Union Pacific railway and the old McFarren mine, which is reached by a spur from the Rock Island system. The same seam is worked in both mines, which are but a few miles apart. This seam, which is from six to seven feet thick, is apparently the lowest in the Measures, and the only one of workable size yet discovered in the district. The coal is, on the whole, of inferior quality as compared with that produced in the districts further north and, in consequence, the output is not very considerable. But the comparatively slight inclination of the beds, continuity of the coal seam, and accessibility of the district are features which, in a measure, offset the poor quality of the fuel, and will render it increasingly productive in proportion as the northern districts become exhausted.

Golden district.—This district contains the White Ash mine—the only one at present in operation—and the Loveland and Murphy mines, on which work has for some time been suspended. These mines are all located on the upturned and overturned outcrop near Golden, the county seat of Jefferson county, and are reached by a branch of the Union Pacific railway. There are two workable seams known. The lower one ranges from 3 to 8 feet, and the upper from 6 to 12 feet in thickness, the two being from 20 to 30 feet apart. These seams occur near the base of the Measures, but are probably not the lowest seams in the field. The quality of the coal appears to improve with depth, which may be due to alteration induced by an extension under the Measures of the intrusive bodies which outcrop near by, rather than to the upturning of the beds. The production of the faults which occur in the northern part of the district no doubt tended in some degree to promote alteration; but even these appear to have originated during the spasmodic movement accompanying the eruption, so that the latter is primarily the cause.

Marshall district.—This district is situated on the drainage of South Boulder creek in Boulder county, and is reached by a branch of the Union Pacific railway. Owing to the depth of erosion on this drainage and northward, the upturned border of the Laramie has been completely carried away, and the outcrop, receding from the base of the range, borders a large area of the Lower Measures, much complicated by faults and broken up into blocks of varying inclination.

The only producing mines of any importance are the Marshall and Fox properties at Marshall, though other smaller properties are operated for local consumption in the northern part of the district. The workings of the Fox mine are on a seam from 7 to 8 feet thick contained in a downthrown block inclined about 7 degrees southwest, the coal being reached by a slope of about 25 degrees easterly through the roof material. The present workings of the Marshall mine are on the same seam, contained in another faulted block lying nearly parallel with the first and a short distance to the east of it. Both these blocks are very nearly exhausted, and as the fault displacements are excessive, there being as much as 150 feet vertical difference between the workings of the Fox and Marshall properties, new mines must be opened in other blocks to keep up the output of the district, which has never been very large and is probably less now than in former years. The Marshall seam is probably the lowest in the Measures, but there are three other workable beds in the badly faulted, and in places upturned, area immediately to the east. The coal from these mines, while decidedly lignitic so far as composition goes, has always had the merited reputation of being the best fuel of the kind shipped to the Denver market.

Louisville district.—This district is also situated in Boulder county, in the adjoining township to the east of that just described, and is reached by a branch of the same railway system. The producing mines are the Acme, Ajax, Caledonia, Welsh, and Hecla, all of which are located in the vicinity of the town of Louisville. The seam worked, in fact the only one of importance in the district, is in two benches, the intervening band of shale, or sandstone, as the case may be, amounting sometimes to a mere parting, as in the Welsh ground, or to a band 2 feet or more in thickness, as in the Acme and Ajax. The thickness of the seam in the Welsh workings ranges from 5 feet to 6 feet 6 inches, most of which can be taken down by keeping the props close together and well up to the face. Usually, however, only about 4 feet of coal—the lower bench—is taken out, the remainder being left to support the roof, which is very bad and liable to drop down in bell-shaped masses after the coal is removed. In the Caledonia, Acme, and Ajax the lower coal is 6 feet or more in thickness and the top coal 4 feet. Between them is a band of sandstone, in some places 2 feet thick, and generally only the lower coal is worked.

The operations are confined to a narrow strip of territory wherein there is a long, somewhat trough-shaped basin of the Measures, bounded on the long sides by enormous fault displacements, coinciding in direction with the northeasterly course of the principal drainage channel (Coal creek) which appears to have been determined by it. All the existing mines are worked through shafts varying in depth from 120 feet to 240 feet. None of the mines in this district make as much water as the structure of the country would lead one to expect, which may be partly owing to the transverse direction of the joint planes with reference to the trough. Individually, these mines have nothing like the capacity of those in the Raton field, which is also true of the mines in the adjacent districts. Still, the aggregate output is considerable. The coal is nearly equal in value to that of the Marshall district and finds ready sale as a cheap fuel.

Lafayette district.—This includes the Simpson, Cannon, Fall, Padfield, and Baker mines, and the best workable area of land that has yet been opened up in the Boulder county districts, containing as it does in the four first named mines a thickness of fully 13 feet of clean coal. These mines are located near Lafayette, on the extension northeasterly of the Louisville trough already noted, and are reached by branches of the Burlington and Union Pacific railways. The Simpson mine workings are at the bottom of the trough, and the coal is hoisted through two shafts, respectively 210 feet deep, and quite close together. The entries connect with those of the Cannon mine on the south and the Fall mine on the north. South of the Cannon shaft the coal soon runs into the upturned and faulted border of the basin. The same takes place north of the Padfield shaft, or on the opposite border of the trough. That portion of the latter which lies between this district and Louisville does not seem to contain thick coal, only thin seams having been reported from the borings made in that territory. The land immediately northeast of Lafayette appears to be of the same character as that on the opposite side of the district, though this conclusion is only based on meager evidence.

The Baker mine is situated about 1½ miles east of Lafayette, and apparently on the very edge of the upturned border. The opening consists of a slope following the seam, which has an inclination of 25 degrees near the outcrop, but flattens rapidly to 13 degrees at the bottom of the slope. The seam is in two benches, the top coal being 7 feet thick and the bottom coal 3½ feet.

Erie district.—This is also, in part, located in the Louisville-Lafayette trough, which curves more to the north after leaving Lafayette. The mines of this district are: (1) The old Boulder Valley and Jay Gould openings near Erie, and the Star, Standard, and Jackson at Canfield, a short distance to the west. All of these mines are now practically exhausted, and some of them dismantled. The McKissick mine, northeast of Erie, seems to be the only one in active operation, but the product is of inferior quality. (2) The Garfield, Marfels, McGregor, Cleveland, and Mitchell, which are situated a short distance south of Erie, on a branch of the Burlington system. The Mitchell shaft has been dismantled; the other mines are still in operation, but on small areas of coal.

There are three workable seams in the district, all of which are stated to be developed in the Mitchell shaft, where they are now reported to have the following thickness: Lower seam, 5½ feet, middle seam, 5½ feet, upper seam, 4½ feet. These seams, however, are very variable, and usually only one seam in the section contains thick coal.

Nonproducing districts.—Mines have been worked in a small way at Mount Carbon, near Morrison; near Sedalia, in Douglas county; at Scranton, about 16 miles north of Denver, and in the northern part of the field at Plattsville and Eaton. The Scranton coal belongs in the upper shaly beds, and is too impure to meet the other fuels on an equal footing. The extensive northern area, so far as known, contains only low coal, which is of poor quality and will not bear shipment. Nevertheless, there will always be more or less of it mined for local use, and as the Measures are generally horizontal and in places easily accessible, the available area is quite extensive. In the country immediately south of Lafayette and Louisville there is considerable territory shown by borings to contain thick coal, but south of the Rock creek drainage deep shafts will be required to reach it. In the extreme southern part of the field there is also additional accessible territory which can be attacked on the outcrop or operated through deep shafts. In the body of the field the coal is altogether too deep to be worked at the present time, the Measures being covered with post-Laramie and Miocene beds and furnishing in places an abundance of artesian water.

SOUTH PARK DISTRICT.

General description.—This district is situated at the northern extremity of the South Park basin, one of the great inter-range depressions whose geological existence dates from early Paleozoic times. It is reached by the Denver, Leadville and Gunnison narrow-gauge division of the Union Pacific system, and the only important mines, those near Como, are operated in the interest of the railway.

The entire length of the Laramie area is about 21 miles, though the average width is less than 3 miles and the maximum not more than 5 miles, with a superficial extent of about 45 square miles, less than half of which can be regarded as workable.

The producing mines—slopes No. 5 and No. 6, which turn out about 150 tons per day—are located on the western border of the area, near the northern extremity.

The inclination of the western outcrop ranges from 30 to 50 degrees, being about 45 degrees at No. 5 slope and 33 degrees at No. 6, but less than this to the southward. Along the eastern border the Laramie outcrop is overlapped by what is probably the post-Laramie formation, which is found resting on the border of the granite hills bounding the district to the eastward.

The seam worked at No. 5 contains from 5 to 7 feet of coal in the lower bench and 2 feet in the upper bench, which is separated from the lower by from 8 inches to 3 feet of shale. At No. 6, which is about a mile south of No. 5, the seam worked is only 4½ feet thick. It is not certain that these openings are on the same seam, though this appears most likely. But the intrusion, both above and below the coal, of sheets of eruptive conglomerate which, a short distance south of No. 6, consolidate into one large body, and thus determine the southern limit of the productive outcrop, throws some doubt on the identity of these seams until further extension of the respective workings shall have settled the question. Workable coal has been opened up some distance north of No. 5, but the locality is badly faulted. There is also another opening near the railway track, on the opposite side of the Laramie area. The South Park coal cakes strongly, and is a good locomotive fuel; but, all things considered, the district has less prospective value than any other independent area in the State.

NORTH PARK FIELD.

General description.—This is the least explored of all the Colorado coal fields, and even at the present time there is not a single equipped mine in operation there, though some coal has been extracted for local consumption. Nor is it likely, owing to the remoteness of the region and absence of any important reasons for railway extension, that any attempt will be made in the near future to open up the big seams of lignitic coal known to exist there.

The Measures of economic value extend from the northeastern border of the North Park basin as far south as the divide separating the drainage of this basin from that of Middle Park. The body of the field, however, is mostly deeply buried under later accumulations.

Coal seams of workable thickness outcrop around Mount Wheatly on the southern border of the basin, but so far as explored are not as important as those near the northeastern border, which, besides being the most accessible portion of the field, contains the greatest aggregate thickness of coal. Between the Canadian and Michigan rivers—tributaries of the North Platte—the Measures are brought to the surface by an anticlinal flexure, from the apex of which the coal beds dip in opposite directions about 15 degrees. On the northeast side of this flexure there is a corresponding synclinal depression about 3 miles broad, terminating in the outcrop of that border of the field. Along this outcrop for a distance of about 12 miles, as well as at the anticline referred to, seams of lignitic coal are exposed naturally or by excavations. There are, apparently, three workable beds in the district—the Red Hill seam, from 21 to 32 feet thick; the Coal Hill seam, 15 feet thick, and the Walden seam, from 4 to 5 feet thick, all of which are remarkmarkably free from shaly impurities.

The composition of North Park coal is decidedly lignitic, in which respect it resembles the product of the South Platte field, though when first extracted it is black and lustrous like ordinary soft coal. Hence, the term "lignitic coal," to distinguish it from true lignite, which as far as external appearance goes is not found in Colorado.

FIELDS OF THE WESTERN GROUP.

THE LA PLATA FIELD.

Geographical features.—This field is situated in the southwestern part of the State, whence it extends south into New Mexico, resembling in this respect the Raton field of the eastern group, and having, accordingly, the State line for the southern boundary of the Colorado portion. The remaining boundaries are very clearly defined, topographically, by a deeply indented line of high bluffs and bold escarpments, brought out in strong relief by the erosion of the soft marine Cretaceous beds underlying the Coal Measure sandstones. The distance between the eastern and western extremities is about 85 miles and the average width between the State line and the northern boundary about 15 miles, the Colorado portion of the field affording a superficial area of, 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.

The principal drainage of the region, so far as it affects the topography of the field, is southward or parallel with the shorter diameter. In consequence, such streams as the San Juan, Piedra, Los Pinos, Florida, Animas, La Plata, and Mancos have plowed great cañons across the field and deeply notched the northern outcrop. All the main cañons are practicable for railways, and one or more trunk lines are thought to be contemplating extensions westward by way of Durango. But at present the producing districts are reached by branch lines only, which merely give access to limited markets in the mining districts of the San Juan mountains.

Geological features.—Pending further investigations now in progress, little can be said respecting the development of the Laramie group in this field. There are, apparently, two coal-bearing horizons; 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 upper formation resembles lithologically the upper portion of the Laramie in the Grand River field—massive, light-colored sandstones predominating. The lower portion consists of thin-bedded sandstones, with shale bands interstratified and heavier layers of sandstone at the top.

The inclination along the northern outcrop varies considerably. At the western extremity of the field, on the Mancos drainage, the Measures are nearly horizontal. On the La Plata they are found dipping about 7 to 8 degrees. On the Animas, the Lower Measures dip at about the same angle, while the Upper, which outcrop on the steep side of a compound flexure, dip about 36 degrees. Further east the outcrop begins to flatten out, and on the San Juan is again in slightly inclined position. The direction of inclination is to the southward and is determined by the uplift of the La Plata mountains, which are a prominent topographical feature of the region. In the body of the field away from this uplift the Measures are probably horizontal, but mostly buried under the post-Laramie tuffs and succeeding Lower Eocene beds.

The post-Laramie deposits are the only rocks of eruptive origin within the limits of the field, except a few dikes which cross the western extremity. But the Measures of the northern border have felt the effects of the great La Plata mountain eruption and probably to some extent the eruption of the Sierra El Late—both of which occurred subsequent to the deposition of the Wasatch Eocene.

Features of the coal seams.—The Upper Measures everywhere contain a large aggregate thickness of workable coal, which, nevertheless, 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 Lower Measures usually contain rather low coal, but there are local expansions where the thickness in one or other of the seams may be as much as 5 feet. On the other hand, there are portions of the outcrop where explorations have failed to develop even low coal of economic value.

The coal at the two extremities of the field is of the semi-coking or domestic kind, while that of the central portion, near the northern border, possesses pronounced coking properties. This particular part of the field is affected by the enormous intrusive masses of the La Plata mountains, by which it is uplifted and folded, probably owing to the extension of the deeper intrusions some distance away from the body of the mountain and under a considerable area of the Measures. The coal as a rule does not give off any serious amount of gas, though this may be due to the fact that most of the workings are above water level, since it is currently reported that in the wet workings of the abandoned Carbonaria mine gas was copiously evolved.

Durango district.—This district is the most important in La Plata county; indeed, the most important in the field. It includes the Porter, San Juan, and La Plata mines, and others, such as the Carbonaria and Shores, which are either abandoned or only worked intermittently and in a very small way. All of these properties are tributary to Durango, the county seat and location of two well-equipped smelting establishments. About thirty beehive coke ovens are in operation near the town.

The Porter mine is situated about 4 miles west of Durango on the line of the Rio Grande Southern railway. The Measures at this point are nearly horizontal, owing to advanced erosion. The seam worked belongs in the Lower Measures and is usually a little over 3 feet thick; but though small the product is of exceptional quality, and the slack from this mine is used exclusively for coke-making at Durango. The La Plata mine is about 3 miles southeast from Durango, and is reached by a short branch from La Plata Junction on the Denver and Rio Grande railway. Here there are openings on three of the four workable seams contained in the section of the Upper Measures exposed at this point. These seams are: (1) The lower seam, 4 feet thick, not worked; (2) the Fairmount seam, 15 feet thick, with bands of shale and bone; (3) the Jumbo seam, 20 feet thick, including shale and bone streaks; (4) the upper or Peacock seam, which has a lower coal 3 feet thick, separated by 4 inches of stony matter from 2 feet of top coal. The horizontal distance between the first and second is, approximately, 100 feet, the inclination of the Measures being 37 degrees. Similarly, the distance between the second and third is about 50 feet and between the third and fourth 80 feet. Most of the present output comes from the Fairmount seam, where there is an upper bench of very good coal about 4 feet thick, which appears to be entirely free from impurities.

A few miles to the west, and near the Animas river, all these seams coalesce and form the big seam at Carbonaria, where the coal and small bands of shale and bone aggregate not less than 100 feet, of which not less than 80 feet is coal. It is doubtful, however, if more than one-third of this thickness can be mined under conditions that are likely to arise in the near future, owing to the difficulty of extracting a marketable product where the streaks of impurities are so numerous. But there are in the section several benches, of from 3 to 5 feet in thickness, of clean coal that it may be practicable to work economically.

The San Juan mine is located on a hill overlooking the town, and the coal is lowered by tramway to the level of the railway track. Whether or not the seam worked is identical with that at the Porter mine is uncertain, but it is certainly contained in the same Measures. The average thickness of the seam is about 4 feet and the inclination of the beds about 10 degrees. This is the only workable coal that has been developed in the Lower Measures at this particular point.

All the coal at the Durango district is of the coking kind. The coke from Porter mine slack is very low in ash, but the structure is decidedly "reedy," and in this respect it would have to be improved before it could be shipped to remote localities, otherwise the small coke produced by handling will be excessive.

La Plata district.—This district is situated on the drainage of the Rio La Plata and is reached by the Rio Grande Southern railway. The producing mines are the Ute and the Hesperus, located on two seams from 4 to 5 feet thick respectively. These seams are contained in the Lower Measures, the outcrop of the Upper Measures being some distance down the river. The coal is an excellent semi-coking variety and is one of the best produced in the field for domestic purposes, but can not be made into coke by the ordinary beehive process.

Nonproducing districts.—At many points along the outcrop, both east and west of the districts already referred to, coal is taken out for the use of farmers and blacksmiths residing in the neighborhood. This is usually the case wherever the northern border is traversed by one of the principal streams, and as far as the Measures extend in either direction, one and sometimes two of the big seams of the upper series have been exposed naturally or by excavations. The quality is, as a rule, fairly good for domestic purposes and the calorific value sufficiently high for locomotive use. The coal of the Lower Measures is much less persistent, though it is occasionally utilized, and near the town of Mancos there is a 4-foot seam in this series which is sometimes mined for the local trade.

Tongue Mesa district.—This district includes a long, exceedingly narrow, isolated strip of Laramie rocks extending beneath an elevated, lava-capped ridge between the Cimarron and Uncompahgre rivers. The thickness of the Measures is about 1,000 feet. Two seams of coal have been worked in a small way for local trade. One of these, at the old Nutter and Clark opening, is from 15 feet to 20 feet thick. The second, known as the Kezar, outcrops about 400 feet higher in the Measures, and contains five feet of clean, hard coal. The inclination measured at the Nutter and Clark opening is 25 degrees northward, though this seems to be a local variation, as the Measures at other points are not so steeply inclined. The coal is of the dry domestic kind, almost lignite in composition, and, except that it may supply a very limited local demand, is not likely to come into general use, even in the neighboring mining districts, which, owing to railway extension, now have access to other and better fuels.

GRAND RIVER FIELD.

This field is so named from the fact that the most accessible part of it, and that which contains the more important varieties of coal, is drained by Grand river and its tributaries. Although it is the most extensive and, prospectively, the most valuable of the Colorado fields, it is really but a portion of a much larger field extending westward through eastern Utah to the base of the Wasatch range. There is, in fact, an absolutely uninterrupted outcrop stretching from the West Elk mountains in Colorado to Castle Gate and Pleasant Valley in Utah.

Extent of the field in Colorado.—The Colorado portion of the field has its eastern extremity at the base of Mount Wheatstone, near Crested Butte, and is bounded on the west by the State line. The most northerly exposures are on the drainage of the Yampa and the most southerly on that of the Gunnison. The meandering marginal outcrop is usually well exposed and is generally a conspicuous topographical feature, owing to the resistance of the Laramie sandstones to erosion as compared with the Wasatch clays above and the Montana shales below. From the southwestern extremity of the field, near the Utah line, to Hogback cañon, on Grand river, this outcrop conforms to the trend of the Little Book cliffs. Sweeping thence in a great curve around Grand Mesa it intersects the North Fork of the Gunnison near the mouth of Hubbard creek. Rising somewhat rapidly from the river it trends around the base of Mount Gunnison, and crossing the divide between this eminence and Mount Lamborn appears in the basins of Clear and Cliff creeks. Here the continuity of the outcrop is interrupted by the laccolites of Mount Beckwith and the anthracite range; but the Measures reappear toward the eastern end of this range and no doubt extend beneath the post-Laramie beds, and are continuous with the body of the field to the northwest. Beyond the anthracite range exposures the outcrop is again interrupted by the eruptive body of Mount Axtel, but appears again on Ohio creek, where there is a limited area that is connected with another equally small area near Crested Butte by a narrow strip of Measures between Mount Carbon and Mount Wheatstone. The Crested Butte area, which may be regarded as the extreme eastern extension, is also separated by intrusive masses from the body of the field.

On the opposite border to the one just outlined the general trend of the outcrop is towards the northwest. From the anthracite range exposures above noted the Measures pass under the post-Laramie beds and reappear along the western base of Ragged mountain—an immense laccolite of orthoclase porphyrite. The outcrop here is not continuous, and in a few miles it disappears beneath the post-Laramie tuffs. At the northern extremity of the mountain it again comes to the surface, rising at a steep angle toward the high divide between the Crystal river and Gunnison drainage, from which it descends quite rapidly to Crystal river at Prospect. Here the Measures occupy a limited area east of the stream, but the outcrop again intersects the river about four miles below Prospect. From this point it trends westward into Coal basin, and thence northwesterly to Thompson creek, Jerome Park, and Sunshine. A short distance beyond the Measures disappear under a basalt overflow, but reappear at South cañon and continue on past Coalridge to New Castle, on Grand river. North of the river the outcrop pursues the same general course to Dry Gap and Rifle creek, but beyond this the trend is more to the northward, and so continues across the head of the Pi-ce-ance to White river, which it strikes about two miles below Meeker.

From Crystal river to White river the outcrop coincides in general with the line of the Great Hogback fold, which continues on north of the White river without change of direction until, with a westerly curve, it passes into the east-and-west fold at the southern Uinta uplift. The outcrop, however, turns abruptly to the eastward on the north side of the river, and continues on this course for several miles, when it again turns north and extends across Milk creek to Axial basin. Here it curves sharply to the westward, following the course of the Axial basin fold, or eastern extension of the Uinta uplift, to Cedar mountain and Twelve Mile springs. Near this point the outcrop swings south and strikes the White river valley, but does not cross it, at the mouth of Deep Channel creek. From this point it swings back toward the north and passes into Utah in a direction parallel with the Uinta fold.

The greatest length of the field, from the most easterly point to where the outcrop on the northern border crosses the Utah line, is about 151 miles. The greatest breadth from the south end of Grand Mesa due north to the opposite border is about 103 miles, while the distance across the field along the State line is about 60 miles. The Grand river field in Colorado, as thus outlined, contains, approximately, an area of 6,950 square miles.

Vertical range of the Laramie.—The lithological features of the Montana group in this field are not constant throughout, and where the beds of this age have their greatest development sandstones, much similar to those of the Laramie, are prominently exposed toward the summit of the group, alternating with relatively thick beds of shale. The proportion of sandstone to shale increases in ascending order, so that, lithologically, the Montana graduates into the Laramie and, with few exceptions, no strongly marked line of separation can be recognized. The sandstones and shales below the productive Measures contain marine shells in abundance, and the only evidence suggesting that at times nonmarine conditions prevailed is the presence of one and sometimes two thin seams of coal.

These beds are succeeded by the true coal-bearing formation containing at the bases thick, workable seams of coal, in the roof-shales of which remains of land plants often abound. The sandstone underlying the lowest of these seams is here taken as the base of the Laramie group, since, notwithstanding that the stratigraphical difference is simply a progressive increase in the thickness of the sandstones and that fucoids and marine shells may be found from 200 to 300 feet above, the horizon in question marks the first important introduction of widespread nonmarine conditions and separates the Montana group from what is economically one continuous series of Measures.

On the Grand river drainage the summit of the Laramie along the northeastern border is defined by the base of ruby beds (post-Laramie), which are continuous from the Elk mountain to White river. South of Coalridge about 200 feet of yellowish clays and soft sandstones occur between the Ruby bed conglomerates and what is regarded as the Laramie sandstone. These clays are not present farther north, but on the Pi-ce-ance there is a bed of very coarse conglomerate at the same horizon. Along the opposite border of the field the post-Laramie is absent, and the lower members of the Wasatch Eocene rest directly upon the Coal Measures.

The thickness of the Laramie is found to be approximately 2,000 feet on the southwestern border, 2,500 feet in Coal basin, and 3,500 feet at Coalridge and New Castle.

Eruptive occurrences.—These are confined to the southern half of the field, or that which lies south of Grand river. The eruptive bodies represent four distinct varieties of rocks, corresponding to the same number of independent eruptions. They consist of fine-grained and conglomeritic tuffs (Ruby beds), diorites, orthoclase porphyrites, and basalts—the relative age being in the order given. The tufaceous deposits of this and other fields have been repeatedly mentioned and require no further reference. The diorite occurrences are the most remote from the border of the field, and their influence in promoting alteration has been exercised indirectly through the uplifting, flexing, and extensive dynamic movement accompanying their eruption. They consist of the enormous bodies of the Snowmass mountain group and the small laccolite at the mouth of Avalanche creek, on Crystal river. The latter appears in strata of Carboniferous age, but the period of eruption is uncertain. The former have tilted up the Carboniferous and later formations to the top of the Laramie, apparently in connection with the post-Bridger orographic movement, which produced the fold of the Great Hogback.

The porphyrite occurrences are by far the most important in the field, since the production of coking coal and anthracite can be credited to the eruption of numerous bodies of this material. They include the great laccolites of the West Elk mountains, some ten in number, together with the Coal basin laccolite and that of Mount Sopris.

The basalts occur as the extensive overflows of Grand Mesa and the Jerome Park region, neither of which appears to have exercised any influence in promoting alteration in any portion of the field that is accessible, except possibly in the Clear creek basin, where there are intrusive sheets of what may be a partly decomposed granular basalt, in which the olivine and augite are no longer recognizable.

Flexures and displacements.—Considered with reference to their origin, these are of two kinds, viz., those produced by regular orogenic movement, with or without accompanying eruptive activity, and those produced by eruptions alone. The first kind includes an indeterminate amount of uplifting and displacement attributable to post-Cretaceous disturbances, and a very much larger amount attributable to the subsequent post-Bridger disturbances, which in a great measure mask the effects of the previous movement. It is to the combined effects of the two, and mostly to those of post-Bridger time, that the flexures and displacements are due. The second kind includes the local upturning and faulting incident to the great eruption of porphyrite, which postdated the orogenic movements just mentioned. To the first kind belongs the fold of the Great Hogback, which forms a continuous line of flexure from the West Elk mountains to the Wasatch, and was produced in connection with the upheaval of the White River and Uinta plateaus. Also the parallel flexure on the opposite side of the field, produced by the contemporaneous upheaval of the Uncompahgre plateau. To the second belong the local flexures and faults of the West Elk mountains.

The inclination of the Measures along the Great Hogback ranges from 25 to 80 degrees, according to the extent to which erosion has removed the steep portion of the fold, which flattens out rapidly towards the horizontal body of the field. On the southwestern border the Measures are found in nearly horizontal positions around Grand Mesa; but proceeding westward the inclination towards the body of the field increases gradually until it reaches a maximum of 17 degrees along the Little Book cliffs north of Grand Junction. Here also the Measures flatten rapidly away from the outcrop, the variation, as before, being due to the removal of the highly inclined beds by erosion.

The coal seams.—The number of seams present in the section will vary considerably. So far as known, there are from two to four workable beds of 3 feet in thickness and upwards, in the eastern, southern, southwestern, and northern portions of the field; while along the central portion of the northwestern border there are usually from five to seven such seams. As once before noted there is a direct relation between the occurrence of very high coal and the number of seams which have expanded in the same locality or vice versa—indicating the recurrence of certain local conditions during the coal-forming period, which were favorable or unfavorable, as the case might be, to the accumulation of vegetable matter.

The character of the coal invariably depends on the presence or absence of intrusive eruptive rocks in the neighborhood, and their relation to the Measures. Thus, along 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 all of the semi-coking kind. Whereas in the West Elk mountains the bulk of the coal is of the coking kind, except where the limit of alteration has been reached in the production of anthracite.

In the areas containing only semi-coking coal, it is evident that some cause other than igneous activity must have operated to produce the chemical and physical changes which renders this coal, even in the horizontal Measures, so far removed from the lignitic varieties of the same age in other fields. The only discernible cause in this case seems to have been superabundant accumulation of post-Laramie and Eocene sediments, and the consequent long continued subjection of the coal to the increase of temperature and pressure due to a thickness of nearly 2 miles of overlying strata. From this cause the coal had very probably already undergone considerable alteration at the time of the porphyrite eruption, which extended, and, under favorable conditions, completed the alteration thus begun. As will be shown in describing the Gunnison county districts, the anthracite of this region occurs under three conditions, viz., immediately under an eruptive body, a short distance above the same, or else at a considerable distance from it. The occurrence under the first condition is too limited to be of anything more than scientific interest, though a small area of workable anthracite thus formed is mined at Los Cerrillos, New Mexico. The second condition mentioned is the most common, and in all such cases the alteration has apparently resulted from elevation of temperature consequent upon the nearness of the eruptive body, probably aided by the action of steam and hot water, since there is occasional evidence of the silicification of the underlying sedimentaries along the joint planes accompanied by the deposition of traces of metallic sulphides. The third condition, which, in fact, is exemplified by the occurrence near Crested Butte, suggests that hot water alone may suffice to complete the alteration to anthracite. Thus, at the Slate River locality, where this condition occurs, the anthracite is apparently as far removed from eruptive bodies as the coking coal into which it graduates, while in the anthracite area the Montana shales are metamorphosed to slates, the Laramie sandstones contain quartz crystals in the joint planes, and important ore bodies have been deposited in the same formation—effects which are usually attributed to the action of thermal solutions.

Crested Butte district.—This district includes the area tributary to Crested Butte, in Gunnison county, drained by Slate river and its branches, and is reached by a spur of the narrow-gauge system of the

Denver and Rio Grande railway. The producing mines are at Crested Butte and Anthracite—the latter being located about 3 miles from the former. 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 dip at this point is from 6 to 10 degrees westward, but is not constant either in direction or amount. 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 present daily capacity of the mine is about 500 tons, and there are 154 beehive ovens operated in connection with the mine. 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 workings of the mine at Anthracite are, as the name implies, on a 5-foot seam of anthracite contained in an isolated area of the Measures capping what is known as Anthracite mesa, and having a superficial extent of 230 acres on the seam. The product is trammed down the hill a vertical distance of 750 feet to the breaker, which has a daily capacity of about 300 tons of sized coal. This mine is operated steadily for ten months in the year, but the output is insufficient to supply the trade and another mine of larger capacity is being equipped in the adjoining Ruby district. There are other anthracite properties near Crested Butte and on Oh! Be Joyful creek, but the seams are usually less than 3 feet in thickness.

Baldwin district.—This district is situated south of Crested Butte on the drainage of Ohio creek, and is reached by a branch of the narrow-gauge system of the Union Pacific railway. There is but one producing mine, which is located at Baldwin. The mine workings are on a clean seam from 5 to 6 feet in thickness dipping about 5 degrees westward. The coal is an excellent slightly-coking domestic fuel and would find a ready market east of the mountains were it more accessible. As it is, the output is necessarily small. In the adjacent ground to the south (Nolan's), the same seam is from 6 to 7 feet in thickness, but in the opposite direction, at the Lewis opening, the thickness is but 4 feet. This thinning out may be partly due to the shrinkage incident to alteration, the coal at this point being semi-coking, owing to the proximity of the eruptive mass of Mount Carbon against which the nearly horizontal Measures terminate.

Ruby district.—This district includes the Laramie beds which outcrop at the head of Anthracite creek on the northern slope of the Anthracite range, and contain what is at present regarded as the finest body of anthracite in the State. The Denver and Rio Grande and Union Pacific railways are now engaged in extending their lines to this district, and a breaker is being erected for a daily capacity of 500 tons of sized coal.

The measures rest at an angle of about 24 degrees on the basal extension of the eruptive body of the range, from which sheets and dikes of porphyrite have been forced into the coal-bearing formation. The thickness of the Laramie at this point will not exceed 1,000 feet. Immediately overlying it are the tufaceous sandstones and conglomerates of the Ruby beds (post-Laramie), which are extensively developed in this region.

There is but one workable seam in the district, and the thickness rarely exceeds 4 feet. But the coal is very clean and of bright luster, like the better grades from the Appalachian fields, and is much superior in quality to that hitherto produced in the State. Unfortunately, the proved area only amounts to about 700 acres, though there is a reasonable prospect of its continuance into unexplored territory.

Other Gunnison county districts.—The nonproducing districts that have been the most explored are those of Chair mountain and Mount Gunnison. The last-mentioned district includes the area of the Clear Creek basin, where, in one section, no less than four seams of strongly coking coal, aggregating 40 feet in thickness, have been opened up. Here, also, is an interesting occurrence of anthracite which is deemed worthy of note. An intrusive sheet of lava about 20 feet thick appears above and conformable with a 10-foot seam of soft coal, and is separated from it by from 15 to 20 feet of shale. But at one place the lava jumps down to within 8 feet of the seam, and maintains this distance for about 300 feet when it rises to the same level as before. But the approach of the lava to within 8 feet of the coal was all that was necessary to transform the latter into anthracite. This suggests that further explorations in the district may result in the development of coal of this character in sufficient quantity to justify an operation, though the district is too remote to warrant railway extension for the soft coal alone, even if it should be made into coke.

The Chair Mountain district first attracted attention on account of the natural exposures of anthracite on the west side of the divide, where there are three seams of workable thickness, though the lower one is too bony to be of value. The upper ones are, respectively, 6 feet and 3 feet in thickness, of fair quality, and inclined about 37 degrees. But the Measures are badly faulted, and the continuance of the anthracite character, for any considerable distance away from the porphyrite mass of the mountain, is problematical. The same seams have been exposed on the east side of the divide, on Chair and Rapid creeks, and are in places of workable size. The South Ragged mountain exposures also show anthracite seams, but they are usually small, and often badly faulted. Probably the best exposure is at what is called Dark cañon. The evidence goes to show that there is a narrow fringe of anthracite bordering the porphyrite bodies, but that the existence of areas of economical value is somewhat doubtful. At least, only extensive and costly borings will result in their discovery.

Coal Basin district.—This includes the most important area of coking coal in the 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, and will be reached by a spur of the Crystal River railway now under construction. The name, Coal basin, has been applied to a broad amphitheater bounded on three sides by the steep slopes and escarpments of the Coal Measures, which rise abruptly 2,500 feet and form a high, sheltering wall to the basin. The exposures in the central part of the amphitheater consist of soft Montana shales, through which protrudes an eruptive mass less than 1,000 feet high. The strata around the basin are inclined away from this body so that the structure is characteristically that of the laccolite, even to the dikes formed during the eruption. The intrusion of the eruptive body took place subsequent to the formation of the Hogback fold, producing a dome-shaped uplift in the nearly horizontal Measures immediately to the west of it, without, apparently, changing the course of the fold or the inclination of the strata affected by it. Hence, the outcrop on both sides of the basin as it nears the line of flexure resumes the steep southwesterly dip common to the northeastern border.

The lithological distinction between the Laramie and Montana beds is more strongly marked than in any other district of the field, and the position of the coal seams with reference to the well-defined sandstone layers of the lower part of the Measures simplifies the work of outcrop exploration.

The workable beds are five in number, aggregating over 30 feet in thickness of workable coal. At the eastern extremity of the basin the lower seam is separated from the next succeeding by about 50 feet of shale, and the second, in turn, from the third, about an equal distance. But along the western border of the basin the three are so near together that only from 2 to 6 feet of shale intervene. The fourth seam is about 300 feet higher in the Measures, and contains from 6 to 9 feet of coal, while the fifth is about 400 feet higher, and contains from 3 to 4 feet of coal. The three seams first mentioned lie between the basal and second sandstones, but nearer to the former than to the latter. The fourth seam occurs just above the second sandstone, and the fifth seam between the third and fourth sandstones. These features, somewhat modified, are recognizable along the outcrop as far as Grand river, and on the opposite side of the field at the outcrop on the north fork of the Gunnison. The inclination varies from 9 degrees at the west end of the basin to 75 degrees on the line of the Hogback fold. The present permanent opening is located at the western extremity, where there is an explored outcrop about 5 miles long, from which slopes can be driven into the slightly inclined measures of the body of the coking coal area. The coal of the 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 coarse nonreedy structure, has an easy cross fracture, and, while fine grained, is found to contain 53 per cent. of cell space when exhausted with a mercury pump and saturated with water. Such coke is better adapted for lead smelters' use than any other produced in the State, though it is probably not as well glazed as an iron smelter would desire. But should it be required for iron smelting, as seems probable, coals very rich in volatile matter, but which produce reedy coke, are available for a mixture that will furnish a highly glazed, porous, nonreedy product of requisite purity. By this means much slack will be utilized for which there is now no market.

Jerome Park district.—This district includes the Spring Gulch and Sunshine mines and a long stretch of outcrop, where, as the demand justifies it, other mines will be put in operation. The name Jerome Park has been applied to a long trough, about one-half mile wide, eroded out of the soft, Cretaceous shales between the upturned Dakota sandstone on the east and the highly inclined Coal Measures on the west—directly on the line of the Hogback fold. The mines are reached by a spur from the Colorado Midland branch of the Atchison, Topeka and Santa Fe railway system.

All the seams of the Coal Basin section are present in the Jerome Park section. But there is this difference, that the fourth seam is no longer of workable size, while the fifth seam has expanded to a thickness of 7 feet at Spring Gulch and to as much as 9 feet or more at Sunshine. The inclination westward ranges from 40 degrees on North Thompson creek to 45 degrees at Spring gulch, and 47 degrees at Sunshine.

At Spring gulch the workings are on the three lower seams, though the lower one is generally too bony to be mined. The intervals separating the second from the first and third are about 50 feet in each case. The bony lower seam is 8 feet in thickness, the second 5½ feet and the third 4½ feet. The coal has been subjected to considerable crushing movement, so that it is very soft and the amount of slack produced is excessive. This, however, is rather an advantage than otherwise, as the coal is mined largely for the purpose of making coke. The plant for this purpose is located at Cardiff, on Roaring fork, about 14 miles from the mine, and consists of 50 beehive ovens and 197 long rectangular ovens which it is the intention to replace with beehives as they wear out. The coke produced is low in ash, but of "reedy" structure. Nevertheless it is preferred by lead-smelters to the coke from the Raton field.

The workings of the Sunshine mines are on the fifth seam, which for this reason is designated "the Sunshine seam." The lower seams are present in the section and the lowest of all is 14 feet thick. But there is no evidence of crushing movement ever having affected the coal in this seam at this point, and the composition is somewhat lignitic. The coal from the Sunshine mine is of the slightly-caking domestic kind—the change in character from coking to domestic taking place at a point not very far south of the mine and within a distance of 300 feet. This fact was developed in the workings of the old Marion mine, which has been temporarily abandoned in order to increase the capacity of the Spring Gulch mine. On North Thompson creek, about 2 miles south of Spring gulch, the coking property of the coal undergoes a decided change, and in coking it develops the structure noted in connection with Coal basin coke.

Grand River district.—This district includes the mines situated within a few miles of Grand river, but on the northwestern outcrop only. The producing properties are: The Grand Butte, at New Castle, and the Vulcan, about 1½ miles southeast of New Castle. Those which have been producers, but are not now in operation, are Coalridge and South cañon.

The outcrop here, as elsewhere along the Hogback fold, exposes the Measures in higly inclined position, the dip ranging from 57 to 60 degrees for the lower seams, and from 25 to 40 degrees for the upper ones, the latter having been eroded more deeply in the direction of the flatter portion of the fold or towards the body of the field. The workable seams are seven in number, although those that are workable in one section do not always correspond exactly with those developed in another. Nevertheless the aggregate thickness throughout the district is very great, and far exceeds that of any other district in the State in respect to the quantity of clean coal that can be mined.

The section at the Grand Butte mine shows, in a thickness of about 1,000 cubic feet, the following clean seams of coal, beginning with those at the top of the productive zone: C seam, 5 feet; Anderson seam, 8 feet; Allen seam, 20 feet; D seam, 5 feet; Wheeler seam, 46 feet; E seam, 18 feet; F seam, 4 feet—a total of 106 feet of clean, workable coal. The C seam is the only workable one of what may be called the upper group, which is separated from the intermediate group (Anderson and Allen) by about 300 feet of shales and sandstones, and this group in turn from the uppermost of the four lower seams by about 400 feet of shales and massive sandstones. The old slope workings of the mine are on the Wheeler and E seams, which are 16 feet apart, so that it is practicable to drive the entries on one and the air courses on the other. But a deep shaft sunk near the outcrop of the Allen seam, and from which a long crosscut is being extended, will shortly render available all but the C seam.

At the Vulcan mine, a crosscut tunnel from the surface exposes the three lower seams, and probably the others will be found on further exploration. At Coalridge the lower seams have been burned out on the outcrop, but there is in one place a thickness of 18 feet of cinders to testify to the presence of a thickness of at least 25 feet of coal below. Of the intermediate seams only one has been opened up, showing 5 feet of clean coal, very rich in volatile hydrocarbons. The present Coalridge workings are on the Piñon Basin seams, which probably correspond to the B and C seams in the Grand Butte section. These seams are, respectively, from 5 to 6 feet in thickness at Coalridge and from 7 to 8 feet in the excavations about 3 miles further to the southeast.

The same seams are present at South Cañon, 4 miles above New Castle, but are burned out on the outcrop. All of the seams of the lower group exposed at the Grand Butte mine are present and workable, but of small size, except the Wheeler seam, which is still 25 feet thick.

Northwest from New Castle about 5 miles are the Dry Gap exposures, which show the Wheeler seam and three others, aggregating 60 feet of clean coal. At Rifle Creek gap all the large seams are burned out on the outcrop, but are exposed near by along the Hogback, and show about the same aggregate thickness of coal. This is the limit of the territory assigned to this district, or which is tributary to the main lines of the Denver and Rio Grande and Colorado Midland railways, following the Grand valley.

The coal is mostly of the semi-coking domestic kind, though some of it, like that from the Piñon basin seams, is noncaking and yet low in moisture—qualities which, taken together, render it an exceptionally desirable domestic fuel.

Other districts of the northeastern border.—This refers to all that portion of the field lying on the drainage of the White and Yampa rivers, a region in which more or less actual development has been done, but in which there are no producing mines worthy of the name, though for years coal has been taken out in a small way for local requirements. Owing to the dryness of the climate, and the favorable geological structure of the country along this border, the coal seams are frequently exposed in the ravines and gulches cutting through the Measures, so that exploration is thereby much simplified, and much coal shown up naturally at intervals of a few miles. The most noteworthy exposures are at the Pi-ce-ance, Thirteen-Mile, White river, Coal Creek and Spring Creek gaps, at Cedar mountain (Coal mountain), Twelve-Mile Springs, and near the mouth of Deep Channel creek. At none of these places is there less than 20 feet in aggregate thickness of coal exposed. This is all of the slightly-caking domestic kind. Along the line of the Hogback fold the Measures are invariably of high inclination, but on the Lower White and in the area north of Meeker the beds approach in places a nearly horizontal position.

Grand Junction district.—This is the only district on the southwestern border of the field that is at present deserving of special mention. It includes the outcrop at Hogback cañon, on Grand river, and that of the Little Book cliffs, north of Grand Junction. The inclination of the measures at Hogback cañon is but a few degrees northerly, but it increases rapidly going west on account of the convergence of the outcrop with relation to the fold at the northern base of the Uncompahgre plateau. There are two workable seams exposed near the base of the Measures. The lower one is from 3 to 4 feet thick, and the upper one about 12 feet—in places only 7 feet—and usually in two benches.

The Carpenter mine at Little Book cliffs has its workings on the lower seam, which at this point has a northerly dip of from 15 to 17 degrees. Formerly the upper seam was worked at the same place and dumped into a wooden chute placed against the cliff. The same seam is worked at the Smith mine near Hogback cañon, and the lower seam has been worked at the same place. But the market is strictly a local one and the present total output of the district is inconsiderable. The coal is of the semi-coking domestic kind and of fair quality.

THE YAMPA FIELD.

This field lies altogether on the Yampa river and tributary streams—hence the name. For the sake of convenience, however, a portion of the southern Wyoming field lying within the Colorado limits, and no doubt connected with the body of the Yampa field beneath the transgressive post-Laramie and Eocene deposits, together with certain remnants in the Flat Top mountains, will be included in the description.

The distance separating the Yampa field from the Grand River field is but a few miles—the width of the anticlinal valley known as Axial basin, already referred to. The Measures of the two fields, together with the more recent terranes, dip away from the valley, and no doubt at one time extended across the intervening narrow area of erosion, thus forming one continuous area of Measures.

The amount of reconnoissance work performed in the Yampa field has not been sufficient to warrant more than a very general description of it; nor have the seams been developed to an extent that would justify an unqualified expression of opinion as to the adaptability of the coals contained therein, except in a few localities. At the present time there is not a single producing mine within the limits of the field, nor is there likely to be until railway extension shall render it accessible to the markets of the prairie States. How soon this will take place is a matter of conjecture, though the agricultural and grazing resources of the region, coupled with the superior quality and variety of the coals and the existence of a practicable route for a through line of road, have already attracted the attention of railway men.

Geographical extent.—The Laramie exposures of the northeastern border of the field begin near the eruptive body of Anita peak, locally known as "The Bear's Ears," and extend thence easterly, across Elk Head creek, at the lower end of California park, to the divide south of Whitehead peak. From there the course of the outcrop is southeast, past the head of Deep creek, to the intersection of the Yampa just below the mouth of Elk river. South of the Yampa it pursues the same general course to Hunts creek. Here it turns somewhat abruptly towards the northwest, and continues on across Trout and Little Fish creeks to Williams river, which for several miles has cut a deep cañon through the Measures to the base of the group. From Williams river the outcrop describes a semicircle to the southward across Waddel and Deer creeks to Axial basin, and thence northwesterly back to the Yampa, north of which the defining limit is simply an imaginary line extending from the outcrop on Lay creek, beneath the Eocene beds to the place of beginning. The above is substantially the outline of the main Yampa field, which embraces an area of about 870 square miles. Of this amount, a very considerable proportion in the body of the field lies deeply buried under post-Laramie and Eocene beds; but there is every reason to believe that the coal-bearing formation passes as a continuous sheet beneath these sediments. Were this not the case, it would still be necessary to include the greater part of the area in question, for the reason that the post-Laramie in this field is also coal bearing.

Regarding the portion of the southern Wyoming field which extends into Colorado, there can be little question of the propriety of attaching it to the Yampa field, since in all probability the Measures extend under the newer sediments and with unbroken continuity around the western end of the Elk Head mountains. The outcrop of this portion of the field is a continuation of the uninterrupted exposure which sweeps south from the Union Pacific railway just west of Rawlins to Little Snake river on the Colorado line. Here, it turns abruptly to the east and extends up the river almost to Three Forks, when it trends south towards the head of Slater's Fork and thence follows, approximately, the drainage divide of the Elk Head mountains to near Anita peak—where, apparently, the outcrop is interrupted and separated from that of the main Yampa field by the eruptive bodies of the Elk Head group. To the westward, the Measures probably extend far out beneath the beds of the great Eocene fresh-water lake which once covered an enormous area between the Uinta mountains and the northern portion of the Wind River basin. But as the extension of the Laramie west of the Elk Head mountains cannot be determined, owing to the absence of exposures of this age in the disturbed Red Creek region beyond, it becomes an open question as in the case of the main Yampa field where the western limit should be placed. Under these circumstances, 150 square miles only has been assigned to this area, since a more liberal allowance would necessitate trespassing on very uncertain ground.

The detached remnants of the Measures outcropping at the northern extremity of the Flat-Top mountains are, from their position, of small economic importance even prospectively. Nor can their area be determined with any degree of accuracy owing to the outcrop being masked with heavy drift or covered by talus from the cliffs of the great basalt overflow of these mountains. An allowance of 80 square miles of Measures is, therefore, nothing more than a mere guess; yet it is thought to be less than the actual area.

With the above additions to the Yampa field, the total area of accessible and inaccessible Measures assumed to contain coal seams of workable thickness will aggregate about 1,100 square miles. In presenting this estimate, it is pertinent to remark that there is room for wide difference of opinion as to how far the Measures may be assumed to extend westward beneath the Eocene beds. Hence, independent estimates, even though based on a careful detailed survey, are not likely to agree very closely. Nevertheless, the tendency will probably be to increase rather than lessen the figures here given.

Geological features.—The characteristics of the field as regards the Coal Measures are, in the main, similar to what has been noted in connection with the Grand river field—more especially in respect to the lower members of the Laramie and their relation to the Montana group. There is the same gradation, through a great thickness of strata, from predominating sandstones above to predominating shales below. The line of demarkation between the Laramie and the succeeding formation has not yet been satisfactorily determined owing to the absence of the characteristic tuffs and the prevalence, throughout, of débris resulting solely from the erosion of Archæan areas. The thickness, however, of the Measures along the southern border is not less than 2,000 feet, though near the Wyoming line it may be less.

The disturbances that have affected the field were—those associated with the principal orographic movements, and those connected with the eruptions. The former resulted in the production of two prominent folds, one on the southern border, parallel with the uplift of the White river plateau, and one on the northeast border, parallel with the axis of the Park range. By this means the Measures along the great fold of the southern border are inclined from 48 to 50 degrees, and along the border facing the Park range from 10 to 15 degrees, except at the auxiliary anticline below Elk river, on the Yampa, where the inclination is from 50 to 55 degrees, and for a short distance the Montana is exposed. South of Williams river, the inclination is, at Waddel creek 20 degrees or more, at Deer creek 10 degrees, and at the west, at Lay creek, 7 degrees. The effect of the spasmodic movement connected with the eruptions is seen in the local upturning and dislocation of the Measures.

The eruptive occurrences, so far as they affect the coals of the field, represent varieties of one group of rocks—basalts—and probably belong to one period of eruption. They consist of cupolas, dikes, sheets, and, rarely, overflows of quite limited extent, as at Battle mountain on Little Snake river. The eruptive bodies are very numerous between the last-named stream and the Yampa. Indeed, with the exception of a sheet outcropping opposite the mouth of Elk Head creek, there are no eruptive occurrences between the Yampa and the Flat Top mountains.

The coal seams.—In none of the coal fields herein described is the influence of intrusive eruptive bodies on the composition of the coals more strikingly demonstrated. The lignitic coals of southern Wyoming are characteristic of the Measures as far south as Little Snake river. But as they approach the most northerly of the intrusive bodies there is a noticeable decrease in the percentage of moisture, and in a few miles the coal is all of the semi-coking kind, or else, where an intrusion is sufficiently near, it has been transformed into anthracite. It is noteworthy, however, that the alteration appears to have been effected by a somewhat different process to that noted in the Grand river field. It was, more properly, a baking of the coal when the intrusion was near by. But owing to the small size of the eruptive bodies, as compared with the vast masses of the West Elk mountains, they were not capable of advancing alteration throughout the Measures beyond the semi-coking stage, and as a consequence coking coal has not been discovered in this field.

The excavations on the Little Snake show a seam about 11½ feet in thickness, exclusive of a thin band of shale near the center and another about 4 feet, which is not always of workable size. The coal of these seams is very similar in most respects to the celebrated Rock Spring coal of Wyoming, though the average moisture contents is generally higher. At the lower end of Slaters park there are small seams of both anthracite and soft coal, but nothing of workable size has been developed. The exposures on Elk Head creek show a seam of semi-coking coal from 7 to 10½ feet in thickness, outcropping in California park, and two small seams of anthracite outcropping in the cañon at the lower end of the park. This anthracite is evidently a very local occurrence, depending on the presence and relative position of an irregular intrusion of lava which appears just above it. About 8 miles to the southeast, at the Dry creek openings, there are two seams, one of anthracite from 7 to 10 feet in thickness, according to the degree of alteration, and one of slightly-coking domestic coal from 5 to 6 feet in thickness, 160 feet higher in the Measures. Below the anthracite there is a thick sheet of lava which rises gradually towards the seam. When this lava sheet comes within about 40 feet of the seam the latter changes rapidly to anthracite of brilliant luster, but when the distance becomes reduced to 10 or 15 feet the coal is found to be friable, and a nearer approach of the lava is marked by the presence of material that is practically anthracite culm. This takes place in the vicinity of a big roll in the sheet, which carries it some distance above the seam and sufficiently near to anthracize the coal of the upper seam, the lower one being now exposed as a seam of slightly-caking domestic coal from 12 to 13 feet in thickness.

On the Yampa river the outcrop is exposed in three places. Near the mouth of Wolf creek an entry shows a seam 17 feet in thickness, separated into three benches of about equal proportions by two 10-inch bands of shale. The inclination here is 5 degrees westward. East of this there are other beds exposed at the anticline, but the principal one appears to have been burned out on the outcrop. The Oak creek exposures at the eastern extremity of the field show four seams of workable thickness, of which the upper three contain only low coal. The bottom bed is 10 feet thick and inclined from 10 to 15 degrees towards the body of the field.

Along the upturned outcrop facing the Flat Top mountains there are usually two workable beds exposed in the cañons traversing the Hogback formed by the tilted Measures. The lower of the two is from 11 to 12 feet in thickness; the upper, about 90 feet higher in the Measures, usually contains low coal. There is evidence of much crushing movement along the seams, especially at the Little Fish creek intersection. Along the Williams river valley the outcrop of the coal is mostly burned out, as is so frequently the case in the fields of the Western group. South of the valley, near Waddel creek, there is a seam containing about 7 feet in thickness of clean coal inclined about 20 degrees. In the same area, on Deer creek, the section shows two seams; the lower, of low coal, from 3 to 4 feet thick, and the upper, from 16 to 18 feet, apparently very clean. On the east side of Lay creek a 75-foot entry shows about 10 feet of coal, part of which is bony, inclined 7 degrees eastward by the Yampa peak uplift.

The soft sandstones, shales, and clays of this field, which are thought to correspond to the post-Laramie group in other fields, and possibly to the beds near Black Buttes, Wyoming, which contains *Ceratops* remains, often afford exposures of lignite. The 12 to 15 foot seam of this substance on the Little Bear, a branch of Fortification creek, belongs in this formation, as also a 4-foot seam near Craig, and another somewhat larger near Hayden. But the coal is not of a quality that would be used until the Laramie coal is exhausted.

The areas of the Flat Top mountains, though altogether inaccessible, contain considerable coal. At the exposures on the head of Coal creek, a small stream emptying into the Yampa, there are no less than four workable seams, each containing from 5 to 6 feet in thickness of clean coal, in a section of not more than 100 feet.

DAKOTA CRETACEOUS MEASURES.

In southwestern Colorado, from the Grand river drainage southward, it is common to find coal seams of small size outcropping at the base of the Dakota formation.

As a rule the seams are too small and the quality of the coal too inferior to render them of economic importance; but there are localities where local expansion of the seams, coupled with remoteness from railways and other sources of fuel supply, entitles the Dakota coal to some consideration.

At several of these places the coal has been mined in a small way. Near Grand Junction there are two seams 18 feet apart, the upper one containing 32 inches of coal with shale partings and the lower 36 inches of bony coal. Some of this coal was mined and used by the Denver and Rio Grande Railway, but its use was soon abandoned. The lower seam rests upon the basal Dakota conglomerate. Near Dallas, on the Uncompahgre, there is a 2-foot seam of impure Dakota coal which has been locally altered to semi-anthracite by an intrusion near by. This has also been mined in a very small way. So, likewise, a seam of the same age below Telluride which expanded in places to 3 feet in thickness. On the Dolores, above Rico, a 20-inch seam was mined, and the product made into coke for the smelting works at that place. But its use was abandoned when railway connection with Durango gave access to a better fuel. Both on the Mancos and on Junction creek there are seams of anthracite either badly crushed or too impure to be of any value. But near Cortez, in Montezuma county, there is one seam of semi-coking impure coal which with shale partings is as much as 5 feet thick, and is mined to a limited extent for local consumption. West and southwest from Cortez the Dakota group invariably contains more or less low coal, which has proved of considerable service to the settlers in that corner of the State. But its utilization in a large way is a remote possibility, and will not take place until the other coal fields of Colorado approach exhaustion.

THE AVAILABLE RESERVES. (*a*)

The statement hereto appended exhibits in a condensed form the area and estimated available reserves in the Colorado coal fields. In making these estimates, the economic working limit of highly inclined Measures is assumed to be one-half mile on the slope of the beds from the general outcrop line; for measures dipping from 10 to 20 degrees from 1 to 2 miles, according to the amount of inclination back from the outcrop and the thickness and quality of the coal; for horizontal, or slightly inclined measures, 4 miles is assumed to be the working limit for high coal, and 3 miles for low coal. An exception to the limit first given has been made in the case of the upturned measures of the Great Hogback, where the enormous thickness of superior coal, the depths of the gorges or points of attack below the mean level of the outcrop, together with the general accessibility, make it reasonable to assume that the seams will be worked to an average distance of one mile. In the Raton field, which has been carefully meandered, the small areas in advanced position, relative to the points of attack, have been calculated and added to the total. In the absence of detailed surveys, it was impossible to do this in the case of any other field.

The least workable thickness is assumed to be 3 feet of clean coal,

a The subjoined estimates are substantially as contributed by the writer to Frank Hall's History of Colorado.

for though smaller seams are worked even now, under very favorable conditions, they can not be followed with profit beyond a short distance. In estimating the available reserves of the Raton, South Platte, Grand River, and Yampa fields, the average aggregate thickness of workable coal developed along each subdivision of the outcrop, as determined by the degree of inclination of the measures and excessive expansion or contraction of the coal seams, was regarded as extending beneath an area bounded in depth by the working limit specified for the conditions. Of course, in all such cases the liability to error is in the direction of underestimation, owing to the existence of seams of low coal which the explorations have not yet developed. Indeed, additions to the reserves of the Raton field are already suggested by discoveries since these estimates were made. In regard to the La Plata and North Park fields, and the remaining fractional areas, the observed average thickness of coal developed was assumed to extend into the field a distance determined by the appropriate working limit. This plan was the only one applicable under the circumstances, and with the exception of the Cañon City district, it is not probable that a very close approximation has been reached.

With respect to the assumed working limits, there can be no doubt that to many engineers they will appear too restricted, even when measured by the standards of the present day, without taking into account the advanced engineering methods of the future. But we can not anticipate the possibilities of the latter, nor can we always apply the former under the conditions existing in the Rocky mountains. On the whole, the figures here given are thought to possess a comparative value, notwithstanding that they will be considerably modified by the results of future surveys.

COMPOSITION OF COLORADO COALS.

Most of the analyses which appear in the following tables were made by the writer in the laboratory of the Colorado Fuel and Iron Company, and, in connection with those from the South Platte field made by Prof. Wm. B. Potter, give a fair idea of the range of Laramie coals.

The method employed in making the ultimate analyses consisted of weighing out in a tared platinum boat two decigrams of finely-powdered coal in which the moisture had been determined on an independent sample, drying it for one hour at 110° C., and at once subjecting it to combustion, at as low a temperature as practicable, in a current of oxygen gas previously dried and purified. The resulting products passed through a roll of copper gauze heated to full redness, and then through hot chromatized asbestos to intercept sulphur compounds. Calcium chloride and soda lime were used in the absorption tubes. The chromatized asbestos is prepared by precipitating lead chromate upon asbestos fiber, using for the purpose a hot saturated solution of lead chloride, in which the asbestos is placed, and adding thereto a sufficient quantity of potassium bichromate. After thorough washing, the asbestos is dried and subsequently ignited in a muffle. This substance is made up into cartridges by placing it loosely in a hemi-cylinder of copper gauze which can be easily pressed into the mouth of the combustion tube. A number of these cartridges are kept hot in an air bath while the analyses are in progress, and a fresh one is used for each determination. On the completion of a combustion the asbestos is placed in a beaker, digested with ammonium carbonate, and the sulphur determined in the usual way. The amount thus found is then deducted from the oxygen estimated by difference. As it frequently happens that a portion of the sulphur remains to be determined in the ash, the summation in such cases will exceed 100 just this amount, as it is the total sulphur that appears in the list. The nitrogen determinations were made in the usual way by combustion with soda lime.

As the composition of the ash is of considerable importance to the lead smelter and also to the large consumer of locomotive and steam coals, to whom the formation of clinker is objectionable, a few typical analyses have been appended.

In this connection the writer wishes to acknowledge his indebtedness to his assistants, Messrs. J. T. Kebler and L. S. Storrs.

Estimated area of Colorado coal fields.

Fields.	Square miles.
Grand River field (Colorado portion)	6,950
Yampa field, including part of Wyoming field in Routt county	1,100
La Plata field (Colorado portion)	1,250
Raton field (Colorado portion)	1,300
South Platte field	6,800
North Park field	300
South Park, Cañon city, and Tongue Mesa districts	100
Dakota Measures (southwestern Colorado)	300
Total	18,100

Estimated quantity of available coal in Colorado fields.

Location.	Accessible area.	Available gross tonnage.
	Sq. miles.	
Grand River field (in Colorado)	1,116	26,384,800,000
Yampa field	440	5,961,500,000
La Plata field (in Colorado)	300	3,387,200,000
Raton field (in Colorado)	473	4,490,200,000
South Platte field	405	2,568,600,000
North Park field	80	1,806,500,000
Cañon City, South Park, and Tongue Mesa districts	49	429,000,000
Dakota Cretaceous Measures	50	169,300,000
Total	2,913	45,197,100,000
Total net tonnage, or 75 per cent. of gross estimate	....	33,897,800,000

Analyses of Colorado coals.

RATON FIELD.

	Carbon.		Hydrogen.		Oxygen.	Nitrogen.	Sulphur.	Moisture.	Ash.	Volatile combustibles.	Net calories. (*a*)	Specific gravity.
	Fixed.	Combined.	Disposable.	With oxygen.								
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
Engleville mine	57.07	17.56	3.67	.99	7.89	.47	.55	.75	11.05	31.13	7066	1.287
Sopris mine	58.40	20.45	4.87	.59	4.68	.99	.60	.52	8.90	32.18	7783	1.318
Do	57.80	16.74	4.05	.89	7.11	.92	.59	.40	11.50	30.30	7177	1.314
Starkville mine	57.39	16.19	3.65	1.18	9.41	.31	.63	.44	10.80	31.37	6967	1.303
Forbes mine, Tingley cañon	57.87	16.08	3.39	1.19	9.51	1.28	.42	1.21	9.05	31.82	6916	1.320
Berwind mine, Lower Group	54.81	24.41	4.53	.91	7.30	1.46	.59	1.24	4.75	39.20	7692	1.274
Do	50.66	21.50	4.41	.79	6.30	1.31	.63	2.05	12.35	34.94	7088	1.380
Road cañon, Upper Group	50.39	24.57	4.55	1.03	10.14	1.39	.67	1.44	5.82	42.35	7347	1.288
Cañon de Agua, Victor seam	54.34	20.94	4.23	.90	7.21	1.34	.69	1.95	8.40	35.31	7282	1.315
Aguilar	57.51	18.31	3.99	1.21	9.67	1.32	.77	1.89	5.33	35.00	7240	1.298
Morley seam, Upper Group	59.19	17.55	4.21	.77	6.21	1.06	.61	1.63	8.77	30.41	7402	1.358
Cañon de Agua, Upper Group	48.83	21.01	3.62	1.36	10.84	1.25	.47	1.49	11.13	38.53	6642	1.282
Santa Clara mine, Walsen seam	51.45	22.74	3.98	1.08	8.64	.84	.64	1.68	8.95	37.92	7112	1.316
Rouse, Cameron seam	53.43	20.87	4.08	1.14	9.10	1.00	.77	2.36	7.25	36.96	7144	1.329
Do	51.12	22.82	3.76	1.24	9.94	.99	.56	2.12	7.45	39.31	7016	1.316
Do	52.04	21.73	3.69	1.16	10.00	.75	.72	2.06	7.75	38.15	6982	1.318
Do	52.77	20.79	4.21	1.01	8.12	1.35	1.48	3.50	6.77	36.96	7123	1.326
Do	52.52	20.42	3.99	1.13	9.06	.80	.69	3.39	8.00	36.09	7003	1.325
Do	50.78	17.39	3.24	1.58	12.60	.80	.72	2.48	10.45	36.29	6378	1.330
Walsenburg, Cameron seam	53.57	16.79	3.07	1.65	13.21	.84	.69	4.88	5.30	36.25	6488	1.341
Do	54.05	19.15	3.86	1.41	11.33	1.36	.67	2.62	5.55	37.78	6976	1.302
Walsenburg, Walsen seam	49.91	22.25	3.61	1.20	9.55	1.31	.60	2.97	8.60	38.52	6829	1.312
Pictou mine, Lenox seam	51.05	21.25	3.84	1.54	12.31	1.29	.60	3.27	5.05	40.63	6888	1.342
Pictou mine, Maitland seam	54.53	17.02	3.50	1.48	11.87	1.26	.74	4.01	5.75	35.71	6725	1.320
Huerfano seam, Upper Bench	49.70	18.25	3.15	1.51	11.99	.83	.64	6.74	7.20	36.36	6314	1.352
Huerfano seam, Lower Bench	48.52	19.24	2.97	1.47	11.82	.92	.55	6.54	7.97	36.97	6249	1.348

a "Net calories" represents the heat due to perfect combustion of the carbon and disposable hydrogen, less that absorbed by the total amount of water given off by the coal.

CAÑON CITY DISTRICT.

Coal Creek mine (pea)	51.47	13.86	3.07	1.40	11.17	1.44	.66	6.21	11.10	31.22	6087	1.344
Coal Creek mine (lump)	53.04	16.45	3.11	1.62	12.97	1.35	.59	7.26	4.00	35.70	6419	1.356
Coal Creek mine	50.51	20.13	3.78	1.35	10.79	.97	.58	6.59	5.30	37.60	6727	1.324
Chandler Creek mine	47.08	18.22	2.90	1.83	12.25	.94	.51	6.18	10.35	36.39	6014	1.332
Brookside mine	51.72	15.15	2.87	1.73	13.86	1.04	.50	8.23	5.00	35.05	6126	1.338

SOUTH PLATTE FIELD.

Erie (*a*)	45.98	19.65	3.41	.83	6.64	1.64	.52	18.57	2.74	....	....	....
Marshall (*a*)	46.43	16.30	5.91	1.51	12.10	1.34	.66	13.19	2.54	....	....	....
Golden 12-foot seam (*a*)	38.46	21.21	3.15	1.73	13.88	.95	.29	17.64	2.67	....	....	....
Golden 4-foot seam (*a*)	34.89	23.08	3.31	1.82	14.59	1.50	.42	17.15	3.22	....	....	....
Mount Carbon (*a*)	37.82	23.67	4.07	.83	6.67	1.25	.40	20.38	4.87	....	....	....
Mitchell	43.31	12.12	1.86	1.42	12.13	.63	.47	22.95	5.10	28.64	4833	1.280
McFarren	40.30	15.07	2.74	1.59	12.71	.88	.39	21.37	4.95	33.38	5094	1.315

a Made by Prof. William B. Potter. See Vol. v, Transactions Am. Inst. Mining Eng.

SOUTH PARK DISTRICT.

Lechner's bank (*a*)	58.61	12.88	3.62	1.60	12.86	2.35	.46	6.30	1.28	....	....	....
Mine No. 5	49.40	17.15	2.23	2.00	15.99	1.06	.53	7.18	4.70	38.72	5903	1.305

NORTH PARK FIELD.

Coal Hill slope	41.90	....	....	....	....	....	1.10	18.35	6.45	32.20	....	1.364
Red Hill outcrop	48.00	....	....	....	....	....	....	15.20	3.50	33.30	....	1.356
No. 1 slope	38.75	....	....	....	....	....	....	12.25	14.25	34.75	....	1.424
No. 3 slope	40.55	....	....	....	....	....	....	15.70	5.50	38.25	....	1.360

LA PLATA FIELD.

Porter mine (lump)	56.62	20.00	3.94	1.12	8.99	1.46	.49	1.14	6.25	33.76	7307	1.278
Do	55.72	21.59	4.49	1.04	8.36	1.42	.52	.82	6.05	37.27	7522	1.258
La Plata mine, choice specimen	53.65	21.11	4.79	1.00	8.02	1.53	.86	1.01	8.10	37.19	7406	1.263
La Plata mine (average)	52.01	17.95	3.55	1.23	9.87	1.48	.78	1.07	12.25	34.61	6639	1.281
San Juan county mine (lump)	60.29	19.46	4.19	1.07	8.56	1.67	.66	1.49	2.65	35.52	7626	1.240
Do	58.52	18.44	3.67	1.25	10.05	1.59	.61	.90	5.00	35.32	7240	1.256
Coppinger, La Plata river	54.46	16.73	2.93	1.75	14.07	1.53	.68	4.10	3.75	37.72	6513	1.270

a Made by Prof. William B. Potter. See Vol. v, Transactions Am. Inst. Mining Eng.

TONGUE MESA DISTRICT.

Kezar bank	36.44	19.34	2.66	1.58	12.68	1.08	.88	15.67	10.10	37.79	5135	1.318

Analyses of Colorado coals—Continued.

GRAND RIVER FIELD.

	Carbon.		Hydrogen.		Oyxgen,	Nitrogen.	Sulphur.	Moisture.	Ash.	Volatile combustibles.	Net calories. (a)	Specific gravity.
	Fixed.	Combined.	Disposable.	With oxygen.								
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
Crested Butte:												
Lower seam	56.93	21.06	4.52	1.03	8.22	1.92	.48	1.79	4.05	37.23	7581	1.280
Long's tunnel	82.31	3.76	3.98	.23	1.87	1.37	.56	1.04	5.05	11.60	8117	1.279
Skinner bank	55.07	19.63	3.80	1.43	11.49	1.72	.55	2.66	4.00	38.27	7078	1.289
Anthracite mine:												
Upper seam	88.82	.63	3.18	.15	1.19	.66	.78	.59	4.00	6.59	8159	1.389
Main entry	84.78	1.12	3.28	.10	.84	.86	.67	.93	7.42	6.87	7903	1.445
Third, West	85.98	1.70	2.83	.05	.42	.71	.68	.58	7.05	6.39	7917	1.437
Ruby mine	87.23	1.17	2.91	.25	2.00	1.29	.84	1.00	3.65	8.12	7987	1.515
Do	87.51	.05	2.77	.34	2.69	1.29	.89	.72	4.15	7.62	7875	1.500
Mount Gunnison:												
Thirteen-foot seam	48.25	21.20	3.29	1.53	12.29	1.02	.48	7.29	4.65	39.81	6473	1.312
Lower seam	46.04	22.25	3.51	1.48	11.88	1.18	1.33	6.48	5.85	41.63	6451	1.327
Upper 10-foot seam	50.66	22.07	3.38	1.42	11.40	1.39	.58	5.65	3.45	40.24	6779	1.300
Coal basin:												
Upper Bench	71.31	9.94	3.69	.69	5.55	1.90	.67	.56	5.70	22.42	7612	1.247
Middle Bench	70.02	8.59	3.28	.80	6.47	1.93	.50	.60	7.85	21.42	7079	1.254
Lower Bench	66.18	9.58	1.10	.98	7.88	1.87	.61	.76	11.15	21.94	6395	1.312
Sunshine mine	56.16	14.00	3.39	1.65	13.18	1.57	.43	4.12	5.50	34.22	6571	1.307
Grand Butte mine, Wheeler seam	48.57	21.04	2.68	1.26	10.11	1.48	.53	2.58	12.00	36.85	6343	1.291
Piñon basin:												
Lower seam	50.32	20.63	2.98	1.58	12.65	.93	.34	4.47	6.10	39.11	6515	1.342
Upper seam	54.44	17.68	3.06	1.69	13.49	1.21	.31	6.11	2.01	37.44	6620	1.319
Lower seam	54.22	21.18	3.69	1.31	10.50	1.34	.42	4.99	2.35	38.44	7095	1.309
Driscoll seam	48.89	23.53	3.69	1.54	12.36	1.45	.92	3.17	4.45	43.49	6854	1.310
Dry Gap:												
Fourteen-foot seam	51.09	23.39	4.23	1.25	10.03	1.22	.55	4.54	3.70	40.67	7186	1.309
Wheeler seam	45.79	20.03	3.74	1.24	9.93	.98	.53	4.81	12.95	36.45	6341	1.368
South cañon, big seam	53.62	18.24	3.29	2.76	14.13	.98	.55	3.85	3.58	38.95	6675	1.303
South cañon, big seam No. 1	52.16	20.11	3.59	1.63	13.04	1.06	.43	3.83	4.15	39.86	6804	1.306
Hogback cañon, Upper seam	48.67	18.23	3.35	1.44	11.54	1.47	.59	4.02	10.90	36.41	6307	1.300
Do	44.71	19.84	3.43	1.31	10.47	1.39	.51	5.43	13.10	36.76	6139	1.297
Meeker mine	54.94	16.05	2.46	1.43	11.46	1.30	.45	6.51	5.40	33.15	6361	1.331
Coal creek, near Meeker	53.11	14.84	2.57	1.95	15.62	1.33	.48	7.63	2.65	36.61	6117	1.269

a "Net calories" represents the heat due to perfect combustion of the carbon and disposable hydrogen, less that absorbed by the total amount of water given off by the coal.

YAMPA FIELD.

Dry creek, anthracite	79.26	.31	2.34	.21	1.66	1.88	.68	2.64	11.70	6.40	7098	1.468
Do	78.92	.64	1.50	.45	3.59	1.11	.63	3.02	10.50	7.56	6835	1.523
Dry creek, 5-foot seam	55.92	7.58	1.54	1.60	12.77	1.26	.41	9.36	9.75	24.97	5459	1.470
Do	51.11	15.53	3.02	1.74	13.90	1.34	.51	9.43	3.45	36.01	6145	1.290
Big seam, Deep creek	48.92	14.27	2.88	1.95	15.60	1.27	.64	7.24	7.35	36.49	5826	1.310
Oak creek, 10-foot seam	51.93	19.02	2.91	1.74	13.94	1.55	1.55	6.67	1.35	40.05	6475	1.294
Little Fish creek, 12-foot seam	51.26	14.64	2.69	1.78	15.07	1.23	.41	7.58	5.45	35.71	5990	1.300
Lay creek, 10-foot seam	48.37	15.34	2.12	2.03	16.21	.98	.95	10.07	4.30	37.26	5624	1.380
Little Bear creek, 15-foot seam	41.97	15.53	2.29	1.68	13.50	1.48	.46	17.08	5.65	35.30	5181	1.324

DAKOTA CRETACEOUS MEASURES.

Near Cortez	42.26	15.65	2.64	1.09	8.70	1.03	.85	1.81	26.30	29.63	5399	1.407
Uncompahgre	52.48	14.40	3.58	.86	6.89	1.08	.55	2.02	18.20	27.30	6412	1.409

Analyses of coal ashes.

	Silica.	Peroxide of iron.	Alumina.	Lime.	Magnesia.	Soda.	Potash.	Sulphuric acid.	Phosphoric acid.	Total.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sopris	60.71	4.68	26.40	4.26	.40	1.58	.76	1.88	.12	100.79
Aguilar	58.40	7.32	27.80	3.52	Trace.	.80	.62	1.76	.12	100.34
Morley	68.60	6.42	19.94	1.30	Trace.	1.46	1.32	.34	(*a*)	100.38
Santa Clara, Walsen seam	65.65	5.30	21.63	3.06	None.	2.59	.88	1.04	.32	100.47
Rouse	49.05	8.63	32.66	3.64	Trace.	2.68	1.07	1.99	.47	100.19
Do	63.85	7.27	22.16	2.94	Trace.	1.72	.59	1.15	.63	100.31
Do	56.10	6.29	28.12	2.30	1.20	2.44	.76	2.47	.54	100.22
Walsenburg, Cameron seam	62.10	6.86	21.39	3.89	.07	2.73	1.34	1.58	.35	100.31
Walsenburg, Walsen seam	65.95	6.23	15.44	4.71	.03	3.54	1.43	2.40	.38	100.11
Anthracite	22.61	*b*21.51	29.39	16.68	.43	3.84	1.95	1.46	2.40	100.27
Ruby	42.65	21.90	25.40	4.56	1.62	1.68	.98	.32	.08	99.13
Crested Butte	36.68	24.32	28.18	6.00	2.46	.80	.44	1.86	.12	100.86
Coal Basin	53.68	12.25	22.86	6.08	.58	1.22	.84	1.38	.16	99.05
Newcastle	39.10	19.52	24.28	11.40	.86	1.00	.82	1.76	.66	99.40
Meeker	65.22	4.74	20.20	4.20	Trace.	1.34	1.02	.98	.26	99.82
Dry creek, anthracite	58.74	3.30	33.66	1.70	.14	1.20	.78	.36	.10	99.98

a Included with iron.

b This includes 0.94 manganese peroxide.

GEORGIA.

Total product in 1892, 215,498 short tons; spot value, $212,761.

In 1892 the work of developing the coal properties in Walker county was completed and an output of 37,761 tons was obtained, the remainder of the product coming from the old Dade mines in Dade county. All of the product is bituminous coal, and the greater portion of it (158,878 tons in 1892) is coked. The following table shows the total product during the past four years, with the distribution and value:

Coal product of Georgia since 1889.

Years.	Loaded at mines for shipment.	Sold to local trade and used by employés.	Used at mines for steam and heat.	Made into coke.	Total amount produced.	Total value.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	
1889	46,131	158	15,000	164,645	225,934	$338,901
1890	57,949	....	....	170,388	228,337	238,315
1891	15,000	1,000	5,000	150,000	171,000	256,500
1892	52,614	250	3,756	158,878	215,498	212,761

Coal product of Georgia from 1884 to 1892.

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

IDAHO.

The following notes in regard to the occurrence of coal in the vicinity of Horse Shoe Bend on the Payette river, Ada county, Idaho, are contributed by Mr. Robert Forrester, U. S. Mine Inspector for Utah. The coal beds described are not yet worked:

"The coal of this region may be divided into three districts, which I will designate as the March, Horse Shoe Bend, and Jerusalem districts, respectively. Owing to the fact that this is a region of diverse displacement, and the erosion that has obtained is well calculated to hide, rather than to expose the structural features, coupled with the fact of the great paucity of fossils, it would require careful and elaborate geological work to correlate satisfactorily the strata of one district with that of the other.

"The March district is divided from that of the Horse Shoe Bend by a great mass of igneous rocks, while the division between the Jerusalem and Horse Shoe Bend is the crest of an anticlinal fold. The Horse Shoe Bend district comprises the western slope and the Jerusalem district the eastern slope of the anticline.

"The faults are of later occurrence than the igneous rocks of the region. They cut the sedimentary and igneous rocks alike.

"*The Jerusalem district.*—There is but one bed of coal opened yet, that being known as the Peterson mine. The bed is 3 feet in thickness and has the following analyses:

Analyses of coal from Jerusalem district, Idaho.

	Top half of vein.	Bottom half of vein.	Average of whole vein.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	11.94	10.92	11.43
Volatile matter	36.98	42.06	39.52
Fixed carbon	37.40	39.11	38.26
Ash	12.48	6.43	9.45
Sulphur	1.20	1.48	1.34
Total	100.00	100.00	100.00

"The ash of the top half of the vein is probably too high; by the appearance of the two samples it certainly is excessive. From the appearance of a quantity of this coal that has lain exposed to the weather for a long time it does not seem to slack very readily. It kindles easily and makes a bright clear fire; however, in burning, the flame is inclined to be light and sparky. It does not show the slightest tendency to coke. There has been little or no work done to prove the existence or nonexistence of other coal beds, either above or below this three-foot bed.

"*Horse Shoe Bend district.*—At this place there are four beds of coal, three of which are of workable thickness. These are as follows in descending order: First, 3 feet of coal, 5 feet of shale; second, 8 feet of coal, about 50 feet of shale; third, 3 to 4 feet of coal.

"The analyses of the top coal is shown herewith:

Analyses of Horse Shoe Bend, Idaho, coal.

	3-foot coal.	8-foot coal.
	Per cent.	*Per cent.*
Moisture	6.52	5.14
Volatile matter	41.20	34.20
Fixed carbon	40.02	33.40
Ash	11.96	26.10
Sulphur	.78	1.16
Total	100.00	100.00

"This coal is too high in ash, but as the drift exposing it had caved in I could not reach the vein to enable me to take a fair sample, so I took a sample from a few sacks that had lain exposed to the weather all through the winter and spring. I was also careful not to take the best sample in the sack, so I am sure this will represent the maximum ash in the coal, and probably too much for a fair average. The following is a section of this 8-foot coal furnished by Mr. Robb: Shale roof; coal, 1 foot 6 inches; shale, 4 inches; coal, 3 feet; shale, 9 inches; coal, 3 feet 6 inches; shale floor.

"*March district.*—The bed exposed at this place is simply a lignite. The woody structure is very distinct, and it has nearly all the properties of wood yet, and although the bed is about eight feet in thickness, it is a very undesirable fuel for two reasons: It slacks very readily, thereby being unsuitable for storing, and it contains too much moisture, which reduces its calorific value. I will therefore pass over this coal without further discussion.

"From the foregoing descriptions it will be observed that the Horse Shoe Bend and Jerusalem coals only are worthy of further consideration. The coal field available in either district is sufficiently extensive for all the demands of a railroad for a long period of time, even if the quality is not equal to that of the Wyoming coals, which are sold along the line of the Oregon Short Line railroad. Still the fact that this Horse Shoe Bend coal, if connected by a railroad, could be mined and delivered at half the rates now charged ($9.50 per ton) for the Wyoming coals, will give the coals of the Horse Shoe Bend district a favorable advantage.

"It will be observed that the Horse Shoe Bend coal is equal to some of the Wyoming coals that supply an extensive demand. The Horse Shoe Bend coal will stand transportation and storage reasonably well. Altogether this district should be thoroughly prospected."

ILLINOIS. (a)

Total product in 1892, 17,862,276 short tons; spot value, $16,243,645.

The eleventh annual compilation of the statistics of coal production in Illinois, gathered by the State bureau of labor statistics from the reports of the State inspectors of mines, presents the following totals and averages as the result of the prosecution of this industry during the year ending July 1, 1892:

Number of counties in which coal has been mined	55
Number of mines and openings of all kinds	839
Number of tons of coal of all grades mined	17, 862, 276
Number of tons of lump coal	14, 730, 963
Number of tons of other grades	3, 131, 313
Number of acres worked out	2, 996. 33
Number of employés of all kinds	33, 632
Number of miners	25, 321
Number of other employés, including boys	8, 311
Number of boys over 14 years of age under ground	953
Average number of days of active operations, shipping mines	219. 5
Aggregate home value of total product	$16, 243, 645
Aggregate home value of lump coal	$15, 158, 430
Aggregate home value of other grades	$1, 085, 215
Average value of lump coal per ton at the mines	$1. 0291
Average value of other grades per ton at the mines	. 3464
Number of tons of coal mined for each man injured	42, 733
Number of employés for each life lost	590
Number of employés for each man injured	80
Number of new mines opened, including old mines reopened	61
Number of mines closed or abandoned	138

(a) Abstract from the report of Col. J. S. Lord, secretary of the Bureau of Labor Statistics of Illinois.

Referring to the totals for the year preceding the following changes are noted:

The number of counties from which coal is reported this year is two less than the number of a year ago. This arises from the suspension of a number of small places on the borders of the more prolific counties, and the result does not appreciably affect the total output.

The number of mining places of all kinds is likewise considerably smaller than at the date of the last report, but the losses in number are confined to places of insignificant proportions, while there has been some increase in the number of more important plants.

The most striking feature of the present report is the notable increase in the total tonnage for this year over all previous years. The aggregate output of all mines this year is 17,862,276 tons of 2,000 pounds each, which is larger by 2,201,587 tons than the output for 1891, and larger by 3,534,095 tons than that for 1888, which was the best year preceding 1891. Of the whole number of tons reported, 14,730,963 are tons of lump, and 3,131,313 tons of other grades, including various sizes named, respectively, egg, nut, pea, buckwheat, and slack.

The average value of lump coal per ton at the mine, as computed for the entire product upon the bases of reported values and quantities at each mine, is substantially the same as for the preceding year, though the decimal of difference is in favor of the value for 1892. In even cents the average for 1891 was $1.01 per ton, and for 1892 $1.03 per ton.

The average price paid for hand mining is here reported as 71.88 cents a ton, while that for last year was 71.5 cents a ton. This comparison, however, signifies but little, because the basis of wages has been very generally changed during the year, under the operation of the so-called gross-weight law. The foregoing average consequently applies only to those mines where unexpired contracts on the customary basis were existing, or where the old order was preserved by mutual consent. No average of the wages paid miners can be profitably computed under present conditions, for the reason that there are now nearly as many different ways of paying miners as there are mines.

The number of employés reported for the year is greater by 681 than the preceding year, and the average number of days of active operations for all commercial mines is 219.5 days for 1892, while that of 1891 was 215.6 days.

While machine mining had made but little progress in this State for several years prior to the present, the totals for 1892 show that the number of machines in use has increased during the present year from 241 to 300, and the number of tons mined by machines has increased from 3,027,305 to 3,871,939, or 844,634 tons.

The number of fatal accidents which have occurred during the year is observed to be 57, while that for the year preceding was 60. In view of the greater tonnage of the present year and the greater number of employés the difference in the death rate is still more gratifying. In 1891 there was a life lost for every 549 employés and for every 261,011 tons mined; in 1892 there has been only one death out of 590 employés and one for each 313,373 tons of product.

There have been 61 new mines of all kinds, principally of the better class, opened during the year, including old mines reopened, and 138 mines, principally of the less important class, have been closed or abandoned.

The estimated area of mineral worked out by the operations of the year is 2,996 acres, which is about 200 acres more than the number reported for 1891. The United States census investigation of 1890 found a total of 191,740 acres of coal land owned or controlled by the mine operators of the State. The number of acres exhausted last year is equal to 1½ per cent. of the foregoing total, which, in itself, is capable of indefinite expansion as the occasion for more coal territory arises.

On the whole the year 1892 has been a prosperous one, both to miners and mine owners. But little disturbance of operations was occasioned by the readjustment of the terms of employment, made necessary by the legislation of the year before, and a healthy increase in business has afforded more continuous employment to men, and made it possible to enlarge the capacity and improve the equipment of many mines.

Classification of mines.—An analysis of the character of the mines here reported, upon the basis of their output, results in the following groups, which are presented with a parallel subdivision of the mines reported for the year preceding:

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.	
	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.
First	13	11	19	21	17	13	12	12	9	13	70	70
Second	169	148	76	72	13	12	2	3	4	5	264	240
Third	125	108	91	82	45	49	9	13	3	4	273	256
Fourth	39	27	34	28	26	20	16	22	11	12	126	109
Fifth	59	41	43	39	61	60	18	19	4	5	185	164
The State	405	335	263	242	164	154	55	69	31	39	918	839
Increase	......	......	......	......	......	......	......	14	......	8	......	......
Decrease	......	70	......	21	......	10	......	......	......	......	......	79
Per cent. of increase	......	......	......	......	......	......	......	25.6	......	29	......	......
Per cent. of decrease	......	17.3	......	8	......	6.1	......	......	......	......	......	8.6

This shows not only the marked preponderance in numbers of the smaller mines, but more especially in what classes the loss in numbers has occurred during the year. Compared with the mines reported in 1891, it is observed that the net loss of 79 mines is occasioned by a total loss of 101 in the three groups of smaller mines, offset by a gain of 22 mines of the first rank. This substitution of 22 mines of large output for 101 of the smaller, 70 of which are of the smallest, while showing a numerical decline, really signifies a material gain in productive capacity, as shown by the output for the State. That the tendency is clearly in the direction of fewer and better mines is made apparent from a glance at the changes which have occurred in this respect during the last ten 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.
1883	209	233	133	39	25	639
1884	262	273	148	38	20	741
1885	286	290	143	40	19	778
1886	316	280	135	44	14	789
1887	320	278	141	42	20	801
1888	327	271	152	47	25	822
1889	321	316	139	55	23	854
1890	398	301	155	54	28	936
1891	405	263	164	55	31	918
1892	335	242	154	69	39	839
Increase	126	9	21	30	14	200
Per cent. of increase	62.4	8.8	36.8	88.2	51.9	67.3

By reference to the number of mines which have found place among the foremost producers in the several years it will be noted that the number producing over 50,000 tons per annum has steadily and uniformly increased year by year, with the result that there are now 108 mines of this class, while there were only 64 ten years ago; in brief, that mines of this class have increased 70 per cent. during the decade, and that those in all classes below them have increased in number only 37 per cent. Extending the observation to the output of the mines in the several foregoing groups their relative importance is made still more conspicuous, as appears in the following table:

Classification of the lump coal product of Illinois during 1892, by mines and districts.

Districts.	Over 100,000 tons. No.	Over 100,000 tons. Quantity.	From 50,000 to 100,000 tons. No.	From 50,000 to 100,000 tons. Quantity.	From 10,000 to 50,000 tons. No.	From 10,000 to 50,000 tons. Quantity.	Less than 10,000 tons. No.	Less than 10,000 tons. Quantity.	Total number of mines and tons. No.	Total number of mines and tons. Quantity.
		Short tons.		*Short tons.*		*Short tons.*		*Short tons.*		*Short tons.*
First	13	1,812,893	12	810,806	13	279,383	32	61,985	70	2,965,067
Second	5	739,283	3	229,532	12	259,562	220	232,847	240	1,461,224
Third	4	531,807	13	839,183	49	1,001,445	190	339,139	256	2,711,574
Fourth	12	1,844,550	22	1,544,543	20	605,169	55	96,659	109	4,090,921
Fifth	5	612,461	19	1,253,221	60	1,438,311	80	198,184	164	3,502,177
The State	39	5,540,994	69	4,677,285	154	3,583,870	577	928,814	839	14,730,963
Percentages:										
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:										
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

Here the fact is revealed that 577 of the smallest mines have delivered only 6.3 per cent. of the total product of the State, while 39 mines of the first class have produced 37.6 per cent. of the whole. Reducing all mines to two classes, it is found that 108 mines reporting a tonnage of over 50,000 tons each per annum have raised an aggregate of 12,396,-419 tons of all grades, or 69.4 per cent. of the whole product, while the remaining 731 mines have raised only 30.6 per cent. of the whole. It is further deducible from these figures that the 262 mines which have produced over 10,000 tons each, and which constitute less than one-third of the whole number, have, in fact, delivered 93.7 per cent. of the total number of tons. The results developed by this table for 1892, when compared with similar deductions for 1891, still further establish the preeminence of the present year in every desirable respect. The percentages of number and product are uniformly greater for the better class of mines and less for the smaller, and the same is true of the average output per mine in the several classes. Following is a further comparison of the relative product of mines by classes for a series of six years:

Annual lump coal product of Illinois since 1887.

Years.	Mines producing over 50,000 tons lump coal.					Mines producing less than 50,000 tons lump coal.				
	Number.	Quantity.	Average per mine.	Per cent. of whole number of mines.	Per cent. of total product.	Number.	Quantity.	Average per mine.	Per cent. of whole Number of mines.	Per cent. of total product.
		Short tons.	*Short tons.*				*Short tons.*	*Short tons.*		
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	91.24	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
Averages	81	7, 785, 587	95, 921			781	4, 558, 012	5, 840		
Percentages				9.42	63.07				90.58	36.93

This establishes the measure of the growth in number and product of the larger mines for a series of years, and likewise the gradual decline in the number and product of the smaller ones. Six years ago 7.74 per cent. of the total number of mines produced over 50,000 tons, and, in the aggregate, 57.90 per cent. of the total output; this year, 12.87 per cent. of the whole number is found in this class, and these mines have delivered 69.37 per cent. of the total product. On the other hand, the proportion of smaller mines has declined in the same period from 92.26 to 87.13 per cent. of the whole number, and their output from 42.10 to 30.63 per cent. of the total product. The number of large mines has steadily increased from 62 to 108; the number of smaller mines has fluctuated from 739 to 855, and back again to 731.

A separation of the mines of the State on the basis of the destination of their product, or the purpose of the several enterprises, is made by grouping the commercial or shipping mines and those which are operated merely for the purpose of supplying a local demand. The result of a classification on this line, by districts, is as follows:

Number of shipping and local mines in Illinois, with percentage of product in 1892, by districts.

Districts.	Shipping mines. Number.	Per cent. of whole number of mines.	Per cent. of total product.	Average of lump coal per mine.	Local mines. Number.	Per cent. of whole number of mines.	Per cent. of total product.	Average of lump coal per mine.
				Short tons.				*Short tons.*
First	37	52.9	97.2	77,876	33	47.1	2.8	2,535
Second	30	12.5	87.1	42,444	210	87.5	12.9	895
Third	85	33.2	90.8	28,962	171	66.8	9.2	1,461
Fourth	56	51.4	97.9	71,482	53	48.6	2.1	1,660
Fifth	101	61.6	97	33,620	63	38.4	3	1,692
The State	309	36.8	95.1	45,356	530	63.2	4.9	1,295

The point brought out here is that 530 local mines produce only 4.9 per cent. of the total tonnage of the State, while the 309 shipping mines deliver 95.10 per cent. of it. That this is not an unusual ratio is illustrated by the following parallel deductions for three consecutive years:

Percentage of product by shipping and local mines for three years.

Years.	Shipping mines. Number.	Per cent. of whole number of mines.	Per cent. of total product.	Average per mine.	Local mines. Number.	Per cent. of whole number of mines.	Per cent. of total product.	Average per mine.
				Short tons.				*Short tons.*
1890	327	34.9	93.6	34,176	609	65.1	6.4	1,328
1891	327	35.6	95.5	37,850	591	64.4	4.5	987
1892	309	36.8	95.1	45,356	530	63.2	4.9	1,295

The only variation observable here is that the proportion of the total product delivered by local mines is less rather than greater than formerly.

The output for the year.—The aggregate product of the mines of the State has this year been 17,862,276 tons, of which 14,730,963 tons were lump coal and the remainder, other grades or sizes less than lump, but, for the most part, of merchantable quality. The following table exhibits the contribution to this total from each of the mine inspection districts and the corresponding totals for each district and the

State for a series of four years. The comparison is made in tons of lump, for the reason that for the earlier years statistics of lump coal only were gathered:

Annual output of lump coal for four years, by districts.

Districts.	Output of lump coal.				Gains and losses.			
	1889.	1890.	1891.	1892.	1890-1891.		1891-1892.	
					Gain.	Loss.	Gain.	Loss.
	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.
First	2, 530. 453	2, 303, 326	2, 701, 652	2, 965, 067	398, 326	....	263, 415	....
Second	1, 087, 848	1, 002, 600	1, 215, 883	1, 461, 224	213, 283	....	225, 341	....
Third	2, 050, 349	2, 375, 970	2, 336, 500	2, 711, 574	....	39, 470	375, 074	....
Fourth	3, 164, 835	3, 716, 464	3, 532, 233	4, 090, 921	....	184, 231	558, 688	....
Fifth	2, 764, 478	3, 240, 004	3, 173, 956	3, 502, 177	....	66, 048	328, 221	....
The State	11, 597, 963	12, 638, 364	12, 960, 224	14, 730, 963	611, 609	289, 749	1, 750, 739	....
Net gain	....	....	....	....	321, 860	....	1, 750, 739	....

In the column showing gains and losses it will be observed that there has been a substantial gain in every district in 1892 over 1891, though in the latter year there were gains over the product of 1890 in only two districts. The percentages of gain and loss by districts for each of four consecutive years and for the term are as follows:

Percentages of increase and decrease in tonnage of lump coal by districts, for four years.

Districts.	1889.		1890.		1891.		1892.		Four years.	
	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.
First	....	13. 73	....	9. 86	17. 29	....	9. 75	....	3. 03	....
Second	....	18. 14	....	8. 5	21. 27	....	18. 53	....	12. 99	....
Third	....	6. 91	15. 88	....	....	1. 26	16. 05	....	23. 70	....
Fourth	10. 88	....	17. 43	....	....	5. 22	15. 82	....	43. 31	....
Fifth	4. 81	....	17. 2	....	....	2. 08	10. 34	....	32. 78	....
The State	....	2. 22	8. 97	....	2. 55	....	13. 51	....	24. 26	....

In the four years since 1888 the output of the State has increased 24.26 per cent. Great inequality, however, is observed in the relative increase by districts. In the first district very little net gain has been made, owing to a decline in output in two of the four years; while in the fourth district continuous gains make an aggregate for the four years of 43.31 per cent. In the fifth district, also, gains have been made for three years in the four, so that the total is 32.78 per cent. A marked accession of product has occurred in all districts during the past year.

The foregoing statistics of product are stated in tons of lump coal. For the last two years a report has also been made by inspectors of the number of tons of other grades, that is, of screenings of all kinds. This has recently become of more importance, owing to the tendency to produce a variety of sizes to suit the needs of all sorts of customers.

Formerly producers screened their coal as little as possible, because there was objection to wide screens on the part of miners, and the trade very generally called for lump coal. Since the passage of the gross-weight law, miners have no longer any interest in the screening process, and a larger portion of the coal is run into the bins for nut, and other sizes. The table below shows the tons of gross product and the reported percentages of lump and other grades for 1891 and 1892, by districts:

Product and percentage of lump and other grades of coal in Illinois during 1891 and 1892, by districts.

Districts.	Total product, 1891.	Percentage of—		Total product, 1892.	Percentage of—	
		Lump grades.	Other grades.		Lump grades.	Other grades.
	Short tons.			*Short tons.*		
First	3,082,915	87.63	12.37	3,458,066	85.74	14.26
Second	1,440,266	82.73	17.27	1,733,608	84.29	15.71
Third	2,794,004	83.54	16.46	3,260 951	83.15	16.85
Fourth	4,428,109	79.61	20.40	5,117,600	79.94	20.06
Fifth	3,915,404	81.06	18.94	4,292,051	81.60	18.40
The State	15,660,698	82.76	17.24	17,862,276	82.47	17.53

It should be understood that the proportions reported as other grades are in some measure a matter of estimate, as it is not practicable to weigh all the product of the screen with the accuracy with which lump is weighed. It is usual, however, to make periodical tests which develop the average proportions of screenings with substantial correctness. The general correspondence is the percentage reported for the foregoing two years, as reduced to a single percentage for the State for each year, confirms the general conclusion that about 17 per cent. of the coal mined throughout the State is of the smaller grades. Some difference is observable in the percentages of the various districts, and some very wide contrasts are found in the different coal fields, all of which are sufficiently explained by local causes or practices. Some of the long-wall mines, for instance, show as low as 5 per cent. of screenings, while at other mines in which the seam is thick, and the coal is won by blasting from the solid, and sizes as large as "egg" are made by the screens, more than half the product is run into "other grades."

By the application of the ratio thus developed, for districts and the State, to the product of lump coal reported in former years, the following totals are obtained as the presumptive product of all kinds derived from the coal mines of the State for a series of eleven years.

Total product, lump and other grades, for eleven years.

Years.	Whole number of mines.	Total product.	Lump coal.	Other grades.
		Short tons.	*Short tons.*	*Short tons.*
1882	704	11,017,069	9,115,653	1,901,506
1883	639	12,123,456	10,030,991	2,092,465
1884	741	12,208,075	10,101,005	2,107,070
1885	778	11,834,459	9,791,874	2,042,585
1886	787	11,175,241	9,246,435	1,928,806
1887	801	12,423,066	10,278,890	2,144,176
1888	822	14,328,181	11,855,188	2,472,993
1889	854	14,017,298	11,597,963	2,419,335
1890	936	15,274,727	12,638,364	2,636,363
1891	918	15,660,698	12,960,224	2,700,474
1892	839	17,062,276	14,730,963	3,131,313
Total	....	147,924,546	122,347,550	25,577,086

The relative importance of counties as the sources of coal is indicated by the general statement that 20 of the 55 counties have produced a total of 15,875,871 tons, or 89 per cent. of the whole. These have all produced over 200,000 tons; 5 of them have produced over 1,000,000 tons each; 8 of them have a record of more than 500,000 and less than 1,000,000 tons, and 7 show an output from 250,000 to 500,000 tons. The list of these counties is given herewith in the order of their rank, and with the number of the district in which they are located. In parallel columns are presented the counties which appeared in this class last year.

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

Districts.	1891. Counties.	Rank.	Total product.	Per cent. of other grades.	Districts.	1892. Counties.	Rank.	Total product.	Per cent. of other grades.
			Short tons.					*Short tons.*	
5	Saint Clair	1	1,595,839	12.93	4	Macoupin	1	1,823,136	21.34
4	Macoupin	2	1,461,344	21.35	5	St. Clair	2	1,759,822	13.66
1	Lasalle	3	1,378,168	14.74	1	Lasalle	3	1,544,311	18.32
4	Sangamon	4	1,051,604	13.21	1	Grundy	4	1,175,084	5.67
1	Grundy	5	921,907	6.55	4	Sangamon	5	1,091,014	12.78
3	Vermilion	6	880,466	17.30	3	Vermilion	6	972,589	14.88
4	Madison	7	719,308	16.55	2	Bureau	7	943,496	14.25
4	Christian	8	718,326	28.54	4	Madison	8	873,770	19.43
2	Bureau	9	701,064	12.66	5	Jackson	9	869,514	22.47
5	Jackson	10	681,859	30.00	4	Christian	10	767,354	31.49
5	Perry	11	604,152	24.29	3	Fulton	11	666,473	19.68
3	Peoria	12	564,119	11.61	3	Peoria	12	632,939	14.44
3	Fulton	13	484,117	19.09	1	Livingston	13	532,667	24.06
1	Livingston	14	458,329	22.37	5	Perry	14	461,068	21.50
5	Marion	15	421,652	21.88	5	Marion	15	376,519	18.72
2	Mercer	16	314,360	29.30	2	Mercer	16	328,542	29.01
1	Will	17	233,603	3.86	5	Williamson	17	322,486	38.88
3	McLean	18	230,129	19.77	3	Menard	18	285,695	16.85
4	Macon	19	207,286	38.94	4	Macon	19	227,020	12,62
5	Williamson	20	206,452	22.26	3	McLean	20	222,372	23,14
3	Menard	21	204,583	16.03					
	Total	....	13,938,667	17.89		Total	....	15,875,871	18.01

From the list of last year Will county has dropped out, leaving twenty in this class this year instead of twenty-one; still the aggregate tonnage has increased nearly two million tons. The three counties at the head of the list have long been the greatest producers in the State. In the last eleven years Lasalle county has contributed the largest annual output twice; Saint Clair county, four times, and Macoupin, five times. Each of them has produced over 1,000,000 tons annually for each of the eleven years. Sangamon and Grundy counties have likewise contested for the fourth place in the list; both are million-ton counties, with the odd tons, this year, in favor of Grundy county. Bureau county is rapidly approaching the front rank in coal production, owing to the operations of several large companies, and may yet stand nearer the head of the list, though the seam in this district is deep and of less than half the thickness of the coal in Macoupin and Saint Clair counties.

Following is a table showing the output of each county, in lump and other grades, for the last six years:

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

Districts.	Output of lump coal.					1891.—Output, all grades.	1892.—Output.		
	1887.	1888.	1889.	1890.	1891.		Lump coal.	Other grades.	All grades.
	Short tons.	*Short tons.*	*Short tons.*	*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	2,965,067	492,999	3,458,066
Counties:									
Grundy	792,954	862,866	698,033	654,017	861,507	921,907	1,108,419	66,665	1,108,419
Kankakee	97,000	82,000	67,380	62,460	84,808	90,908	81,793	10,365	92,158
Lasalle	1,125,235	1,090,435	1,039,703	926,214	1,174,961	1,378,168	1,261,467	282,844	1,544,311
Livingston	387,600	495,388	382,965	372,504	355,800	458,329	404,491	128,176	532,667
Will	284,040	347,105	342,372	288,131	224,576	233,603	108,897	4,949	113,846
Second district	1,069,027	1,293,187	1,087,848	1,002,600	1,215,883	1,440,266	1,461,224	272,384	1,733,608
Counties:									
Bureau	459,580	635,097	493,730	372,701	612,292	701,064	809,009	134,487	943,496
Hancock	6,208	6,515	6,028	6,948	6,740	6,740	5,380	....	5,380
Henry	117,533	108,831	101,716	98,734	116,173	131,986	142,762	13,974	156,736
Knox	64,324	57,013	57,588	51,653	44,974	44,974	43,137	....	43,137
Marshall	73,928	87,013	59,784	56,574	53,319	65,219	64,276	14,300	78,576
McDonough	110,103	104,274	98,386	83,401	73,596	81,732	82,001	9,126	91,127
Mercer	127,708	167,931	175,690	238,290	222,237	314,360	233,244	95,298	328,542
Rock Island	85,282	57,872	47,363	39,696	38,6[illegible]	41,540	34,017	2,092	36,109
Schuyler	22,686	34,403	16,243	21,836	15,369	20,122	13,685	3,107	16,792
Stark	17,865	18,690	19,171	18,672	20,157	20,157	22,349	....	22,349
Warren	13,810	15,518	12,149	14,095	12,372	12,372	11,364	....	11,364
Third district	1,781,395	2,192,121	2,050,349	2,375,970	2,336,500	2,794,004	2,711,574	549,377	3,260,951
Counties:									
Cass	2,325	7,300	4,414	4,650	5,680	6,466	13,270	2,060	15,330
Fulton	337,215	461,589	366,577	404,417	391,721	484,117	535,288	131,185	666,473
Logan	159,000	174,330	138,700	164,650	155,048	176,052	163,002	24,354	187,356
McLean	141,700	117,110	129,322	173,492	184,629	230,129	170,912	51,460	222,372
Menard	155,621	181,075	181,621	230,662	171,784	204,583	237,419	48,276	285,695
Peoria	452,123	533,817	454,731	482,725	498,601	564,119	541,659	91,280	632,939
Tazewell	51,847	59,324	67,973	81,141	85,692	107,252	94,190	25,966	120,156
Vermilion	359,119	499,076	537,411	704,509	728,156	880,466	827,893	144,696	972,589
Woodford	122,445	158,500	169,600	129,724	115,189	140,820	127,941	30,100	158,041

Fourth district	2,568,291	2,854,540	3,164,835	3,716,464	3,532,233	4,428,109	4,090,921	1,026,679	5,117,600
Counties:									
Bond	36,076	38,200	59,724	66,746	76,067	102,535	92,308	29,504	121,812
Calhoun		1,036	1,078	1,468	2,773	2,773	4,637		4,637
Christian	149,973	147,030	249,774	439,451	513,315	718,326	525,746	241,608	767,354
Coles	34,612	27,210							
Effingham				796	(a)487	(a) 487	(a) 302		302
Green	12,578	14,494	19,048	11,714	16,442	16,442	19,870		19,870
Jasper				152	(b)	(b)	(b)		
Jersey	2,684	3,949	4,040	7,500	4,252	4,252	3,378		3,378
Macon	118,183	280,805	233,309	179,050	126,569	207,286	198,375	28,645	227,020
Macoupin	926,588	1,016,624	1,202,187	1,369,919	1,149,380	1,461,344	1,434,021	389,115	1,823,136
Madison	521,705	512,948	490,181	646,228	600,294	71 08	703,980	169,790	873,770
Montgomery	10,220	14,295	24,425	58,617	94,975	107,190	119,850	28,020	147,870
Morgan	6,669	12,545	13,019	16,601	6,584	7,610	4,266		4,266
Pike				135	(b)	(b)	(b)		
Richland				154	(b)	(b)	(b)		
Sangamon	730,391	764,970	846,012	879,888	912,643	1,051,604	951,517	139,497	1,091,014
Scott	9,802	12,491	15,028	20,022	14,255	14,755	17,006	500	17,506
Shelby	8,810	7,943	7,010	18,023	14,197	14,197	15,665		15,665
Fifth district	2,173,348	2,637,546	2,764,478	3,240,004	3,173,956	3,915,404	3,502,177	789,874	4,292,051
Counties:									
Clinton	55,238	66,463	121,557	170,416	146,903	174,166	156,376	35,497	191,873
Franklin				700	200	200	200		200
Gallatin	31,437	45,374	30,044	52,383	31,119	34,462	13,782	720	14,502
Hardin				40	24	24			
Hamilton				450	280	280	220		220
Johnson	28,000	28,210	3,000	12,110	424	424	2,200		2,200
Jackson	375,718	445,575	477,474	580,521	477,330	681,859	674,161	195,353	869,514
Jefferson				2,100	1,104	1,104	100		100
Marion	98,915	156,975	180,777	218,499	251,283	321,652	306,019	70,500	376,519
Perry	319,552	306,235	381,347	497,768	457,431	604,152	362,926	98,142	461,068
Randolph	74,263	167,321	98,202	134,699	162,717	172,321	160,532	8,447	168,979
Saline	19,518	32,550	35,496	45,845	38,729	54,269	41,992	19,610	61,602
Saint Clair	1,018,149	1,184,579	1,198,100	1,332,978	1,389,429	1,595,839	1,519,472	240,350	1,759,822
Washington	40,220	43,600	36,220	25,160	56,500	68,200	54,183	8,783	62,966
Williamson	112,338	160,664	202,261	166,335	160,483	206,452	210,014	112,472	322,486
State totals	10,278,890	11,855,188	11,597,963	12,638,364	12,960,224	15,660,698	14,730,963	3,131,313	17,862,276

a Includes Jasper, Pike, and Richland counties.

b Included in Effingham county.

The number of employés.—The number of men engaged in the labor of mining and shipping the coal of the State is reported in two totals from each mine; one is the average number employed throughout the year and the other is the largest number employed in any one month.

The largest number thus reported from all mines for the year under consideration is 33,632, and the average number, 28,077, or 16.5 per cent. less than the maximum. In these reports the former is carried as the probable number of mine operatives in the State, though many of them are not continuously employed, and there is a great deal of shifting about from place to place among miners, which makes an exact enumeration by mines impracticable. The number of employés reported annually for each of ten years and from each district and the State is given in the following table:

Total number of employés in and about Illinois coal mines by districts and years.

Districts.	Years.										Net increase.
	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	
First	7,566	8,013	7,463	7,613	7,915	8,623	9,018	8,258	9,128	9,572	2,006
Second	3,211	3,616	3,391	3,599	4,068	4,914	4,498	4,099	5,089	4,865	1,654
Third	4,070	5,018	5,213	4,870	4,903	5,250	5,117	5,171	6,458	6,453	2,383
Fourth	4,417	4,781	4,950	5,197	4,934	5,086	5,679	5,685	5,881	6,542	2,125
Fifth	4,675	4,147	4,429	4,567	4,984	5,537	5,764	5,361	6,395	6,200	1,525
The State	23,939	25,575	25,446	25,846	26,804	29,410	30,076	28,574	32,951	33,632	9,693

The foregoing totals embrace employés of all kinds, in and about mines, exclusive of the clerical and administrative force, and are classified as miners, other employés, and boys over fourteen years of age. Miners include those who operate machines as well as those who mine with pick, and number 25,321; other employés are those commonly known as day men, who assist at all the operations of hauling, hoisting, and handling the mineral, and their number is 8,311, including the boys, who are 953 in number, and are employed under ground as drivers, trappers, and helpers in various ways of their fathers or others.

Days of active operations.—Continuity of operations, and consequently of employment, is the great end sought for by operators and men alike in mining enterprises, and at the same time it is the one thing most difficult of attainment. The influences which disturb this industry are many and various; they grow out of the conditions of the market, which are largely influenced by the weather; the facilities for transportation; mishaps on the surface, or within workings; floods and drought throughout the country; fires, and faults or failures of the mineral, and disagreements between employers and men resulting in strikes and lockouts. From such causes coal mines in general are, according to the records of this office, in suspension about one-third of the time. This, however, is an average for all mines, some of which succeed in so far overcoming all obstacles as to run continuously, while others are shut down for more than half the working days in the year.

The record of average running time is made up from the days of active operations reported from every mine which is equipped for and expected to work the year round. This eliminates country coal banks which are operated only through the winter months, and also those commercial or shipping mines which have been opened or closed during the year and thus have had only a fractional year's experience. On this basis the computation for the year under consideration shows an average of 219.5 days of active operation for 299 mines. Last year this average was 215.6 days; the year before, 203.5 days. These are the days of active operations which have come to those reported as shipping mines. There are mines, however, the product of which is not shipped, though they continue in operation as great a portion of the year as possible for the supply of local demands. By reason of these, and in order to embrace as many mines as possible, a computation is made of the running time of all mines which have produced 1,000 tons or more, and have been active for 100 days or more. This gives a total of 495 mines whose average activity is represented by 217.7 days. Last year this average was 215.8 days for 501 mines. The figures for both methods of computing average time and for two years are here presented by districts:

Average working time at Illinois coal mines in 1891 and 1892.

Districts.	Shipping mines.				Mines producing 1,000 tons or more, and working 100 days or more.			
	1892.		1891.		1892.		1891.	
	Number.	Average number of days.	Number.	Average number of days.	Number.	Average number of days.	Number.	Average number of days.
First	35	218.3	34	207.6	59	207.5	53	200.9
Second	29	214.8	26	214.6	91	208	90	215.4
Third	84	203.8	88	193	144	239.9	148	201
Fourth	55	239.9	54	238.8	81	240	86	233.5
Fifth	96	221.8	106	225	120	227.7	124	227.8
The State	299	219.5	308	215.6	495	217.7	501	215.8

Average value of coal.—The customary computation of average worth of coal at the mine, based on the figures given to the inspectors by the proprietors of mines, has been made for the year under consideration, and the results for districts and the State for a series of years are comprised in the following table:

Average value of Illinois lump coal per short ton at the mines.

Districts.	Years.										
	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
First	$1.75	$1.59	$1.49	$1.41	$1.32	$1.316	$1.369	$1.355	$1.302	$1.298	$1.323
Second	1.87	1.97	1.75	1.71	1.57	1.497	1.473	1.432	1.477	1.426	1.432
Third	1.43	1.45	1.31	1.25	1.16	1.095	1.138	1.104	1.065	1.032	1.053
Fourth	1.33	1.32	1.09	.985	.969	.887	.947	.965	.873	.853	.836
Fifth	1.31	1.26	.961	.894	.862	.823	.857	.867	.811	.757	.8173
The State	1.51	1.48	1.26	1.17	1.10	1.085	1.1226	1.0775	1.0194	1.0084	1.0291
Increase	......	......	......	......	......	......	.0376	......	......	......	.0207
Decrease	......	.03	.22	.09	.07	.015	......	.0451	.0581	.0110	......

By this it appears that the changes from year to year, when the average for the whole State is considered, have not been great in recent years, but that there has been a uniform decline each year from the value of the preceding year, except only in the years 1888 and the present year. In the former there was an apparent increase in value over the preceding year, of 3.75 cents per ton, and in the latter of 2.07 cents over the reported values of 1891. Examined by districts the figures show an increase in average value in the first, second, and third districts, in which coal bears the highest prices, and a decrease in the fourth, where coal is more plentiful and cheap. In the fifth district, where the average for the preceding year was only 75.7 cents per ton, the reported value in 1892 is 81.7 cents, though this is still the lowest value among districts.

These averages are obtained from average values reported for the product of each mine by the owner of it, and are not actual selling prices nor market quotations, but merely mathematical deductions from the figures voluntarily reported by mine owners. Although this may be considered a prejudiced source of information, and notwithstanding it is entirely discretionary with owners to make whatever report they may deem proper, yet the general conclusions derived from the massing of all values, given for all quantities, in an average for the State, bear internal evidence of the substantial correctness of the reports made.

On the basis of the value reported for all tons mined at all places in the State for the last four years, the aggregate home value of all coal produced is as follows:

Product and value of coal in Illinois for four years.

Years.	Total product of lump coal.	Average value per ton at the mine.	Aggregate value of total product.
	Tons.		
1889	11,597,963	$1.0775	$12,496,805
1890	12,638,364	1.0194	12,883,548
1891	12,960,224	1.0084	13,069,090
1892	14,730,963	1.0291	15,158,430

COAL FIELDS OF ILLINOIS.

The coal fields of Illinois have been repeatedly described in previous volumes, and it is only necessary to state here that this State contains the greater part of the Illinois coal field, a very large proportion of its surface being underlaid by the Coal Measures. The field is longest from northwest to southeast, the eastern side spreading over a considerable portion of Indiana and the southeastern extremity passing across the Ohio into Kentucky. The Coal Measures, as in the Appalachian system, contain repeated alternations of sandstone, shales, bituminous slate, thin bands of limestone, and seams of coal, with the under clays which usually accompany them. In southern Illinois they attain an aggregate of from 1,200 to 1,400 feet, while in the northern portion of the State their entire thickness does not exceed 600 or 800 feet. The Conglomerate sandstones at the base of the true Coal Measures must be considered with the latter, for the reason that they contain, as in other States, coal seams of workable thickness, which shade into the true Coal Measures in such a manner that it is difficult to fix any dividing line between them. In the southern part of the State these Conglomerate Coal Measures are from 200 to 300 feet in thickness, and at some points contain well-defined coal seams, though generally local in their character.

Within the limits of the Coal Measures there have been discovered sixteen different seams of coal. These seams vary in quality, in continuity, and in thickness, and are never all found at any one place; yet some of the most persistent of them pervade large areas, are of good minable thickness, easily worked, and sufficiently near the surface to be readily reached. At the same time there is a marked degree of uniformity in the distribution of these productive seams throughout the State, so that coal may be said to be generally prevalent.

Analyses of some Illinois coals.

Designation.	Water.	Ash.	Volatile matter.	Fixed carbon.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Bloomington, McLean county	7.90	4.96	34.02	53.12
Blair Bluff, Henry county	12.60	9.90	28.96	48.54
Barclay, Sangamon county	10.80	17.10	27.32	44.78
Carbondale, Jackson county	6.36	7.40	26.40	59.84
Catlin, Vermilion county	7.80	12.70	31.08	48.42
Danville, Vermilion county	9.60	14.64	31.20	44.56
DuQuoin, Perry county	8.86	7.00	23.54	60.60
Elmwood, Peoria county	7.60	9.50	27.60	55.30
Farmington, Fulton county	8.52	11.72	29.28	50.48
Grape Creek, Vermilion county	9.74	10.60	28.34	51.32
Kewanee, Henry county	15.60	7.14	27.60	49.66
Lincoln, Logan county	10.92	14.84	27.60	46.64
Lombardville, Stark county	9.42	7.46	31.38	51.74
Mount Carbon, Jackson county	6.12	2.70	24.68	66.50
Oglesby, Lasalle county, second vein	12.12	7.72	30.84	49.32
Oglesby, Lasalle county, third vein	10.06	3.72	30.34	55.88
Peru, Lasalle county, second and third vein	10.30	4.54	33.90	51.26

INDIANA.

Total product in 1892, 3,345,174 short tons; spot value, $3,620,582.

The decreased product of 332,463 tons in 1891, as compared with 1890, is followed in 1892 by an increased output of 371,700 short tons over 1891, and brings the total output up to the highest figure yet attained in the history of the State.

Clay county continues to be the most important coal producer, more than one-third of the State's total being obtained from that county. The entire product of the State is bituminous, with the exception of 75,000 tons reported as semi-bituminous from Vanderburg county.

The average price realized by operators in 1892 was $1.08 against $1.03 in 1891. Following are the statistics of production in 1892 by counties:

Coal product of Indiana in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Clay	1, 131, 662	9, 845	5, 390	....	1, 146, 897	$1, 431, 949	$1. 25	239	2, 707
Daviess	171, 360	3, 000	200	....	174, 560	192, 123	1. 11	224	403
Fountain	13, 440	....	448	....	13, 888	12, 400	.89	315	30
Greene	206, 874	15, 700	6, 000	....	228, 574	191, 858	.84	227	335
Knox	14, 314	....	....	....	14, 314	12, 166	.84	138	28
Owen	7, 500	500	200	....	8, 200	10, 250	1. 25	240	22
Parke	384, 104	3, 511	6, 720	....	394, 335	429, 480	1. 09	228	639
Perry	28, 675	8, 731	390	....	37, 796	32, 626	.86	227	88
Pike	76, 260	300	1, 000	1, 200	78, 760	68, 446	.87	163	160
Spencer	7, 776	50	600	....	8, 426	6, 809	.80	310	13
Sullivan	296, 461	8, 121	8, 089	4, 222	316, 893	280, 867	.89	242	522
Vanderburg	80, 406	99, 092	10, 848	....	190, 346	202, 542	1. 06	262	282
Vermillion	299, 213	1, 525	325	....	301, 063	289, 453	.96	164	545
Vigo	296, 358	9, 044	1, 711	....	307, 113	351, 615	1. 14	217	491
Warrick	74, 508	8, 801	700	....	84, 009	67, 998	.81	141	171
Small mines	....	40, 000	....	....	40, 000	40, 000	1. 00	....	....
Total	3, 088, 911	208, 220	42, 621	5, 422	3, 345, 174	3, 620, 582	1. 08	225	6, 436

The following table shows the annual coal output of Indiana for the past twenty years:

Product of coal in Indiana from 1873 to 1892.

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

The annual production by counties since 1889, and the increases or decreases in 1892, as compared with 1891, are shown in the following table:

Coal product of Indiana since 1889, by counties.

Counties.	1889.	1890.	1891.	1892.	Increase in 1892.	Decrease in 1892.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Clay	695, 649	1, 161, 730	980. 921	1, 146, 897	165, 976	
Daviess	191, 585	189, 696	155, 358	174, 560	19, 202	
Dubois	15, 848	13. 994	7, 700			7, 700
Fountain	41, 141	24, 000	23, 700	13, 888		9, 812
Gibson	1, 267					
Greene	185, 849	197, 338	164, 965	228, 574	63, 609	
Knox	9, 040			14, 314	14, 314	
Martin	710					
Owen	3, 958		12, 600	8, 200		4, 400
Parke	357, 434	345, 460	307, 382	394, 335	86, 953	
Perry	40, 050	40, 201	35, 400	37, 796	2, 396	
Pike	154, 524	115, 836	122, 066	78, 760		43, 306
Spencer	18, 456	11, 656	15, 340	8, 426		6, 914
Sullivan	317, 252	286, 323	181, 434	316, 893	135, 459	
Vanderburg	183, 942	192, 284	205, 731	190, 346		15, 385
Vermilion	187, 651	173, 000	228, 488	301, 063	72, 575	
Vigo	371, 903	429, 160	400, 255	307, 113		93, 142
Warren	2, 160					
Warrick	66, 638	89, 059	96. 134	84, 009		12, 125
Small mines		36, 000	36, 000	40, 000	4, 000	
Total	2, 845, 057	3, 305, 737	2, 973, 474	3, 345, 174	564, 484	192, 784

In the following table is shown the total output and its value since 1886, together with the statistics of labor employed since 1889:

Statistics of coal production in Indiana since 1886.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
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	. 90	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

Clay county.—The amount of coal produced in Clay county in 1892 was 1,146,897 short tons, valued at $1,431,949, an increase over 1891 of 165,976 short tons, or 17 per cent., and of $307,490. The product is chiefly what is known as Indiana "block" coal, a good quality of non-coking bituminous.

Coal product of Clay county, Indiana, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	695, 649	$795, 140	$1. 14		2, 592
1890	1, 161, 730	1, 177, 666	1. 01	218	2, 179
1891	980, 921	1, 124, 459	1. 15	181	2, 346
1892	1, 146, 897	1, 431, 949	1. 25	239	2, 707

Daviess county.—The product in 1892 was 174,560 short tons, against 155,358 tons in 1891, an increase of 19,202 tons or a little more than 12 per cent. The value increased from $174,701 to $192,123, a gain of $17,422, or 10 per cent. A small portion of the product is cannel coal, commanding a better price than the bituminous, which forms the bulk of the output.

Coal product of Daviess county, Indiana, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	191,585	$195,793	$1.02	....	455
1890	189,696	197,696	1.04	231	280
1891	155,358	174,701	1.12	217	359
1892	174,560	192,123	1.11	224	403

Dubois county.—No product has been reported from Dubois county in 1892. The output in 1889 was 15,848 short tons; in 1890, 13,994 tons, falling off to 7,700 tons in 1891, and ceasing entirely in 1892, except what little was obtained from country banks and which is not included in this report outside of the estimated product from this source for the whole State.

Fountain county.—One mine at Silverwood produces the entire output of the county, which in 1892 amounted to 13,888 short tons, against 23,700 tons in 1891.

Coal product of Fountain county, Indiana, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	41,141	$53,218	$1.29	....	85
1890	24,000	24,000	1.00	260	48
1891	23,700	23,400	.99	252	40
1892	13,888	12,400	.89	315	30

Greene county.—With the output of one mine not reported the county shows a product of 228,574 short tons in 1892, the largest in its history, and again over the output of 1891 of 63,609 short tons. The value of the product increased from $150,000 to $191,858, an increase in amount of $41,858, but showing a decline from 91 cents to 84 cents in the average price per ton.

Coal product of Greene county, Indiana, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	185,849	$169,595	$0.91	....	296
1890	197,338	186,294	.94	218	250
1891	164,965	150,000	.91	154	300
1892	228,574	191,858	.84	227	335

Knox county.—The product in 1892 was 14,314 short tons, valued at $12,166. This is the first output reported since 1889, when a total of 9,040 short tons, valued at $10,405, was obtained.

Owen county.—An accident, which necessitated the sinking of a new air shaft in the principal producing mine, caused a falling off in the output of the county from 12,600 short tons in 1891, valued at $15,750, to 8,200 short tons in 1892, valued at $10,250.

Parke county.—Parke county produced 394,335 short tons of bituminous coal in 1892, valued at $429,480, against 307,382 short tons in 1891, worth $347,707, an increase in tonnage of 86,953 and in value of $81,773.

Coal product of Parke county, Indiana, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	357,434	$377,324	$1.05	....	591
1890	345,460	378,033	1.09	254	558
1891	307,382	347,707	1.13	255	510
1892	394,335	429,480	1.09	228	639

Perry county.—The total output of Perry county in 1892 was 37,796 short tons, valued at $32,626, an increase over the product of 1891 of 2,396 short tons, but a decrease in the total value of $6,349, the average price per ton declining from $1.10 to 86 cents. Operators report that the tonnage would have been larger but for low water in the Ohio river which prevailed from August to December.

Coal product of Perry county, Indiana, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	40,050	$47,175	$1.18	....	109
1890	40,201	42,201	1.05	250	100
1891	35,400	38,975	1.10	190	95
1892	37,796	32,626	.86	228	88

Pike county.—The returns for Pike county are so incomplete that it is only possible to give an estimate of the output.

Coal product of Pike county, Indiana, for four years.

Years.	Short tons.	Years.	Short tons.
1889	154,524	1891	122,066
1890	115,836	1892	78,760

Spencer county.—The output of Spencer county shows a decline of about 45 per cent., or from 15,340 short tons in 1891 to 8,426 short tons in 1892.

Coal product of Spencer county, Indiana, for four years.

Years.	Short tons.	Value.	Average price per ton	Number of days active.	Number of employés.
1889	18,456	$21,207	$1.15	....	29
1890	11,650	11,116	.96	261	39
1891	15,340	13,525	.88	204	46
1892	8,426	6,809	.80	310	13

Sullivan county.—The amount of coal produced in Sullivan county in 1892 was 316,893 short tons, valued at $280,867. In 1891 the output was much less than usual owing to a fire occurring in one of the larges mines and causing a stoppage of eleven months in mining. A loss of three months' work was occasioned from the same cause at another mine producing about 1,800 tons a month in 1892.

Coal product of Sullivan county, Indiana, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	317,252	$299,286	$0.94	....	556
1890	286,323	268,525	.94	181	588
1891	181,434	184,115	1.01	130½	544
1892	316,893	280,867	.89	242	522

Vanderburg county.—Vanderburg county produced in 1892 190,346 short tons, valued at $202,542, a decrease of 15,385 short tons and $21,490, as compared with the output of 1891. Of the product in 1892, 75,000 tons are reported as semi-bituminous, the remainder being classed as bituminous.

Coal product of Vanderburg county, Indiana, for four years.

Years.	Short tons.	Valne.	Average price per ton.	Number of days active.	Number of men employed.
1889	183,942	$212,572	$1.16	....	318
1890	192,284	197,224	1.02	244	307
1891	205.731	224,032	1.09	228½	338
1892	190,346	202,542	1.06	262	282

Vermilion county.—Although having an increased product of 72,575 short tons in 1892 over that of 1891, this county falls from fourth to fifth place in rank of producing importance. This was due to the comparatively small output in Sullivan county in 1891, and its recovery in the following year.

Coal product of Vermilion county, Indiana, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	187,651	$167,590	$0.89		276
1890	173,000	203,000	1.17	161	280
1891	228,488	224,159	.98	147	380
1892	301,063	289,453	.96	164	545

Vigo county.—Vigo county drops from second place to fourth as a coal producer in the State, having a product in 1892 of 307,113 short tons, valued at $351,615. The product in 1891 was 400,255, valued at $320,056, showing a decrease of 93,142 short tons in the quantity mined, but an increase in value of $31,559, and an advance in the average price per ton from 80 cents to $1.14.

Coal product of Vigo county, Indiana, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	371,903	$330,205	$0.88		629
1890	429,160	341,998	.80	262	454
1891	400,255	320,056	.80	244	487
1892	307,113	351,615	1.14	217	491

The following analysis of coal from the Larimer mine in Vigo county has been made by Mr. N. W. Lord, of the Ohio State university:

Analysis of coal from Larimer mine, Vigo county, Indiana.

	Per cent.
Moisture	8.70
Volatile matter	43.10
Fixed carbon	43.70
Ash	4.50
Total	100.00
Sulphur	1.86

Warrick county.—The annual increase in the production of coal in Warrick county, noted in the preceding report, was not continued in 1892, the output for that year being 12,125 short tons less than in 1891. The entire product is classed as bituminous.

Coal product of Warrick county, Indiana, for four years.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1889	66,638				
1890	89,059				
1891	96,134	$73,870	$0.77	199	161
1892	84,009	67,998	.81	141	171

INDIAN TERRITORY.

Total product in 1892, 1,192,721; spot value, $2,043,479.

In 1891 the amount of coal produced in the Indian Territory reached for the first time an aggregate of a million tons, the actual output being 1,091,032 short tons. The product in 1892 added more than a hundred thousand tons to this, the percentage of increase being 10. The value of the product increased from $1,897,037 to $2,043,479, a gain of $140,442 or about 8 per cent. The following table shows the statistics of production in 1891 and 1892:

Coal product of the Indian Territory in 1891 and 1892.

Distribution.	1891.	1892.
	Short tons.	*Short tons.*
Loaded at mines for shipment	1,026,932	1,156,603
Sold to local trade and used by employés	9,405	10,840
Used at mines for steam and heat	22,163	18,089
Made into coke	32,532	7,189
Total	1,091,032	1,192,721
Total value	$1,897,037	$2,043,479
Total number of employés	2,891	3,257
Average number of days worked	222	211

The following table exhibits the total production of the Territory since 1885:

Product of coal in the Indian Territory from 1885 to 1892, inclusive.

Years.	Short tons.	Value.	Average price per ton.	Number of employés.	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	228	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

IOWA.

Total product in 1892, 3,918,491 short tons; spot value, $5,175,060.

The amount of coal produced in Iowa in 1892 varied very little from that of 1891, the difference being only 92,996 short tons, or a little less than 2½ per cent. The value of the product, however, increased from $4,867,999 to $5,175,060, an increase of $307,061, or about 6 per cent., the average price per ton advancing from $1.27 to $1.32.

Although the output during the year under review was not appreciably greater than in the preceding one, the industry was in a very satisfactory condition. No strikes worthy of mention disturbed the trade; prices seem to have been in the main satisfactory, and there was a liberal and steady demand for the coal. Two fires, one in No. 3 mine of the Diagonal Coal Company at Oswalt, and one which destroyed the surface improvements of the Seymour Coal Company at Seymour, caused a suspension of operations for about six weeks at each place.

Coal product of Iowa in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	Used at mines for steam and heat.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Appanoose	391, 293	14, 356	6, 338	411, 987	$622, 004	$1. 51	184	1, 213
Boone	107, 874	28, 594	3, 352	139, 820	250, 586	1. 80	189	534
Dallas	21, 881	3, 269	1, 400	26, 550	43, 073	1. 71	242	89
Greene	35, 375	5, 400	2, 585	43, 360	76, 765	1. 76	214	120
Jasper	153, 736	2, 770	7, 354	163, 860	210, 027	1. 28	274	426
Jefferson	600	400	....	1, 000	1, 400	1. 40	175	3
Keokuk	339, 502	13, 191	8, 540	361, 233	460, 812	1. 28	285	610
Mahaska	1, 113, 783	17, 569	9, 779	1, 141, 131	1, 310, 583	1. 15	238	1, 818
Marion	119, 100	14, 640	660	134, 400	157, 459	1. 17	244	267
Monroe	494, 434	7, 428	5, 244	507, 106	639, 731	1. 26	233	1, 112
Polk	277, 728	102, 562	8, 300	388, 590	608, 868	1. 57	268	938
Taylor	10, 154	5, 050	....	15, 204	30, 408	2. 00	223	54
Van Buren	23, 462	5, 176	308	28, 946	38, 280	1. 32	226	92
Wapello	219, 366	12, 974	2, 132	234, 472	301, 393	1. 29	260	445
Warren	1, 800	1, 744	56	3, 600	6, 300	1. 75	250	7
Wayne	39, 313	22, 064	701	62, 078	92, 191	1. 49	232	140
Webster	109, 624	4, 668	862	115, 154	185, 180	1. 61	247	302
Small mines	....	140, 000	....	140, 000	140, 000	1. 00	....	....
Total	3, 459, 025	401, 855	57, 611	3, 918, 491	5, 175, 060	1. 32	236	8, 170

With the exception of about 12,000 tons of cannel coal produced in Webster county the entire product of the State is bituminous.

The State is divided into three inspection districts, known respectively as the southern or first district, the northeastern or second district, and the northwestern or third district. In previous volumes of "Mineral Resources" the annual production of the State since 1883 has been given by districts, and for the sake of comparison the tables are carried up to 1892.

Total production of coal in Iowa, by districts, from 1883 to 1892, inclusive.

Districts.	1883.	1884.	1885.	1886.	1887.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
First	1, 099, 503	1, 040, 895	1, 156, 224	1, 264, 433	1, 426, 841
Second	1, 477, 024	1, 413, 811	1, 231, 963	1, 688, 200	1, 775, 978
Third	1, 403, 419	1, 447, 585	1, 194, 469	900, 741	791, 671
Small mines	....	....	....	....	....
Total	3, 979, 946	3, 902, 291	3, 582, 656	3, 853, 374	3, 994, 490

Districts.	1888.	1889.	1890.	1891.	1892.
	Long tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
First	1, 528, 967	1, 497, 685	1, 536, 978	1, 229, 512	1, 398, 793
Second	1, 974, 352	1, 720, 727	1, 626, 193	1, 814, 910	1, 666, 224
Third	918, 503	876, 946	718, 568	641, 073	713, 474
Small mines	....	....	140, 000	140, 000	140, 000
Total	4, 421, 822	4, 095, 358	4, 021, 739	3, 825, 495	3, 918, 491

Product of coal in the first inspection district of Iowa from 1883 to 1892, inclusive.

Counties.	1883.	1884.	1885.	1886.	1887.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Appanoose	128,896	158,986	245,896	150,000	160,351
Adams	3,891	3,981	3,896	9,581	19,851
Cass	......	......	......	......	......
Davis	527	1,207	33,655	1,000	1,800
Jefferson	38,887	8,172	1,116	1,083	10,397
Lucas	487,821	410,729	439,956	530,759	472,998
Marion	90,985	97,085	100,011	141,694	212,695
Monroe	93,435	98,427	101,517	117,700	183,505
Montgomery	......	......	......	......	......
Page	748	1,009	1,819	1,550	1,780
Taylor	94	127	617	8,585	12,180
Van Buren	1,678	1,778	1,193	8,038	26,331
Wapello	237,821	240,720	187,911	237,111	272,073
Warren	12,828	13,727	12,825	23,332	24,796
Wayne	1,892	4,947	25,812	34,000	28,084
Total	1,099,503	1,040,895	1,156,224	1,264,433	1,426,841

Counties.	1888.	1889.	1890.	1891.	1892.
	Long tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Appanoose	210,263	285,194	284,560	409,725	411,987
Adams	18,817	13,457	(*a*)	(*a*)	(*a*)
Cass	......	280	(*a*)	(*a*)	(*a*)
Davis	1,800	3,825	(*a*)	(*a*)	(*a*)
Jefferson	9,387	8,123	} 351,600	800	1,000
Lucas	364,969	339,229			
Marion	230,652	145,180	153,506	165,867	134,400
Monroe	233,896	258,401	324,031	393,227	507,106
Montgomery	......	1,040	(*a*)	(*a*)	(*a*)
Page	3,430	2,768	(*a*)	(*a*)	(*a*)
Taylor	8,002	9,736	(*a*)	10,500	15,204
Van Buren	25,960	39,258	47,464	36,166	28,946
Wapello	380,395	359,199	341,932	165,827	234,472
Warren	17,103	14,515	8,470	2,000	3,600
Wayne	24,293	17,480	25,415	45,400	62.078
Total	1,528,967	1,497,685	(*b*)1,536,978	(*b*)1,229,512	(*b*)1,398,793

a Included in product of small mines. *b* Exclusive of product of small mines.

Product of coal in the second inspection district of Iowa from 1883 to 1892.

Counties.	1883.	1884.	1885.	1886.	1887.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Mahaska	927,387	932,714	762,785	851,362	1,025,548
Keokuk	500,040	430,940	372,816	545,304	599,007
Jasper	45,883	46,336	90,425	286,034	142,039
Scott	3,714	3,821	5,937	3,000	8,634
Marshall	......	......	......	400	200
Hardin	......	......	......	2,000	450
Muscatine	......	......	......	100	100
Total	1,477,024	1,413,811	1,231,963	1,688,200	1,775,978

Counties.	1888.	1889.	1890.	1891.	1892.
	Long tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Mahaska	835,981	1,056,477	1,103,831	1,231,405	1,141,131
Keokuk	541,966	455,162	349,318	316,303	361,233
Jasper	275,179	199,152	173,044	267,202	163,860
Scott	9,080	9,446	(*a*)	(*a*)	(*a*)
Marshall	......	......	......	......	......
Hardin	1,000	490	(*a*)	(*a*)	(*a*)
Muscatine	......	......	......	......	......
Total	1,663,206	1,720,727	(*b*)1,626,193	(*b*)1,814,910	(*b*)1,666,224

a Included in product of small mines. *b* Exclusive of product of small mines.

Product of coal in the third inspection district of Iowa from 1883 to 1892.

Counties.	1883.	1884.	1885.	1886.	1887.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Boone	466,981	473,073	458,191	294,970	167,068
Dallas	38,208	37,185	32,986	21,986	40,420
Greene	88,851	96,327	89,587	117,538	105,894
Guthrie		5,187	4,596	17,194	18,305
Hamilton	1,998	1,878	918	3,312	6,669
Polk	558,821	619,921	462,895	337,964	305,094
Webster	248,560	214,014	145,296	107,777	146,221
Story					2,000
Total	1,403,419	1,447,585	1,194,469	900,741	791,671

Counties.	1888.	1889.	1890.	1891.	1892.
	Long tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Boone	140,142	174,392	153,229	151,659	139,820
Dallas	48,622	67,055	33,466	48,710	26,550
Greene	106,042	51,438	45,192	53,215	43,360
Guthrie	18,680	12,275	(*a*)	(*a*)	(*a*)
Hamilton	6,480				
Polk	300,669	434,047	367,852	309,467	388,590
Webster	159,715	137,739	118,829	78,022	115,154
Story	2,000				
Total	785,350	876,946	(*b*)718,563	(*b*)641,073	(*b*)713,474

a Included in product of small mines. *b* Exclusive of product of small mines.

Résumé.—In the foregoing tables the product for the years previous to 1889 has been given in long tons, while that of 1889, 1890, 1891, and 1892 is given in short tons. In the following table the product for all the years from 1883 to 1892 is given in short tons.

Product of coal in Iowa from 1883 to 1892.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of employés.
1883	4,457,540				
1884	4,370,566				
1885	4,012,575				
1886	4,312,921	$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	1.32		9,247
1890	4,021,739	4,995,739	1.24	213	8,130
1891	3,825,495	4,807,999	1.27	224	8,124
1892	3,918,491	5,175,060	1.32	236	8,170

Appanoose county.—The output increased from 409,725 short tons in 1891 to 411,987 short tons in 1892, a gain of 2,262 short tons. The value increased $52,708 or from $569,296 to $622,004. The average price per ton realized advanced from $1.39 to $1.51. The labor statistics show the employment of 1,213 men and 184 average working days, against 1,419 men and 207 working days in 1891.

Coal product of Appanoose county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	144,364	1888	235,495
1884	178,064	1889	285,194
1885	275,403	1890	284,560
1886	168,000	1891	409,725
1887	179,593	1892	411,987

Boone county.—The product in 1892 was 139,820 short tons, valued at $250,586. In 1891 the output was 151,659 short tons, worth $282,651, showing a decrease in 1892 of 21,839 short tons and $32,065.

The number of men employed in 1892 was 534, and the mines were active an average of 189 days, as against 484 men for 196 days in 1891.

Coal product of Boone county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	523, 019	1888	156, 959
1884	529, 842	1889	174, 392
1885	513, 174	1890	153, 229
1886	330, 366	1891	151, 659
1887	187, 116	1892	139, 820

Dallas county.—Dallas county produced 26,550 short tons in 1892, valued at $43,073, against 48,710 tons valued at $77,847 in 1891, a decrease of 22,160 short tons, and $34,774. The falling off was due to one of the two producing mines being shut down during 1892.

Coal product of Dallas county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	42, 793	1888	54, 457
1884	41, 647	1889	67, 055
1885	36, 944	1890	33, 466
1886	24, 614	1891	48, 710
1887	45, 270	1892	26, 550

Greene county.—Coal produced in 1892, 43,360 short tons; value, $76,765. The output in 1891 was 53,215 short tons, worth $74,725, showing a decrease in 1892 of 9,855 short tons and an increase in value of $2,040.

Coal product of Greene county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	99, 513	1888	118, 767
1884	107, 886	1889	51, 438
1885	100, 337	1890	45, 192
1886	131, 643	1891	53, 215
1887	118, 601	1892	43, 360

Jasper county.—A fire occurred in mine No. 3 of the Diagonal Coal Company, at Oswalt, which caused a suspension of work for about six weeks, and one company operating at Draper went out of business. In consequence the amount of coal produced in the county shows a decrease of 104,342 short tons.

Coal product of Jasper county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	51,389	1888	318,200
1884	51,996	1889	199,152
1885	101,276	1890	173,044
1886	320,358	1891	267,202
1887	159,084	1892	163,860

Jefferson county.—Jefferson county has but one producing mine of commercial importance, though a number of country banks, whose product is not included in this report, make the actual output much larger than that reported. The one mine mentioned produced 1,000 short tons, valued at $1,400 in 1892, against 800 tons worth $1,200 in 1891.

Coal product of Jefferson county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	43,553	1888	10,513
1884	9,153	1889	8,123
1885	1,250	1890	1,600
1886	1,213	1891	800
1887	11,645	1892	1,000

Keokuk county.—Keokuk county produced in 1892 361,233 short tons, valued at $460,812, against 316,303 short tons worth $417,395, an increase in quantity of 44,930 tons and in value of $43,417, the average price per ton realized for coal sold declining from $1.32 to $1.28.

Coal product of Keokuk county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	560,040	1888	607,002
1884	482,653	1889	455,162
1885	417,554	1890	319,318
1886	610,740	1891	316,303
1887	670,888	1892	361,233

Mahaska county.—This county is the most important coal producer, in the State, yielding nearly 29 per cent. of the State's total output in 1892. In 1891 it produced 32 per cent., and in 1890 26.5 per cent. The actual output in 1892 was 1,141,131 short tons, worth $1,310,583, against 1,231,405 tons, worth $1,306,579 in 1891. The production in previous years is shown in the following table:

Coal product of Mahaska county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	1,038,673	1888	936,299
1884	1,044,640	1889	1,056,477
1885	854,319	1890	1,103,831
1886	953,525	1891	1,231,405
1887	1,148,614	1892	1,141,131

Marion county.—Coal produced in 1892, 134,400 short tons, valued at $157,459. The amount of coal produced in Marion county in 1892 was smaller than in any year since 1805, being 31,467 short tons less than in 1891 and showing a loss in value of $34,829.

Coal product of Marion county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	101, 903	1888	258, 330
1884	108, 735	1889	145, 180
1885	112, 012	1890	153, 506
1886	158, 697	1891	165, 867
1887	238, 218	1892	134, 400

Monroe county.—Coal produced in 1892, 507,106 short tons; value, $639,731.

The amount of coal produced in Monroe county has increased each year since 1883. In 1892 the product was 113,879 short tons more than in 1891, in which year a gain of 69,196 was made over the product of 1890. The increase in the value of the product was $83,775 in 1891 and $164,987 in 1892. The county also advanced from third to second place in producing importance, changing places with Appanoose county.

Coal product of Monroe county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	104, 647	1888	261, 964
1884	110, 238	1889	258, 401
1885	113, 699	1890	324, 031
1886	131, 824	1891	393, 227
1887	207, 526	1892	507, 106

Polk county.—Coal produced in 1892, 388,590 short tons; value, $608,868.

The amount of coal mined in Polk county in 1892 exceeded that of 1891 by 79,123 short tons, the value increasing $144,553. Previous to 1892, with the exception of 1889, the output of the county has shown an annual decline since 1884, when the largest production in the history of the county was reported.

Coal product of Polk county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	625, 880	1888	333, 749
1884	695, 312	1889	434, 047
1885	518, 442	1890	367, 852
1886	378, 520	1891	309, 467
1887	341, 605	1892	388, 590

Taylor county.—Coal produced in 1892, 15,204 short tons; value $30,408. Increase over 1891, 4,704 short tons and $7,788.

Coal product of Taylor county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	105	1888	8,962
1884	142	1889	9,736
1885	691	1890	(*a*)10,000
1886	9,615	1891	10,500
1887	13,642	1892	15,204

a Estimated.

Van Buren county.—Coal produced in 1892, 28,946 short tons; value, $38,280.

The amount of coal mined in this county in 1891 was 36,166 short tons, worth $46,728, showing a decrease in 1892 of 7,220 tons and $8,448. The number of men employed in 1892 was 92, who worked an average of 226 days against 85 men for 207 days in 1891. The average price per ton advanced from $1.29 to $1.32.

Coal product of Van Buren county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	1,879	1888	29,065
1884	1,991	1889	39,258
1885	1,336	1890	47,464
1886	9,002	1891	36,166
1887	29,591	1892	28,946

Wapello county.—Coal produced in 1892, 234,472 short tons; value, $301,393.

The output of coal in Wapello county in 1891 was 165,827 short tons, less than half of what it was in 1890. The returns for 1892 show an increase over 1891, of 68,645 short tons and an increase in value of $95,264.

Coal product of Wapello county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	266,360	1888	426,042
1884	269,606	1889	359,199
1885	210,460	1890	341,932
1886	263,193	1891	165,827
1887	304,722	1892	234,472

Warren county.—Coal produced in 1892, 3,600 short tons; value, $6,300.

The output in 1892 was 1,600 tons more than in 1891, the value increasing $2,800. About half of the product is used to supply the local demand of Summerset.

Coal product of Warren county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	14,367	1888	19,155
1884	15,374	1889	14,515
1885	13,364	1890	8,470
1886	26,132	1891	2,000
1887	27,772	1892	3,600

Wayne county.—Coal produced in 1892, 62,078 short tons; value, $92,191.

The product in 1892 exceeded that of 1891 by 16,678 short tons (the value increasing $23,224), and was, by the same figures, the largest in the history of the county. In its production 140 men were employed, and the collieries were worked an average of 232 days, against 130 men working 205 days in 1891.

Coal product of Wayne county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	2,119	1888	27,298
1884	5,541	1889	17,480
1885	28,909	1890	25,415
1886	38,080	1891	45,400
1887	31,454	1892	62,078

Webster county.—Coal produced in 1892, 115,154 short tons; value, $185,180.

The output exceeded that of 1891 37,132 short tons, the value increasing $52,433. Included in the product of Webster county are about 12,000 tons of cannel coal, the remainder of the product being bituminous. The cannel coal produced in Webster county is all of that variety reported in the State.

Coal product of Webster county, Iowa, since 1883.

Years.	Short tons.	Years.	Short tons.
1883	278,387	1888	178,881
1884	239,696	1889	137,739
1885	162,732	1890	118,829
1886	120,710	1891	78,022
1887	163,768	1892	115,154

The following description of the coal areas of Iowa is furnished by Dr. Charles R. Keys, Assistant State Geologist:

SKETCH OF THE COAL DEPOSITS OF IOWA.

[By Charles R. Keyes.]

Extent of the coal industry.—Among the mineral products of Iowa that of coal takes first rank. The production for the calendar year 1892, according to the returns sent to the United States Geological Survey, amounted to nearly 4,000,000 tons, valued at $5,175,060. The mining of this fuel gave employment to 8,170 men. Besides there are probably 8,000 additional men directly dependent for a livelihood upon the coal industry of the State.

Coal fields of the interior basin.—The coal-bearing strata of Iowa, form the northernmost extension of the great interior coal field of the American continent. This basin comprises northwestern Kentucky, southwestern Indiana, southern and central Illinois, the southern third of Iowa, the northwestern half of Missouri, the extreme eastern border of Nebraska, Kansas, and Indian Territory, western Arkansas; and extends still farther southwestward in a narrow belt into central Texas. The Mississippi river divides the area into two parts; an eastern interior district including about one-third of the entire basin; and a western interior portion, embracing the remaining two-thirds. Along the dividing line the river has cut its channel completely through the coal strata, exposing in a narrow border on each side, much older rocks. Everywhere within the limits of the area just bounded, along the borders of the stream outliers of the coal-bearing layers are found in ancient gorges and depressions, the connecting beds having been almost completely removed through erosion, leaving only scattered remnants of their once greater extension.

Geographic limits.—The Iowa coal-bearing rocks cover a little more than one-third of the entire surface of the State. Geometrically, the area is a trapezoid, with the entire southern boundary of the State forming one side; the Missouri river another; an irregularly curved line connecting Keokuk and Fort Dodge a third; while the fourth, or northwesterly side, is not as yet well defined on account of the deep deposits of drift materials covering the region, but it is probably approximately along a sinuous line running from Fort Dodge to Council Bluffs. Beyond these boundaries, eastward especially, outliers of coal deposits are scattered even as far north as Jackson county on the Mississippi river. Many of these isolated basins often afford seams of coal sufficiently thick for profitable working.

The coal-bearing rocks of the State, as briefly described above, are distributed over half of the total number of counties. The area covered by these Carboniferous strata is not far from 20,000 square miles. It must not be inferred, however, that the coal is equally distributed over all this district. The broad belt running southeast and northwest, and traversed its entire length by the Des Moines river, from Fort Dodge to Keokuk, has heretofore been found to be much more productive of coal than other parts of the region. Lately, in places outside of this belt, coal has been discovered in abundance, and mines are rapidly being opened throughout this area, often where the presence of the commodity was unsuspected before.

All of the coal region of Iowa lies within the limits of the glaciated area, and the entire surface is covered consequently with glacial débris, often to a considerable depth. The topography of this part of the State is consequently greatly subdued by the deposits of drift and Loess.

Geologic subdivisions.—With the exception of a few Carbonaceous seams in the Cretaceous rocks, in the northwestern part of the State, the coal-bearing strata of Iowa belong to the median portion of the Carboniferous age, or Coal Measures. The rocks of this formation are made up largely of argillaceous materials, with sandstones and limestones, the coal beds forming an inconspicuous part of the entire series.

It has been customary in Missouri and Iowa to subdivide the Coal Measures into—

3. Upper Coal Measures.
2. Middle Coal Measures.
1. Lower Coal Measures.

In considering the Coal Measures as a whole two tolerably distinct classes of sediments are readily recognized: (1) The marginal or coastal deposits, and (2) the beds laid down in the more open sea.

These two kinds of beds are sharply contrasted lithologically, stratigraphically, and faunally. The first is characterized by the rocks being predominantly clay shales and sandstones, with practically no limestones. The individual beds have usually a very limited extent, and replace one another in rapid succession both laterally and vertically. The sandstones often form great lenticular masses, which are sometimes deeply channeled on the upper surface, the excavations being filled with Coal Measure clays. These and many other phenomena attest a constantly shifting shore line and shallow waters. The fossils contained are nearly all brackish water forms or shore species. The remains of pelagic organisms are not numerous.

On the other hand the second class of beds above mentioned is made up largely of calcareous shales, with heavy beds of limestone. The layers are evenly bedded and extend over very considerable areas. The fauna are chiefly strictly open sea forms.

As the conditions of deposition were evidently those of a slowly sinking shore, the marginal deposits as a whole practically underlie the open sea formations, the former being regarded as the "Lower" Coal Measures and the latter as the "Upper" Coal Measures. At the same time it must be remembered that this does not necessarily imply that the "Lower" Measures are to be considered much older than the "Upper;" but rather that along the great and successive planes of sedimentation different kinds of beds in the upper and lower divisions were laid down contemporaneously. With this idea of the Coal Measures of the interior basin the limits of the formation in Iowa assumes somewhat different lines from those that have commonly been recognized.

It is proposed, therefore, to divide the Coal Measures or Upper Carboniferous into:

2. The Upper Coal Measures, or Missouri stage.
1. The Lower Coal Measures, or Des Moines stage.

The Des Moines formation represents the Lower Coal Measures, or marginal deposits of the Upper Carboniferous. It takes its name from the Des Moines river which flows for more than 200 miles directly through the beds of this terrane. It extends into Missouri along the northern and western boundaries of the Ozark uplift, continuing southwestward into Kansas and the Indian Territory.

The Missouri formation corresponds essentially to the Upper Coal Measures representing more strictly marine deposits. It is the formation typically developed in the northwestern part of Missouri. The Missouri river also winds its way for more than 400 miles through the beds of this stage, exposing numerous fine sections on both sides of the stream throughout the entire distance.

Lithological characters of the Iowa Coal Measures.—In the order of their abundance the rocks of the Coal Measures are clay-shales, sandstones, limestones, and coals. The secondary part that the calcareous beds play in the Coal Measures of the State, especially in the lower division, contrasts this formation with the other paleozoic rocks. Below, the Coal Measures rest on a great basement of massive limestone, with but few clay or sandy beds of separation. Not less striking is the relative thinness, as a rule, of the individual layers which replace one another upwards and laterally in rapid succession. If the upper and lower divisions of the Coal Measures in Iowa were to be contrasted upon lithological characters it would be found that the former is prevailingly lime-bearing, the latter largely clayey.

Lower Coal Measures (Des Moines formation).—As already stated, the clay shales make up by far the greater part of the formation as represented in Iowa. On exposure to atmospheric agencies the shales rapidly disintegrate, forming soft clays which are easily carried away by running waters. For the most part they are gray, ashen, or black in color; red, yellow, buff, and blue shales are not of uncommon occurrence. The shales may be argillaceous, arenaceous, calcareous, or bituminous.

As already stated, the sandy material present in the Coal Measures of the region under consideration is usually mixed with clay to such an extent as to actually form sandy shales. In some cases, however, the sand constitutes a rock, which is sufficiently hard to form material for ordinary masonry. The hard portions of the sandstones are for the most part very limited, being only 2 or 3 feet in thickness, or in the form of hard concretionary masses in a soft matrix.

The limestones of the Lower Coal Measures play an important part in the lithological features of the region. They consist merely of a few thin bands, chiefly in the upper portion of the section, and seldom exceed 10 or 12 inches in thickness. The calcareous beds are the most persistent and easily recognizable over wide areas of all the horizons in central Iowa.

Little need be said here concerning the characters of the coals of the

State. They are all of the bituminous variety. The carbonaceous seams vary from a few inches to 7 or 8 or even 10 feet in thickness, the average of the veins at present worked being between 4 and 5 feet. These beds are deposited, not in two or three continuous layers over the entire area, as has been commonly supposed, but in more or less lenticular masses, varying from a few feet to several miles in extent.

Upper Coal Measures (Missouri formation).—As in the lower division of the Iowa Coal Measures, the argillaceous material of the upper part predominates over the other components, but the clays are largely calcareous rather than bituminous.

The limestones assume a very important part in making up the Upper Coal Measures. They also constitute the most striking lithological distinction between the upper and lower divisions. In thickness the beds vary from a few inches to 20 or 30 feet and upwards. The recognition becomes greatly simplified through the wide persistence of the limestone layers, which are thus valuable aids in accurate correlation.

The sands of the Upper Coal Measures are largely disseminated through clays, forming sandy shales or shaley sandstones. Massive sandstones are not uncommon. They are chiefly confined to the lower layers, and are only a few feet in thickness. Over large parts of the Upper Measures coal seams of economic importance are not common. Deep borings, however, will probably disclose a large amount of workable coal. This has already been accomplished with profit at Leavenworth, Kansas, and neighboring places.

Variability of strata.—In considering the stratigraphic features of the Lower Coal Measures the conclusion will probably be reached that all of the beds present great variability. Such is indeed the case. In fact it is one of the most striking characteristics of the formation as represented in Iowa. The rapid passage from one bed to another lithologically very distinct is everywhere apparent, the transition taking place vertically in different layers or laterally in the same horizon.

Thickness of the Coal Measures.—For reasons which need not be stated in detail here, considerable difficulty is encountered in working out the structural features of the Coal Measures in Iowa. The general inclination of the beds is to the southwestward. Careful estimates indicate that the greatest thickness of the Lower Coal Measures in the State is probably in the neighborhood of 400 feet, and that the maximum vertical measurement of the upper division is more than thrice that figure. Erosion has largely removed the coal-bearing strata of this district, and the original thickness of these rocks is not now present at any one place.

Extent and character of individual coal beds.—There is an opinion prevalent among the miners of the State that there are only three workable coal horizons. These are usually designated as the "first," "second," and "third" seams. Should any subordinate seams be encountered in the sinking of a shaft, they are not taken into consideration. As a matter of fact the "three" veins are not continuous over areas of any great extent, and may have widely different stratigraphic values, even within very short distances. The "first," "second," and "third" seams of one shaft may be entirely distinct from the similarly called seams of another mine scarcely half a mile away. A noteworthy instance for citation in this connection is in a boring made near the city of Des Moines. It was 200 feet in depth. Twelve distinct coal horizons were met with, giving a total thickness of coal 13½ feet; yet none of the beds were thick enough for profitable working. Only one-third of a mile away was a mine removing coal from two seams, one of which was 4 to 5 feet in thickness.

The stratigraphical importance of the coal seams is not so great as has generally been supposed, since the individual beds are, with very few exceptions, comparatively limited. Only a single case is at present known in which the geographic extent of a coal stratum is more than 4 or 5 miles, and for the greater part of this distance the coal is but a few inches in thickness. On the other hand, the total amount of coal in the State is probably very much greater than has been commonly regarded.

The basal coal seams in the Lower Coal Measures of Iowa appear to be more extensive than those toward the top, where they are only a few inches in vertical measurement and perhaps a hundred yards in extent. The coal may therefore be regarded as disposed in numerous basins of greater or less area, thickened centrally, but gradually becoming attenuated toward the margins. These are arranged in various horizons, interlocking with one another but separated by varying thicknesses of sandstone and shale. Thus at any one point a dozen or more seams may be passed through in sinking a shaft, only two or three perhaps being workable.

The disposition of the coal in numerous limited lenticular basins instead of a few layers extending over broad areas is of the utmost importance from a purely economical standpoint. In all mining operations and in all prospecting it is very essential that this fact be kept constantly in mind. With methods of boring more modern than those commonly in vogue throughout the western States there is every reason to believe that in the Lower Coal Measures especially, the large majority of good coal seams 12 inches in thickness and over, encountered in prospecting, can be traced readily and easily to localities where they are thick enough for profitable working.

Interrupted continuity of the coal beds.—In Iowa the restrictions upon the distribution of the individual seams are not numerous as compared with other regions. Yet there are disturbances of various kinds which break the continuity of the coal strata, locally interfering seriously with mining operations. They are referable to the three general agencies of deposition, erosion, and dislocation.

The irregularities of deposition are due, (1) to unevenness of the floor and (2) to presence of varying currents at the time the beds were laid down. The effects of the inequalities of the bottom—the result of erosion or other causes—are to terminate the coal layers abruptly against a wall in an old channel or gorge ; to cause a rapid thinning and disappearance of the bed as in the neighborhood of an ancient elevation; to subdivide a coal basin, as when sharp ridges traverse the area. Or, the converse of these results are effected in all these cases where depressions are present instead of elevations, causing a local increase in the thickness of the coal. The existence of former currents results in unequal accumulation of bituminous material.

The most serious interference with the continuity of coal beds arises from erosion. The erosive effects of later geological or post-glacial times are easily inferred from the present topography of the region, and cause but little embarrassment in mining operations. The work of preglacial degredation can not be read from existing topographical features. Some of the most familiar phenomena of this kind are met with in mines and old channels filled with sandstone or shales that cut off abruptly the thickest coal veins, as is shown in the old Polk county coal mine near Des Moines.

KANSAS.

Total product in 1892, 3,007,276 short tons; spot value, $3,955,595.

The coal fields of Kansas are described very completely in Mineral Resources of the United States, 1888, and for this reason further description is omitted.

Only eight counties in the State produce coal from "commercial" mines, and of these one supplies coal only to the local trade near the colliery. One county (Crawford) produced over 1,300,000 tons; one (Cherokee) produced over 800,000 tons; two (Leavenworth and Osage) each produced over 300,000 tons, while the combined product of the other four did not aggregate 60,000 tons.

The total product for the State was greater than in 1891 by 290,571 short tons, or 11 per cent. The value increased $398,290, the per centage of increase being about the same as that of the product. During 1891 the total number of men employed was 6,201, and the average number of days worked was 222. In 1892 6,559 men were employed, while the mines were worked an average of 208 days. All of the coal produced in Kansas is bituminous. The average price per ton ranged from $1.08 in Crawford county to $2.50 in Labette county, the general average for the State being $1.31½.

Coal product of Kansas in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.				
Cherokee	798,434	8,489	18,608		825,531	$1,009,524	$1.22	183	1,777
Coffey	2,240	1,424			3,664	6,800	1.85	128	23
Crawford	1,289,060	9,597	10,589		1,309,246	1,413,423	1.08	213	2,249
Franklin	7,300	3,800	50		11,150	20,671	1.85	180	57
Labette		800			800	2,000	2.50	100	6
Leavenworth	272,149	44,656	13,260	101	330,166	528,307	1.60	247½	1,020
Linn	37,570	5,880	463		43,913	55,645	1.27	237	115
Osage	350,059	21,392	1,355		372,806	759,225	2.04	202	1,312
Small mines		110,000			110,000	160,000	1.45		
Total	2,756,812	206,038	44,325	101	3,007,276	3,955,595	1.31½	208½	6,559

The following table shows the statistics of coal production in Kansas since 1880:

Coal product of Kansas for thirteen years.

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

The product by counties since 1885 has been as follows:

Coal product of Kansas since 1885, by counties.

Counties.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.	Short tons.
Cherokee	371,930	375,000	385,262	450,000	549,873	724,861	832,289	825,531
Coffee					18,272	12,200	1,218	3,664
Crawford	221,741	250,000	298,049	425,000	827,159	900,464	997,759	1,309,246
Franklin	14,518	15,000	18,080	25,000	37,771	9,045	10,277	11,150
Labette					2,541	4,000	800	800
Leavenworth	120,561	160,000	195,480	210,000	245,616	319,866	380,142	330,166
Linn	5,556	8,900	12,400	17,500	25,345	10,474	38,934	43,913
Osage	370,552	380,000	393,608	415,000	446,018	179,012	355,286	372,806
Small mines	107,199	211,100	294,000	307,500	68,448	100,000	100,000	110,000
Total	1,212,057	1,400,000	1,596,879	1,850,000	2,221,043	2,259,922	2,716,705	3,007,276

Cherokee county.—Coal produced in 1892, 825,531 short tons; value, $1,009,524.

Cherokee county is the second largest producing county in the State, yielding in 1892 something over 25 per cent. of the total output. Compared with the product of 1891 that of 1892 shows a decrease of 6,758 short tons in the quantity of coal obtained, but an increase of $19,739 in the amount received for it, the average price per ton advancing from $1.19 to $1.22. The number of men employed in 1892 was 1,777 making an average of 183 days, against 1,609 men for 180 days in 1891. Following are the statistics of coal production in this county since 1885:

Coal product of Cherokee county, Kansas, since 1885.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1885	371,930				
1886	375,000				
1887	385,262				
1888	450,000				
1889	549,873	$662,858	$1.20		1,196
1890	724,861	882,186	1.22	186	1,413
1891	832,289	989,785	1.19	180	1,609
1892	825,531	1,009,524	1.22	183	1,777

Coffey county.—The amount of coal obtained in 1892 was 3,634 short tons, valued at $6,800, against 1,218 tons, valued at $2,638, in 1891.

Crawford county.—Coal produced in 1892, 1,309,246 short tons; value, $1,413,423.

The amount of coal produced in Crawford county has increased annually since 1885. In 1889 the output was more than 400,000 tons in excess of that of 1888 and made the county the largest producer in the State, which position it has maintained. In 1890 a further gain of nearly 75,000 tons were made; in 1891 nearly 100,000 tons more, and in 1892 an increase of over 300,000 tons is observed. This increase was obtained without any material change in the selling price of the product, the average for the county being only 1 cent per ton less than in 1891. The number of employés was 2,234 against 1,785 and the average working days 213 against 202.

Coal product of Crawford county, Kansas, since 1885.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1885	221,741				
1886	250,000				
1887	298,049				
1888	425,000				
1889	827,159	$991,857	$1.20		1,629
1890	900,464	1,114,701	1.24	198	1,447
1891	997,759	1,090,540	1.09	202	1,785
1892	1,309,246	1,413,423	1.08	213	2,234

Franklin county.—Coal produced in 1892, 11,150 short tons; value, $20,671. The product of coal in 1892 was 873 short tons more than in 1891, the value increasing $1,143.

Coal product of Franklin county, Kansas, since 1885.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1885	14,518	....	....	....	....
1886	15,000	....	....	....	....
1887	18,080	....	....	....	....
1888	25,000	....	....	....	....
1889	37,771	$82,499	$2.18	....	75
1890	9,045	18,130	2.00	224	47
1891	10,277	19,528	1.90	207	48
1892	11,150	20,671	1.85	180	57

Labette county.—The only coal mined in the county was to supply the local trade at Oswego, and amounted to 800 tons, sold at $2.50 per ton.

Leavenworth county.—Coal produced in 1892, 330,166 short tons; value, $528,307.

Compared with 1891 the amount of coal produced in 1892 shows a falling off of 49,976 short tons, while in the amount received for it there was a decrease of only $2,374, the average price per ton advancing from $1.40 to $1.60.

Coal product of Leavenworth county, Kansas, since 1885.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1885	120,561	....	....	....	....
1886	160,000	....	....	....	....
1887	195,480	....	....	....	....
1888	210,000	....	....	....	....
1889	245,616	$415,751	$1.69	....	937
1890	319,866	490,224	1.60	273	745
1891	380,142	530,681	1.40	245	1,073
1892	330,166	528,307	1.60	247	1,020

Linn county.—Coal produced in 1892, 43,913 short tons; value, $55,645.

The product of Linn county in 1892 was 4,979 tons more than in 1891. The value af the product increased $7,744. The average price per ton advanced from $1.23 to $1.27. The number of men employed increased from 94 to 115 and the average working days from 236 to 237.

Coal product of Linn county, Kansas, since 1885.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1885	5,556	....	....	....	....
1886	8,900	....	....	....	....
1887	12,400	....	....	....	....
1888	17,500	....	....	....	....
1889	25,345	$33,665	$1.32	....	62
1890	10,474	14,078	1.34	164	60
1891	38,934	47,901	1.23	236	94
1892	43,913	55,645	1.27	237	115

Osage county.—Coal produced in 1892, 372,806 short tons; value, $759,225.

There are many mines in Osage county whose individual product is small, but when combined form a considerable factor in the total output of the county. They produce from 100 to 5,000 tons each (most of them yielding between 300 and 500 tons) and supply principally the local demand at Carbondale and Burlingame.

Compared with 1891 there was a gain in the production of 17,520 short tons and $34,993. The average price per ton received for the coal is considerably higher than that obtained in the three other large producing counties. This might seem to be on account of the number of small mines selling to local trade, but such does not appear to be the case. The product of only one mine was sold for as low as $1.50 per ton, and the output of that mine was less than 5,000 tons. The output of one mine was sold for $1.70 per ton, that of another for $1.75, and of five others for $1.90; but only one of these mines produced as much as 20,000 tons. Most of the operators sold their coal for $2 per ton, but the largest producing mine in the county yielded coal that brought an average of $2.12½ per ton.

The statistics of production for the past eight years are as follows:

Coal product of Osage county, Kansas, since 1885.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1885	370,552				
1886	380,000				
1887	393,608				
1888	415,000				
1889	446,018	$903,602	$2.03		2,032
1890	179,012	242,198	1.35	209	804
1891	355,286	724,232	2.04	270	1,581
1892	372,806	759,225	2.04	202	1,312

KENTUCKY.

Total product in 1892, 3,025,313 short tons; spot value, $2,771,238.

In 1891 the amount of coal produced in Kentucky was 2,916,069 short tons, valued at $2,715,600, indicating an increase in 1892 of 109,244 short tons, or 3.7 per cent., and of $55,638, or about 2 per cent. The average price per ton realized declined slightly, or from 93 cents to 92 cents. The number of men employed in 1892 was 6,724, who worked an average of 217 days, against 6,355 men for 225 days in 1891. There were 20 counties in the State producing coal in 1892 from commercial mines. Of these, Hopkins county ranks first, having an output exceeding 700,000 tons; Whitley county comes second and Ohio third, each producing more that 300,000 tons; Muhlenburg ranks fourth and Laurel fifth, each being credited with more than 200,000 tons product; Boyd, Carter, Union, and Knox follow in the order named, with more than 100,000 tons, and Lawrence county lacked only 3,000 tons of that figure.

The product of the State consisted of 2,901,043 tons of bituminous coal, 77,000 tons of semi-bituminous, 25,383 tons of cannel coal while 21,887 tons are returned as semi-cannel. This latter product is included in the amount of cannel coal in the table giving the output of coal by States and classification.

With the exception of a two months' strike in Bell county, there were no disturbances of this nature during 1892, so far as reported. The production by counties, together with the distribution and value, and the statistics of labor employed are shown in the following table:

Coal product of Kentucky in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Bell	726	355	50	6,840	7,971	$11,957	$1.50	136	30
Boyd	193,270	1,000	200		194,470	146,000	.74	285	300
Butler	18,751	200			18,951	37,902	2.00	192	65
Carter	132,846	4,693	1,812		139,351	179,312	1.29	276	375
Christian	43,870	2 525	1,500		47,895	45,280	.95	210	135
Daviess		8,064			8,064	9,000	1.12	240	10
Hancock	13,393				13,393	33,483	2.50	275	100
Henderson	62,382	17,079	1,200		80,661	69,404	.86	231	150
Hopkins	664,531	18,159	12,113	36,076	730,879	510,340	.70	228	1,292
Johnson	24,343	200			24,543	58,095	2.37	291	157
Knox	102,061	3.600	370		106,031	84,121	.79	185	225
Laurel	228,553	11,166	1,410		241,129	227,385	.94	177	775
Lawrence	95,000	1,000	1,000		97,000	111,550	1.15	295	325
Muhlenburg	269,603	4,902	3,360		277,865	246,364	.89	219	555
Ohio	300.640	6,075	3,574		310,289	256,137	.83	169	818
Pulaski	10,520	370	100		10,990	13,188	1.20	135	45
Rock Castle	9,624	150			9,774	10,556	1.08	120	100
Union	76,038	44,770	6,417		127,225	128,245	1.00	191	313
Webster	35,570	2,437	200		38,207	33,697	.86	194	64
Whitley	338,825	1,240	550		340,615	359,222	1.05	216	890
Small mines		200,000			200,000	200,000	1.00		
Total	2,620,556	327,985	33,856	42,916	3,025,313	2,771,238	.92	217	6,724

The following table exhibits the annual coal product of Kentucky since 1873:

Annual coal product of Kentucky since 1873.

Years.	Short tons.	Years.	Short tons.
1873	300,000	1883	1,650,000
1874	360,000	1884	1,550,000
1875	500,000	1885	1,600,000
1876	650,000	1886	1,550,000
1877	850,000	1887	1,933,185
1878	900,000	1888	2,570,000
1879	1,000,000	1889	2.399,755
1880	1,000,000	1890	2,701,496
1881	1,100,000	1891	2,916,069
1882	1,300,000	1892	3,025,313

Bell county.—The anticipations of extended developments in the Bell county coal mines had not been conspicuously realized up to the close of 1892. In fact, against a product of 15,693 tons in 1891, a total of only 7,971 tons was reported in 1892. The coal of the county is a good bituminous and makes an excellent coke, 6,840 tons of the 7,971 produced in 1892 being so used.

Boyd county.—Coal produced in 1892, 194,470 short tons; value, $146,000.

The amount of coal produced in Boyd county in 1892 was 15,120 short tons more than in 1891, but the value increased only $888, the average price declining from 81 cents to 74 cents. The entire product is from one mine and is bituminous.

Coal product of Boyd county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	145,945				
1888	(*a*)				
1889	163,124	$179,385	$1.10		
1890	179,600	151,176	.84	281	287
1891	179,350	145,112	.81	287	300
1892	194,470	146,000	.74	285	300

a Not reported.

Butler county.—Coal produced in 1892, 18,951 short tons; value, $37,902.

Coal mining in Butler county on a commercial scale began in 1889, when a total product of 12,871 short tons was obtained. There is no railroad communication, all of the product sent to a distance going by Green river boats.

Carter county.—Coal produced in 1892, 139,351 short tons; value, $179,312.

The product in 1892 was 6,586 short tons less than in 1891, but the value increased $27,906; the average price per ton advanced from $1.04 to $1.29, an advance of 25 cents per ton. This increase in value is due largely to the increased product of cannel coal, which was 4,926 short tons in 1891 and 9,248 tons in 1892. This coal brings from $4 to $4.50 per ton. In addition to this an output of 21,887 short tons of "semi-cannel" coal was reported in 1892.

Coal product of Carter county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	158,021				
1888	(*a*)				
1889	172,776	$196,892	$1.14		432
1890	179,379	197,027	1.10	237	459
1891	145,937	151,406	1.04	227½	437
1892	139,351	179,312	1.29	276	375

a Not reported.

Christian county.—The amount of coal produced in Christian county in 1892 was 47,895 short tons, valued at $45,280, against 34,060 tons, valued at $39,373 in 1891, an increase of 13,835 tons in quantity and of $5,907 in value. The price for lump coal per ton in 1892 was $1.25, but the average for all sizes was 95 cents, a decline of 21 cents compared with 1891.

Coal product of Christian county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	24,507				
1888	(a)				
1889	27,281	$34,348	$1.26		
1890	35,339	30,271	.86	155	125
1891	34,060	39,373	1.16	187	125
1892	47,895	45,280	.95	210	135

a Not reported.

Daviess county.—A total product of 8,064 short tons, valued at $9,000, was reported for 1892, against 6,711 short tons, worth $7,149 in 1891. All of the product was used to supply the local demand of Owensboro.

Coal product of Daviess county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	15,243				
1888	(a)				
1889	30,870	$40,231	$1.30		
1890	6,392	8,181	1.27	300	12
1891	6,711	7,149	1.07	264	12
1892	8,064	9,000	1.12	240	10

a Not reported.

Hancock county.—With the exception of a limited product of bituminous coal from country banks, all of the output is cannel coal. The amount in 1892 was 13,393 short tons, valued at $33,483, against 16,815 short tons, worth $31,008 in 1891.

Henderson county.—After an increase in the product of 1891 of 36,781 tons over that of 1890, and bringing the total output up to over 124,000 tons, the product fell back in 1892 to 80,661 short tons, a decrease of 43,360 tons.

Coal product of Henderson county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	50,912				
1888	(a)				
1889	65,682	$82,457	$1.26		148
1890	87,240	77,300	.89	251	131
1891	124,021	114,535	.92	249	231
1892	80,661	69,404	.86	231	150

a Not reported.

Hopkins county.—Coal produced in 1892, 730,879 short tons; value, $510,340.

Hopkins county ranks first in the amount of coal produced, yielding nearly 25 per cent. of the State's total. The output in 1892 was 50,593 short tons in excess of that of 1891, and the largest in the history of the county. The number of men employed in 1892 was 1,292, against 1,203 in 1891. The average number of working days was 228 against 244. As will be seen in the following table, the production has increased each year since 1887, but the value has not increased proportionately, the average price per ton declining from 78 cents in 1889 to 76 cents in 1890, and 73 cents in 1891, dropping finally to 70 cents in 1892:

Coal product of Hopkins county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	487,916				
1888	(*a*)				
1889	555,119	$434,606	$0.78		904
1890	604,307	461,177	.76	231	1,104
1891	680,386	494,939	.73	244	1,203
1892	730,879	510,340	.70	228	1,292

a Not reported.

Johnson county.—Coal produced in 1892, 24,543 short tons; value, $58,095.

Nearly all of the coal produced in Johnson county is of the cannel variety, but the output has been comparatively limited. In 1892 the product was 3,021 short tons more than in the preceding year, and an advance in the average price (from $2.28 to $2.37) increased the total value $8,845.

Coal product of Johnson county, Kentucky, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	(*a*) 32,347	$54,178	$1.67		
1890	21,222	45,234	2.13	267	110
1891	21,522	49,250	2.28	280	153
1892	24,543	58,095	2.37	291	157

a Includes 7,555 tons produced from county banks.

Knox county.—Coal produced in 1892, 106,031 short tons; value, $84,121.

Compared with 1891 the product in 1892 shows an increase of 6,031 tons. No output was reported from Knox county previous to 1889. Since that year the production has been as follows:

Coal product of Knox county, Kentucky, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	47,503	$41,000	$0.84	....	....
1890	90,000	69,600	.77	240	200
1891	100,000	100,000	1.00	200	215
1892	106,031	84,121	.79	185	225

Laurel county.—Coal produced in 1892, 241,129 short tons; value, $227,385.

The output in 1892 was 67,113 short tons less than in 1891, the county dropping from third to fifth place as a coal producer. The value of the product shows a decrease of $80,634, the average price per ton declining from $1 to 94 cents. All of the coal of Laurel county is bituminous.

Coal product of Laurel county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	226,617	....	....	....	....
1888	(a)	....	....	....	....
1889	280,451	$251,122	$0.90	....	799
1890	291,178	276,718	.95	225	680
1891	308,242	308,019	1.00	233	798
1892	241,129	227,385	.94	177	775

a Not reported.

Lawrence county.—Coal produced in 1892, 97,000 short tons; value, $111,550.

The output of coal in Lawrence county was 16,152 tons more than in 1891, but still 3,200 tons short of the product in 1890, the year of largest yield.

Coal product of Lawrence county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	46,598	....	....	....	....
1888	(a)	....	....	....	....
1889	79,787	$107,103	$1.34	....	....
1890	100,200	125,000	1.25	280	200
1891	80,848	80,848	1.00	289	300
1892	97,000	111,550	1.15	295	325

a Not reported.

Muhlenburg county.—Coal produced in 1892, 277,865 short tons; value, $246,364.

With an increased product of 17,550 tons over 1891, Muhlenburg county advances from fifth to fourth place in rank of importance, Laurel county dropping from third to fifth. The entire product of Muhlenburg county is bituminous.

Coal product of Muhlenburg county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	189.511				
1888	(a)				
1889	206.855	$180,654	$0.87		
1890	240,983	193,330	.80	213	495
1891	260,315	219,695	.84	215	586
1892	277,865	246,364	.89	219	555

a Not reported.

Ohio county.—The amount of coal produced in 1892 was 12,122 short tons less than in 1891, though the value increased $2,759. In producing importance the county drops from second to third place, being displaced by Whitley county:

Coal product of Ohio county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	150,578				
1888	(a)				
1889	246,253	$200,497	$0.81		
1890	267,736	208,072	.78	236	520
1891	322,411	253,378	.79	225	625
1892	310,289	256,137	.83	169	818

a Not reported.

Pulaski county.—Only one mine was operated in Pulaski county in 1892, producing 10,990 short tons, valued at $13,188, against 15,810 tons, worth $21,948, in 1891.

Rock Castle county.—Rock Castle county reports in 1892 a product of 9,774 short tons, valued at $10,556. This is the first production reported since 1889, when 1,432 tons were obtained from country banks.

Union county.—The amount of coal produced in Union county has increased steadily since 1887, the product in 1892 being 40,547 tons more than in 1891. The average price per ton declined 25 cents.

Coal product of Union county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	47,130				
1888	(a)				
1889	56,556	$63,803	$1.13		
1890	67,763	72,999	1.08	189	131
1891	86,678	109,598	1.26	161	289
1892	127,225	128,245	1.01	191	313

a Not reported.

Webster county.—Webster county produced 38,207 short tons of bituminous coal in 1892, valued at $33,697, against 33,883 tons, worth $29,670, in 1891, an increase in quantity of 4,324 tons and in value of

$4,023. The price per ton declined 2 cents, but was compensated for by a decrease of 3 in the number of employés and of 32 days in working time.

Coal product of Webster county, Kentucky, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	32,729	$26,379	$0.80	....	....
1890	33,016	24,860	.78	214	65
1891	33,883	29,670	.88	226	67
1892	38,207	33,697	.86	194	64

Whitley county.—An increase of over 75,000 tons in the product of 1892 as compared with 1891 brings Whitley county to second place as a coal producer. In 1891 it held fourth place, with a total product of 265,516 short tons.

Coal product of Whitley county, Kentucky, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	223,337	....	....	....	....
1888	(*a*)	....	....	....	....
1889	184,874	$203,264	$1.10	....	....
1890	262,541	286,724	1.09	204	625
1891	265,516	315,235	1.19	190	680
1892	340,615	359,222	1.05	216	890

a Not reported.

Other counties.—In addition to the coal-producing counties of Kentucky, of which mention has been made in the foregoing report, there are twenty-six counties which produced coal from country banks in 1889, and which are not enumerated in this report, the product being included in the 200,000 tons estimated from this source. These counties are Breathitt, Clay, Edmonson, Elliott, Floyd, Grayson, Greenup, Harlan, Jackson, Knott, Lee, Leslie, Letcher, McLean, Madison, Magoffin, Martin, Menifee, Morgan, Owsley, Perry, Pike, Powell, Todd, Wayne, and Wolfe.

THE COAL FIELDS OF KENTUCKY. (*a*)

Kentucky is the only State having within its borders parts of both of the great coal fields—having in the eastern part of the State 11,180 square miles of the great eastern or Appalachian field, and in the western part of the State 4,500 square miles of the great western or Illinois coal field. The latter is the nearest good coking coal to Chicago and the immense deposits of Bessemer ores in the Lake region. The entire coal-field area of Great Britain (7,876 square miles) is about one-half that of the coal area of Kentucky. Much of the Kentucky coal is above

a From a recent paper on the resources of Kentucky, by Prof. John R. Proctor, State Geologist.

drainage, and can be mined water-free by inexpensive adits in the mountain sides.

The Western coal field.—This field has an area of 4,500 square miles, is a broad syncline, with its central axis nearly parallel with Green river. The coals of the Lower Measures are brought to the surface around the eastern, southern, and western parts of the field. These coals disappear beneath the drainage toward the center of the field and the upper coals come in succession. There are twelve workable coals in this field, but all are not present in any one vertical section. Green river, which is navigable at all seasons, cuts entirely through the center of this field, exposing in its course outcrops of all of the coals of the field. This renders a large area of coal accessible to cheap water transportation connecting with the lower Ohio and Mississippi rivers. Excellent coals are convenient to the Ohio river in the western part of this field. Coke of excellent physical structure, but high in sulphur, is being made from one of the coals in the Upper Measures. Railways traverse this field east and west and north and south, so that both rail and water transportation are ample. There is an abundant supply of cheap iron ores convenient to the coals of western Kentucky. Associated with the coals in the Lower Measures in the counties of Grayson, Edmonson, Butler, Muhlenburg, and Ohio are stratified carbonates and limonites from 2 feet to 5 feet in thickness, and ranging from 33 per cent. to 49 per cent. of metallic iron, with from 11 per cent. to 30 per cent. of silica, and from 0.2 per cent. to 1.5 per cent. of phosphorus. Should it be demonstrated that a good furnace coke can be produced here, as there are reasons to hope, a cheap pig iron could be made in the Green river valley, notwithstanding these ores are low-grade ores. In the sub-Carboniferous limestone of the lower Cumberland and Tennessee region west of the coals are deposits of very excellent limonites that will run from 45 to 55 per cent. of iron, and freer from phosphorus than the above-mentioned ores. Should the proposed Chicago ship canal, connecting Lake Michigan with the Mississippi river be completed, then the high-grade ores of the lake regions can be brought to Kentucky to mix with these cheap ores, and coals returned by an all water route. Such an enterprise will greatly aid the development of Kentucky coals accessible to water transportation. There is much fertile land in the western coal field, and most of the land is arable.

The Eastern coal field.—This field has an area of 11,180 square miles and is remarkable for the great purity of some of the coals, the number, thickness, and excellence of the cannel coals, and the superior quality of the coke produced from some of the coals. The thickest part of the measures is on the syncline, between the Pine and Cumberland mountains, where there is a thickness of from 1,500 to 2,500 feet of Coal Measure rocks above drainage, and from eight to ten coals of workable thickness outcrop along the streams and on the mountain sides. Nearly all the coals are present on the headwaters of the streams, north of Pine mountain. Along the northwestern edge of the field only the coals of the Lower Measures are present. Cannel coals of workable thickness have been found outcropping in sixteen counties in the eastern coal field. Some of these coals contain from 50 to 66 per cent. of volatile combustible matter, and are very low in ash and sulphur Such coals will stand costs of export. It has been demonstrated 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 first 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. This coal attains its greatest thickness in Pike, Letcher, and Harlan counties, Kentucky, and Wise county, Virginia, but is thick enough for profitable mining, when transportation is secured, in eight additional counties in Kentucky. This coal produces a coke with from 92 to 94 per cent. of fixed carbon, and low in sulphur and ash. Careful tests have demonstrated beyond question that pure strong coke can be produced from this coal, equal to the best furnace and foundry cokes of this country or England.

The importance of the discovery of large deposits of coking coals in eastern Kentucky, in its bearing upon the future development of the Appalachian region, can not be overestimated. Some of these coking coals are nearer Chicago and the great deposits of Bessemer ores of the Lake region than is the Connellsville coke, the present source of supply, and they are the nearest coking coal to Cincinnati and Louisville. But their great value is the nearness to great deposits of ores in the South. They will find a market in Alabama and Tennessee to supply furnaces already built with a high-grade coke, and a local market will be developed by the building up of iron centers in eastern Kentucky, east Tennessee, and southwestern Virginia, where the conditions are most favorable for the manufacture of cheap iron and steel.

MARYLAND.

Total product in 1892, 3,419,962 short tons (or 3,053,538 long tons); spot value, $3,063,580.

The coal product of Maryland in 1891 was 3,820,239 short tons, or 3,410,928 long tons, valued at $3,082,515, showing a decrease in 1892 of 400,277 short tons, or 353,390 long tons. The loss in value, however, was only $18,935. In his annual report Mr. Francis J. McMahon, mine inspector, gives the product for 1892 at 3,063,909 long tons, the difference between his figures and those of the Survey being but little more than 10,000 tons. Mr. McMahon attributes the decrease in output during 1892 to a disinclination on the part of operators to cut prices in competition with coal from other regions. The decrease of nearly 400,000 short tons in product and practically no decrease in the value from that of 1891 sustains this statement. Mr. McMahon also states that difficulty was experienced in obtaining cars, many being detained at the sea-board by scarcity of vessels to transport the coal, and from scarcity of boats on the Chesapeake and Ohio canal. These conditions not only tended toward a restriction in production, but, doubtless, also assisted in maintaining prices.

The statistics of production in 1892 are shown in the following table:

Coal product of Maryland in 1892.

Distribution.	Short tons.
Loaded at the mines for shipment	3,385,384
Sold to local trade and used by employés	30,955
Used at mines for steam and heat	3,623
Total product	3,419,962
Total value	$3,053,580
Total number of employés	3,886
Average number of days worked	225

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

Product of coal in Maryland from 1883 to 1892.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	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	3,053,580	.89	225	3,886

The following tables showing the shipments from the various mines in Maryland since 1883, and of the total shipments from the Cumberland field (including the West Virginia mines in the field), are obtained from the official reports of the Cumberland coal trade. The quantities are expressed in long tons. If reduced to short tons it will be seen that these figures do not materially differ from the amounts given above.

Shipments of coal from Maryland mines from 1883 to 1892.

Companies.	1883.	1884.	1885.	1886.	1887.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Consolidation Coal Co	456, 238	689, 212	710, 064	675, 652	936, 799
New Central Coal Co	210, 850	210, 140	203, 814	149, 561	181, 906
Georges Creek Coal and Iron Co	257, 490	266, 042	257, 343	265, 942	394, 012
Maryland Union Coal Co	137, 105	117, 180	98, 095	116, 771	148, 523
Borden Mining Co	151, 665	162, 057	179, 537	137, 747	192, 636
Maryland Coal Co	235, 854	295, 736	365, 319	288, 742	316, 518
American Coal Co	190, 055	194, 330	220, 339	211, 305	259, 632
Potomac Coal Co	139, 723	169, 463	196, 280	156, 757	209, 793
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	....
Swanton Mining Co	34, 905	28, 620	52, 862	42, 688	61, 610
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
National Coal Co	38, 998	42, 680	48, 307	62, 637	117, 775
Davis and Elkins mine	....	74, 437	58, 002	58, 382	82, 667
James Ryan	....	....	....	....	3, 608
George M. Hansel	....	....	....	....	1, 989
Total	2, 210, 781	2, 469, 301	2, 529, 765	2, 247, 837	2, 926, 902

Companies.	1888.	1889.	1890.	1891.	1892.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Consolidation Coal Co	1, 023, 349	871, 463	956, 031	910, 977	912, 787
New Central Coal Co	169, 484	118, 885	218, 169	206, 813	201, 428
Georges Creek Coal and Iron Co	437, 992	311, 258	351, 310	356, 927	297, 632
Maryland Union Coal Co	106, 620	....	....	....	....
Borden Mining Co	212, 520	206, 549	290, 055	300, 268	253, 629
Maryland Coal Co	340, 866	268, 438	366, 839	406, 464	280, 946
American Coal Co	287, 058	297, 537	386, 731	449, 631	384, 681
Potomac Coal Co	208, 777	205, 212	217, 232	184, 706	137, 738
Atlantic and Georges Creek Coal Co. (Pekin mine)	6, 375	3, 884	752	....	....
Swanton Mining Co	58, 383	40, 748	41, 401	33, 029	5, 162
Blæn Avon Coal Co	....	....	....	....	....
Union Mining Co	6, 396	3, 734	17, 933	179, 232	176, 996
National Coal Co	76, 592	72, 571	60, 206	....	....
Davis and Elkins mine	98, 443	18, 089	....	....	....
James Ryan	....	....	....	....	....
George M. Hansel	3, 559	113	....	....	....
Barton and Georges Creek Valley Co	69, 857	123, 429	175, 838	201, 124	201, 365
Enterprise mine	399	288	11	....	....
Franklin Consolidated Coal Co	....	71, 837	66, 644	76, 593	72, 117
Big Vein Coal Co	....	21, 310	52, 917	62, 832	66, 683
Piedmont-Cumberland Coal Co	....	2, 493	29, 003	42, 439	14, 564
Anthony Mining Co	....	....	115	9, 725	10, 665
Total	3, 106, 670	2, 637, 838	3, 231, 187	3, 420, 760	3, 016, 393

Total shipments from the Cumberland coal field in

Years.	Frostburg region.						
	Cumberland and Pennsylvania railroad.				Cumberland Coal and Iron Company's railroad.		
	By Baltimore and Ohio railroad.	By Chesapeake and Ohio canal.	By Pennsylvania railroad.	Total.	By Baltimore and Ohio railroad.	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	70,669	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
					Cumberland Branch.		
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	246,145
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	289,232	1,926,876	463,142	39,294	502,436
1892	1,426,994	93,705	214,011	1,734,710	349,207	170,116	519,323
Total	31,982,002	11,134,363	3,531,219	46,647,584	4,885,613	2,759,481	7,645,094

Maryland and West Virginia from 1842 to 1892.

Frostburg region. Georges Creek and Cumberland railroad. By Chesapeake and Ohio canal.	Frostburg region. Georges Creek and Cumberland railroad. By Pennsylvania railroad.	Frostburg region. Georges Creek and Cumberland railroad. Local and Baltimore and Ohio.	Frostburg region. Georges Creek and Cumberland railroad. Total.	Piedmont region. Georges Creek railroad.	Piedmont region. Hampshire railroad, by Baltimore and Ohio railroad.	Total. Baltimore and Ohio railroad and local.	Total. Chesapeake and Ohio canal.	Total. Pennsylvania railroad.	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	......	(a)2,557,177	266,901	1,205,486	4,029,564
584,876	3,705,516	2,733,715	7,024,107	6,785,224	1,475,969	50,336,209	15,772,561	8,946,775	75,055,545

a Includes 105,059 tons used on line of Cumberland and Pennsylvania railroad and its branches, and at Cumberland and Piedmont; also 373,988 tons used by the Baltimore and Ohio railroad in locomotives, rolling mills, etc.

MICHIGAN.

Total product in 1892, 77,990 short tons; spot value, $121,314.

The amount of coal produced in Michigan in 1891 was 80,307 short tons, indicating a decrease of 2,317 short tons in the product of 1892. The value fell off $12,073, or from $133,387 to $121,314. The entire product is bituminous coal and the greater portion is consumed in the city of Jackson for domestic and manufacturing purposes.

Coal product of Michigan in 1892.

Distribution.	Short tons.
Loaded at mines for shipment	27, 200
Sold to local trade and used by employés	45, 180
Used at mines for steam and heat	5, 610
Total	77, 990
Total value	$121, 314
Average price per ton	$1. 56
Total number of employés	230
Average number of days worked	195

In the following table is shown the annual product of coal in Michigan since 1887. The largest output for any one year was in 1882, when a total of 135,339 tons was obtained. The suspension of two of the larger companies in the following year reduced the product nearly 50 per cent., and the loss has not since been made up.

Product of coal in Michigan from 1877 to 1892.

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

THE COAL FIELDS OF MICHIGAN.

The Coal Measures of Michigan lie in an isolated basin having no connection with the coal of any other State. They are supposed to occupy an area comprising about one-fifth of the central portion of the lower peninsula. The seams of coal are interstratified with beds of shale, beds of coarse, friable sandstone, and clay. The entire formation has an estimated maximum thickness of about 300 feet.

The extent of the coal field is embraced in a circle with a radius of 50 miles, having its center southeast of the village of Saint Louis, in Gratiot county, and its southern boundary passing a few miles south of the city of Jackson. Over the greater portion of this wide field indications of coal have been found, and in many localities some incipient mining work has been done. But a limited amount of systematic exploring has been prosecuted, and the coal seams which have been reached vary from a few inches to a maximum of 4 feet in thickness. The rock beds in lower Michigan have but few exposures; everywhere they are deeply buried by the overlying drift, so that actual boring is required to determine whatever of mineral value may lie beneath the surface in any particular locality. This operation involves considerable trouble and expenditure, and, unless for a specific object, is seldom resorted to. While the coal deposits probably exist over a wide field in Michigan, it by no means follows that the beds are continuous, and that coal may be everywhere found in workable quantity. The basins in which the coal was originally laid down, unprotected by later deposits, have suffered from exposure to the forces of nature during the long geological periods that have intervened. Probably the greater portion of the coal originally deposited in this State during the epoch of the coal formation was subsequently worn away and destroyed by the moving glaciers of the Drift period. The soft, yielding rock deposits of lower Michigan were eroded and swept away by the great rivers of ice that moved over them, to be again buried and hidden beneath the accumulated drift and débris furnished by these glacier masses and by subsequent geological changes.

The consequent absence of precipices and ledges renders it difficult to study the strata and formation of the State. Enough has been done, however, to prove that in this State there are deposits of coal of necessarily limited extent. So far as is known there is but a single workable seam, and this has only a maximum thickness of 4 feet, with an average of from 2½ to 3 feet.

MISSOURI.

Total product in 1892, 2,733,949 short tons; spot value, $3,369,659.

The coal product of Missouri increased from 2,674,606 short tons in 1891 to 2,733,949 short tons in 1892, a gain of 59,343 short tons. The value increased from $3,283,242 to $3,369,659, a gain of $86,417.

There are twenty counties in the State which produced coal on a commercial scale in 1892. Of these, two, Bates and Macon, each produced over half a million tons, and their combined output was nearly 50 per cent. of the State's total. Lafayette county produced over 300,000 tons, and Ray county exceeded 200,000 tons. Three others, Putnam, Randolph, and Vernon yielded each more than 100,000 tons, while Henry county fell a little less than 2,000 tons short of that amount. Only one other county, Barton, had an output exceeding 50,000 tons.

The counties having increased production in 1892 were Adair, Johnson, Lafayette, Linn, Macon, Montgomery, Putnam, Ray, Saint Clair, and Vernon. Those whose product in 1892 fell below that of 1891 were

Audrain, Barton, Bates, Boone, Caldwell, Calloway, Grundy, Henry, Morgan, and Randolph.

So far as reported to this office the industry was not disturbed by any labor troubles worthy of notice. Some operators claim that oppressive freight rates restricted their production, while others, whose product is consumed locally, report a decreased output on account of mild weather during the winter months. A small amount (766 tons) of cannel coal was produced in Montgomery county. All of the rest of the coal mined in the State was bituminous. In the table following is shown the statistics of production during 1892, by counties:

Coal product of Missouri in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	Used at mines for steam and heat.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Adair	11,000	38	100	11,138	$19,491	$1.75	300	40
Audrain	10,040	12,748	224	23,012	34,518	1.50	224	60
Bates	561,660	3,510	7,560	572,730	574,622	1.00	207	663
Barton	49,667	204	690	50,561	64,989	1.29	179	149
Boone	10,622	5,014	....	15,636	23,956	1.53	273	38
Caldwell	22,560	6,471	1,775	30,806	67,789	2.20	244	158
Callaway	1,600	20,002	108	21,710	33,831	1.56	243	97
Cooper	1,278	282	160	1,720	3,440	2.00	150	6
Grundy	200	25,275	1,825	27,300	55,965	2.05	275	140
Henry	79,626	9,638	505	89,769	126,393	1.41	219	246
Johnson	4,660	1,020	....	5,680	8,912	1.57	142	25
Lafayette	305,655	16,613	2,580	324,848	520,389	1.60	233	949
Linn	36,968	3,648	6	40,622	63,528	1.56	249	135
Macon	657,776	2,900	7,470	668,146	694,381	1.04	252	1,489
Montgomery	356	15,971	362	16,689	22,750	1.36	195	40
Morgan	....	40	8	48	120	2.50	15	2
Putnam	131,560	1,658	3,840	137,058	187,184	1.37	241	393
Randolph	143,010	4,355	2,243	149,608	160,748	1.07	227	371
Ray	220,044	11,163	4,091	235,298	363,303	1.54	206	694
Saint Clair	6,000	500	....	6,500	9,750	1.50	250	12
Vernon	145,323	2,364	7,383	155,070	158,600	1.02	166	186
Small mines	....	150,000	....	150,000	175,000	1.17	......	....
Total	2,399,605	293,414	40,930	2,733,949	3,369,659	1.23	230	5,893

Adair county.—Coal produced in 1892, 11,138 short tons; value, $19,491.

The product in 1892 was 198 tons more than in 1891. The value increased $216, there being no change in the price.

Coal product of Adair county, Missouri, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	18,592	$30,860	$1.66	....	....
1890	(*a*) 16,000	27,200	1.70	280	48
1891	10.940	19,175	1.75	300	40
1892	11,138	19,491	1.75	300	40

a Estimated.

Audrain county.—The returns from Audrain county show a product in 1892 of 23,012 short tons, valued at $34,518, an increase of the product of 1891 of 14,240 short tons and $20,795.

Coal product of Audrain county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	102,032	....	....	....	....
1888	(*a*)	....	....	....	....
1889	26,194	$38,490	$1.47	....	....
1890	20,261	32,688	1.61	205	70
1891	8,772	13,723	1.57	180	33
1892	23,012	34,518	1.50	224	60

a Not reported.

Barton county.—The output of coal in 1892 was 50,561 short tons, valued at $64,989, against 85,002 tons, valued at $103,780, a decrease of 34,441 short tons and $38,791.

Coal product of Barton county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	132,275	....	....	....	....
1888	(*a*)	....	....	....	....
1889	61,167	$82,655	$1.35	....	182
1890	28,500	30,200	1.06	231	90
1891	85,002	103,780	1.22	221	263
1892	50,561	64,989	1.29	179	149

a Not reported.

Bates county.—Coal produced in 1892, 572,730 short tons; value, $574,622.

The output of coal in Bates county was 45,850 short tons less than in 1891, and in consequence the county loses first place in producing importance, being supplanted by Macon county. Production has decreased annually since 1887.

Coal product of Bates county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	1,071,106	....	....	....	....
1888	(*a*)	....	....	....	....
1889	755,989	$857,060	$1.14	....	1,500
1890	751,702	767,542	1.02	215	1,315
1891	628,580	654,160	1.04	235	1,077
1892	572,730	574,622	1.00	207	663

a Not reported.

Boone county.—The product decreased from 16,340 short tons in 1891 to 15,636 short tons in 1892, a loss of 704 tons. The value fell off from $24,510 to $23,956.

Coal product of Boone county, Missouri, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	31,405	$48,244	$1.54	....	82
1890	17,000	25,500	1.50	290	46
1891	16,340	24,510	1.50	257	53
1892	15,636	23,956	1.53	273	38

Caldwell county.—The product in 1892 was 20,259 short tons less than in 1891, the value decreasing $42,219.

Coal product of Caldwell county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	26,000	....	....	....	....
1888	(a)	....	....	....	....
1889	13,594	$26,810	$1.97	....	....
1890	21,599	42,706	1.98	294	77
1891	51,065	110,008	2.15	230	194
1892	30,806	67,789	2.20	244	158

a Not reported.

Callaway county.—Callaway county produced 21,710 short tons in 1892, against 22,458 short tons in 1891. Nearly all of the product is consumed in the town of Fulton in the manufacture of brick and for domestic use.

Coal product of Callaway county, Missouri, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	16,053	$28,727	$1.79	....	....
1890	5,331	7,996	1.50	218	11
1891	22,458	32,661	1.42	230	90
1892	21,710	33,831	1.56	243	97

Grundy county.—Coal produced in 1892, 27,300 short tons; value, $55,965.

The product in 1892 was 2,700 tons less than in 1891, when 30,000 tons were obtained. The value fell off $5,535, or from $61,500 to $55,-965. There was no change in the price for four years.

Coal product of Grundy county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	36,183	....	....	....	....
1888	(a)	....	....	....	....
1889	23,401	$47,972	$2.05	....	....
1890	24,000	49,200	2.05	200	50
1891	30,000	61,500	2.05	297	90
1892	27,300	55,965	2.05	275	140

a Not reported.

Henry county.—The output declined from 102,866 short tons in 1891 to 89,769 short tons in 1892. The value decreased from $137,617 to $126,393.

Coal product of Henry county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	199,777				
1888	(a)				
1889	180,118	$278,986	$1.55		
1890	109,768	161,995	1.48	207	311
1891	102,866	137,617	1.33	218	286
1892	89,769	126,393	1.41	219	246

a Not reported.

Johnson county.—The coal production of Johnson county increased from 4,500 short tons, worth $6,750 in 1891 to 5,680 tons worth $8,912 in 1892.

Lafayette county.—Lafayette county holds third place in the amount of coal production. In 1892 the yield of the county was 324,848 short tons, valued at $520,389, against 277,393 short tons, worth $430,581; increase in 1892, 47,455 short tons and $89,808.

Coal product of Lafayette county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	352,087				
1888	(a)				
1889	348,670	$557,186	$1.60		1,116
1890	347,688	539,402	1.55	217	1,056
1891	277,393	430,581	1.55	206	850
1892	324,848	520,389	1.60	233	949

a Not reported.

Linn county.—The production increased from 26,994 short tons, valued at $32,018, in 1891 to 40,622 short tons, valued at $63,528, in 1892.

Coal product of Linn county, Missouri, since 1887.

Years.	Short tons.	Value.	Average. price per ton.	Number of days active.	Number of men employed.
1887	728				
1888	(a)				
1889	6,992	$13,140	$1.88		
1890	1,300				
1891	26,994	32,018	1.19	240	90
1892	40,622	63,528	1.56	249	135

a Not reported.

Macon county.—With an increased product of 76,041 short tons, over 1891, Macon county takes first place as a coal producer. The total product in 1892 was 668,146 short tons, worth $694,381.

Coal product of Macon county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	637,092				
1888	(a)				
1889	446,396	$550,475	$1.23		
1890	540,061	600,373	1.11	259	1,027
1891	592,105	608,974	1.02	228	1,198
1892	668,146	694,381	1.04	252	1,489

a Not reported.

Montgomery county.—Coal produced in 1892, 16,689 short tons; value, $22,750.

The output in 1892 exceeded that of 1891 by 560 short tons. Of the total product 14,261 short tons were sold to the Wabash railroad for locomotive use. Seven hundred and sixty-six tons produced in 1892 were cannel coal.

Coal product of Montgomery county, Missouri, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	12,300	$17,449	$1.42		
1890	13,584	18,393	1.35	200	33
1891	16,129	21,842	1.35	200	37
1892	16,689	22,750	1.36	195	40

Putnam county.—The amount of coal produced in Putnam county in 1892 was 137,058 short tons, an increase over the product of 1891 of 14,392 short tons. The value increased $26,676, and the average price per ton advanced from $1.31 to $1.37.

Coal product of Putnam county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	117,600				
1888	(a)				
1889	83,774	$112,089	$1.34		
1890	108,514	140,014	1.31	234	355
1891	122,666	160,508	1.31	196	430
1892	137,058	187,184	1.37	242	393

a Not reported.

Randolph county.—The coal product of Randolph county decreased from 274,520 short tons, valued at $291,955, in 1891 to 149,608 short tons, valued at $160,748 in 1892.

Coal product of Randolph county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	279,416				
1888	(a)				
1889	221,463	$285,019	$1.29		
1890	269,372	306,736	1.14	229	635
1891	274,520	291,955	1.06	249	535
1892	149,608	160,748	1.07	227	371

a Not reported.

Ray county.—Coal produced in 1892, 235,298 short tons; value, $363,303.

The output of coal in Ray county in 1892 was 21,959 tons more than in 1891, but still short of the yield in 1890 over 40,000 tons. A less number of men were employed in 1892 than in 1891, but the number of working days increased from 178 to 206.

Coal product of Ray county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	202,586				
1888	(a)				
1889	220,530	$351,153	$1.57		819
1890	278,118	422,074	1.52	241	687
1891	213,539	346,236	1.62	178	753
1892	235,298	363,303	1.54	206	694

a Not reported.

Vernon county.—Coal produced in 1892, 155,070 short tons; value, $158,600.

The opening up of a new mine by the Central Coal and Coke Company (formerly the Keith and Perry Coal Company), increased the county's output more than 200 per cent. over that of 1891, making Vernon county one of the three producing more than 100,000 tons and placing it in sixth place among the coal producing counties.

Coal product of Vernon county, Missouri, since 1887.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1887	22,344				
1888	(a)				
1889	39,420	$46,506	$1.18		
1890	13,385	16,183	1.20	118	44
1891	48,017	50,004	1.04	131	139
1892	155,070	158,600	1.02	166	186

THE COAL MEASURES OF MISSOURI.

[By Arthur Winslow.]

Distribution and topography.—The Coal Measures of Missouri occupy the whole western and northwestern portions of the State. The general eastern and southern boundary of the formation is a sinuous line running from the northeastern to the southwestern corner. Beyond this general boundary there are, further, isolated patches, or outliers of the formation, which carry its limits still further east. The total area thus included is estimated to be about 25,000 square miles, distributed over fifty-seven counties in whole or in part. Topographically the Coal Measure country is a plateau in which denudation has not progressed very far. It is the product of the action of erosion upon a land surface of moderate elevation, composed of horizontal strata of varying degrees of hardness. The Missouri river traverses the area, from the northwest to the southeast and divides it into two large but unequal portions, that north of the river being considerably the greater. Away from the immediate vicinity of the larger streams the characteristic contour is that of a flat or slightly undulating plain, bordered by gentle and sometimes steep slopes along the drainage channels. In the immediate vicinity of the larger streams the horizontal area on the summits between the depressions, is smaller and the slopes are steeper and longer.

Lithology.—The rocks of the Coal Measures consist of sandstones, shales, clays, limestones, and coals. The sandstones are of white, drab, yellow, or reddish colors, are generally fine grained and friable, and are often filled with specks of carbon and with impressions of leaves and stems, especially along the stratification planes; mica is almost always present. The sandstones are most abundant and prominent in the eastern and marginal area of the Coal Measures, where they constitute a considerable portion of the section. In the interior, or central area, they are not prominent members, though arenaceous shale is abundant, and it is frequently difficult to say whether such material should properly be classed as a shale or as a sandstone. The shales are argillaceous, bituminous, arenaceous or calcareous, and frequently grade, by almost imperceptible degrees, into sandstones or limestones; they are of black, drab, gray, and red colors. The shales predominate, by far, over any of the other classes of rock, are widely distributed, and are about equally prominent in all sections of the Coal Measures. The limestones occur sometimes in massive beds, 3, and even 4 or more feet in thickness, are occasionally concretionary in nodular forms, are sometimes laminated with uneven bedding planes, but are almost always of a fine compact texture; they are of drab color and are readily distinguished from the white coarse-grained, semi-crystalline limestones of the Lower Carboniferous. The limestones are least abundant over the extreme marginal area, and become more frequent and thicker towards the interior; in the northwestern portion of the State they occur in successive beds, aggregating twenty or more feet in thickness. Lime is here very abundantly represented in all the rocks, many of the shales, even the black bituminous layers being decidedly calcareous. As with the shales and sandstones, so with the shales and limestones, it is often impossible to class a rock as a limestone or a shale.

The coals are all bituminous, with the exception of certain limited deposits which approach cannel coal in character. The beds range in thickness from 1 inch to about 5 feet. The coals are generally soft and pyritiferous, with selenite or calcite almost always present, in thin scales along the joint planes. They are most frequently underlain by clay, which sometimes contains stigmaria casts, and are generally immediately overlain by black shales, frequently fissile, or by a gray drab clay shale. In this roof shale leaf impressions are found in places, but the localities are few where such are abundant. Sometimes sandstone rests directly upon the coal, or a limestone cap rock is barely separated from it by a few inches of clay or shale; but such instances are exceptional. The coal beds are most abundant and are thickest over the marginal portion of the Coal Measures, where they occur near the surface and where they have been more widely and most extensively operated up to the present time. They seem here, however, to be more irregular in character and distribution than in the interior, so far as one can judge from the limited developments which have been made in the deeply seated coals of the interior region.

Stratigraphy.—The rocks of the Coal Measures are arranged in a series of strata which have, generally, a slight undulating westerly dip, such that the uppermost rocks are at the surface in the northwestern portion of the State, and lower rocks crop out along the margin to the east. The estimated maximum thickness of these Coal Measure rocks is about 1,900 feet. That is, to penetrate the entire section of these strata in the northwestern corner of the State a shaft 1,900 feet deep would be necessary. Eastward from such a point the thickness of the underlying rocks constantly dimininishes, owing partly to the westward tilting of the strata, above referred to, and partly to the conditions under which these strata were deposited. Therefore the thickness of this formation at any point within the area of its distribution may be anywhere from 0 to 1,900 feet. Thus, along its margin, the Coal Measure formation may be considered to taper to a feather edge, while in the extreme northwestern corner of the State, it has an aggregate thickness of nearly 2,000 feet and consists of more than 200 strata.

Limitations of coal beds.—No one coal bed in Missouri can be affirmed to be coextensive with the area of the Coal Measures, and, within a still smaller area, does any one bed possess those characteristics of thickness and quality, or is it accompanied by the other conditions which go to make it workable. As the strata have generally an eastward rise, coal beds which are deep seated at one place naturally come to the surface as one proceeds eastwards from that point. Where the coal beds are near the surface the larger streams have eroded broad valleys and thus removed large bodies of coal between what are now the outcrop of the beds. This facilitates mining, however, and permits the coal to be worked by drifts. Such drift mining is common along the marginal area of the Coal Measures in Macon, Randolph, Ray, and Lafayette counties. In Henry and Bates counties great amounts of coal are obtained by stripping. In addition to these channels and valleys of the present drainage system buried channels, no longer visible at the surface, traverse the Coal Measures and restrict the distribution of the coal. Some of these are of Coal Measure age; others are probably pre-Glacial. The former are filled with consolidated sandstone, the latter with loose clay, sand, or gravel. Buried channels of the first class have been recognized in Johnson, Lafayette, Randolph, and Monroe counties; those of the second class have been recognized in Putnam, Sullivan, Linn, and Macon counties. Another condition restricting the extent of the coal beds is the fact that they have been deposited in basins of limited dimensions. The beds are thus of somewhat lenticular shapes, tapering to a feather edge towards their limits. An extreme illustration of such limitation of a coal area is furnished by those remarkable deposits known as "coal pockets" which occur in the region bordering the Coal Measures. In these the coal often attains a thickness of 20 feet or more while the area of the basin may be only a few acres. Such deposits have apparently accumulated in ravines or sink holes in the Lower Carboniferous and lower rocks, which depressions must have existed before and during the Coal Measure period.

Restrictions to availability.—In addition to these restrictions to the extent of the coal beds, there are others affecting their availability. Some beds are too thin to work. In Missouri 3 feet is near the average thickness of the coal beds of the State, and beds of 18 inches are profitably mined on a large scale. Any bed uniformly thinner than this can not ordinarily be considered available. About a fourth of the annual production of the coal in the State is from beds not over 2 feet in thickness. Beds 3 and 4 feet thick are of frequent occurrence, especially in Macon, Randolph, Henry, and Bates counties; but they are not so abundant nor so widespread as to make the 2-foot bed unworthy of consideration. The roof over a large portion of the coal mining area in the State is excellent and offers no obstacle to mining, though in some localities it gives trouble. This is the case in Sullivan, Adair, and Henry counties. The quality and condition of the roof is not regional, however, but often varies greatly within one mining district. This is illustrated in Macon, Randolph, Boone, Clay, and Henry counties. Disturbances known as "rolls," "faults," "squeezes," etc., are quite common in certain coal beds, and seriously impair the value of the coal. They are particularly noticeable in the mines of Audrain, Montgomery, Boone, Caldwell, Adair, Schuyler, and Clay counties.

Character of coals and depths of mining.—All Missouri coals are bituminous, with the exception of the cannels, which are found in local and small deposits. The bituminous coals have, as a rule, a high percentage of ash, as compared with the best bituminous coals; they are comparatively soft, suffering much from excessive handling or long exposure, and they almost always carry pyrite, either in lenticular or nodular concretions or in thin plates, between the joints of the coal. The last impurity, as stated, injures them for use in the manufacture of illuminating gas, though many of the coals have an abundance of hydrocarbons of high candle power. Missouri coal mines are not much troubled by excess of water—in fact many of the mines are so exceedingly dry that they are actually dusty. Most of Missouri's coal mines are less than 200 feet deep. The Randolph shaft in Ray county is 420 feet deep to the coal, and is one of the deepest. The deepest operated which is, exactly speaking, within the State is near Hamilton, in Caldwell county, and is about 500 feet deep. At Leavenworth, Kansas, along the State line, however, a coal bed of only 22 inches is extensively worked at depths varying from 700 to 800 feet. This is, probably, near the limit of depth at which a bed of good coal, of this thickness, with a good roof, can be profitably mined, at least at the present date and with the present condition of the coal industry.

The markets.—The conditions affecting the market of the coals west of the Mississippi river are, in some respects, different from those in the eastern part of the country. The Western bituminous coal field is surrounded on all sides by large expanses of country destitute of merchantable coal. These great areas, with their constantly increasing populations and needs, must, under natural conditions, draw their supplies of coal largely from the mines of Iowa, Missouri, Kansas, Arkansas, Indian Territory, and Texas. East of the productive portions of these States their coals are brought into competition with the coals of Illinois, Indiana, Kentucky, and Ohio in the north, and with those of Tennessee and Alabama in the south; even the anthracites of eastern Pennsylvania are sold within the very limits of these Western coal fields, on account of their special adaptabilities. The natural facilities for transportation provided by the Ohio and Mississippi rivers enable the coals of western Pennsylvania and of Ohio to compete very successfully with the geographically much nearer Western coals, especially along the lower Mississippi. Further, through the distribution of railway lines and adjustment of rates, Illinois coals force the competition line much farther west than would seem possible from geographic considerations. Thus, the territory affected by this competition to the east, is large, and it will probably always be considerable, though subject to variations.

Towards the west, however, there stretches a great area of country in Nebraska, Kansas, Indian Territory, and Texas, which is not only destitute of coal, but has, further, a sparse supply of timber to answer as a substitute for such mineral fuel. This is especially the case in Kansas, and its effects upon the Missouri coal industry is important. West of this coal-barren area are the deposits of Dakota, Wyoming, Colorado, and New Mexico, which are, to a certain extent, competitors in the market, and which may become more so in the future. It is not to be anticipated, however, that this competition with the coals of Missouri and adjacent States will reach very far east, for the latter coals are generally superior in quality to those farther west, which are largely lignitic, and the supply of superior coals in Colorado and New Mexico appears to be not more than is needed to satisfy the home needs and the more imperative demands for coal still farther west. Thus the coal-barren area surrounding the Western bituminous coal field may be looked upon as a most promising market for the future, especially that to the west, where the population is destined to increase rapidly in the next few years, with a proportionate increase in coal consumption.

In addition to the foreign markets, however, there is, in Missouri, a good home market; one which will increase greatly in the future, and which will always be a steady consumer of coal and the most substantial supporter of the coal industry. The coal fields of Missouri are not located in a mountainous, rugged, or sterile region; on the contrary, they are in a country of moderate elevation, with gently undulating surface, where bluffs and steep declivities occur only along the largest streams; a country with a most fertile soil in a well-advanced stage of cultivation. It is already well populated, a network of railways traverses it, small towns are numerous, and cities occur at short intervals. These conditions furnish consumers for the coal at the very mouth of the mine, they cause small operations to be numerous and to be profitably prosecuted, and they further permit the mining of coal for local uses under conditions which would not be profitable for the general market. These conditions furnish opportunities for obtaining labor, and inducements for retaining it, which are entirely absent in many coal-mining regions.

The uses and adaptabilities of the coals.—The railways of the State constitute, without a doubt, the largest class of consumers of coal. Hence the greatest single use to which coal is put is for the production of steam in locomotives; but for manufacturing purposes, a large amount of coal is also used in steam production. Domestic consumption in stoves and furnaces ranks next in importance. For the production of illuminating gas a few coals of the State have been roughly experimented with, but not with generally satisfactory results, and very little of the coal product is used for this purpose. Thus, coal from the vicinity of Moberly has been used there at the gas works, and when well purified the gas from it was excellent, but the cost of purifying it from sulphur was too great. The coal mined at the Hamilton Coal Company's shaft, in Caldwell county, has been tested for gas production, and it is reported to have yielded an abundance of gas, but it would not coke in the retorts and, therefore, could not be profitably used. The coal mined in Trenton, in Grundy county, has also been tested with similar results. In Henry county are several coals which have been used for gas production with reported favorable results. The thick coal bed south of Lewis station is such a coal, and also that from the Pitcher mine, south of Clinton. These coals have been used not only in the immediate vicinity of the mines, but have been shipped to remote points in the State for this special purpose. The coal mined at Minden, Barton county, also gives promise of being a gas producer, inasmuch as coal from the same bed mined at Cherokee and other points farther west in Kansas is largely used for that purpose. No coal in the State, to the writer's knowledge, is used for coke manufacture. Partial tests have been made of a few coals, but the results are not encouraging. The coal from the Excelsior Coal and Coke Company's shaft, at Higginsville, in Lafayette county, was thus experimented with. The product was of fair quality for domestic use, but was too weak and contained too much sulphur for furnace coke.

Coal tonnage.—We have not the data at present to make even an approximate estimate of the available tonnage. Figures have been deduced in the past by assuming an average thickness of the coals for the whole area and multiplying this coal into such area. Such results are naturally of little value other than as suggestions. The fact that the net product of a two-foot bed of coal for one square mile is 1,006,500 tons is, in itself, significant of the amount which the State must possess.

Areas of future development.—Though the rate of increase of production of coal in the State during recent years has not been very great, there has yet been a noticeable activity on the part of capitalists and mine operators in the extension of prospecting and in the securing of large bodies of coal lands. This has been the case particularly in the central, northern, and southwestern portions of the State, in Macon and Randolph, Bates and Henry counties. The results of recent developments continue to emphasize the fact that the most productive portion of the Coal Measures is along its margin; towards the interior the beds of coal are materially reduced in size, and, further, the workable beds are there encountered at greater depths. Proximity to large markets in some cases is an offset to these disadvantages. Thus, at Kansas City a coal bed of about 18 inches thick has been operated at a depth of nearly 400 feet, and the Leavenworth bed is over 700 feet deep. The beds of the northern half of the State, as represented in Lafayette, Ray, Randolph, and Macon counties, are more regular in their distribution and more constant in their character over large areas than are those of other counties. Here and in portions of the adjacent counties of Boone, Howard, Audrain, Adair, Sullivan, Linn, and Caldwell are undoubtedly large bodies of, as yet, undeveloped coal land. In Putnam, Sullivan, and Grundy counties there is also good promise for the future. In the southwestern part of the State the coal beds of Bates and Henry counties have been large contributors to the production of the past. The beds here are thick, and are very accessible, having often so little covering as to be readily stripped. These beds, however, especially the thicker ones, lie in somewhat limited basins or troughs, so that one portion of the same square mile may be underlain by workable coal, while in another portion it is absent or too thin to work. This characteristic of these beds, of course, adds an additional factor of uncertainty. Concerning the untouched areas of these and adjacent counties, we feel, however, safe in the prediction that much undeveloped coal exists there, especially in the eastern portion of Bates county, where railroads have not yet penetrated.

MONTANA.

Total product in 1892, 564,648 short tons; spot value, $1,330,847.

Montana produced in 1892, 22,787 short tons more coal than in 1891. The value of the product increased from $1,228,630 to $1,330,847, a gain of $102,217, the average price per ton advancing from $2.27 to $2.36. Two counties, Cascade and Park, contribute nearly 90 per cent. of the total output of the State, their combined product being over 500,000 short tons; Gallatin county produced 60,998 short tons, and the balance of the product (less than 2,500 tons) is divided among four counties, Choteau, Dawson, Fergus, and Meagher. Deer Lodge and Lewis and Clarke counties, which have yielded a small amount of coal in the past to supply a local demand, are not credited with any product in 1892.

The following table shows the statistics of coal production in Montana in 1892, by counties:

Coal product of Montana in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons	Short tons	Short tons	Short tons	Short tons				
Cascade	241,596	524	....	....	242,120	$484,320	$2.00	275	426
Choteau	200	1,366	8	....	1,574	6,338	4.03	118	12
Dawson	....	335	....	....	335	1,000	3.03	100	2
Fergus	....	350	50	....	400	2,100	5.25	50	6
Gallatin	59,146	461	1,591	....	61,198	152,496	2.50	298	146
Meagher	....	30	....	....	30	120	4.00	60	1
Park	220,579	1,800	200	36,412	258,991	684,473	2.64	224	565
Total	521,521	4,866	1,849	36,412	564,648	1,330,847	2.36	258	1,158

The annual coal product of Montana since 1883 has been as follows:

Product of coal in Montana since 1883.

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

Of the 564,648 short tons of coal produced in Montana in 1892, 317,668 short tons were classed as bituminous, 245,337 tons as semi-bituminous, and 1,443 tons as lignite. Of the semi-bituminous coal Cascade county produced 242,110 short tons, the remainder, 3,227 tons, coming from Gallatin county. Choteau county yielded 708 tons of lignite, Dawson county 335 tons, and Fergus county 400 tons. The bituminous product was obtained from Cascade county, 10 tons; Choteau county, 866 tons; Gallatin county, 57,771 tons; Meagher county, 30 tons, and Park county, 258,991 tons.

Cascade county.—Coal produced in 1892, 242,120 short tons; value, $484,320.

Compared with 1891 there was an increase of 44,013 short tons in the product of Cascade county, the value increasing $88,101. The average price per ton was the same as in 1891. All of the product was classed as semi-bituminous with the exception of 10 tons of bituminous.

Coal product of Cascade county, Montana, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	166,480	$339,226	$2.04	....	....
1890	200,435	406,748	2.03	....	379
1891	198,107	396,219	2.00	....	401
1892	242,120	484,320	2.00	275	426

Choteau county.—The product was 1,096 short tons more than in 1891. With the exception of 200 tons the product is used entirely for local consumption; 866 tons of the output were bituminous and 708 tons lignite.

Coal product of Choteau county, Montana, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	820	$2,160	$2.64	....	....
1890	800	2,000	2.50	....	6
1891	478	1,723	3.60	....	10
1892	1,574	6,338	4.03	118	12

Dawson county.—Dawson county produced 335 tons of lignite, against 250 tons in 1891. It is used by the local trade of Glendive and to supply ranchmen in the vicinity.

Coal product of Dawson county, Montana, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	733	$1,900	$2.59	....	....
1890	1,260	5,740	4.56	....	8
1891	250	625	2.50	....	1
1892	335	1,000	3.00	100	2

Fergus county.—A small amount of lignite is mined in Fergus county to supply the local trade of Lewiston. The product in 1892 was 400 tons, against 250 tons in 1891.

Gallatin county.—Coal produced in 1892, 60,998 short tons; value, $152,496.

The product in 1892 was 4,017 tons more than in 1891. It consisted of 57,771 tons of bituminous coal and 3,227 tons of semi-bituminous. The value advanced from $2.38 to $2.50 per ton.

Coal product of Gallatin county, Montana, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	43,838	$104,377	$2.38		
1890	51,452	119,084	2.31		120
1891	56,981	135,893	2.38		139
1892	60,998	152,496	2.50	298	146

Park county.—Coal produced in 1892,258,991 short tons; spot value, $684,473.

The output in 1892 was 26,754 short tons less than in 1891, when 285,745 tons were obtained. All of the product is classed as bituminous coal. The Rocky Fork mine, at Deer Lodge, and the Park Coal and Coke Company at Horr are the principal producers.

Coal product of Park county, Montana, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	147,300	$421,950	$2.86		
1890	252,737	690,870	2.73		705
1891	285,745	692,570	2.43		562
1892	258,991	684,473	2.64	241	565

Meagher county.—The total product reported from Meagher county was thirty tons of bituminous coal. It is all consumed by local trade at Castle.

NEW MEXICO.

Total product in 1892, 661,330 short tons; spot value, $1,074,601.

In 1891 New Mexico produced 462,328 short tons of coal, having a spot value of $779,018. The yield in 1892 shows, accordingly, an increase in tonage of 199,002, or 43 per cent. The increase in the value of the product was $293,583, or about 38 per cent. the average price per short ton declining from $1.68 to $1.62, a loss of 6 cents per ton. The number of men employed increased from 806 in 1891 to 1,083 in 1892. The statistics relating to the number of days the mines were shipping were not collected in 1891, and the figures are, therefore, not available for comparison. An increase of 270 in the number employed is, however, in good proportion to the increase in tonnage, being about 34 per cent.

A small part (2,100 short tons) of the New Mexico product in 1892 was anthracite coal. This was obtained in Santa Fe county. In Lincoln county 1,295 short tons of semi-anthracite were reported. Of lignite 38,725 short tons were produced, of which 37,125 tons were from Bernalillo county, and 1,600 tons from Lincoln county. Bernalillo county also produced 208,606 tons of semi-bituminous coal. The remainder of the Territory's product (410,504 short tons) was bituminous, and distributed among the producing counties as follows: Bernalillo county, 3,180 short tons; Colfax county, 297,911 short tons; Lincoln county, 150 short tons; Rio Arriba county, 20,600 short tons; San Juan county, 200 short tons; Santa Fe county, 34,680 short tons; Socorro county, 53,783 short tons.

The following table shows the statistics of coal production in 1892, by counties, with the distribution for consumption, and value:

Coal product of New Mexico in 1892 by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	Used at mines for steam and heat.	Total product.	Total value.	Average price per ton.	Average number of days active.	Total number of employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*				
Bernalillo	245, 738	1, 425	1, 748	248, 911	$361, 651	$1. 45	179	449
Colfax	294, 565	1, 565	1, 781	297, 911	393, 426	1. 33	261	370
Lincoln	....	3, 045	100	3, 145	12, 990	4. 15	110	17
Rio Arriba	20, 000	....	600	20, 600	30, 900	1. 50	270	35
San Juan	....	200	....	200	200	1. 00	50	2
Santa Fe	33, 360	2, 340	1, 080	36, 780	96, 700	2. 63	267	30
Socorro	51, 894	201	1, 688	53, 783	178, 734	3. 43	253	180
Total	645, 557	8, 776	6, 997	661, 330	1, 074, 601	1. 62	223	1, 083

As will be seen in the following table, which shows the annual output since 1882, the product in 1892 was the largest in the history of coal mining in the Territory. The largest production in any previous year was in 1888, when a total product of 626,665 tons was reported.

Coal product of New Mexico since 1882.

Years.	Short tons.	Value.	Years.	Short tons.	Value.
1882	157, 092	....	1888	626, 665	1, 879, 995
1883	211, 347	....	1889	486, 943	872, 628
1884	220, 557	....	1890	375, 777	504, 390
1885	306, 202	$918, 606	1891	462, 328	779, 018
1886	271, 285	813, 855	1892	661, 230	1, 074, 251
1887	508, 034	1, 524, 102			

It is probable that the value placed upon the product for 1885, 1886, 1887, and 1888 was somewhat overestimated. The average price per ton was estimated for those years at $3 per ton. the figures for subsequent years are those obtained from individual operators, and represent the actual value received at the mines, showing an evident excessive valuation in preceding years.

Bernalillo county.—Coal produced in 1892, 248,911 short tons; spot value, $381,651.

The product in 1892 consisted of 3,180 tons of bituminous coal, 37,125 tons of lignite, and 208,606 tons of semi-bituminous. Compared with 1891 there was a total gain of 172,396 short tons, and $248,476.

Coal product of Bernalillo county, New Mexico, since 1882.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1882	33,373				
1883	42,000				
1884	62,802				
1885	97,755				
1886	106,530				
1887	275,952				
1888	300,000				
1889	233,059	$395,892	$1.70		
1890	181,647	207,948	1.14		375
1891	76,515	113,175	1.47		187
1892	248,911	361,651	1.45	179	449

Colfax county.—Coal produced in 1892, 297,911 short tons; spot value, $393,426.

The product was practically the same as in 1891, the difference being less than 1 per cent. The value decreased a little over $6,000, which was compensated for in a slight reduction in the force employed.

Coal product of Colfax county, New Mexico, since 1882.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1882	91,798				
1883	112,089				
1884	102,513				
1885	135,833				
1886	87,708				
1887	154,875				
1888	227,427				
1889	151,464	$201,027	$1.33		
1890	151,400	198,500	1.31		360
1891	295,089	399,432	1.35		384
1892	297,911	393,426	1.33	261	370

Lincoln county.—The product comprised 1,295 tons of semi-anthracite coal, 150 tons bituminous, and 1,600 tons lignite. The first mentioned was entirely consumed in operating the Homestake gold mine at White Oaks. All of the remainder was sold to local consumers.

Coal product of Lincoln county, New Mexico, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	1,255	$3,138	$2.50		
1890	1,175	5,415	4.60		11
1891	1,000	5,000	5.00		2
1892	3,045	12,640	4.15	180	10

Rio Arriba county.—Coal produced in 1892, 20,600 short tons; spot value, $30,900.

The product in 1892 was the largest in the history of the county. The coal is bituminous and used largely by the Denver and Rio Grande Railroad.

Coal product of Rio Arriba county, New Mexico, since 1882.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1882	12,000				
1883	17,240				
1884	11,203				
1885	14,958				
1886	7,000				
1887	11,000				
1888	12,000				
1889	13,650	$24,843	$1.82		
1890	12,175	21,000	1.72		20
1891	7,350	14,350	1.95		20
1892	20,600	30,900	1.50	270	35

Santa Fe county.—The output in 1892 was larger than in any previous year, the nearest approach being in 1889, when 34,870 tons were obtained. The product included 2,100 tons of anthracite, which sold for $4.50 per ton. The remainder of the yield was bituminous, which brought a little more than $2 per ton.

Coal product of Santa Fe county, New Mexico, since 1882.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1882	3,600				
1883	3,000				
1884	3,000				
1885	1,000				
1886	1,000				
1887	7,500				
1888	25,200				
1889	34,870	$74,666	$2.14		
1890	22,770	52,190	2.29		55
1891	16,500	35,100	2.13		36
1892	36,780	96,700	2.63	267	30

Socorro county.—Coal produced in 1892, 53,783 short tons; spot value, $178,734.

The product in 1892 was 11,791 less than in 1891, with a decrease in value of $32,627. The average price advanced from $3.22 to $3.43. The coal is bituminous, of good quality, and is used to a considerable extent at smelting works of New Mexico and at El Paso, Texas.

Coal product of Socorro county, New Mexico, since 1882.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1882	16,321				
1883	37,018				
1884	41,039				
1885	56,656				
1886	69,047				
1887	58,707				
1888	62,038				
1889	52,205	$171,807	$3.29		
1890	(*a*)50,000	162,500	3.25		
1891	65,574	211,361	3.22		175
1892	53,783	178,734	3.43	253	180

a Estimated.

San Juan county.—The output in 1892 was 200 short tons, valued at $1 per ton against 300 tons in 1891. It is classed as bituminous, and consumed entirely by local trade.

NORTH CAROLINA.

Total product in 1892, 6,679 short tons; spot value, $9,599.

North Carolina began producing coal in 1889, the yield in that year being 192 short tons. In 1890 active work began and an output of 10,262 tons was obtained. The product in 1891 was nearly double that of 1890, and a still larger output would doubtless have been secured in 1892, but a fire which occurred in the only commercial mine, stopped operations for several months and curtailed production. The coal is of bituminous quality. The following tables show the statistics of production in 1891 and 1892, and the total product for four years:

Coal product of North Carolina in 1891 and 1892.

Distribution.	1891.	1892.
	Short tons.	*Short tons.*
Loaded at mines for shipment	18,780	6,679
Sold to local trade and used by employés	600	
Used at mines for steam and heat	975	
Total product	20,355	6,679
Total value	$39,635	$9,599
Total number of men employed	80	90

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

NORTH DAKOTA.

Total product in 1892, 40,725 short tons; spot value, $39,250.

More reliable information has been obtained regarding the output of coal in North Dakota than has been the case since the census year, 1889. Three counties contributed to the total product, Morton, Stark, and Ward, each containing one productive colliery. All of the product is lignite and burns rapidly, and it is estimated that one and a half tons of this coal are necessary to create the same amount of steam as one ton of bituminous coal. The output of one mine was curtailed about 1,500 tons by fire in the mine, and complaint is made by operators that insufficient transportation facilities have caused a restriction in the production and that high freight tariffs have also prevented running the mines to their fullest capacity.

The statistics of production in 1892 are shown in the following table:

Coal product of North Dakota in 1892.

Distribution.	Short tons.
Loaded at mines for shipment	38,000
Sold to local trade and used by employés	2,725
Total product	40,725
Total value	$39,250
Number of men employed	54
Number of days active	216

Coal product of North Dakota since 1884.

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

OHIO.

Total product in 1892, 13,562,927 short tons; spot value, $12,722,745.

The coal fields of Ohio have been fully described in the previous volumes of this series.

The amount of coal produced in Ohio in 1891 was 12,868,683 short tons, valued at $12,106,115. The increase in the product of 1892 was accordingly 694,244 short tons or 5 per cent. The value increased $616,630, the percentage of increase being about the same as that of the product. There were 17 counties whose product in 1892 exceeded that of 1891, and 10 counties whose output decreased. Morgan county, which was not a producer in 1891, is credited with a product of 12,000 tons in 1892.

The total number of men employed in 1892 was 22,576 against 22,182 in 1891 and 20,576 in 1890, the product in the latter year being 11,414,506 short tons. The average number of days the mines were active in 1892 was 212 against 206 days in 1891 and 201 days in 1890.

All of the product in 1892 was bituminous coal with the exception of 27,000 tons of cannel coal mined in Stark county and 798 tons of the same variety from Jackson county.

Coal product of Ohio in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Athens	1,351,794	29,978	7,100	11,993	1,400,865	$1,196,225	$0.85	193	2,536
Belmont	837,926	189,031	3,783	6,960	1,037,700	870,393	.84	224	1,713
Carroll	365,819	700	536	....	367,055	303,752	.83	214	595
Columbiana	484,089	14,307	5,311	17,048	520,755	469,198	.90	223	932
Coshocton	215,877	12,450	400	....	228,727	232,024	1.01	229	386
Gallia	18,500	500	....	....	19,000	17,500	.92	220	38
Guernsey	441,297	7,600	7,100	....	455,997	330,742	.72	229	800
Harrison	....	3,220	....	....	3,220	4,820	1.50	179	9
Hocking	1,733,250	51,157	2,396	....	1,786,803	1,514,265	.85	216	2,099
Jackson	1,730,135	89,578	14,197	....	1,833,910	1,831,443	.99	214	3,347
Jefferson	828,677	97,213	4,045	2,542	932,477	761,273	.92	208	1,544
Lawrence	60,936	10,440	....	....	71,376	75,571	1.06	263	247
Mahoning	190,873	10,630	3,602	....	205,105	291,089	1.41	206	484
Medina	101,240	....	200	....	101,440	124,613	1.23	255	175
Meigs	121,790	141,659	2,597	....	266,044	299,626	1.13	190	636
Morgan	12,000	....	....	....	12,000	9,000	.75	160	20
Muskingum	166,603	10,835	....	....	177,438	161,038	.91	192	356
Noble	200	100	....	....	300	300	1.00	40	5
Perry	1,401,799	31,206	19,974	....	1,452,979	1,239,268	.85	187	2,380
Portage	69,832	3,766	2,800	....	76,398	116,243	1.52	207	204
Stark	811,808	15,709	29,090	....	856,607	1,044,674	1.22	199	1,776
Summit	138,213	9,215	419	....	147,847	211,839	1.43	221	406
Trumbull	27,537	1,650	1,000	....	30,187	46,577	1.54	205	86
Tuscarawas	701,316	65,769	10,130	....	777,215	660,987	.85	224	1,300
Vinton	70,307	12,206	600	....	83,113	84,756	1.02	198	197
Washington	42,120	2,584	16	....	44,720	32,443	.73	189	109
Wayne	71,318	91	2,190	....	73,599	93,086	1.30	166	196
Small mines	....	600,000	....	....	600,000	700,000	1.17	....	....
Total	11,995,256	1,411,642	117,486	38,543	13,562,927	12,722,745	.94	212	22,576

The following table shows the annual coal output in Ohio by counties since 1884:

Coal produced in Ohio since 1884, by counties.

Counties.	1884.	1885.	1886.	1887.	1888.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Athens	627, 944	823, 139	899, 046	1, 083, 543	1, 336, 698
Belmont	643, 129	744, 446	573, 779	721, 767	1, 108, 106
Columbiana	469, 708	462, 733	336, 063	516, 057	466, 191
Coshocton	56, 562	99, 609	52, 934	124, 791	167, 903
Carroll	102, 531	150, 695	216, 630	293, 328	355, 097
Guernsey	375, 427	297, 267	433, 800	553, 613	383, 728
Gallia	20, 372	16, 383	17, 424	15, 365	16, 722
Holmes	12, 052	11, 459	12, 670	10, 526	8, 121
Hocking	372, 694	656, 441	741, 571	853, 063	1, 086, 538
Harrison	....	....	5, 509	4, 032	2, 865
Jackson	831, 720	791, 608	856, 740	1, 134, 705	1, 088, 761
Jefferson	316, 777	271, 329	275, 666	293, 875	243, 178
Lawrence	176, 412	145, 916	166, 933	143, 559	137, 806
Medina	77, 160	152, 721	252, 411	225, 487	198, 452
Meigs	248, 436	234, 756	192, 263	185, 205	242, 483
Muskingum	84, 398	86, 846	96, 601	171, 928	211, 861
Mahoning	241, 599	275, 944	313, 040	272, 349	231, 035
Morgan	7, 636	5, 536	4, 370	4, 100	....
Noble	....	....	3, 342	6, 320	6, 200
Perry	1, 379, 100	1, 259, 592	1, 607, 666	1, 870, 840	1, 736, 805
Portage	65, 647	77, 071	70, 339	65, 163	70, 923
Scioto	3, 650	2, 440	....	....	....
Stark	513, 225	391, 418	593. 422	784, 164	793, 227
Summit	253, 148	145, 134	82. 225	95, 815	112, 024
Tuscarawas	317, 141	285, 545	267, 666	506, 466	546, 117
Trumbull	257, 683	264, 517	188, 531	167, 989	157, 826
Vinton	69, 740	77, 127	60, 013	89, 727	108, 695
Wayne	120, 571	81, 507	109, 057	105, 150	91, 157
Washington	5, 600	5, 000	5, 500	1, 880	2, 432
Total	7, 640, 062	7, 816, 179	8, 435, 211	10, 300, 807	10, 910, 951

Counties.	1889.	1890.	1891.	1892.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
Athens	1, 224, 186	1, 205, 455	1, 482, 294	1, 400, 865
Belmont	641, 862	774 110	819, 236	1, 037, 700
Carroll	351, 782	328, 967	313, 543	367, 055
Columbiana	596. 824	567, 595	621, 726	520, 755
Coshocton	166, 599	177, 700	189, 469	228, 727
Gallia	23. 208	16, 512	17, 493	19, 000
Guernsey	362, 168	413, 739	390, 418	455, 997
Harrison	33. 724	8, 600	3, 960	3, 220
Hocking	845, 049	1, 319, 427	1, 515, 719	1, 786, 803
Holmes	9, 423	....	....	....
Jackson	926, 874	970, 878	1, 475, 939	1. 833, 910
Jefferson	271, 830	491, 172	697, 193	932, 477
Lawrence	102, 656	77, 004	76. 235	71, 376
Mahoning	240, 563	256, 319	200, 734	205, 105
Medina	136, 061	139, 742	160, 184	101. 410
Meigs	220, 277	255, 365	282, 094	266. 044
Monroe	20, 725	1, 000	....	....
Morgan	8, 060	....	....	12, 000
Muskingum	214, 005	229, 719	160, 154	177, 488
Noble	38, 400	6, 850	3, 800	300
Perry	1, 565, 786	1, 921, 417	1, 785, 626	1, 452, 979
Portage	78, 117	70. 666	69, 058	76. 398
Stark	851, 994	836, 449	917, 995	856, 607
Summit	50, 726	112, 997	140, 079	147, 847
Trumbull	108, 120	47, 714	83, 950	30, 187
Tuscarawas	683, 505	589, 875	736, 297	777, 215
Vinton	102, 040	80, 716	98, 166	83, 113
Washington	18, 045	5, 990	5, 950	44, 720
Wayne	84, 178	38, 528	21, 371	73, 599
Small mines	....	550, 000	600, 000	600, 000
Total	9, 976, 787	11, 494, 506	12, 868, 683	13, 562, 927

From the table above, the following statement, showing the annual increase and decrease of coal production in the twenty-nine producing counties for the more recent years, is deduced. In the comparisons between 1888 and 1889 and between 1889 and 1890 an apparent inconsistency appears in the net increase or decrease, due to the inclusion of the outputs of country banks in the product of 1889 and the exclusion of the same factor in the other years.

Comparative statistics of coal production in Ohio, by counties, from 1886 to 1892.

Counties.	1887 compared with 1886.		1888 compared with 1887.		1889 compared with 1888. (*a*)	
	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Athens	184,497		253,155			112,512
Belmont	147,988		386,339			466,244
Carroll	76,698		61,784			3,315
Columbiana	179,994			49,866	130,633	
Coshocton	71,857		43,112			1,304
Gallia		2,059	1,357		6,486	
Guernsey	119,813			169,885		21,560
Harrison		1,477		1,167	30,859	
Hocking	111,492		233,475			241,489
Holmes		2,144		2,405	1,302	
Jackson	278,865			45,944		161,887
Jefferson	18,209			50,697	28,652	
Lawrence		23,374		5,753		35,150
Mahoning		40,691		41,314	9,528	
Medina		26,924		27,035		62,391
Meigs		7,058	57,278			22,206
Monroe					(*d*) 20,725	
Morgan		270		4,100	(*d*) 8,060	
Muskingum	75,327		39,933		2,144	
Noble	2,978			120	32,200	
Perry	263,175			134,035		171,019
Portage		5,176	5,760		7,194	
Stark	190,742		9,063		58,767	
Summit	13,590		16,209			61,298
Trumbull		20,542		10,163		49,706
Tuscarawas	238,800		39,651		137,388	
Vinton	29,714		18,968			6,655
Washington		3,620	552		15,613	
Wayne		3,907		13,933		6,979
Total	2,003,739	137,242	1,166,636	556,477	489,551	1,423,715
Net increase or decrease	1,866,497		610,159			934,164

Counties.	1890 compared with 1889. (*b*)		1891 compared with 1890.		1892 compared with 1891.	
	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Athens		18,731	276,839			81,429
Belmont	132,248		45,126		218,464	
Carroll		22,815		15,424	53,512	
Columbiana		29,229	54,131			100,971
Coshocton	11,101		11,769		39,258	
Gallia		6,696	981		1,507	
Guernsey	51,571			23,321	65,579	
Harrison		25,124		4,640		740
Hocking	474,378		196,292		271,084	
Holmes		(*c*)9,423				
Jackson	44,004		505,061		357,971	
Jefferson	219,342		206,021		235,284	
Lawrence		25,652		769		4,859
Mahoning	15,756			55,585	4,371	
Medina	3,681		20,442			58,744
Meigs	35,088		26,729			16,050
Monroe		19,725		1,000		
Morgan		(*c*)8,060			12,000	
Muskingum	15,714			69,565	17,334	
Noble		31,550		3,050		3,500
Perry	355,631			135,791		332,647
Portage		7,451		1,608	7,340	
Stark		15,545	81,546			61,388
Summit	62,271		27,082		7,768	
Trumbull		60,406	36,236			55,763
Tuscarawas		173,630	146,422		40,918	
Vinton		21,324	17,450			15,053
Washington		12,055		40	38,770	
Wayne		45,650		17,157	52,228	
Total	1,420,785	533,066	1,652,127	327,950	1,423,388	729,144
Net increase or decrease	887,719		1,324,177		694,244	

a Includes product of small banks in 1889 and not in 1888.
b Includes product of small banks in 1889 and not in 1890.
c Product of small banks in 1889 not enumerated in 1890.
d Entire product of 1889; no product reported in 1888.

In the following table is shown the total annual product of the State for twenty-one years.

Annual coal product of Ohio since 1872.

Years.	Short tons.	Years.	Short tons.
1872	5,315,294	1883	8,229,429
1873	4,550,028	1884	7,640,062
1874	3,267,585	1885	7,816,179
1875	4,864,259	1886	8,435,211
1876	3,500,000	1887	10,301,708
1877	5,250,000	1888	10,147,180
1878	5,500,000	1889	9,470,738
1879	6,000,000	1890	11,414,506
1880	7,000,000	1891	12,864,683
1881	8,225,000	1892	13,562,927
1882	9,450,000		

PRODUCTION BY COUNTIES IN DETAIL.

There were twenty-seven counties in Ohio which produced coal from commercial mines in 1892. This is one more than in 1891, Morgan county reporting a product of 12,000 tons in 1892 and having no output the preceding year, except from country banks. In 1892 there were five counties in each of which the total product exceeded 1,000,000 tons; these were Athens, Belmont, Hocking, Jackson, and Perry. Two of these, Hocking and Jackson, attained nearly 2,000,000 tons each, their combined product exceeding 3,600,000 tons. In 1891 only four counties exceeded 1,000,000 tons, Belmont county having in that year an output of 819,236 tons, but reaching to 1,037,700 tons in 1892. Four counties—Columbiana, Jefferson, Stark, and Tuscarawas—produced between 500,000 and 1,000,000 tons each, three of them exceeding 750,000 tons. Four counties—Carroll, Coshocton, Guernsey, and Meigs—exceeded 250,000 tons. Four—Mahoning, Medina, Muskingum, and Summit—produced over 100,000 tons; and four others—Lawrence, Portage, Vinton and Wayne, each yielded over 50,000 tons.

Athens county.—Coal produced in 1892, 1,400,865 short tons; spot value $1,196,225.

The total product of Athens county in 1891, was 1,482,294 tons, showing a decrease in the product of 1892 of 81,429 short tons. As a result of this decrease the county falls from third to fourth place in the importance of production, Jackson county, with an increased product of 357,971 tons, advancing from fourth place to first. The decrease in the product of Athens county is partly accounted for by suspension of operations at the Glen Ebon mine on May 14, caused by a fire in the mine, and by the failure of the railroads to furnish sufficient cars. The mines employed in 1892 a total of 2,536 men for an average of 193 days, against 2,702 men for 193 days in 1891, and 2,122 men for 198 days in 1890.

Coal product of Athens county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	627,944				
1885	823,139				
1886	899,046				
1887	1,083,543				
1888	1,336,698				
1889	1,224,186	$994,344	$0.81		
1890	1,205,455	999,003	.83	198	2,122
1891	1,482.294	1,257,081	.85	193	2,702
1892	1,400,865	1,196,225	.85	193	2,536

Belmont county.—The output of Belmont county in creased from 819, 236 tons in 1891 to 1,037,700 tons in 1892, a gain of 218,464 tons, or over 26 per cent. The county advanced from sixth place to fifth in rank of producing importance. The coal is used largely by the iron and nail works at Bridgeport and Bellaire and for domestic purposes in those towns. Over 20 per cent. of the product in 1892 was so consumed.

Coal product of Belmont county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	643,129				
1885	744,446				
1886	573,779				
1887	721,767				
1888	1,108,106				
1889	641,862	$558.333	$0.87		
1890	774,110	605,604	.78	201	1,401
1891	819,236	690,726	.84	238½	1,276
1892	1,037,700	870,393	.84	224	1,713

Carroll county.—Carroll county produced 339,399 short tons in 1892 against 313,543 tons in 1891, an increase of 25,856 short tons, or about 8 per cent. This is the largest output since 1889, and was obtained in spite of the fact that three mines, operated by Messrs. S. Allen's Sons, of Cleveland, were worked out and abandoned during the year.

Coal product of Carroll county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	102,531				
1885	150,695				
1886	216,630				
1887	293,328				
1888	355,097				
1889	351,782	$261,813	$0.74		565
1890	328,967	278,704	.85	188	642
1891	313,543	254,613	.81	200	589
1892	339,399	281,627	.83	214	568

Columbiana county.—The output in 1892 was over 100,000 short tons less than in 1891, being 520,755 short tons against 621,726 short tons. The value, however, decreased over $125,000, the average price per ton declining from 96 cents in 1891 to 90 cents in 1892.

Coal product of Columbiana county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	469, 708	....	....	....	....
1885	462, 733	....	....	....	....
1886	336. 063	....	....	....	....
1887	516, 057	....	....	....	....
1888	466, 191	....	....	....	....
1889	596, 824	$471, 945	$0. 79	....	955
1890	567, 595	518, 136	. 91	219	987
1891	621, 726	595, 390	. 96	251	1, 031
1892	520, 755	469, 198	. 90	223	932

Coshocton county.—The product of Coshocton county in 1892 was 258,827 short tons against 189,469 tons in 1891, an increase of 39,258 short tons. The value of the product increased from $189,111 to $232,-024, a gain of $42,913.

Coal product of Coshocton county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	56, 562	....	....	....	....
1885	99, 609	....	....	....	....
1886	52, 934	....	....	....	....
1887	124, 791	....	....	....	....
1888	167, 903	....	....	....	....
1889	166, 599	$163, 659	$0. 98	....	290
1890	177, 700	159, 150	. 90	237	327
1891	189, 469	189, 111	1. 00	265	284
1892	228, 727	232, 024	1. 01	229	386

Gallia county.—The product is from one mine, and amounted in 1892 to 19,000 short tons against 17,443 tons in 1891 and 16,512 tons in 1890.

Guernsey county.—The product increased from 390,418 short tons in 1891 to 455,997 short tons in 1892, a gain of 65,579 tons. This is the largest output since 1887, when a total product of 553,613 tons was reported. During 1892 the mines gave employment to 800 men for 229 days against 810 men for 188 days in 1891.

Coal product of Guernsey county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	375, 427	....	....	....	....
1885	297, 267	....	....	....	....
1886	433, 800	....	....	....	....
1887	553, 613	....	....	....	....
1888	383, 728	....	....	....	....
1889	362, 168	$313, 480	$0. 87	....	668
1890	413, 739	282, 355	. 68	225	788
1891	390, 418	306, 299	. 79	188	810
1892	455, 997	330, 742	. 72	229	800

Harrison county.—There were two mines producing coal in Harrison county in 1892 and only one in 1891, but the product, nevertheless, decreased from 3,960 tons to 3,220 tons. None of the coal is shipped, the entire product, which is small, being sold to the local trade of Freeport and Tippecanoe.

Coal product of Harrison county, Ohio, since 1886.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1886	5,509				
1887	4,032				
1888	2,865				
1889	33,724	$41,028	$1.21		8
1890	8,600	12,900	1.50	268	14
1891	3,960	5,860	1.48	236	9
1892	3,220	4,820	1.50	179	9

Hocking county.—Hocking county continues in second place as a coal producer, though Jackson has superseded Perry as the leading county. There are only ten mines in Hocking county, but the average tonnage from them in 1892 was 178,680 tons, the total product of the county being 1,786,803 short tons, valued at $1,514,265 against 1,515,719 tons, worth $1,235,017 in 1891.

Coal product of Hocking county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	372,694				
1885	656,441				
1886	741,571				
1887	853,063				
1888	1,086,538				
1889	845,049	$683,551	$0.80		1,187
1890	1,319,427	1,084,557	.81	240	1,625
1891	1,515,719	1,235,017	.81	241	1,674
1892	1,786,803	1,514,265	.85	216	2,099

Jackson county.—Jackson county increased its product from 1,475,939 short tons in 1891 to 1,833,910 tons in 1892, and jumped from fourth place to first as a coal producer. The increase in the product of 1892 over 1891 was 357,971 short tons, or over 24 per cent. The value of the product increased $271,896, or a little more than 17 per cent. The average price realized for the product declined from $1.06 to 99 cents per ton.

Coal product of Jackson county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	831,720				
1885	791,608				
1886	856,740				
1887	1,134,705				
1888	1,088,761				
1889	926,874	$953,696	$1.03		2,251
1890	970,878	974,892	1.00	180	2,654
1891	1,475,939	1,559,547	1.06	189	3,097
1892	1,833,910	1,831,443	.99	214	3,347

Jefferson county.—Coal produced in 1892, 932,477 short tons; spot value, $761,273.

The product of Jefferson county in 1892 exceeded that of 1891 by 235,284 short tons, or 34 per cent. The increase in the production of coal is due principally to the falling off in the supply of natural gas. There are quite a number of brick yards in the county, the proprietors of which mine coal merely for their own use, and the same may be said of several iron works. This product is included in that "sold to local trade, etc.," which amounted to nearly 100,000 tons in 1892.

Coal product of Jefferson county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	316,777				
1885	271,329				
1886	275,666				
1887	293,875				
1888	243,178				
1889	271,830	$273,075	$1.00		511
1890	491,172	409,654	.83	203	944
1891	697,193	589,667	.85	235	1,237
1892	932,477	761,273	.92	208	1,544

Lawrence county.—The amount of coal produced in Lawrence county in 1892 was 71,376 short tons against 76,235 tons in 1891, a decrease of 4,859 tons. The decrease is due to a smaller consumption of coal at the iron and nail works of Ironton, which used 33,135 tons in 1891 and only 24,712 tons in 1892. The average price per ton advanced from $1.04 to $1.06.

Coal product of Lawrence county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	176,412				
1885	145,916				
1886	166,933				
1887	143.559				
1888	137,806				
1889	102,656	$106,269	$1.04		232
1890	77,004	83,265	1.08	198	242
1891	76,235	79,143	1.04	223	232
1892	71,376	75,571	1.06	263	247

Mahoning county.—Coal produced in 1892, 205,105 short tons; spot value, $291,089.

The product in 1892 was 4,371 tons more than in 1891, the value increasing $20,345. The mines gave employment to 484 men for an average of 206 days against 525 men for 233½ days in 1891.

Coal product of Mahoning county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	241,599				
1885	275,944				
1886	313,040				
1887	272,349				
1888	231,035				
1889	240,563	$280,406	$1.12		636
1890	256,319	306,633	1.20	220	537
1891	200,734	270,744	1.35	233½	525
1892	205,105	291,089	1.41	206	484

Medina county.—Coal produced in 1892, 101,440 short tons; spot value, $124,613.

Reports were received from four mines in Medina county in 1891, but in 1892 only two were operated, and the product accordingly shows a decrease of 58,744 short tons, or about 36 per cent. The depression in prices in 1891 was succeeded by an advance in 1892 to $1.23 per ton, the highest price obtained in several years.

Coal product of Medina county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	77,160				
1885	152,721				
1886	252,411				
1887	225,487				
1888	198,452				
1889	136,061	$158,003	$1.16		379
1890	139,742	167,538	1.20	219	310
1891	160,184	185,462	1.16	221	314
1892	101,440	124,613	1.23	255	175

Meigs county.—Coal produced in 1892, 266,044 short tons; spot value, $299,626.

Compared with 1891 the product of Meigs county decreased 16,050 short tons, while the value increased $28,483, the average price per ton advancing from 96 cents to $1.13. Of the product in 1892, 106,599 tons were used in iron, nail, and salt works at Pomeroy, Middleport and Syracuse. This is delivered to the mills from the mines direct and is therefore included among the local sales.

Product of Meigs county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	248,436				
1885	234,756				
1886	192,263				
1887	185,205				
1888	242,483				
1889	220,277	$223,614	$1.02		567
1890	255,365	316,247	1.24	202	616
1891	282,094	271,143	.96	190	623
1892	266,044	299,626	1.13	190	636

Morgan county.—Morgan county produced 12,000 tons of coal in 1892, worth $9,000. This was the first output from commercial mines reported from this county.

Muskingum county.—Coal produced in 1892, 177,488 short tons; spot value, $161,038. Fourteen mines contributed to the output in 1892, one more than in 1891. The amount of coal produced increased from 160,154 tons to 177,488 tons, and the value from $130,674 to $161,038. The number of men employed in 1892 was 356, against 338 the preceding year, and the number of working days 192, against 213.

Coal product of Muskingum county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	84, 398				
1885	86, 846				
1886	96, 601				
1887	171, 928				
1888	211, 861				
1889	214, 005	$212, 873	$0. 99		304
1890	229, 719	197, 640	. 86	250	366
1891	160, 154	130, 674	. 82	213	338
1892	177, 488	161, 038	. 91	192	356

Noble county.—One mine was abandoned, one was idle, and only one was active, producing 300 tons during 1892.

Perry county.—From a total production of 1,785,626 short tons in 1891, and first place in importance, Perry county descends to third place in 1892 with a total product of 1,452,979 short tons. The product in 1891 was from 33 mines and in 1892 from 29 mines. In 1891 a total of 3,284 men were employed and the mines were active an average of 170 days. In 1892, 2,380 men were employed and the average number of working days was 187.

Coal product of Perry county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	1, 379, 100				
1885	1, 259, 952				
1886	1, 607, 666				
1887	1, 870, 840				
1888	1, 736, 805				
1889	1, 565, 786	$1, 317, 963	$0. 84		3, 056
1890	1, 921, 417	1, 642, 967	. 85	188	2, 977
1891	1, 785, 626	1, 483, 542	. 84	170	3, 284
1892	1, 452, 979	1, 239, 268	. 85	187	2, 38[illegible]

Portage county.—Coal produced in 1892, 76,398 short tons; spot value, $116,243.

Portage county produced 69,058 short tons in 1891, valued at $104,-906, showing an increase of 7,340 tons in 1892. The average price received by operators in 1892 varied from $1.46 to $1.58, the general average being $1.52, the same as in 1891.

Coal product of Portage county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	65,647				
1885	77,071				
1886	70,339				
1887	65,163				
1888	70,923				
1889	78,117	$99,213	$1.27		179
1890	70,666	112,475	1.59	236	155
1891	69,058	104,906	1.52	225	149
1892	76,398	116,243	1.52	207	204

Stark county.—Coal produced in 1892, 856,607 short tons; spot value, $1,044,674.

The output of Stark county was 61,388 short tons less than in 1891, the value decreasing $103,548. The number of commercial mines operated was 21, two less than in 1891. The number of employés in 1892 was 1,776, and the average number of working days 199, against 1,952 men for 190 days in 1891 and 1,930 men for 182 days in 1890. Of the product in 1892, 27,000 tons were cannel coal; all the rest was bituminous.

Coal product of Stark county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	513,225				
1885	391,418				
1886	593,422				
1887	784,164				
1888	793,227				
1889	851,994	$1,073,703	$1.26		1,975
1890	836,449	1,088,978	1.30	182	1,930
1891	917,995	1,148,222	1.25	190	1,952
1892	856,607	1,044,674	1.22	199	1,776

Summit county.—Coal produced in 1892, 147,847 short tons; spot value, $211,839.

The output of Summit county in 1892 was 7,768 tons more than in 1891, the value increasing $18,459, and the average price per ton advancing from $1.38 to $1.43. Five mines contributed to the product (the same number as in 1891) and gave employment to 406 men for an average of 221 days, against 376 men for 194 days the preceding year

Coal product of Summit county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	253,148				
1885	145,134				
1886	82,225				
1887	95,815				
1888	112,024				
1889	50,726	$92,723	$1.83		170
1890	112,997	169,171	1.50	173	389
1891	140,079	193,380	1.38	194	376
1892	147,847	211,839	1.43	221	406

Trumbull county.—Coal produced in 1892, 30,187 short tons; spot value, $46,577.

Three of the six mines of the county were worked out and abandoned in 1892, and the output of the county decreased in consequence 53,763 tons, or 64 per cent. The number of employés decreased from 176 to 86 and the working days from 226 to 205.

Coal product of Trumbull county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	257,683				
1885	264,517				
1886	188,531				
1887	167,989				
1888	157,826				
1889	108,120	$176,934	$1.64		388
1890	47,714	57,713	1.20	243	102
1891	83,950	118,286	1.41	226	176
1892	30,187	46,577	1.54	265	86

Tuscarawas county.—Coal produced in 1892, 777,215 short tons; spot value, $660,987.

The output of Tuscarawas county increased from 736,297 short tons in 1891 to 777,215 short tons in 1892, a gain of 40,918 tons. The value increased $77,781 or from $583,206 to $660,987.

There were 21 mines operating in 1892, against 19 the previous year. Employment was given to 1,300 men, who averaged 224 days, against 1,161 men for 232 days in 1891, and 1,082 men for 196 days in 1890.

Coal product of Tuscarawas county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	317,141				
1885	285,545				
1886	267,666				
1887	506,466				
1888	547,117				
1889	683,505	$544,524	$0.80		1,061
1890	589,875	499,685	.85	196	1,082
1891	736,297	583,206	.79	232	1,161
1892	777,215	660,987	.85	224	1,300

Vinton county.—Coal produced in 1892, 83,113 short tons; spot value, $84,756.

The product of Vinton county was 15,053 short tons less than in 1891. Five mines were producing coal, the same number as in 1891, one mine being idle and a new one opened.

Coal product of Vinton county, Ohio, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	69,740				
1885	77,127				
1886	60,013				
1887	89,727				
1888	108,695				
1889	102,040	$104,972	$1.03		256
1890	80,716	86,611	1.07	241	186
1891	98,166	103,148	1.05	206	197
1892	83,113	84,756	1.02	198	197

Washington county.—Coal produced in 1892, 44,720 short tons; spot value, $32,434.

The production of coal in Washington county in previous years was comparatively insignificant, being less than 6,000 tons in any year except 1889, when, including the output of country banks, a total of 18,045 tons was obtained.

Wayne county.—The product in 1892 was 73,599 short tons, valued at $93,086. This was the largest yield since 1889, the output for 1890 being 38,528 short tons, and in 1891, 21,371 short tons. There is only one mine of commercial importance in the county. This mine employed 196 men in 1892, and was worked 166 days.

OREGON.

Total product in 1892, 34,661 short tons; spot value, $148,546.

The amount of coal produced in Oregon in 1891 was 51,826 short tons, showing a decrease of 17,165 tons. The price obtained for the coal, however, advanced from $3 per ton in 1891 to $4.29, and the total amount realized for the product in 1892 was nearly as large as that of the preceding year, being $148,546, against $155,478. The Newport mine, in Coos county, remains the only producer. The coal is a lignite, of good quality, and is shipped by sea, the greater portion of the output going to San Francisco. The annual product since 1885 has been as follows:

Coal product of Oregon from 1885 to 1892.

Years.	Short tons.	Years.	Short tons.
1885	50,000	1889	64,359
1886	45,000	1890	61,514
1887	31,696	1891	51,826
1888	75,000	1892	34,661

PENNSYLVANIA.

Total product in 1892, 88,532,036 long tons, or 99,167,080 short tons; spot value, $121,459,164. This includes all grades of both anthracite and bituminous coal taken from the mines, except the culm or slack thrown on the dump and not sold or used.

Anthracite.—Total product in 1892, 46,850,450 long tons, or 52,472,504 short tons; spot value, $82,442,000. The increase over 1891 was 1,613,458 long tons, or 1,807,073 short tons, the value increasing $8,457,265. The average price per long ton advanced from $1.79 in 1891 to $1.92 in 1892.

Bituminous.—Total product in 1892, 46,694,576 short tons; spot value, $39,017,164. Increase in tonnage over 1891, 3,906,086 short tons. Increase in value, $1,746,111. The average price per ton for bituminous coal declined from 87 cents in 1891 to 84 cents in 1892.

The details of production of anthracite and bituminous coal in Pennsylvania are discussed separately in the following pages. The report on anthracite has been prepared, as for the preceding three years, by Mr. John H. Jones, of Philadelphia. The statistics of bituminous production have been collected and compiled by the Survey office in Washington.

PENNSYLVANIA ANTHRACITE PRODUCTION.

[By John H. Jones.]

These fields are situated in the eastern part of the State, and extend 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 known under three general divisions, viz., Wyoming, Lehigh, and Schuylkill regions. Geologically they are divided into four well-defined fields or basins, which are again subdivided, for convenience of identification, into districts, as follows:

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 anthracite fields are reached by eleven so-called initial railroads, viz:

Delaware, Lackawanna and Western Railroad Company.
New York, Susquehanna and Western Railroad Company.
New York, Ontario and Western Railroad Company.
Delaware and Hudson Canal Company.
Erie and Wyoming Valley Railroad Company.
Central Railroad Company of New Jersey.
Lehigh Valley Railroad Company (Philadelphia and Reading Railroad Company, lessees).
Pennsylvania Railroad Company.
Philadelphia and Reading Railroad Company.
New York, Lake Erie and Western Railroad Company.
Delaware, Susquehanna and Schuylkill Railroad Company.

The total production of the above fields for the calendar year 1892 amounted to 46,850,450 long tons, the largest in any one year of the anthracite trade. Of the total product, however, only 41,898,630 tons were shipped from the mines, 1,043,114 tons being sold to local trade in the vicinity of the mines and used by employés, and 3,908,706 tons used for steam and heat at the mines. This last item is more or less of an approximate, consisting largely of culm and dirt, of which the operators keep no account and are therefore compelled to estimate. For the above reasons this coal is not considered in the valuation of the product. In 1892 the average price per ton of coal at the mines was $1.92, or a value of $82,442,000 for the entire product.

The average number of days worked during the year was 198, and the average number of persons employed, including superintendents, engineers, clerical force at the mine offices, etc., 129,050.

The following table gives a comparison of the details above given, with those for 1891:

Comparative statistics of anthracite coal production in 1891 and 1892.

Years.	Total product.	Value at mines.	Average price per ton.	Number of persons employed.	Number days worked.
	Long tons.				
1891	45,236,992	$73,944,735	$1.79	126,350	203
1892	46,850,450	82,442,000	1.92	129,050	198

It will be noticed in the above table that there was not only an increase in the production, but also a considerable increase in the value of coal, which has resulted in an improvement throughout the whole trade.

The following tables give a comparison of the detailed production by counties for the years 1891 and 1892:

Distribution of the anthracite product of Pennsylvania in 1891.

Counties.	Total product of coal of all grades.	Disposition of total product.		
		Loaded at mines for shipment on railroad cars.	Used by employés and sold to local trade at mines.	Used for steam and heat at mines.
	Long tons.	*Long tons.*	*Long tons.*	*Long tons.*
Susquehanna	366,262	342,037	4,225	20,000
Lackawanna	10,639,276	9,607,754	267,508	764,014
Luzerne	17,404,013	15,677,617	388,029	1,338,367
Carbon	1,266,649	1,129,139	40,794	96,716
Schuylkill	10,358,373	9,163,258	128,471	1,066,644
Columbia	717,008	635,740	7,274	73,994
Northumberland	3,720,844	3,313,431	62,655	344,758
Dauphin	764,567	581,567	43,000	140,000
Total	45,236,992	40,450,543	941,956	3,844,493

Distribution of the anthracite product of Pennsylvania in 1892.

Counties.	Total product.	Distribution.		
		Loaded at mines for shipment.	Used by employés and sold to local trade.	Used for steam and heat at mines.
Susquehanna	404,300	350.000	20,000	34,300
Lackawanna	11,309,635	10,292,972	353,864	662,799
Luzerne	18,753,704	16,731,470	446,021	1,576,213
Carbon	1,154,188	1,034,276	5,370	114,542
Schuylkill	9,913,463	8,693,550	130,615	1,089,298
Columbia	896.536	797,425	13,521	85,590
Northumberland	3,718,612	3,385,340	47,441	285,831
Dauphin	700,012	613,597	26,282	60,133
Total	46,850,450	41,898,630	1,043,114	3,908,706

It will be noticed in the above tables that only Lackawanna and Luzerne counties show any marked increase over the production for 1891, the other counties remaining about stationary or actually falling behind, as in the case of Carbon and Schuylkill.

The only authentic record of anthracite mining since the practical commencement of the industry is given in the following table. The figures, however, show only the actual shipments made from the mines. An addition of about 12 per cent. of the shipments of any year added to these shipments will give a close approximate of the total production for that year, as it has been found recently by careful investigation that about this percentage is consumed at the mines and sold to local trade.

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions from 1820 to 1892.

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	38.62	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	15,669,721
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

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions from 1820 to 1892—Continued.

Years.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Long tons.	*Per ct.*	*Long tons.*	*Per ct.*	*Long tons.*	*Per ct.*	*Long tons.*
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	6,882,226	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	30.00	5,898,634	18.65	*a*16,236,470	51.35	31,623,530
1886	9,381,407	29.19	5,723,129	17.81	*a*17,031,826	53.00	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*21,852,365	57.29	38,145,717
1889	10,474,364	29.58	6,285,421	17.75	*a*18,647,925	52.67	35,407,710
1890	10,867,821	30.31	6,329,658	17.65	*a*18,657,694	52.04	35,855,173
1891	12,741,258	31.50	6,381,838	15.78	*a*21,325,239	52.72	40,448,335
1892	12,626,784	30.14	6,451,076	15.40	*a*22,815,480	54.46	41,893,340

a Includes Loyalsock field.

The distribution of the shipments for the years 1891 and 1892 is shown in the following table, partly approximated:

Distribution of anthracite coal for consumption in 1891 and 1892.

Regions.	1891.		1892.	
	Long tons.	Per ct.	Long tons.	Per ct.
Pennsylvania, New York, and New Jersey	24,734,103	61.15	25,974,441	61.99
New England States	6,187,665	15.30	6,367,785	15.20
Western States	6,249,526	15.45	6,342,893	15.14
Southern States, including Delaware, Maryland, and District of Columbia	1,826,298	4.51	1,856,494	4.43
Pacific coast	15,001	.04	16,000	.04
Dominion of Canada	1,393,998	3.44	1,285,708	3.07
Foreign ports	43,952	.11	55,309	.13
Totals	40,450,543	100.00	41,898,630	100.00

The above table shows a large increase in 1892 in the amount of coal consumed in Pennsylvania, New York, and New Jersey, a fair increase in the Eastern States, and a very small increase in the Western and Southern States, none of the groups of States maintaining their percentages except Pennsylvania, New York, and New Jersey.

The small increase in the shipments to the West and South were mainly the results of the peculiar trade conditions during the latter half of 1892, the dealers holding off in buying their coal with the hope that it would fall in price. These conditions continued until the early part of 1893, when on account of the extreme cold weather it became absolutely necessary to replenish stocks, which by that time were completely exhausted.

The eastern competitive tonnage, which includes all coal which for final consumption or in transit reaches any point on the Hudson river or New York bay, or which passes out of the Capes of the Delaware, is shown in the following table, which also gives what percentage this tonnage is of the total shipments.

Eastern competitive tonnage from the anthracite fields in 1891 and 1892, compared with total shipments.

Years.	Competitive tonnage.	Total shipments.	Per cent of total.
	Long tons.	*Long tons.*	
1892	13,593,541	41,898,630	32.44
1891	13,313,719	40,450,543	32.91
Increase	279,822	1,448,087	19.33

In general the anthracite trade has seldom been in better condition than at the close of 1892. On account of the severity of the weather, stocks which had been held by the producing companies at various points throughout the United States were practically cleaned up. At the same time the large production for the year was almost entirely disposed of at more remunerative prices than have obtained for many years. The above causes could not but have a widespread influence for good on all branches of the anthracite trade, and left it at the commencement of 1893 in a most satisfactory condition for the present year.

One of the most interesting subjects connected with the anthracite trade, and which has received much attention by those concerned, is the practical utilization of so called anthracite waste. In 1890 a commission consisting of Messrs. E. B. Coxe, P. W. Sheafer, and J. A. Price, was appointed by the governor to look into this subject. Of the original commission only Mr. Coxe survives, Messrs. Heber S. Thompson and William Griffith being appointed to the places of the deceased members.

The present commission has just published its report, which is a most exhaustive and valuable treatise, considering the subject from all sides and in every light. The report gives as the causes of waste:

1. Waste in the direct mining of the coal, part of which is unavoidable, it being necessary to leave pillars of coal for the support of the roof, and in addition much coal is lost on account of its not being readily accessible. However, much which has heretofore been considered unavoidable waste, on account of careless mining, could be saved by more careful and scientific methods.

2. Waste in the preparation of the coal for market—that is, breaking it up into the proper sizes, loading it on cars, storing, etc. Here the report goes into detail in describing plans to minimize this item as far as possible by better methods and improved machinery at the breakers.

The Commission further comments on the commercial waste of coal, and the methods now in vogue to utilize the coal which was formerly considered of no value. When the freight rates were uniform on all sizes of anthracite, it did not pay to use small sizes which would not give as much efficient heat as the larger coals; this resulted in the accumulation of enormous amounts of small coal and culm throughout the regions. Since freight rates are now proportioned to the value of the coal, efforts are being made to turn these culm banks into money. The sizes pea and buckwheat are now used extensively by locomotives and for manufacturing purposes, pea is in domestic use, and culm is used free, mixed with bituminous coal or other combustible materials, or with the waste from oil stills, tar, or other adhesive materials, manufactured into eggettes. The Commission is of the opinion, however, that it is much better to turn attention to the construction of grates suitable for the small sizes than to try to prepare the small sizes for the grates now in use which are designed for the combustion of the larger sizes of anthracite.

These investigations and recommendations have been intended to provide in some measure for the small sizes of anthracite now being produced. In addition to this the Commission has given great attention to the old culm and slate banks of the regions which have accumulated up to the present time.

These banks are divided into three classes:

1. Banks containing culm too small to be sold at the time the coal was mined.

2. Rock and slate banks consisting exclusively of rock and slate.

3. The ordinary slate banks consisting of various sizes of slate, coal, bony coal, and slate coal mixed.

In most cases all of these materials have been dumped together, and on this account it is almost impossible to separate them. Their value is still further decreased by other refuse matters, fires and exposure to the atmosphere. On these accounts the report strongly recommends that in the future care be taken by the operators to keep the good coal dirt apart from other waste materials.

It further advises the building up of industries through the anthracite region which can use to advantage the smaller sizes of anthracite and culm, as it is by using it at the point of production, thereby saving freight, that the greatest advantage is realized.

Some of the most interesting information in the report has been prepared by Mr. A. D. W. Smith, of the Pennsylvania Geological Survey.

The original contents and areas of the anthracite coal fields as given by Mr. Smith are given in the following table:

Total area and contents of the Pennsylvania anthracite fields.

Fields.	Area.	Contents.
	Sq. miles.	*Tons.*
Northern	176	5,700,000,000
Eastern Middle	33	600,000,000
Western Middle	94	4,000,000,000
Southern	181	9,200,000.000
Total	484	19,500,000,000

According to the divisions as made by the trade, these amounts are as follows:

Area and contents of anthracite fields by trade regions.

Regions.	Area.	Contents.
	Sq. miles.	*Tons.*
Wyoming	176	5,700,000,000
Lehigh	45	1,600,000,000
Schuylkill	263	12,200,000,000
Total	484	19,500,000,000

The probable average percentage of coal won from 1820 to January 1, 1893, has been estimated by Mr. Smith at about 40 per cent. of the coal contained in the areas mined over.

The total shipments to January 1, 1893, amounted to 820,362,995 tons. If we add 10 per cent. to these shipments to represent coal used about the mines, etc., we will have the production for this period, 902,000,000 tons. The following tables give the details by regions:

Total product from the anthracite regions.

Regions.	Shipments.	Production, adding 10 per cent.
	Long tons.	*Long tons.*
Wyoming	382, 990, 423	421, 000, 000
Lehigh	147, 652, 656	162, 500, 000
Schuylkill	289, 719, 916	318, 500, 000
Total	820, 362, 995	902, 000, 000

On the 40 per cent. basis, *i. e.*, that for every ton of coal produced, 1½ tons are lost, the amount actually consumed is 2,255,000,000 tons.

The following table shows the estimated original contents with the amounts used up to the present time, and the estimated remaining contents:

Original and estimated remaining contents of anthracite fields.

Regions.	Estimated original contents.	Amount used up; 2½ times production.	Estimated contents remaining.
	Long tons.	*Long tons.*	*Long tons.*
Wyoming	5, 700, 000, 000	1, 052, 500, 000	4, 647, 500, 000
Lehigh	1, 600, 000, 000	406, 250, 000	1, 193, 750, 000
Schuylkill	12, 200, 000, 000	796, 250, 000	11, 403, 750, 000
Total	19, 500, 000, 000	2, 255, 000, 000	17, 245, 000, 000

The above table shows the amount of coal still in the ground to be 17,245,000,000 tons. Taking the 40 per cent. basis again as the amount of marketable coal to be gained, we have 6,898,000,000 tons, or over seven times as much coal as has already been mined.

This amount, at the present rate of mining, will be exhausted in about one hundred and fifty years, but as the annual production will increase as time goes on, the amount of available anthracite will not last as long as the above estimate.

Following is a complete directory of anthracite mines in Pennsylvania, with names of operators, railroads on which collieries are located, etc.

Directory of anthracite coal mines in Pennsylvania.

NORTHERN COAL FIELD.

Map Nos.	Names of mines.	Locations.						Operators.	
		Local districts.	Inspector's districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping stations.	Names.	Post-office addresses.
15	Erie	Carbondale	1	Carbondale twp	Lackawanna	D. & 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. & W. R. R.	Winton	Pierce Coal Co., limited	Winton.
18	Edgerton	do	1	do	do	D. & H. C. Co. R. R.	Mayfield	Edgerton Coal Co., limited	Scranton.
6	Elk Creek	do	1	Fell twp	do	N. Y., L. E. & W. R. R.	Carbondale	The Frisbie Coal Co.	Elmira, N. Y.
25	Sterrick Creek	do	1	Blakely twp	do	D. & H. C. Co. R. R.	Winton	Sterrick Creek Coal Co.	Peckville.
36	Jermyn, No. 3	do	1	do	do	N. Y., S. & W. R. R., and N. Y., O. & W. R. R.	Dickson	John Jermyn	Priceburg.
35	Jermyn, No. 4	do	1	do	do	do	do	do	Do.
28	Marshwood	do	1	do	do	D. & H. C. Co. R. R.	Peckville	Moosic Mountain Coal Co.	Marshwood.
43	Murray	do	1	Dunmore twp	do	D., L. & W. R. R.	Dunmore	Murray, Carney & Co.	Dunmore.
5	Simpson	do	1	Fell twp	do	N. Y., L. E. & W. R. R.	Carbondale	Northwest Coal Co.	Scranton.
27	White	do	1	Blakely twp	do	N. Y., S. & W. R. R.	Winton	Winton Coal Co., limited	Do.
24	Mount Jessup	do	1	do	do	D., L. & W. R. R., and N. Y., O. & W. R. R.	do	Mount Jessup Coal Co., limited.	Winton.
7	Ben Carbon	do	1	Fell twp	do	N. Y., L. E. & W. R. R.	Carbondale	Chas. Hutchinson	Kingston.
8	Watkins	do	1	do	do	D. & H. C. Co. R. R.	do	Stroud & Chamberlain	Carbondale.
33	Olyphant, No. 2	do	1	Blakely twp	do	do	do	Delaware and Hudson Canal Co.	Scranton.
34	Eddy Creek	do	1	do	do	do	do	do	Do.
29	Grassy Island	do	1	do	do	do	do	do	Do.
20	White Oak	do	1	do	do	do	do	do	Do.
19	Jermyn Shaft	do	1	Carbondale twp	do	do	do	do	Do.
11	Coal Brook	do	1	do	do	do	do	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. & W. R. R.	do	do	Do.
9	Fall Brook	do	1	do	do	D. & H. C. Co. R. C.	do	John Murrin	Carbondale.
26	Dolph	do	1	Blakely twp	do	N. Y., S. & W. R. R.	Jessup	Dolph Coal Co., limited	Scranton.
32	Lackawanna	do	1	do	do	do	Olyphant	Lackawanna Coal Co., limited.	Olyphant.
31	Ontario, No. 1, & Stg's	do	1	do	do	N. Y., O. & W. R. R.	Peckville	New York and Scranton Coal Co.	Peckville.

2	Forest City	do	1	Forest City	Susquehanna	N. Y., L. E. & 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. & W. R. R.	Winton	Riverside Coal Co.	Do.
69	Archbald	Scranton	2	Lackawanna twp	do	D., L. & W. R. R.	Scranton	Delaware, Lackawanna and Western R. R. Co.	Do.
63	Bellevue	do	2	do	do	do	do	do	Do.
60	Brisbin	do	2	3d ward, Scranton	do	do	do	do	Do.
59	Cayuga	do	2	do	do	do	do	do	Do.
66	Central	do	2	15th ward, Scranton	do	do	do	do	Do.
68	Continental	do	2	Lackawanna twp	do	do	do	do	Do.
64	Dodge	do	2	do	do	do	do	do	Do.
67	Hampton	do	2	do	do	do	do	do	Do.
71	Holden	do	2	do	do	do	do	do	Do.
65	Hyde Park	do	2	5th ward, Scranton	do	do	do	do	Do.
62	Oxford	do	2	do	do	do	do	do	Do.
73	Pyne	do	2	Lackawanna twp	do	do	do	do	Do.
70	Sloan	do	2	do	do	do	do	do	Do.
44	Storrs	do	1	Blakely twp	do	do	do	do	Do.
72	Taylor	do	2	Lackawanna twp	do	do	do	do	Do.
61	Diamond, No. 1	do	2	21st ward, Scranton	do	do	do	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. & 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	Blue Ridge	do	1	do	do	N. Y., O. & W. R. R.	Peckville	Blue Ridge Coal Co.	Peckville.
	Austin	do	2	Old Forge twp	do	L. V. R. R.	Coxton	Austin Coal Co	Scranton.
40	Gypsy Grove, No. 3	do	1	Dunmore twp	do	E. & W. V. R. R.	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. & 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	1	3d ward, Scranton	do	do	do	James Flynn	Do.
76	Greenwood, No. 1	do	3	Lackawanna twp	do	do	Minooka	Greenwood Coal Co., limited.	Do.
77	Greenwood, No. 2	do	3	do	do	do	do	do	Do.
80	Jermyn, Nos. 1-2	do	3	Old Forge twp	do	do	Taylorville	Jermyn & Co.	Do.
37	Pancoast	do	1	Blakely twp	do	do	Scranton	Pancoast Coal Co	Do.
56	Providence	do	2	2d ward, Scranton	do	do	Green Ridge	Providence Coal Co., l't'd.	Do.
79	Sibley	do	3	Old Forge twp	do	do	Taylor	Elliott, McClure & Co	Do.
42	Spencer	do	2	Dunmore twp	do	do	Nay Aug	A. D. & F. M. Spencer	Dunmore.
	Tripp	do	2	21st ward, Scranton	do	do	Park Place	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	1	13th ward, Scranton	do	D. & H. C. Co. R. R.	Carbondale	Delaware and Hudson Canal Co.	Do.
46	Leggitt's Creek	do	1	1st ward, Scranton	do	do	do	do	Do.
45	Marvine	do	2	do	do	do	do	do	Do.
48	Von Storch	do	2	2d ward, Scranton	do	do	do	do	Do.

a Operated jointly with Delaware, Lackawanna and Western R. R. Co.

Directory of anthracite coal mines in Pennsylvania—Continued.

NORTHERN COAL FIELD—Continued.

Map Nos.	Names of mines.	Locations.						Operators.	
		Local districts.	Inspector's districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping stations.	Names.	Post-office addresses.
47	Dickson	Scranton	2	2d ward, Scranton	Lackawanna	D. & H. C. Co. R. R.	Carbondale	Delaware and Hudson Canal Co.	Scranton.
50	Green Ridge	do	2	Dunmore twp	do	do	do	O. S. Johnson	Do.
	Richmond	do	2	Scranton twp	do	do	Providence	Elk Hill Coal and Iron Co.	Do.
57	Mount Pleasant	do	2	14th ward, Scranton	do	D., L. & W. R. R	Scranton	Wm. T. Smith	Do.
81	William A	Pittston	3	Old Forge twp	do	L. V. R. R	Lackawanna	Connell Coal Co	Do.
88	Katy-Did	do	3	do	do	E. & W. V. R. R	Moosic	Robertson & Law	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	3	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	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	PittstonJunction	do	Do.
112	Annora	do	3	Jenkins twp	do	C. R. R. of New Jersey	Laflin	Annora Coal Co	Wilkesbarre.
91	Avoca	do	3	Pittston twp	do	L. V. R. R	Avoca	Avoca Coal Co., limited	Avoca.
90	Langcliffe	do	3	Pittston	do	do	do	Langcliffe Coal Co., limited,	Do.
101	Twin	do	3	do	do	do	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. & W. R. R	Wyoming	Delaware, Lackawanna and Western R. R. Co.	Scranton.
83	Hallstead	do	3	Marcy twp	do	do	Duryea	do	Do.
95	Butler	do	3	Pittston twp	do	L. V. R. R	Pittston	Butler Mine Co., limited	Pittston.
97	Fernwood	do	3	Jenkins twp	do	do	Jenkins Station	do	Do.
106	Schooley	do	3	Exeter twp	do	do	Wyoming	do	Do.
84	Columbia	do	3	Marcy twp	do	D., L. & W. and L. V. R. R.	PittstonJunction	Old Forge Coal Co	Do.
85	Phœnix	do	3	do	do	do	do	do	Do.
82	Babylon	do	3	do	do	L. V. R. R	Duryea	Babylon Coal Co	Scranton.
89	Consolidated	do	3	Pittston	do	E. & W. V. R. R	Moosic	Hillside Coal and Iron Co.	Do.
103	Clear Spring	do	3	West Pittston	do	D. L. & W. R. R	West Pittston	Clear Spring Coal Co	Pittston.
94	Elmwood	do	3	Pittston twp	do	L. V. R. R	Avoca	Florence Coal Co., limited	Dupont.

96	Fairmount	do	3	do	do	D. & H. C. Co. R. R.	Pittston	W. M. Mallory, Est	Towanda.
113	Keystone	do	3	Plains twp	do	do	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. & W. and L. V. R. R.	Wyoming	Mount Lookout Coal Co	Do.
	Morning Star	do	3	do	do	L. V. R. R.	do	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	Avoca	do	Do.
	Spring Brook	do	3	Old Forge twp	do	D. & 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.
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 Lyons	do	Do.
117	Bennett	do	3	Plains twp	do	C. R. R. of N. J	Mill Creek	Thomas Waddell & Co	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	Mocanaqua	West End Coal Co	Shickshinny.
140	Maffet	do	4	Hanover twp	do	C. R. R. of N. J	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	do	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	4	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.	Corbondale	Delaware and Hudson Canal Co.	Scranton.
116	Pine Ridge	do	3	do	do	do	do	do	Do.
125	Laurel Run	do	3	do	do	do	do	do	Do.
120	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	do	do	Do.
128	Conyngham	do	3	Wilkesbarre	do	do	do	do	Do.
114	Delaware	do	3	Plains twp	do	do	do	do	Do.
168	Lance, No. 11	Plymouth	4	Plymouth	Luzerne	D. L. & W. R. R	Plymouth	Lehigh and Wilkesbarre Coal Co.	Wilkesbarre.

Directory of anthracite coal mines in Pennsylvania—Continued.

NORTHERN COAL FIELD—Continued.

Map Nos.	Names of mines.	Locations.						Operators.	
		Local districts.	Inspector's districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping stations.	Names.	Post-office addresses.
169	Nottingham, No. 15.	Plymouth	4	Plymouth	Luzerne	D. L. & W. R. R.	Plymouth	Lehigh and Wilkesbarre Coal Co.	Wilkesbarre.
170	Reynolds, No. 16	do	4	do	do	do	do	do	Do.
172	Avondale	do	4	Plymouth twp	do	do	do	Delaware, Lackawanna and Western Railroad 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	do	Kingston	W. G. Payne & Co	Kingston.
171	Parrish	do	4	Plymouth	do	do	Plymouth	Parrish Coal Co	Plymouth.
173	Colliery, No. 3	do	4	West Nanticoke	do	do	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. & H. Co. R. R.	Plymouth	Delaware and Hudson Canal Co.	Scranton.
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. & W. R. R.	Kingston	Delaware, Lackawanna and Western R. R. Co.	Do.
156	Kingston, No. 1	do	4	Kingston twp	do	do	do	Kingston Coal Co	Kingston.
158	Kingston, No. 2	do	4	Plymouth	do	do	do	do	Do.
	Kingston, No. 3	do	4	do	do	do	do	do	Do.
157	Kingston, No. 4	do	4	Kingston twp	do	do	do	do	Do.
167	Gaylord	do	4	Plymouth twp	do	do	Plymouth	do	Do.
152	Harry E	do	3	Kingston twp	do	do	Bennett	Wyoming Valley Coal Co.	Wilkesbarre.
151	Harry E., No. 2	do	3	do	do	D. L. & W. and L. V. R. R.	do	do	Do.
154	Black Diamond	do	3	do	do	do	Kingston	John C. Haddock	Do.
153	Mill Hollow	do	3	do	do	do	Bennett	Thomas Waddell	Pittston.
150	Maltby	do	3	do	do	do	Wyoming	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	Milnesville	A. S. Van Wickle	Hazleton.
188	Lattimer, No. 1								
189	Lattimer, No. 2	do	5	do	do	do	Lattimer	Pardee Bros. & Co	Lattimer
190	Lattimer, No. 3								Mines.
192	Hollywood	do	5	do	do	do	Hollywood	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.
	Highland, No. 5	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. & 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	Tomhicken	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	Silver Brook.
209	Humboldt	do	5	Hazle twp	do	do	Humboldt	Linderman & Skeer	South Bethlehem.
201	East Sugar Loaf, No. 1	do	5	do	do	do	Stockton	do	Do.
200	East Sugar Loaf, No. 2	do	5	do	do	do	do	do	Do.
199	East Sugar Loaf, No. 5	do	5	do	do	do	do	do	Do.
208	Harwood	do	5	do	do	D., S. & S. R. R	Harwood	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.
217	Beaver Brook	Beaver Meadow	5	do	do	L. V. R. R., & C. R. R. of N. J.	Audenried	C. M. Dodson & Co	Bethlehem.
211	Beaver Meadow	do	5	Banks twp	Carbon	D., S. & S. R. R. & L. V. R. R.	Beaver Meadow	Coxe Bros. & Co	Drifton.
218	Honeybrook, No. 2	do	5	do	do	C. R. R. of N. J	Audenried	Lehigh and Wilkesbarre Coal Co.	Wilkesbarre.
219	Honeybrook, No. 4	do	6	Klein twp	Schuylkill	do	do	do	Do.
220	Honeybrook, No. 5	do	6	do	do	do	do	do	Do.
	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.

Directory of anthracite coal mines in Pennsylvania—Continued.

WESTERN MIDDLE COAL FIELDS—Continued.

Map Nos.	Names of mines.	Locations.						Operators.	
		Local districts.	Inspector's districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping stations.	Names.	Post-office addresses.
212	Coleraine	Beaver Meadow.	5	Banks twp	Carbon	L. V. R. R	Beaver Meadow	W. T. Carter & Co	Philadelphia.
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.	Inspector's districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping stations.	Names.	Post-office addresses.
235	Ellangowan	East Mahanoy	6	Mahanoy twp	Schuylkill	P. & 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	St. Nicholas	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	Lehigh Valley Coal Co	Wilkesbarre.
230	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	Bethlehem.
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	Delano	Primrose Coal Co	New York City.
234	Maple Hill	do	6	do	do	P. & R. R. R	St. Nicholas	Philadelphia and Reading Coal and Iron Co.	Pottsville.
284	Alaska	West Mahanoy.	7	Mount Carmel twp	Northumberland.	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	Mt. Carmel	do	Do.
285	Black Diamond	do	7	do	do	L. V. & N. C. Rwy	do	Ferndale Coal Co	Mt. Carmel.
276	Mount Carmel	do	7	do	do	P. & R., N. C., and L. V. R. R.	do	Thomas M. Righter & Co	Do.
274	Bellmore (a)	do	7	N. Conyngham twp.	Columbia	L. V. R. R	do	S. S. Bickel & Co	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	Mt. Carmel	May, Troutman & Co	Shamokin.
268	North Ashland	do	7	do	do	P. & R. R. R	Ashland	Philadelphia and Reading Coal and Iron Co.	Pottsville.
278	Potts	do	7	do	do	do	Locust Dale	do	Do.
270	Continental	do	7	do	do	L. V. R. R.	Centralia	Lehigh Valley Coal Co	Wilkesbarre.
	Locust Run	do	7	do	Schuylkill	P. & R. R. R.	Ashland	Philadelphia and Reading Coal and Iron Co.	Pottsville.
267	Bast	do	7	Butler twp	do	do	Big Mine Run Jc.	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	Gilberton	do	Do.
237	Bear Run	do	6	do	do	do	St. Nicholas	do	Do.
241	Gilberton	do	6	West Mahanoy twp.	do	do	Gilberton	do	Do.
	Sidney	do	6	do	do	do	Mahanoy Plane	Sidney Coal Co	Mahanoy Plane.
260	Girard Mammoth	do	6	do	do	do	Rappahannock	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	Rappahannock	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	Big Mine Run Jc.	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	Simon Moore & Co	Mahanoy Plane.
255	William Penn	do	6	do	do	do	William Penn	William Penn Coal Co	Shaft.
258	Packer, No. 2	do	6	do	do	L. V. R. R.	Lost Creek	Lehigh Valley Coal Co	Wilkesbarre.
256	Packer, No. 3	do	6	do	do	do	do	do	Do.
257	Packer, No. 4	do	6	do	do	do	do	do	Do.
259	Packer, No. 5	do	6	Butler twp	do	do	do	do	Do.
305	Bear Valley	Shamokin	7	Coal twp	Northumberland.	P. & R. R. R	Shamokin	Philadelphia and Reading Coal Iron Co.	Pottsville.

a The mine extends into Northumberland county.

Directory of anthracite coal mines in Pennsylvania—Continued.

WESTERN MIDDLE COAL FIELDS—Continued.

Map Nos.	Names of mines.	Locations.						Operators.	
		Local districts.	Inspector's districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping stations.	Names.	Post-office addresses.
293	Buck Ridge	Shamokin	7	Coal twp	Northumberland.	P. & R. R. R	Shamokin	Philadelphia and Reading Coal Iron Co.	Pottsville.
304	Burnside	...do	7	...do	...do	...do	...do	...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	...do	Union Coal Co	Shamokin.
291	Hickory Swamp	...do	7	...do	...do	...do	...do	...do	Do.
286	Pennsylvania	...do	7	Mt. Carmel twp	...do	...do	...do	...do	Do.
287	Enterprise	...do	7	Coal twp	...do	P. & R. R. R	Excelsior	Enterprise Coal Co	Excelsior.
288	Excelsior	...do	7	...do	...do	...do	...do	Excelsior Coal Co	Do.
289	Corbin	...do	7	...do	...do	...do	...do	...do	Do.
292	Colbert	...do	7	...do	...do	N. C. Rwy	Shamokin	Smith & Keiser	Shamokin.
302	Neilson	...do	7	...do	...do	P. & R. R. R	...do	J. Langdon & Co	Elmira, N. Y.
	Natalie	...do	7	...do	...do	...do	Natalie	Penn. Anthracite Coal Co.	Natalie.
275	Midvalley	...do	7	Mt. Carmel twp	Columbia	L. V. R. R	Wilburton	Midvalley Coal Co	Wilburton.

SOUTHERN COAL FIELD.

Map Nos.	Names of mines.	Local districts.	Inspector's districts.	Townships, etc.	Counties.	Railroads.	Nearest shipping stations.	Names.	Post-office addresses.
307	Colliery No. 1	Panther Creek	5	Packer twp	Carbon	C. R. R. of N. J	Nesquehoning	Lehigh Coal and Navigation Co.	Lansford.
308	Colliery No. 4	...do	5	...do	...do	...do	Hanto	...do	Do.
309	Colliery No. 5	...do	5	...do	...do	...do	...do	...do	Do.
	Colliery No. 6	...do	5	...do	...do	...do	...do	...do	Do.
311	Colliery No. 8	...do	8	Rahn twp	Schuylkill	...do	...do	...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	...do	...do	Do.
314	Colliery No. 11	...do	8	...do	...do	...do	...do	...do	Do.
312	Colliery No. 12	...do	8	...do	...do	...do	...do	...do	Do.
315	Colliery No. 13	...do	8	...do	...do	...do	...do	...do	Do.
337	Beechwood	East Schuylkill.	8	Newcastle twp	...do	P. & R. R. R	Mt. Laffee	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	Cuubola	do	Do.
316	East Lehigh	do	8	Tamaqua	do	do	Tamaqua	Mitchell & Shepp	Tamaqua.
336	Flowery Field	do	8	Newcastle twp	do	do	Pottsville	Geo. U. Sturdevant	Pottsville.
321	Kaska William	do	8	Blythe twp	do	do	Middleport	Alliance Coal Mining Co.	Lansford.
329	Penna. Schuylkill Val., No. 1.	do	8	Newcastle twp	do	P. R. R.	Newcastle	Tyler & McTurk	St. Clair.
334	Wadesville	do	8	do	do	P. & R. R. R.	Pottsville	Philadelphia and Reading Coal and Iron Co,	Pottsville.
325	Pine Forest	do	8	East Norwegian twp	do	do	St. Clair	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 Mt. Hope	do	8	East Norwegian twp	do	do	St. Clair	G. B. Linderman & Co.	South Bethlehem.
338	York Farm	do	8	do	do	L. V. R. R.	Pottsville	Lehigh Valley Coal Co.	Wilkesbarre.
344	Glendower	West Schuylkill	8	Foster twp	do	P. & R. R. R.	Glendower	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	Thomaston	do	Do.
349	Phœnix Park	do	8	do	do	do	Llewellyn	do	Do.
343	Richardson	do	8	Foster twp	do	do	Richardson	do	Do.
339	Ellsworth	do	8	Newcastle twp	do	do	Schuylkill Haven	John H. Davis	St. Clair.
	Jugular	do	8	do	do	do	New Castle	Jacob S. Hepner	Broad Mountain.
345	Oak Hill	do	8	Cass twp	do	do	Oak Hill	Leisenring & 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. & R. R. R.	Newtown	do	Do.
354	East Franklin	do	8	Tremont twp	do	do	East Franklin	Philadelphia and Reading Coal and Iron Co.	Pottsville.
353	Middle Creek	Lykens Valley	8	Frailey twp	do	do	Blackwood	do	Do.
359	West Brookside	do	8	Porter twp	do	do	Tower City	do	Do.
355	Lincoln	do	8	Tremont twp	do	do	Lincoln	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 R. R. Co.	Wilkesbarre.
361	Short Mountain	do	7	do	do	do	Lykens	Lykens Valley 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, No. 108 South Fourth street, Philadelphia.
Philadelphia and Reading Coal and Iron Company, No. 143 Liberty street, New York.
Lehigh Valley Coal Company, No. 108 South Fourth 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, No. 233 South Fourth street, Philadelphia.
Lykens Valley Coal Company, No. 233 South Fourth street, Philadelphia.
Mineral Railroad and Mining Company, No. 233 South Fourth street, Philadelphia.
Summit Branch Railroad Company, No. 233 South Fourth street, Philadelphia.
Union Coal Company, Eric, Pennsylvania.
New York, Ontario and Western Railroad Company, 16 Exchange Place, New York.

The following extracts from the report of the president of the Philadelphia and Reading Railroad Company for the year ending November 30, 1892, will show the conditions which developed during the progress of the year 1892 in respect to the proposed consolidation of the initial coal lines, and of the producing companies.

Negotiations were opened with the management of the Lehigh Valley Railroad Company for the acquisition by lease of its roads, extending from the waters of New York bay to the Great Lakes at Buffalo, New York, with a line of steamers on the lakes reaching the ports of Duluth, Milwaukee, and Chicago, giving the command of a large proportion of eastbound traffic for distribution in the populous local territory of the Reading lines, and for export from Philadelphia, at the same time extending and enlarging the markets for the produce of the industries of Philadelphia and other points on the Reading lines. A lease was agreed upon for the term of nine hundred and ninety-nine years upon terms which were communicated to the public and are already familiar to the shareholders. This arrangement has already contributed to both systems an increase of traffic of all kinds, although in operation for too brief a period to effect the change in the accustomed channels of traffic to the full extent which is confidently looked for.

The acquisition of this powerful line also enables the Reading Company to compete with other trunk lines for the large volume of west-bound traffic from the eastern centers of trade and industry. The net traffic earnings of the Lehigh Valley system have already been increased by about $1,000,000, but there has not been sufficient time since the close of the year to present a résumé of the general results of the operations, and the management is compelled to reserve a full statement concerning them for a later communication. This combination has been assailed in various quarters as being in contravention of law.

For over a quarter of a century the traffic relations subsisting between the Philadelphia and Reading Railroad Company and the Central Railroad Company of New Jersey have been of the most intimate and harmonious character, the latter furnishing to a great extent the terminal facilities in New York for the traffic of the Reading Company, while this company furnished in Philadelphia the requisite terminal facilities for traffic originating on the lines of the Central Company. The mutual interchange of traffic had reached large proportions, and was daily growing in extent and importance. It had been governed in the past by contracts and informal agreements which it was deemed to the interests of both parties to place in a more permanent and tangible form. So long as the ownership of the controlling interest in both properties should remain in the hands of the present holders, the parties were entirely confident that motives of mutual interest would preserve the prevailing methods of interchange so advantageous to both, but it was sought to place the relations beyond the reach of a temporary change of the ownership of either, which might result in serious injury to the other, through diversion of traffic to other lines, or a denial of the use by either of the valuable terminals of the other.

Under these circumstances, a lease of the railroads of the Central Railroad Company of New Jersey to the Port Reading Railroad Company was executed shortly after the last annual meeting. The Port Reading Company is a corporation of the State of New Jersey, which was promoted by this company. At the time this lease was executed there existed, under the laws of New Jersey, certain technical obstacles to the consummation of the transaction. Accordingly, a measure was introduced in the legislature which was passed with substantial unanimity.

But, before the act had received the sanction of the executive, clamor was raised against the act, and it was disapproved by the governor in a message which placed its disapproval on ground relating to the supposed effect of the combination on the price of anthracite coal in New Jersey. Subsequently, some months after the negotiations of the lease, and more than a month after the filing of the veto message above referred to, the Philadelphia and Reading Coal and Iron Company, a corporation of Pennsylvania, acquired by purchase the coal to be produced by the Lehigh and Wilkesbarre Company, also a corporation of Pennsylvania, in which the Central Company held a considerable interest, and also that to be produced by various other miners and shippers whose mines were located on lines controlled by the Central Company, by lease or otherwise.

Proceedings were commenced on the information of the attorneygeneral of New Jersey, for the purpose of obtaining a decree of the proper court, annulling the lease and the contract of the guarantee of the Philadelphia and Reading Railroad Company which accompanied it. The case came to a preliminary hearing upon ex parte affidavits and upon various technical points involved, and the chancellor entered a decree directing the directors and officers of the Central Company, pending the final hearing, to reënter upon their property and conduct its operations, and restraining the Port Reading Railroad Company and the Philadelphia and Reading Railroad Company from interfering with it. This order was promptly obeyed. Notwithstanding the surrender of the property of the Central, the continuance of the delivery of coal to the Philadelphia and Reading Coal and Iron Company by the Lehigh and Wilkesbarre Company, a corporation controlled by a different board of directors, has been insisted upon as evincing a spirit of disobedience of the orders of the courts. The parties to this later contract, therefore, deemed it wise and prudent to cancel it. It will be observed that the lease of the Lehigh Valley Railroad Company to the Philadelphia and Reading Railroad Company has not been disturbed.

PRODUCTION OF PENNSYLVANIA BITUMINOUS COAL.

Total product in 1892, 46,694,576 short tons; spot value, $39,017,164.

Comparing the production of bituminous coal in Pennsylvania in 1892 with that of 1891, an increase is shown of 3,906,086 short tons, or a little over 8 per cent. The increased output, however, was obtained at a comparative loss in revenue, for the average price per ton realized for coal sold declined from 87 cents in 1891 to 84 cents in 1892, and the increase in the total amount received for the product was only $1,746,111, against an increase in tonnage of nearly 4,000,000. The total output of 46,694,576 short tons is the largest ever attained in the State; in fact the annual production has shown an uninterrupted increase since 1886.

A glance at the table below will show the counties whose production increased or decreased in 1892. Seventeen of the 25 producing counties show an increase in product, and there are 8 whose output was less than in 1891. The gross increases amounted to 4,671,570 short tons. The total decreases amounted to 765,484 short tons, making the net increase 3,906,086.

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	(*b*)
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	(*b*)
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	(*b*)
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	(*a*)	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.		
		Total product.	Increase.	Decrease.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
Allegheny	5, 640, 669	6, 399, 199	758, 530	....
Armstrong	484, 000	583, 519	99, 519	....
Beaver	129. 961	140, 835	10, 874	....
Bedford	389, 257	552, 461	163, 204	....
Blair	237, 626	259, 224	21, 598	....
Bradford	68, 697	57, 708	....	10, 989
Butler	211, 647	145, 729	....	65, 918
Cambria	2, 932, 973	3, 086, 554	153, 581	....
Cameron	....	....	....	....
Center	526, 753	496, 521	....	30, 232
Clarion	479, 887	569, 333	89, 446	....
Clearfield	7, 143, 382	6, 876, 785	....	266, 597
Clinton	130, 802	98, 242	....	32, 560
Elk	973, 600	731, 575	....	242, 025
Fayette	5, 782, 573	7, 260, 044	1, 477, 471	....
Greene	....	....	....	....
Huntingdon	269, 021	333, 855	64, 834	....
Indiana	456, 077	514, 463	58, 386	....
Jefferson	3, 160, 614	3, 706, 329	545, 715	....
Lawrence	164, 669	216, 561	51, 892	....
Lycoming	....	20, 515	20, 515	....
McKean	15, 345	21, 282	5, 937	....
Mercer	526, 220	420, 145	....	106, 075
Somerset	480, 194	509, 610	29, 416	....
Tioga	1, 010, 872	999, 784	....	11, 088
Venango	....	....	....	....
Washington	2, 606, 158	2, 903, 235	297, 077	....
Westmoreland	7, 967, 493	8, 791, 068	823, 575	....
Small mines	1, 000, 000	1, 000, 000	....	....
Total	42, 788, 490	46, 694, 576	4, 671, 570	765, 484
Net increase	486, 317	3, 906, 086	3, 906, 086	....

a Included in county distribution.

b Included in product of small mines.

The more important increases it will be noticed occur in Allegheny, Fayette, Jefferson, and Westmoreland counties, while Washington county shows an increase of nearly 300,000 tons, and Bedford and Cambria counties each increased their output over 150,000 tons. Owing to the great strike in the Connellsville coking region in 1891, the production of Fayette and Westmoreland counties decreased nearly 1,000,000 tons. The returns for 1892 indicate that the region has recovered from the effects of the strike, the combined product of the two counties showing an increase over 1891 of a little more than 2,300,000 tons, and exceeding that of 1890 by 1,247,527 tons.

In the following table are shown the statistics of bituminous coal production in Pennsylvania in 1892:

Bituminous coal product of Pennsylvania in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Allegheny	6,052,630	331,098	15,471	....	6,399,199	$5,848,483	$0.91	225	11,223
Armstrong	565,399	18,080	40	....	583,519	443,160	.71	246	964
Beaver	120,244	20,096	80	415	140,835	142,174	1.01	210	323
Bedford	510,678	5,363	1,420	35,000	552,461	450,697	.82	265	975
Blair	115,875	2,868	2,894	137,587	259,224	219,272	.85	203	848
Bradford	(*a*)55,617	1,200	891	....	57,708	81,945	1.42	206	122
Butler	140,792	3,686	1,251	....	145,729	135,818	.93	169	358
Cambria	2,424,799	392,461	21,685	247,609	3,086,554	2,545,867	.82	228	4,913
Center	451,716	272	675	43,858	496,521	397,335	.79	181	767
Clarion	548,433	18,710	2,190	....	569,333	424,477	.75	235	985
Clearfield	6,582,271	36,061	45,438	213,015	6,876,785	5,538,591	.81	212	10,225
Clinton	98,242	....	....	....	98,242	99,208	1.01	175	175
Elk	685,234	4,012	4,102	38,227	731,535	611,112	.83	230	1,265
Fayette	1,051,414	155,630	70,675	5,982,325	7,260,044	5,620,159	.77	239	7,952
Huntingdon	239,282	8,355	6,559	79,659	333,855	249,715	.75	244	560
Indiana	418,348	1,095	250	94,770	514,463	393,388	.77	191	656
Jefferson	3,002,432	23,185	14,844	665,868	3,706,329	3,006,617	.81	232	4,567
Lawrence	215,466	865	230	....	216,561	221,329	1.02	250	368
Lycoming	16,600	3,865	50	....	20,515	23,036	1.13	252	60
McKean	12,610	8,672	....	....	21,282	23,410	1.10	304	28
Mercer	396,076	7,235	16,834	....	420,145	368,479	.88	181	876
Somerset	485,227	6,429	....	17,954	509,610	346,705	.66	238	577
Tioga	945,420	16,655	6,336	31,373	999,784	1,434,878	1.44	223	2,249
Washington	2,872,332	23,188	7,715	....	2,903,235	2,538,375	.87	202	4,895
Westmoreland	4,418,812	118,746	137,149	4,116,361	8,791,068	7,102,934	.81	234	10,724
Small mines	....	1,000,000	....	....	1,000,000	750,000	.75	......	......
Total	32,425,949	2,207,827	356,779	11,704,021	46,694,576	39,017,164	.84	223	66,655

a Includes 2,100 tons stocked at the mines, December 31, 1892.

As will be seen in the above table Westmoreland county continues to hold first place both in the amount of coal produced and in the value of the product. Fayette county holds second place in total tonnage, but drops to third place in the value of its output. Clearfield county ranks third in importance of production and fourth in value. Allegheny county ranks fourth in quantity of coal obtained, but in spite of a decline from $1.03 to 91 cents in the average price per ton, it exceeds both Fayette and Clearfield counties in the total value of its product, and takes second place in this particular. Jefferson county comes fifth in importance, both in quantity of coal and its value; Cambria sixth, and Washington seventh.

All of these counties produced more than 2,000,000 tons, and, with the exception of Washington county, more than 3,000,000 tons, Washington county lacking about 100,000 of the latter figure. It is somewhat singular that there was no county in the State whose product was between one and two million tons, each county which passed the first figure also passing the second, though Tioga county needed only 216 tons to attain the million-ton mark. In 1891 Tioga county produced 1,010,872 short tons, but fell to 999,786 tons in 1892. Elk county yielded 1,121,534 tons in 1890, but its product decreased to 973,600 tons in 1891, and further to 731,575 tons in 1892.

Three counties employed more than 10,000 men each during the year. These were Allegheny (11,223), Clearfield (10,225), and Westmoreland (10,724). The largest number of days made (that is, the quantity obtained by multiplying the number of men employed by the average working time at each mine and summing up the results) was in Westmoreland county, the total figure thus obtained being 2,505,484. Allegheny came next with 2,430,662, while Clearfield county had 2,167,106. Dividing these amounts by the total number of employés the average working time is found to have been, in Westmoreland county, 234 days; in Allegheny county, 225 days, and in Clearfield county, 212 days. By the same method the averages of time for all the counties have been obtained, and they are found to have ranged from 169 days in Butler county to 304 days in McKean county. These counties, however, especially McKean county, which employed only 28 men, are comparatively of small importance and have little effect upon the general results. Seventeen of the 25 counties enumerated show average working time ranging from 200 to 250 days, the general average for the State being 223 days.

The average price per ton is obtained by dividing the total value for each county by its total product. The averages thus obtained ranged from 66 cents in Somerset county to $1.44 in Tioga county, the two extremes being reached by two counties, one of which lies on the northern boundary line of the State, and the other on the southern, but adjoining each other in the alphabetical arrangement of the tabulated statements. The general average for the State, also obtained by dividing the total value by the total product, was 84 cents per ton, 3 cents per ton less than the average price in 1891. Fractions in all cases are eliminated.

Included in the output of bituminous coal are all varieties produced in the State except anthracite; that is to say, there were small amounts of semi-anthracite and cannel coal and nearly two million tons of semi-bituminous coal produced in the State, which are included in the tables of bituminous production. To particularize, there were 25,920 short tons of cannel coal obtained, 1,410 tons of which were produced in Butler county and 24,510 tons in Clearfield. Cambria county produced 698,212 short tons of semi-bitumnious coal; Clearfield county, 486,927 tons; Somerset county, 108,270 tons; and Tioga county, 605,996 tons; in all, 1,899,405 tons of semi-bituminous coal. Clearfield county produced the only semi-anthracite coal reported, 22,200 tons. With the foregoing exceptions all of the coal reported from the bituminous producing counties is classed as bituminous coal only.

Allegheny county.—Coal produced in 1892, 6,399,199 short tons; spot value, $5,848,083.

Allegheny county was fourth in the amount of coal produced in 1892, but was second in the value of the product, notwithstanding a decline of 12 cents in the average price per ton, or from $1.03 to 91 cents. The total product in 1892 exceeded that of 1891 by 758,530 tons, and was the largest ever obtained. The total number of employés increased from 11,194 in 1891 to 11,223 in 1892. The average working days also increased from 199 to 225.

Coal product of Allegheny county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	2, 863, 631	....	....	....	....
1885	3, 588, 244	....	....	....	....
1886	4, 202, 086	....	....	....	....
1887	4, 680, 924	....	....	....	....
1888	5, 575, 505	....	....	....	....
1889	4, 717, 431	$4, 000, 104	$0. 85	....	9, 386
1890	4, 894, 372	4, 534, 708	. 93	198	9, 036
1891	5, 640, 669	5, 790, 967	1. 03	199	11, 194
1892	6, 399, 199	5, 848, 083	. 91	225	11, 223

Armstrong county.—Coal produced in 1892, 583,519 short tons; spot value $443,160.

Armstrong county increased its output in 1892 over 1891 by 99,519 short tons, and, like Allegheny county, exceeded all previous records. The value increased from $367,906 to $443,160, a gain of $75,252. The average price per ton was the same as in 1891. The total number of men employed in 1892 was 964, against 805 in 1891. The average working time increased from 230 days to 246 days.

Coal product of Armstrong county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	170, 826	....	....	....	....
1885	139, 327	....	....	....	....
1886	210, 856	....	....	....	....
1887	235, 221	....	....	....	....
1888	226, 093	....	....	....	....
1889	289, 218	$210, 067	$0. 73	....	459
1890	380, 554	275, 011	. 72	251	661
1891	484, 000	367, 906	. 76	230	805
1892	583, 519	443, 160	. 76	246	964

Beaver county.—Coal produced in 1892, 140,835 short tons; spot value, $142,174.

Complete returns from all of the commercial mines in Beaver county show a total product of 140,835 short tons, an increase over 1891 of 10,874 tons. The output in 1892 was the largest since 1887. The value of the product increased $12,123 over 1891, and the average price advanced 1 cent per ton. A seeming discrepancy exists in comparing the number of employés and the average days worked. Much of it is probably due to an additional number of men employed in opening a new mine which began shipping in 1892.

Coal product of Beaver county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	156,695				
1885	184,631				
1886	208,820				
1887	197,863				
1888	63,900				
1889	93,461	$110,604	$1.18		162
1890	139,117	145,946	1.05	251	205
1891	129,961	130,051	1.00	201½	228
1892	140,835	142,174	1.01	210	323

Bedford county.—Coal produced in 1892, 552,461 short tons; spot value, $450,697.

With the exception of 1891, the coal product of Bedford county has increased annually since 1888, the output in 1892 being 163,204 short tons more than in the preceding year, and the largest ever obtained. The value increased $126,295. A decline of 4 cents is noted in the average price. The total number of men employed increased from 605 to 975, and the average working days from 230 to 265.

Coal product of Bedford county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	69,770				
1885	107,694				
1886	173,372				
1887	311,452				
1888	248,159				
1889	257,453	$205,672	$0.80		560
1890	445,192	356,005	.80	288	662
1891	389,257	324,402	.86	230	605
1892	552,461	450,697	.82	265	975

Blair county.—Coal produced in 1892, 259,224 short tons; spot value, $219,272.

The output of Blair county in 1892 was 21,598 tons more than in 1891, but did not reach the amount obtained in 1890. The value increased $13,283 over 1891, the average price declining from 87 cents to 85 cents. The number of employés increased from 503 to 848, but the average working time decreased from 249 days to 203 days.

Coal product of Blair county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	208, 541				
1885	205, 075				
1886	305, 695				
1887	287, 307				
1888	314, 013				
1889	215, 410	$210, 465	$0. 98		466
1890	298, 196	241, 678	. 81	284	595
1891	237, 626	205, 989	. 87	249	503
1892	259, 224	219, 272	. 85	203	848

Bradford county.—The product of Bradford county continues to decrease. The output in 1892 was from one mine, the same as in 1891, and was 10,989 tons less. The average price per ton, however, advanced from $1.34 to $1.42. The number of employés decreased from 169 to 122, and the working days from 228 to 206.

Coal product of Bradford county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	313, 575				
1885	249, 920				
1886	206, 998				
1887	167, 416				
1888	163, 851				
1889	129, 141	$171, 387	$1. 33		321
1890	126, 687	161, 751	1. 28	196	292
1891	68, 697	92, 054	1. 34	228	169
1892	57, 708	81, 945	1. 42	206	122

Butler county.—Coal produced in 1892, 145,729 short tons; spot value, $135,818.

Butler county's product in 1892 was 65,918 tons less than in 1891. The value decreased $51,663. The average price per ton advanced from 89 cents to 93 cents. The number of men employed was larger than in 1891, being 358 against 342, but the average working days decreased from 240 to 169. Of the coal mines in 1892, 1,410 short tons were of the cannel variety. All the rest was bituminous.

Coal product of Butler county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	151, 355				
1885	85, 429				
1886	162, 306				
1887	161, 764				
1888	194, 715				
1889	288, 591	$270, 394	$0. 97		451
1890	167, 578	146, 162	. 87	237	314
1891	211, 647	187, 481	. 89	240	342
1892	145, 729	135, 818	. 93	169	358

Cambria county.—Coal produced in 1892, 3,086,554 short tons; spot value, $2,545,867.

Cambria county ranks sixth in the State in importance of coal production. The yield in 1892 was 153,581 tons more than in 1891, and was the largest output in the history of the county. The total number of men employed in 1892 was 4,913 against 4,284 in 1891. The average working time was 228 days against 258. About 300,000 tons of the product in 1892 was used in rolling mills by the companies mining the coal. This amount and 31,000 tons sold at the mines to railroads, are included in the amount sold to local trade. The output in 1892 included 698,212 tons of semi-bituminous coal.

Coal product of Cambria county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	659, 843	....	....	....	....
1885	1, 037, 000	....	....	....	....
1886	1, 222, 028	....	....	....	....
1887	1, 421, 980	....	....	....	....
1888	1, 540, 460	....	....	....	....
1889	1, 751, 664	$1, 348, 484	$0. 77	....	2, 791
1890	2, 790, 954	2, 332, 997	. 83	361	4, 140
1891	2, 932, 973	2, 354, 831	. 80	258	4, 284
1892	3, 086, 554	2, 545, 867	. 82	228	4, 913

Center county.—Coal produced in 1892, 496,521 short tons; spot value, $397,335.

The coal product of Center county in 1892 was 30,232 tons less than in 1891, the value, however, remaining about the same. The total number of employés decreased from 823 to 767 and the average working days from 200 to 181.

Coal product of Center county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	216, 422	....	....	....	....
1885	373, 504	....	....	....	....
1886	313, 383	....	....	....	....
1887	508, 255	....	....	....	....
1888	382, 770	....	....	....	....
1889	395, 127	$311, 544	$0. 79	....	750
1890	452, 114	356, 121	. 79	230	623
1891	526, 753	397, 451	. 75	200	823
1892	496, 521	397, 335	. 79	181	767

Clarion county.—Coal produced in 1892, 569,333 short tons; spot value, $424,477.

Clarion county increased its product in 1892 over 1891 by 89,446 short tons. The average price per ton remained the same. The number of men employed increased from 895 to 985 and the average working time from 221 to 235.

Coal product of Clarion county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	329,973				
1885	299,216				
1886	429,544				
1887	593,758				
1888	535,192				
1889	596,589	$430,850	$0.72		940
1890	512,387	386,617	.75	237	938
1891	479,887	361,741	.75	221	895
1892	569,333	424,477	.75	235	985

Clearfield county.—Coal produced in 1892, 6,876,785 short tons; spot value, $5,538,591.

The product of Clearfield county in 1892 was 266,597 short tons less than in 1891. The decrease is attributable mainly to a scarcity of cars for shipping the product, many operators stating that their output was restricted for that reason. The Clearfield county coal is one of the best steam producing fuels in the country, being rivalled only in this respect by the Pocahontas coal of Virginia and West Virginia. It is more widely distributed than any other bituminous coal produced in the United States. Of the product in 1892, 486,927 tons are classed as semi-bituminous, 22,200 tons as semi-anthracite, and 24,510 tons as cannel. There were 10,225 men employed in the mines of Clearfield county in 1892 against 10,067 in 1891. The average time made was 212 days against 227 in 1891.

Coal product of Clearfield county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	2,177,543				
1885	3,368,671				
1886	3,753,986				
1887	5,180,311				
1888	5,398,981				
1889	5,224,506	$4,403,551	$0.84		7,703
1890	6,651,587	5,642,098	.85	236	9,324
1891	7,143,382	5,968,763	.84	227	10,067
1892	6,876,785	5,538,591	.81	212	10,225

Clinton county.—Coal produced in 1892, 98,242 short tons; spot value, $99,208.

The output of Clinton county is from one mine and in 1892 was 32,560 tons less than in 1891. The loss in value amounted to $50,622, the average price per ton declining from $1.15 to $1.01.

Coal product of Clinton county, Pennsylvania, since 1888.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1888	32,000				
1889	106,000				
1890	159,000	$123,326	$0.78	265	200
1891	130,802	149,830	1.15	291	181
1892	98,242	99,208	1.01	175	175

Elk county.—Coal produced in 1892, 731,575 short tons; spot value, $611,112.

The product of Elk county in 1892 was 242,025 short tons less than in 1891. The average price per ton did not change. Shortness of car supply is given as the reason for decreased production. The restricted production necessitated a reduction of the number of men employed, the total force being 1,265 against 1,622 in 1891. The average time made remained about the same.

Coal product of Elk county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	413,243				
1885	537,826				
1886	526,036				
1887	609,757				
1888	555,960				
1889	614,113	$498,728	$0.81		1,185
1890	1,121,534	942,081	.84	255	1,181
1891	973,600	804,635	.83	229	1,622
1892	731,575	611,112	.83	230	1,265

Fayette county.—Coal produced in 1892, 7,260,044 short tons; spot value, $5,620,159.

The output of coal in Fayette county in 1891 was much less than in the preceding year, owing to the prolonged strike at the Frick ovens No such serious trouble occurred in 1892, and an increased product of nearly 1,500,000 tons over that of 1891 was obtained. The number of employés increased from 7,545 to 7,952, and the average working days from 216½ to 239. The average price per ton for coal sold declined 5 cents. In computing the value of the total product the amount of coal coked is taken usually at 75 cents per ton.

Coal product of Fayette county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	4,041,643				
1885	3,192,172				
1886	4,194,613				
1887	4,540,322				
1888	5,208,993				
1889	5,897,254	$3,702,548	$0.63		6,567
1890	6,413,081	4,931,015	0.77	247	6,503
1891	5,782,573	4,755,444	0.82	216½	7,545
1892	7,260,044	5,620,159	0.77	239	7,952

Huntingdon county.—Coal produced in 1892, 333,855 short tons; spot value, $249,715.

The output of Huntingdon county in 1892 was 64,834 tons more than in 1891, though the number of men employed and the average working time both decreased. Of the product in 1892, 17,682 tons were classed as semi-bituminous.

The coal fields of the county are contained exclusively in the Broad Top semi-bituminous field. The mines are located in what is known as the Broad Top mountain field, being opened on both sides of the mountain, and known, respectively, as the east and west fields.

On account of the superior character of the coal it is much sought for by the trade to supply special consumers. Although a very small area of the southwestern corner of the county is underlaid by coal beds, yet the amount of available coal is very considerable, and there are no facts to warrant the popular impression that the coal beds will be early exhausted, since the amount of available tonnage contained is such as to make it impracticable at the present time to enter into any speculation on this question.

Coal product of Huntingdon county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	212, 587				
1885	247, 424				
1886	313, 581				
1887	265, 479				
1888	281, 823				
1889	280, 133	$211, 597	$0. 75		538
1890	322, 630	247, 364	. 77	237	611
1891	269, 021	210, 918	. 78	246	595
1892	333, 855	249, 715	. 75	244	560

Indiana county.—Coal produced in 1892, 514,463 short tons; spot value, $393,388.

Indiana county's product in 1892 was 58,386 tons more than in 1891, and its value increased $47,765. The total number of employés in 1892 was 656, against 561 in 1891. The average working days decreased from 227 to 191. As will be seen in the following table the development of the coal fields of Indiana county since 1884 has been exceptionably rapid.

Coal product of Indiana county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	30, 758				
1885	82, 750				
1886	103, 615				
1887	207, 597				
1888	157, 285				
1889	153, 698	$124, 088	$0. 71		139
1890	357, 580	294, 389	. 82	215	658
1891	456, 077	345, 623	. 76	227	561
1892	514, 463	393, 388	. 77	191	656

Jefferson county.—Coal produced in 1892, 3,706,329 short tons; spot value, $3,006,617.

Jefferson county maintains its position as fifth in producing importance. The production of the county, with the exception of a slight falling off in 1890, has increased steadily since 1884, the product in 1892 being 545,715 short tons more than in 1891. The average price per ton declined from 88 cents to 81 cents. The number of employés increased from 4,172 to 4,567 and the average time decreased from 237 days to 232 days.

Coal product of Jefferson county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	450,079				
1885	479,675				
1886	1,023,186				
1887	1,693,492				
1888	2,275,349				
1889	2,896,487	$2,117,531	$0.73		3,738
1890	2,850,799	2,421,960	.85	245	3,971
1891	3,160,614	2,774,610	.88	237	4,172
1892	3,706,329	3,006,617	.81	232	4,567

Lawrence county.—Coal produced in 1892, 216,561 short tons; spot value, $221,329.

Five mines contributed to the output, which in 1892 was 51,892 tons more than in 1891. The average price remained the same as in the two years previous. The total number of men employed in 1892 was 368 and the average working days 250, against 327 men and 236 days in 1891.

Coal product of Lawrence county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	42,818				
1885	42,137				
1886	101,154				
1887	125,361				
1888	106,921				
1889	143,410	$150,537	$1.05		267
1890	140,528	142,682	1.02	232	307
1891	164,669	168,114	1.02	236	327
1892	216,561	221,329	1.02	250	368

Lycoming county.—Lycoming county appears for the first time as a producer of coal otherwise than from country banks. The Red Run Coal Company opened a mine in 1892 at Ralston and took out 20,515 tons of coal valued at $23,036. Shipments to the amount of 16,600 tons were made over the Northern Central Railway.

McKean county.—Coal produced in 1892, 21,282 short tons; spot value, $23,410.

The output of McKean county is from one mine, and is used largely by the locomotives of the Western New York and Pennsylvania railroad. The product in 1892 was 5,937 tons more than in 1891.

Shipments of coal from McKean county, Pennsylvania, since 1875.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1875	33,501				
1876	81,830				
1877	73,222				
1878	72,098				
1879	85,745				
1880	100,046				
1881	110,099				
1882	73,834				
1883	84,899				
1884	78,870				
1885	44,312				
1886	617				
1887	8,761				
1888	10,443				
1889	11,500				
1890	(*a*)				
1891	15,345	$16,112	$1.05	230	42
1892	21,282	23,410	1.10	301	28

a None.

Mercer county.—Coal produced in 1892, 420,145 short tons; spot value, $368,479.

The output in 1892 was 106,075 short tons less than in 1891. The value decreased $106,374; the average price per ton, 2 cents; the number of men employed, 96, and the average working days, 60.

Coal product of Mercer county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	276,350				
1885	378,503				
1886	537,712				
1887	539,721				
1888	487,122				
1889	575,751	$511,202	$0.89		1,094
1890	524,319	446,392	.85	231	1,023
1891	526,220	474,853	.90	241	972
1892	420,145	368,479	.88	181	876

Somerset county.—Coal produced in 1892, 509,610 short tons; spot value, $346,705.

The output of coal in Somerset county in 1892 was 29,416 tons more than in 1891, but did not attain as large a figure as in 1890, the year of heaviest production. The average price declined from 71 cents in 1891 to 66 cents in 1892. The total number of employés increased from 531 to 577, but there was a decrease in the average working days from 266 to 238. The output in 1892 included 108,270 tons of semi-bituminous coal.

Coal product of Somerset county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	269,930				
1885	302,715				
1886	349,926				
1887	416,240				
1888	370,238				
1889	442,027	$308,400	$0.70		525
1890	522,796	341,518	.65	225	646
1891	480,194	338,533	.71	266	531
1892	509,610	346,705	.66	238	577

Tioga county.—Coal produced in 1892, 999,784 short tons; spot value, $1,434,878.

The amount of coal produced in Tioga county during 1892 was 11,088 short tons less than in 1891, but the value of the product, owing to an advance of 30 cents in the average price per ton, increased $277,919. No explanation is offered for this increase in the value. It was probably due to an increased demand for the coal, and as the unfavorable condition of the coal beds does not favor increased production, higher prices were obtained for the coal mined. About three-fifths, or 605,996 short tons, of the product in 1892 was semi-bituminous.

Coal product of Tioga county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	931,922				
1885	1,067,081				
1886	1,384,800				
1887	1,328,963				
1888	1,106,146				
1889	1,036,175	$1,264,889	$1.22		2,400
1890	903,997	995,936	1.10	192	2,019
1891	1,010,872	1,156,959	1.14	241	1,980
1892	999,784	1,434,878	1.44	223	2,249

Washington county.—Coal produced in 1892, 2,903,235 short tons; spot value, $2,538,375.

Washington county shared in the general improvement in the coal trade of the State, the product of the county being 297,077 short tons more than in 1891. The value increased proportionately, the average price per ton being the same as in the preceding year. The total number of employés increased 760, or from 4,135 to 4,895. The average number of working days, however, decreased from 222 to 202.

Coal product of Washington county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	707, 262				
1885	836, 633				
1886	1, 612, 407				
1887	1, 751, 615				
1888	1, 793, 022				
1889	2, 364, 901	$1, 557, 486	$0. 66		4, 005
1890	2, 836, 667	2, 649, 627	. 93	227	4, 644
1891	2, 606, 158	2, 251, 788	. 87	222	4, 135
1892	2, 903, 235	2, 538, 375	. 87	202	4, 895

Westmoreland county.—Coal produced in 1892, 8,791,068 short tons; spot value, $7,102,934.

Westmoreland county has for a number of years been the banner coal-producing county in the State. The same causes which affect Fayette county, influence Westmoreland, and, like the former, the output in 1892 shows a substantial increase, the gain being 823,575 short tons. The average price in Fayette county declined 5 cents in 1892 and that of Westmoreland, 6 cents. Unlike Fayette county, however, there were less employés in 1892, although the average working time increased.

Coal product of Westmoreland county, Pennsylvania, since 1884.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1884	3, 282, 733				
1885	3, 774, 072				
1886	5, 446, 480				
1887	6, 074, 486				
1888	6, 519, 773				
1889	7, 631, 124	$5, 674, 493	$0. 74		9, 109
1890	8, 290, 504	6, 691, 532	. 80	228	12, 080
1891	7, 967, 493	6, 891, 998	. 87	221	11, 083
1892	8, 791, 068	7, 102, 934	. 81	234	10, 724

The Connellsville coal field.—Considerable discussion has recently arisen in regard to the length of life yet remaining to this famous coke producing region, some claiming that the field is rapidly approaching exhaustion. The following information has been collected by persons interested in the region, and is submitted as furnishing a fairly accurate estimate of the possibilities of the field:

The Connellsville coal field is in the southwestern part of Pennsylvania and extends in a rather narrow strip from a few miles south of Latrobe in Westmoreland county on the north, to a point near Smithfield, Fayette county, on the south. Its length from north to south is about 42 miles and ranges from 1 mile to 4 miles in width. Surveys made by the H. C. Frick Coke Company place the total original area of the field at 87,097 acres or 136.09 square miles. This includes everything within the crop line and is distributed as follows: North of Sewickley creek, 24.56 square miles; Sewickley creek to Jacobs creek, 28.65 square miles; Jacobs creek to Youghiogheny river, 11.76 square miles; Youghiogheny river to Redstone creek, 39.72 miles; south of Redstone Creek, 31.40 miles. Excluding the coal in reservations, lying under towns, and the area worked out, it is estimated that there are yet remaining about 70,000 acres of available coal still left in the field.

During 1892, Mr. John Fulton, General Mining Engineer of the Cambria Iron Company, of Johnstown, made a strenuous effort to ascertain with some degree of exactness what the actual amount of coal is yet to be obtained in this region, but owing to very incomplete records of the amount of coal shipped out of the field prior to 1880 there was no satisfactory information upon which to base reliable estimates. He calculates, however, that the Connellsville bed affords an output of 11,000 long tons per acre when carefully mined. Taking the Frick estimate of 70,000 acres as a basis, the amount of coal still left in the field would be in the neighborhood of 770,000,000 long tons, or say 860,000,000, short tons. The total amount of coal mined in Westmoreland and Fayette counties in 1892 was about 16,000,000 tons. All of this, however, was not from the Connellsville bed. The amount of coal made into coke in the two counties in 1892 was about 10,000,000 tons. Practically all of this was from the Connellsville bed. It would be safe to estimate that about 2,000,000 tons were taken from the bed and not coked, and taking into consideration the natural increase of production it is thought that a productive life of sixty years still remains for the Connellsville field.

TENNESSEE.

Total product in 1892, 2,092,064 short tons; spot value, $2,355,441.

The output of coal in 1892 was 321,614 short tons less than that in 1891, when a product of 2,413,678 short tons was obtained. The total value of the product decreased from $2,668,188 to $2,355,441, a loss of $312,747, the average price per ton advancing from $1.10½ to $1.13.

The decrease in the production of coal in Tennessee was due to the riots at Briceville, Coal Creek, Tracy City and Oliver Springs. These riots, which were caused by the opposition of "free labor" to the employment of State convicts in competition with it, have been so thoroughly discussed in the daily and technical press and when the occurrences were fresh in the minds of the public that it is only necessary at this time to mention them in connection with their effect on the coal mining industry of the State.

With the exception of a slight decrease in 1889 the amount of coal produced in Tennessee has increased annually from 1878, when 375,000 tons were won, to 1891, when the product reached its highest figure with 2,413,678 short tons, a difference of over 2,000,000 tons. The actual loss to the industry in 1892 was 312,747 short tons, or about 12½ per cent., but it is probable that except for the disturbances the yield of the State would have increased with the general improvement throughout the country, and the presumptive loss may be safely placed at half a million tons, representing a valuation of at least as many dollars. In addition to this loss there was that occasioned by the wanton destruction of property by the rioters, the principal outrage being the burning of the convict stockades at Tracy City on August 13. The losses sustained by one company operating in Anderson county were so great that it was necessary to put its affairs in the hands of a receiver. The strikes occurred in Anderson, Grundy, and Morgan counties, and the losses in product were distributed among them as follows: Anderson county decreased from 587,558 tons in 1891 to 409,970 tons in 1892, a loss of 177,588 tons; Grundy county, from 398,936 tons to 358,023 tons, a loss of 40,913 tons (the convict stockades burned at Tracy City, this county August 13, were rebuilt by September 2, and the convicts who had been sent to Nashville at the time of the fire were returned to work); Morgan county, from 125,287 tons to 34,970 tons, a loss of 90,317 tons. The total loss in the three counties was 308,818 tons.

The total number of men employed in Tennessee coal mines in 1892 was 4,926 and the average number of working days is reported at 240, against 5,097 men for 230 days in 1891. This makes the total working time in 1892 a little greater than in 1891, but the returns for 1892 doubtless include the time engaged in making repairs, etc.

In submitting the following table showing the output of the State in 1892, with the distribution, etc., it is pertinent to state that it is compiled from individual statements from every operator in the State with one exception. The report lacking is of a comparatively small working, the output not exceeding 10,000 tons annually, and is placed in the report for 1892 at 8,000 tons.

Coal product of Tennessee in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Anderson	404,225	3,779	1,966	....	409,970	$454,532	$1.11	218	1,072
Campbell	280,577	4,658	2,370	2,000	289,605	346,980	1.19	213	732
Claiborne	107,836	....	....	29,383	137,219	142,754	1.04	207	276
Franklin	600	800	....	....	1,400	2,800	2.00	50	20
Grundy	137,575	658	2,607	217,183	358,023	397,406	1.11	309	800
Hamilton	87,546	539	820	16,378	105,283	116,652	1.11	192	365
Marion	129,214	11,448	684	100,628	241,974	262,167	1.08	286	375
Morgan	34,439	231	300	....	34,970	47,250	1.36	148	156
Rhea	....	13,143	3,360	116,921	133,424	133,424	1.00	307	175
Roane	25,194	2,495	1,053	73,846	102,588	107,238	1.05	282	207
Scott	152,978	13,201	2,077	14,974	183,230	227,105	1.24	243	448
White	88,078	500	1,800	....	90,378	112,973	1.25	232	300
Small mines	....	4,000	....	....	4,000	4,100	1.03	....	....
Total	1,448,262	55,452	17,037	571,313	2,092,064	2,355,441	1.13	240	4,926

In the following table is exhibited the total product of the State since 1889 by counties, with the increases and decreases in 1892 compared with 1891.

Coal product of Tennessee since 1889, by counties.

Counties.	Product in— 1889.	1890.	1891.	1892.	Increase in 1892.	Decrease in 1892.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*		
Anderson	457,069	582,403	587,558	409,970	....	177,588
Campbell	123,103	126,367	159,937	289,605	129,668	....
Claiborne	(*a*)	(*a*)	73,738	137,219	63,481	....
Franklin	(*b*)	1,500	1,400	1,400	....	....
Grundy	400,107	349,467	398,936	358,023	....	40,913
Hamilton	241,067	277,896	243,298	105,283	....	138,015
Marion	203,923	213,202	271,809	241,974	....	29,835
Morgan	68,229	143,518	125,287	34,970	....	90,317
Rhea	149,194	211,465	213,649	133,424	....	80,225
Roane	(*c*) 174,551	70,452	112,308	102,588	....	9,720
Scott	108,027	136,365	142,943	183,230	40,287	....
White	(*b*)	52,650	78,315	90,378	12,063	....
Other counties and small mines	419	4,300	4,500	4,000	....	500
Total	1,925,689	2,169,585	2,413,678	2,092,064	245,499	567,113
Net increase	....	243,896	244,093	(*d*) 321,614	....	321,614

a Developing. *b* Included in Roane county. *c* Includes Franklin and White counties. *d* Net decrease.

As shown above the decreases in product were not confined to those counties in which the labor troubles occurred, Hamilton, Marion, Rhea, and Roane counties having each sustained losses, but these were offset by the increased production in Campbell, Claiborne, Scott, and White counties. In Hamilton county one mine, out of the three producers, was idle throughout the year, due to poor business, and the mines of the Soddy Coal, Iron and Railway Company (changed in September, 1892, to the New Soddy Coal Company) were not operated to their usual extent. The decrease in the product of Marion county was not explained, but as two of the producing mines changed hands during the year, the transferring of the property doubtless restricted production. The decrease was 29,835 tons, a little more than 10 per cent. of the product in 1891. No explanation was furnished for the decreased output in Rhea and Roane counties, except that as nearly all the product of the former is consumed in the iron works of the company mining it, the production depends upon the condition of the iron industry. The loss in the latter was small—9,720 tons.

The following table shows the annual output of the State for twenty years:

Coal product of Tennessee from 1873 to 1892.

Years.	Short tons.	Years.	Short tons.
1873	350,000	1883	1,000,000
1874	350,000	1884	1,200,000
1875	360,000	1885	1,440,957
1876	550,000	1886	1,714,290
1877	450,000	1887	1,900,000
1878	375,000	1888	1,967,297
1879	450,000	1889	1,925,689
1880	641,042	1890	2,169,585
1881	750,000	1891	2,413,678
1882	850,000	1892	2,092,064

Anderson county.—Coal produced in 1892, 409,970 short tons; spot value, $454,592.

The strikes and riots which made the season of 1891–'92 notorious in the history of coal mining in Tennessee occurred too late in 1891 to seriously affect the amount of production, in that year the output in Anderson county exceeding that of 1890 by 5,155 tons. But in 1892 the effect was disastrous to the trade. The product of this county fell off 177,588 tons (nearly two-fifths of the entire output in 1892), the price declined from $1.15 to $1.11 per ton, and the losses sustained by one company were so great that it went into the hands of a receiver. The number of employés decreased from 1,350 to 1,072, practically throwing 282 men out of employment, and the number of working days was reduced from 242 to 218.

Coal product of Anderson county, Tennessee, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	457,069	$531,920	$1.16	....	986
1890	582,403	680,249	1.17	291	1,325
1891	587,558	671,633	1.15	242	1,350
1892	409,970	454,592	1.11	218	1,072

Campbell county.—Coal produced in 1892, 289,605 short tons; spot value, $346,980.

Campbell county increased its output in 1892 over 1891 by 129,668 tons, or a little over 80 per cent. This large increase was probably due to a demand created by the falling off in the product of Anderson county. The two counties adjoin and Campbell county would naturally secure trade belonging to Anderson county when the latter's product is shut off. Campbell county furnishes what is known as "Jellico" coal. It is a popular fuel for steam and domestic use, being low in sulphur and ash, and large quantities are shipped to Savannah and Brunswick, Georgia, and other coast ports for steamer fuel.

Coal product of Campbell county, Tennessee, since 1889.

Years.	Short tons.	Value.	Average price per ton.	Number of days active.	Number of men employed.
1889	123,103	$146,610	$1.15	....	393
1890	126,367	153,790	1.22	212	251
1891	159,937	203,729	1.27	145	451
1892	289,605	346,980	1.19	213	732

Claiborne county.—Coal produced in 1892, 137,219 short tons; spot value, $142,754.

The first output reported from Claiborne county was in 1891, when 73,738 short tons, valued at $87,624, were obtained. The tonnage in 1892 was accordingly 63,481 greater than in 1891, an increase of 86 per cent. In the report for 1891 mention was made of the extensive work being done in the coal fields of Claiborne county and an increased production predicted. The production in 1893 will probably show still further increase. The number of men employed in 1892 was 276 and the mines were worked an average of 207 days, against 165 men for 172 days in 1891.

Franklin county.—The output is from one mine at Sewanee. The production varies very little from year to year, the tonnage in 1891 and 1892 being reported the same. About half the product is consumed locally, supplying the University of the South at Sewanee and residents in the vicinity.

Grundy county.—Coal produced in 1892, 358,023 short tons; spot value, $397,406.

Grundy county was one of the sufferers from the "convict labor" riots, the stockades used for the confinement of the convicts being burned on August 13. This necessitated their removal to Nashville, but by September 2 sufficient quarters for their shelter had been arranged, and they were brought back and put to work. In consequence of the disturbances the amount of coal produced was 40,913 short tons less than in 1891.

Coal product of Grundy county, Tennessee, since 1889.

Years.	Total product.	Total value.	Average price per ton.	Number of days active.	Total employés.
	Short tons.				
1889	400,107	$395,767	$0.99	....	501
1890	349,467	326,827	.94	310	880
1891	398,936	353,313	.89	311	515
1892	358,023	397,406	1.11	309	800

Hamilton county.—Coal produced in 1892, 105,283 short tons; spot value, $116,652.

Operators in Hamilton county complain of poor business and low prices in 1892, and one mine was shut down during the entire year The result was a reduction in the output of 138,015 short tons, or about 56 per cent. The average price per ton was 1 cent less than in 1891; the number of employés was reduced from 475 to 365, and the number of working days from 213 to 192.

Coal product of Hamilton county, Tennessee, since 1889.

Years.	Total product.	Total value.	Average price per ton.	Number of days active.	Total employés.
	Short tons.				
1889	241,067	$313,991	$1.30	....	625
1890	277,896	318,898	1.15	285	500
1891	243,298	282,502	1.12	213	475
1892	105,283	116,652	1.11	192	365

Marion county.—Coal produced in 1892, 241,974 short tons; spot value, $262,167.

The output of Marion county was 29,835 short tons or about 12 per cent. less than in 1891. The value of the product declined from $301,-910 to $262,167, and a reduction of 3 cents per ton is noted in the average price. The number of employés decreased from 615 to 375, but the average working days increased from 220 to 286.

Coal product of Marion county, Tennessee, since 1889.

Years.	Total product.	Total value.	Average price per ton.	Number of days active.	Total employés.
	Short tons.				
1889	203,923	$230,116	$1.13	....	423
1890	213,202	225,403	1.06	226	523
1891	271,809	301,910	1.11	220	615
1892	241,974	262,167	1.08	286	375

Morgan county.—Coal produced in 1892, 34,970 short tons; spot value, $47,250.

Strikes and riots among the miners interfered with the production, the output decreasing from 125,287 short tons in 1891 to 34,970 tons in 1892, a loss of 90,317 tons or of 70 per cent. The number of employés was reduced from 363 to 156, and the working days from 250 to 148.

Coal product of Morgan county, Tennessee, since 1889.

Years.	Total product.	Total value.	Average price per ton.	Number of days active.	Total employés.
	Short tons.				
1889	68,229	$91,511	$1.34	....	135
1890	143,518	158,243	1.10	258	363
1891	125,287	135,202	1.09	250	363
1892	34,970	47,250	1.36	148	156

Rhea county.—Coal produced in 1892, 133,424 short tons; spot value, $133,424.

The output of coal in Rhea county in 1891 was 213,649 short tons, showing a decrease in 1892 of 80,225 tons. There was only one producing mine in 1892, and with the exception of about 16,000 tons sold to local trade and used about the mines the entire product is made into coke and used in the iron works of the company mining it. The coal production of the county, therefore, depends almost entirely upon the activity of the iron works.

Coal product of Rhea county, Tennessee, since 1889.

Years.	Total product.	Total value.	Average price per ton.	Number of days active.	Total employés.
	Short tons.				
1889	149,194	$164,118	$1.10	....	475
1890	211,465	211,465	1.00	200	450
1891	213,649	213,649	1.00	250	350
1892	133,424	133,424	1.00	307	175

Scott county.—Coal produced in 1892, 183,230 short tons; spot value, $227,105.

Scott county has increased its output each year since 1889, the gain in 1892 being 40,287 short tons. The product was from four mines, the same as in 1891.

Coal product of Scott county, Tennessee, since 1889.

Years.	Total product.	Total value.	Average price per ton.	Number of days active.	Total employés.
	Short tons.				
1889	108,027	$145,075	$1.34	....	180
1890	136,365	175,327	1.29	241	475
1891	142,943	179,165	1.25	182	347
1892	183,230	227,105	1.24	243	448

Roane county.—Coal produced in 1892, 102,588 short tons; spot value, $107,238.

The product of Roane county was 9,720 tons less than in 1891, and the average value declined $1.15 to $1.05 per ton. There are two producing mines in the county, one being opened in 1891 to supply principally the local trade at Harriman. Of the product of the other mine the greater portion is made into coke by the company mining it for use in its iron mills.

White county.—One mine at Bon Air Mines yields the entire product of the county, which in 1892 was 90,378 short tons, valued at $112,973 against 78,315 tons worth $102,593 in 1891, an increase of 12,063 tons, and $10,380. The number of men employed in 1892 was 300 and the number of working days 232, against 246 men and 228 days in 1891.

THE TENNESSEE COAL MEASURES.

[By J. M. Safford, State Geologist.]

Topography.—The Coal Measures in Tennessee, constitute, topographically, a sharply defined division of the State, being the elevated flat-topped area known variously as the Cumberland mountain, the Cumberland mountain table-land, or the Cumberland plateau. The division is the Tennessee part of a mountain belt which extends quite across the State from Kentucky to Alabama, or, indeed, the Tennessee part of the greater belt of the Alleghany mountains which reach from Pennsylvania southward into Alabama.

The trend of the Cumberland table-land in Tennessee is northeast and southwest. It is, speaking generally, and as stated, flat-topped, has a mean width, measured directly east and west, of about 60 miles, and an area approximately of 5,100 square miles. As a table mountain it stands in sharp relief from 800 to 1,200 feet above the plains and valley lands at its foot on each side. Its mean elevation above the sea is about 2,000 feet. Its western border is irregularly scalloped and notched by deep coves and valleys, separated from each other by bold jutting spurs. Its eastern border, overlooking the valley of East Tennessee, is, however, remarkably different. Here the edge of the mountain presents a nearly direct or slightly curving line. Without going into any special detail it may be mentioned, first, that the southern half of the table-land is split, longitudinally, into two arms by a narrow, deep, and straight valley, known as the Sequatchie valley, the eastern arm bearing the name of Walden ridge; (*a*) and secondly, that within the northeastern portion of the table-land are high massive ridges which rise from 500 to 1,400 feet above the general level—mountains, indeed, on the table-land. The portion referred to here lies mainly within that part of the table-land bounded by the Cincinnati Southern railroad on the southwest and the Ohio division of the East Tennessee, Virginia, and Georgia railroad on the northeast. It includes parts of Anderson, Morgan, Campbell, and Scott counties. As to the elevation of the mountains in this region it may be stated that one high point, named Mount Safford by the late Prof. Henry E. Colton, is said to be 3,400 feet above the sea; another, the American Knob, 3,200; and another, 3,100. (See a paper by Professor Colton "On the Upper Coal Field of Tennessee," in the Transactions of the American Institute of Mining Engineers.)

With this much premised it is easy to understand the topography of the Tennessee Coal Measures. They are in truth, coextensive with the table-land, and everywhere make its top or capping portion. The table-land is the coal field. The area of the one is the area of the other.

The base of the table-land is limestone; its top is the coal series, in which hard, resisting sandstones and conglomerate predominate. The strata are horizontal, or, in a general view, may be so regarded. Along the western escarpment of the mountain the removal of the limestone by acid waters undermines the sandstone top, leaving the latter projecting in a prominent, overhanging brow or line of cliffs, below which the steep limestone slopes begin and run down to the lowlands. On the eastern side, along the very margin of the mountain, the strata have been disturbed, upturned, or faulted, often to a great degree. The sandstones frequently stand at high angles or vertically, and have so controlled the work of the eroding agencies as to give the margin the straight or gently curving character referred to.

In the northern half of the State this eastern margin, with its plates of sandstone, develops into a remarkable topographical feature. From Rhea county northeasterly it takes upon itself more and more the character of a sharp ridge, at the same time, and in corresponding

(*a*) This, which we may call the Walden ridge of the south, does not, as a whole, correspond to the Walden ridge of the north, referred to below. This is a flat-topped mountain; ridge the other is a sharply crested ridge. So far as they are related, the latter corresponds to the eastern edge of the former.

degree, separating itself along a great fault line from the main mountain. In the northern part of Roane county the separation is complete, and so continues in Anderson and Campbell; the ridge becomes isolated, and is the Walden ridge of this part of the State. The ridge is steep and roof-like. Winding gracefully along at the foot of the main mountain, it is a veritable bulwark, guarding effectually the mountain mass in the rear, and only allowing access at rare intervals through the water gaps of the streams. In its course through Roane and Anderson counties it is cut by the four following streams, each supplying a water gap: Big Emory and Little Emory rivers in Roane county, and Poplar and Coal creeks in Anderson county. Good sections of the rocks, mostly the strata of the lower members of the Coal Measures, are to be seen in these gaps, displaying to advantage the composition and structure of the ridge. The gaps have been well called natural gateways. This they are preëminently. That of the Big Emory gives passage to the Cincinnati Southern railroad; those in Anderson are very important outlets for the coal of the main mountain; and all have been highways for the common roads of the country for scores of years.

In speaking of the mountain or table-land in general, we include Walden ridge of the north with it. This understood, and following the eastern margin of the mountain through its long course of 150 miles from Georgia to Cumberland gap, the limestone of the base is often seen on the slopes in outcropping exposures, and usually with a dip downward into the mountain. In places the limestone is buried or displaced in faults, the coal beds and their rocks dropping to the valley.

A section or block of the main mountain, back of Walden ridge, having a front of about 15 miles and lying to the west-northwest from Knoxville, in Anderson and Campbell counties, has suffered great vertical displacement. On the northwest side of a great fault, which completely separates the strata of the mountain from those of the ridge, this block of mountain, carrying with it the limestone and all the rocks of the two lower series of the Coal Measures, has dropped bodily down 2,000 feet, more or less, completely burying the limestone and the lower coals below water level. This downthrow occurs within the northeasterly portion of the coal field, that portion in which are the high massive ridges above referred to. Within the area the strata as a rule dip slightly to the southeast. In the reverse direction they rise, when followed, quite across the whole coal field. Near the line of the Cincinnati Southern railroad and to the west beyond the strata of the lower series of the Coal Measures come to the surface. Simultaneously, the high mountain ridges disappear and the plateau assumes its more normal character. Further north and reaching to the Kentucky line, in contiguous portions of Campbell and Scott counties, there is another deep and similar downthrow of the Coal Measures. This occurs on the northwest side of the fault running lengthwise through the valley of the Elk

Fork, a stream flowing northeasterly into Kentucky and a tributary of the Cumberland river.

The Measures in three series.—For the purposes in view we group the strata of the Coal Measures, as has been done substantially by Mr. Colton, into three divisions or series. This classification, while not claiming to be a scientific one, conforms well to the topography of the Measures and the geographical distribution of the coal. It is based in part upon the persistent stratum well known as the Conglomerate, which, whatever it may be elsewhere, is with us a single conspicuous bed of rock, pervading in its proper geological horizon the entire coal field, and having great importance as a plane of reference in making out and locating beds of coal. We call it the Sewanee Conglomerate, from Sewanee, in Franklin county, the site of the University of the South, and located on the table-land in a region where the conglomerate is the capping or surface rock. Numerous outcrops and exposures of the rock make Sewanee one of the best localities for its study.

The stratum is a sandstone, well charged with white quartz pebbles. The pebbles make it easily recognizable. Its thickness varies from 50 to 150 feet. It has been a leading factor in determining the form of the table land, the most effective of the sandstones constituting the resisting cap of the mountain. Over most of the westerly parts it appears as the capping stratum. Altogether, it is the surface rock of not less than a third of the entire plateau area. Once the Conglomerate was everywhere heavily covered, as it now is in the more easterly portions, with the higher strata of the Coal Measures; but to-day, over large areas of its westerly portions, it is stripped and naked, the superior strata having been swept away by eroding and denuding agencies.

The first series.—This, the first and lowest division of the Coal Measures, includes all the strata embraced between the limestone of the base of the mountain and the top of the Conglomerate. It corresponds to the division which, in the Chattanooga sheet of the United States Geological Survey, has been named the "Lookout sandstone." The series has two distinct members, the Conglomerate, or, as we name it, the Sewanee Conglomerate, above, and a group of sandstones, shales and coal seams, below, known as the sub-Conglomerate Measures. It is desirable for local purposes at least to keep up this distinction. The first series has great extent, and necessarily so, as it constitutes the base of the Coal Measures. It underlies, therefore, an area of 5,100 square miles. Much of it, however, is covered by strata of the higher series. In the great downthrows of the Coal Measures, occurring as above noticed, one in Anderson and Campbell counties and another in Campbell and Scott, it is deeply buried below the water levels of the country.

Wherever the Conglomerate is the surface rock the series in question has a high position and its coal beds are made easily accessible. Such conditions prevail along the western side of the table-land, and here, wherever the mountain breaks away in steep slopes, the horizontal strata are exposed in outcrops, the whole usually surmounted by the projecting cliffs, or sometimes by the retreating edge of the Conglomerate. This displays the coal beds to advantage, giving the miner the information he seeks, and often at little expense.

Along the eastern edge of the mountain, or, what is the same, along the eastern slopes of Walden ridge south and Walden ridge north, the upturned strata bring with them the coal beds, exposing them to view edgewise. The beds, out-cropping high or low on the slopes, are presented at various angles, dip into the mountain or stand upright, sandwiched between great plates of sandstone. Here and there, in the round of disturbances and dislocations, they may even be found to occupy locally a horizontal or a nearly horizontal position.

The thickness of the sub-Conglomerate Measures varies from 60 to 400 feet. They include from one to four seams of coal. These often appear to have the character of extended lenses, some thinning out, when followed long distances, and others coming in to take their places. The more continuous seams vary in thickness, alternately swelling to workable dimensions and sinking to a few inches or to mere traces. It often happens that in given sections no one of them has thickness enough to be profitably worked. At many localities, however, one or more thicken up and become important and great bodies of coal. Sometimes, as in instances given below, a seam will swell to an extraordinary thickness, giving as high as 10 or 12 feet of excellent coal. Such exceptional developments, however, do not reach any great distance, not over a few score yards at most.

A notable body of these coals is largely worked at the Bon Air mines in White county, and is an important source of supply to the Nashville market. A branch railroad has been built from Sparta, the county seat of White county, to reach it. The coal is a superior free-burning, domestic fuel, and commands the best of prices. Two seams are worked at these mines carrying a maximum thickness of from three to four feet.

But the most important body of these sub-Conglomerate coals is found in Fentress and the eastern part of Overton county. Two areas here, together estimated to contain 90 square miles of territory, are underlaid by a bed of coal of high grade, which ranges from three and a half to five and a half feet in thichness, with an average probably above four. This is comparatively a new development, a coal field promising much for Nashville and middle Tennessee. A railroad is now under construction and well advanced, the primary object being to strike this coal. The top of the mountain in this region is, with the exception of a single and sharply cut valley, level or but little broken for miles in every direction. The Conglomerate is the capping stratum, below the bottom of which, at depths ranging from 140 to 260 feet, is the coal. Below this again, from 13 to 130 feet deeper, is the limestone at the base of the measures.

The two areas are known, respectively, as the western and the eastern. The former is deeply and well dissected by the gorges of the East fork of Obey's river, the valley referred to, on the slopes or faces of which the coal is well exposed in numerous outcrops. The eastern area, with a different drainage, has no stream that cuts through the Conglomerate to the coal. The latter, however, has been fairly well tested by diamond drills and found to be good, both in quality and volume. The coal of these areas is a clean, hard, laminated coal, a superior steam and domestic fuel. Though not primarily a coking coal it produces "a coke of good carrying capacity with good cell space."

At numerous points in the disturbed strata along the southeastern escarpment of the table-land the sub-Conglomerate coals show themselves in outcrops, not a few of which are the seat of mining operations. They are seen at intervals from Cumberland Gap to the Georgia line, and are worked among other points at the water gaps of the two Emory rivers, at Dayton, Roaring Creek, Soddy, and at Ætna in the Raccoon mountain region In ante-bellum days the sub-Conglomerate beds in the latter region yielded large amounts of coal for southern markets. The thickness of the beds at the various mines just mentioned rarely reaches four feet. An average of three feet is considered good, while coal less than this is often worked.

Passing to Sequatchie valley, we find many banks, old and new, in these lowest coals. They are found high upon the slopes of the mountain in sight of South Pittsburg, under the cliffs overlooking Battle creek, at Wall view, Sequatchie, and points farther north. The beds as a rule are comparatively thin, but locally swell out to exceptional thicknesses of 5 and 6 feet. In Little Sequatchie valley there are remarkable instances of such local thickening of the beds, as, for example, the Colwell bank, 6 feet; the Parmley, 8 feet; and the Petre-cave Fork bank, 12 feet. The coals of Sequatchie valley are mostly good coking coals when free from shale. One, the so-called Battle creek, is a free burning block coal, greatly in demand for domestic use. It has been extensively mined even where less than 20 inches in thickness. The University of the South, at Sewanee, gets its best coal from the lowest of the series. The bed ranges from 1 to 3 feet, rarely reaching the latter thickness. From the account given it will appear that the coal beds of this division of the Tennessee Measures, while even now an important source of supply, promise much more for the future. The coal is of high grade, and, with the coke made from it, finds ready sale, not only in Tennessee, but in more southern States as well.

The second series.—In crossing the table-land from west to east, along one of many lines that might be taken, we first travel for a number of miles upon the flat top of the Conglomerate; then, traveling on, begin to rise gradually or steeply, as the case may be, over outcropping shales and sandstones, until finally the top of a bench or flat ridge is reached, which is soon seen to be a plateau ridge upon the table-land. Such ridges rising up back from the brow of the main mountain, often in steep escarpments, are spoken of as the "back ridges" or "back mountains." In height they are from 250 to 500 feet above the Conglomerate floor upon which they rest. Passing on to the eastern part of the table-land the plateau ridges or back ridges lose more or less of their identity as a distinct topographical feature and are hardly separable, or often not at all so, from the general Coal Measure mass of the mountain.

The strata of the plateau ridges constitute our second series of the Coal Measures. They are shales and sandstones, containing interlaminated a number of seams of coal, all surmounted at top by a heavy sandstone. One of the beds of coal, known as the "Main Sewanee," is, on account of its great extent, uniformity of thickness, accessibility, and the quality of its product, the most important bed of coal in Tennessee. The thickness of the beds varies from 2 to 7 feet, generally maintaining an average thickness not far from 4 feet. Tracy City, in Grundy county, is at the foot of a widely-extended plateau ridge. In this the Sewanee coal has been and is largely mined. A section of the outcropping strata at Tracy has been taken as a typical one of the second series. This section, from the floor of the Conglomerate to the top surface of the sandstone capping the plateau ridge, shows a series of horizontal strata 300 feet in thickness. It includes four seams of coal. The lowest seam, outcropping twenty feet above the Conglomerate, is here not thick enough to be profitably worked. Ten miles to the southeast it is thicker and once supplied a fair amount of coal. On the extreme eastern escarpment of the mountain, in Hamilton county, it appears to be represented by the "Soddy" coal at Rathburn and Daisy. It is worked at Rathburn and is reported to have a thickness of more than four feet. The "Nelson" coal of Dayton and Graysville, averaging about the same thickness, may also belong to this horizon.

The second seam or bed, thirty-three feet above the first and fifty-five above the Conglomerate, is the Main Sewanee, which has been spoken of. The other two seams are high in the section, the third within twenty-four feet of the capping sandstone, and the fourth and highest immediately under it. Both are thin and unimportant in this region, but have interest in that they represent horizons which elsewhere in the table-land develop beds locally, at least, workable and of value. But the Main Sewanee is preëminently the bed of the series, and, indeed, as stated, of the whole coal field. Its thickness has been given. It is estimated that it underlies nearly half the surface of the table-land, and is easily accessible over the greater part of this. It has been for many years largely mined, as stated, in the Tracy City region, its products being carried as raw coal to Nashville and to towns of middle Tennessee, and as coke to furnaces for making iron. The Sewanee is the principal coal of the Victoria and Whitwell mines in Marion county, where, as at Tracy City, it has supplied and is supplying coal for domestic uses, and coke for furnaces and manufacturing establishments. Their products go chiefly to South Pittsburg and Chattanooga. The same coal is found in the mountains on the west side of Sequatchie valley from Whitwell to the head of the valley, and on beyond through Cumberland into counties farther north and west. Passing to the eastern margin of the table-land, the Sewanee bed is seen in the water gaps of Walden ridge in Anderson and Roane counties, at some of which, as at that of the Big Emory, it has been worked. Southwesterly from these it is the coal of Rockwood and supplies coke for the pioneer furnace of post-bellum time in East Tennessee. South of this a short distance, in the same bed, and of ante-bellum and ante-railroad time, was the famous Kimbrough mine, prized in its day for the quality of the coal it yielded, now a thing of the past and the circumstance of its existence well nigh forgotten.

Passing on southeasterly along the eastern escarpment of the mountain and passing outcrops and exposures well worthy of notice, we come to mining localities, in Rhea and Hamilton counties, at which two or more seams of the coal of the Sewanee series are known. Some of these with maximum thicknesses of three and five feet are extensively mined. One, the "Nelson," would appear to be correlated with the Sewanee, and another, already mentioned, the "Soddy," with the first seam of the Tracy City section, or as suggested, both may pertain to the lowest horizon, in which case the Sewanee would be a higher seam.

In the Raccoon mountain or Ætna region, seams of the second series, including the Sewanee, have, with the sub-Conglomerate coals, been for forty years or more a fruitful source of supply, both in coal and coke, to Chattanooga and points farther south.

In the great downthrows of Anderson, Campbell, and Scott, the members of the second series have been, with those of the first, sunk out of view, lost to recognition and approach. North and east of the Ohio division of the East Tennessee, Virginia and Georgia Railroad, in Campbell and Claiborne counties, are uplifts which, over portions of the area, bring the coal beds of the lower series to the light again. Among these the Sewanee and other horizons are recognized, but, as a whole, they require more study for their satisfactory classification and correlation.

The third series.—The second series of the Coal Measures, just considered, is terminated at top by a sandstone, which, from its massive development at Big Emory gap, we have called the Emory sandstone. The name, we note, is intended to apply more to a particular horizon, or to a group of sandstones, than to a single stratum. In the central and more westerly parts of the table land, where the strata are horizontal or nearly so, the Emory sandstone, as at Tracy City, is not only the uppermost rock of the second series, but the capping rock of the plateau ridges as well. Along the southern half of the eastern edge of the table land it is often seen in outcrops, dipping northwesterly, with the other strata, into the mountains, or else displaced in abnormal positions. Along the northern half of the edge, in the detached Walden ridge of the region, the sandstone is usually conspicuous among the vertical plates of rocks that make up this remarkable ridge.

The section in the gap of the Big Emory, in which we find the two lower series of the Measures, is terminated by the Emory sandstone, occurring here in great force. The vertical strata of the section, commencing with the most easterly (lowest geologically), succeed each other in order, ending with the sandstone. Including the latter member, the entire exposure, measured along the track of the Cincinnati Southern Railroad which passes through this gap, is about 250 yards in length. The Emory sandstone, as seen respectively at this gap and at Tracy, presents phases highly in contrast; here, it is an upright standing wall; there, a level, spreading floor. All strata above the Emory sandstone are included in the third series of the Coal Measures. The geographical bounds of the division lie within the counties of Morgan, Anderson, Campbell, Scott, and Claiborne. Its area is estimated roughly at 700 square miles, or about one-seventh of the entire area of the coal field. Patches and strips of its lowest strata are to be found farther south in the counties of the eastern side of the mountain, but these are local and superficial and are not included. The greatest development of the series is in the high mountain ridges of Morgan, Anderson, and Campbell. These are embraced in an area made up of contiguous portions of the counties and contain about 400 square miles of territory. The main ridge of the group, with its highest points from 3,000 to 3,400 feet above the sea, and a part of the great divide between the waters of the Tennessee river on the east and of the Cumberland on the west, is a prominent border for the area. In its course it forms in the region a great U-shaped bend, nearly sixty miles around and inclosing a complex of rugged mountain ridges. The U lies with its open end to the northwest and its curvature to the southeast. Looking outwards from this curvature, easterly and southeasterly, the slope of the ridge is seen to be very steep, its high crest looking down upon Walden ridge at its foot, and overlooking the great valley region of East Tennessee beyond. Looking within or westerly, we have the complex spoken of. It is in this, as a mountain basin, that the head streams of New river take their rise. New river flows westerly, its waters finally reaching the Cumberland. As much of the area of the third series is drained by this river, it has been named by Mr. Colton and appropriately, the New River coal field.

The strata of the New River field have a general dip to the southeast of about 60 feet to the mile. At the foot of the main ridge, on the northeast and southeast sides of the U bend, the strata are suddenly cut off by a fault, the lowest dropping, as before stated, much below water level. By the same fault the strata of the mountain are sharply separated from the inclined or vertical strata of Walden ridge.

In the highest of the New River ridges, the third series of the Measures reaches its maximum thickness of from 2,800 to 3,000 feet. The upper 2,300 feet of this, commencing with a coal bed a little below water level at Careyville, in Anderson county, and extending to the highest point of the main ridge, Mount Safford, 3,400 feet, as stated, above the sea, is fairly well known, and contains the important beds of coal. At points of greatest thickness the third series contains, it is estimated, twenty seams of coal, great and small, about eleven of which are workable, and range from 2½ to 7 feet in thickness. The seam that has been mined to the greatest extent is one lying conveniently near the foot of the mountain. It is from 4 to 6 feet in thickness, and has yielded in years past, and is yielding now, a great quantity of coal. The locations of mines in the seam have been largely determined by the gaps in Walden's ridge, these giving the pioneers in the coal business easy access to the foot of the mountain. Noted points are Poplar Creek, Coal Creek, and Careyville.

The long ridge, known as Jellico mountain, in Campbell and Claiborne counties, has not been included in the New River coal field. The ridge is nearly twenty miles long, has a northeasterly and southwesterly trend, and lies to northwest of Elk valley and overlooks it. Its strata include altogether eight or nine seams of coal, several workable, the uppermost belonging to the third series.

The Coal Measures in Campbell and Claiborne counties, east of the Ohio division of the East Tennessee, Virginia and Georgia railroad, have been referred to. They doubtless contain coal beds of all three series, though chiefly made up of the strata of the first and second.

TEXAS.

Total product in 1892, 245,690 short tons; spot value $569,333.

The coal product of Texas in 1892 was the largest ever obtained, being 61,250 tons more than in 1890, when the largest previous output was reported. In 1891 the total product was 172,100 short tons valued at $412,300, showing an increase in 1892, of 73,590 tons or 43 per cent. in quantity and of $157,033 or 38 per cent. in value. The average price per ton declined from $2.40 in 1891 to $2.32 in 1892. The total number of men employed in 1892 was 871 and the mines were in active operation an average of 218 days. In 1891, 787 men were employed for an average of 225 days.

There were five counties producing coal in 1892, namely: Bexar, Erath, Maverick, Parker, and Webb; four of these produced coal in 1891, Parker county reporting in 1891 for the first time. The following table exhibits the amount and value of the coal mined in each county in 1892.

Coal product of Texas in 1892, by counties.

Counties.	Short tons.	Value.
Bexar	11,723	$29,304
Erath	211,097	485,273
Maverick	4,464	8,928
Parker	8,106	19,078
Webb	10,300	25,750
Total	245,690	569,333

The product of Bexar county is lignite and is used to some extent for domestic purposes in San Antonio, and also for steam making at the Lone Star brewery in that city. All of the remainder of the product is bituminous, of which Erath county produces about 90 per cent. The Erath county coal is used largely by the locomotives of the Texas and Pacific railroad.

The mines of Maverick county were on fire for nearly five months during 1892 and the output was accordingly restricted. The company operating them is enlarging its plant and expects to double the producing capacity in 1893.

The Santa Tomas mines, Webb county, after several months litigation, changed hands in October and the new company, styled the Minera Colliery Company, is now working the mines to their full capacity, producing about 125 tons per day.

The following table shows the annual output of coal in Texas for four years with the value and distribution:

Coal product of Texas since 1889.

Distribution.	1889.	1890.	1891.	1892.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
Loaded at mines for shipment	120,602	180,800	169,300	241,005
Sold to local trade and used by employés	6,552	1,840	900	4,460
Used for steam and heat at mines	1,062	1,800	1,900	225
Total	128,216	184,440	172,100	245,690
Total value	$340,617	$465,900	$412,300	$569,333

THE COAL FIELDS OF TEXAS.

[By Robert. T. Hill.]

The general facts concerning the knowledge of the Texas coal fields were set forth in this annual for the preceding year. There has been no literature since published adding to the knowledge of this large and promising area, and the Texas Geological Survey primarily organized for the purpose of studying the fields, has been discontinued without completing the study. Development of the central Texas coal fields has, however, progressed considerably in Parker and Erath counties, and it is to be hoped that private investigations will soon add extensively to the exploitation of the beds. The Cretaceous coal fields in the vicinity of Eagle Pass on the Rio Grande have also been further prospected, and there is every reason to believe that this valuable field will soon be more extensively developed. Considerable interest has been excited in the State by the continuous advocacy of the utilization of the Tertiary and Cretaceous lignites, and an official State report (*a*) has been published thereon which presents the following conclusions:

"1. Brown coal and lignite of good quality and under proper conditions are fully capable of replacing bituminous coal for any and all household, industrial, and metallurgical purposes, and have proved to be most excellent fuels where properly used.

"2. Texas has an abundant supply of brown coal, which is equal to the best quality of that which has been utilized, and far superior to much that is being used satisfactorily in other countries.

"3. The deposits are so situated and of such extent as to permit the mining of these brown coals and their delivery in the various markets of the State at prices far below anything which can be attained with bituminous coals under the most favorable conditions, and the fuel values of the brown coals are such as to enable them, if heating power and price be considered, to compete with any of the bituminous coals which are accessible.

"The methods of use which are positively assured for our Texas brown coals are:

"The raw coal may be used for all purposes in stoves and grates, under stationary boilers or locomotives, as part fuel in iron smelting, for burning all clay products, cement, lime, etc.

"In the form of producer gas it may be used for any and every purpose for which such a gaseous fuel is applicable.

"It can be made into illuminating gas and used for lighting and heating.

"It can be made into artificial fuel by briquetting with coal tar pitch or some similar agglomerant, and the resulting briquettes will constitute a fuel which can be used in the same manner, as satisfactorily, and for the same purposes as any ordinary bituminous coal.

"Certain varieties of our brown coal will form a coke, if charred, with bond of coking coal and coal tar pitch, which, even if it should not prove sufficiently firm for the blast furnace, will nevertheless answer for fuel for locomotive engines and other similar purposes.

"These are the facts. What use shall be made of them, and what benefits derived from them, rests with the people of Texas, for whom they have been gathered, and for whose information they are here presented."

While the above facts are mostly admitted, this report fails to deal with the first and most vital question concerning all mining products, and that is the question of the cost of production and manipulation. No one has ever doubted the abundance of Texas lignities, but it has not

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a Report on the brown coal and lignite of Texas, by Edwin T. Dumble, 230 pp., 1892.

been shown, notwithstanding the numerous experiments, that they can seriously enter into competition with the true coals of the region, or that the cost of depriving them of the large percentage of moisture they contain (from 10 to 20 per cent.), can be so economically done that they can be profitably utilized except locally.

One of the chief obstacles to the utilization of these lignities on a large commercial scale, provided the labor could be profitably secured, is the large amount of moisture they contain, which objection has been clearly stated in another report of the Texas Survey as follows:

"It may be said in a general way that the more moisture a coal contains the less value it has, because the moisture prevents the combustion and must be driven off before complete combustion takes place. Part of the heat generated by the other material of the coal must be taken up to drive out this moisture. Again, it takes up a part of the weight that would otherwise be occupied by combustible material. Thus, if a coal has 5 per cent. of moisture, that would be 100 pounds in every ton that might be occupied by combustible material, and then it would take as much more to drive out the moisture, so at least 200 pounds out of every ton would be unavailable on account of that percentage of water."

A writer in the *Manufacturer's Record* has taken exception to the author's remarks that the State had not sufficiently exploited its coal fields, and calls attention to a report by himself in the second annual report of the Geological Survey of Texas, Austin, 1890. Upon careful examination of this report the author finds therein no reason for changing the conclusions heretofore expressed. In order, however, that no injustice be done the following extracts are given therefrom concerning the occurrence, composition, and extent of the carboniferous coals in Texas.

According to the writer in the Texas report the entire thickness of the carboniferous formation in central Texas, the extent of which was given in the preceding volume of "Mineral Resources," is about 6,000 feet, and contains two workable beds of coal, besides several minor ones, occupying a workable area of 2,700 square miles. The workable seams only average 2½ feet in thickness. The writer is of the opinion that in such a vast accumulation of coal bearing strata, that a more extensive exploitation would reveal a much larger proportion of workable coal than is given in this report.

The following analyses are given of the Texas coal in the report mentioned, and as shown in the footnote they are obviously selected specimens.

Analyses of Texas coals.

Localities.	Water.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
1. Bridgeport, Wise county	2.00	31.47	56.32	8.15	2.06
2. Sheuber shaft, near Bowie, Montague county	2.30	34.48	61.28	0.69	1.14
3. Gilfoil shaft, Young county	1.10	35.50	43.00	15.60	4.60
4. Thurber, shaft No. 1	0.85	31.23	56.98	9.30	1.64
5. Thurber, shaft No. 2	0.90	30.96	60.01	6.85	1.28
6. Thurber, shaft No. 3	0.90	33.51	53.46	10.65	1.48
7. Waldrip, McCulloch county	4.55	38.50	44.80	12.14	7.96
8. Bull creek, Coleman county	10.40	35.94	49.46	4.19	1.53

NOTE.—The coal of Nos. 3 and 7 in this table of analyses were samples taken from the dump, and were not fair specimens of the coal at these localities.

These analyses show the Texas coals to be rather high in sulphur, and the article used by the Texas Pacific railway, the chief consumer, is somewhat higher in ash.

The coking qualities of the Texas coal has not as yet been proven, and concerning it the Texas report above quoted says: "So far as laboratory tests can determine, the coals of Texas have good coking qualities, and tests of the coal for coking purposes made in ovens where other coals are being coked have proven only partially satisfactory. The body of the coke was good enough, but the sulphur it retained was too high."

It is to be sincerely hoped that the private and public searches for suitable coals in Texas will soon result in cheapening this commodity in the State.

UTAH.

Total product in 1892, 361,013 short tons; spot value, $562,625.

The coal product of Utah in 1891 was 371,045 short tons, valued at $666,646. The output in 1892 was not materially different, being 10,032 tons, less a decrease of less than one-third of 1 per cent. The value of the product, however, fell off $104,021, a decrease of over 15 per cent. The average price per ton realized in 1891 was $1.80, which declined in 1892 to $1.56. All of the product is bituminous.

The following table shows the statistics of coal production in Utah in 1892, by counties:

Coal product of Utah in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Emery	283,319	2,481	1,800	26,298	313,898	$490,201	$1.56	210	474
Morgan		100			100	250	2.50	30	3
San Pete		2,095			2,095	4,443	2.12	143	14
Summit	38,112	2,099	4,709		44,920	67,731	1.50	305	155
Total	321,431	6,775	6,509	26,298	361,013	562,625	1.56	230	646

No record of the production of the Territory prior to 1885 was kept. Subsequent to that year the annual output has been as follows:

Coal product of Utah since 1885.

Years.	Short tons.	Years.	Short tons.
1885	213,120	1889	236,651
1886	200,000	1890	318,159
1887	180,021	1891	371,045
1888	258,961	1892	361,013

COAL FIELDS OF UTAH.

[By Robert Forrester.]

The coal industry of Utah has been advancing during the last few years, and is finding markets outside the Territory. Although the imports of coal from outside States are increasing, it is not to be wondered at when it is remembered that the coal fields of Wyoming are practically as near the principal coal markets of Utah as the coal producing districts of the Territory itself.

The imports of coal into the Territory for the last three years are as follows:

Imports of coal into Utah for three years.

Years.	Rio Grande Western railway.		Union Pacific railway.
	Anthracite.	Bituminous.	Bituminous.
	Short tons.	*Short tons.*	*Short tons.*
1890	7,584	6,582	89,229
1891	13,017	5,151	115,868
1892	12,128	5,799	136,564
Total	32,729	18,532	341,661

The coal patents issued through the Salt Lake City land office are as follows:

Patents issued through Salt Lake City land office.

	No.	Acres.	Value.
Patents	105	15,638.62	$226,696.90
Filings	(*a*) 49	7,200.00	....

a Only those still in force.

The above does not include about 10,000 acres of coal land owned by the San Pete Valley Railroad Company.

The coals of Utah compare very favorably with any of the western States or Territories. Tests made by the quartermaster-general are shown on pages 255 and 256. The Laramie coal of Utah is hard, and well adapted for transportation to great distances, as may be proved by the fact that the Pleasant Valley Coal Company is competing successfully in California markets against all other coals. This coal does not readily crumble down on exposure to the weather, as is shown by the heaps of coal lying at the mouth of prospect holes driven ten or twelve years ago. On the exterior surfaces of the coal there is but a thin film of a sooty black color, whilst inside of this film the coal is unchanged in any respect; this quality renders it very desirable for storing purposes. In making coke from this coal, at Castle Gate, about 12 per cent. of fine coke was produced, and the coal company making this coke is placing it on the market to take the place of anthracite for domestic use.

The available area underlaid with coal has been computed at 2,000 square miles.

The Carboniferous formation in Utah appears to be devoid of coal so far as proved. However, in the Lower Carboniferous, about eight miles east of Salt Lake City, there is a stratum nearly eight feet in thickness of a coal-like substance, graphitic in structure; and from samples of this material that have lain exposed to the weather for many years the following analysis was obtained. The samples were collected by the writer and analyzed by M. S. Hanaur, of Union assay office:

Analysis of carbonaceous material from near Salt Lake, Utah.

	Per cent.
Water	6.8
Volatile matter	17.5
Fixed carbon	65.9
Ash	9.8

The land underlaid by the above stratum has been located by persons in Salt Lake City, who will intersect this bed by a tunnel at a depth of 150 or 200 feet below the outcrop. If a workable vein of coal is exposed this company will have a field of 2,000 acres free of faults or flexures, and near to Salt Lake City.

The Cretaceous, however, is the great repository of coal in this Territory, and it is from this series that the future coal supply will be derived. All the subdivisions of the Cretaceous, as the Laramie, Montana, Colorado, and Bear River Laramie, contain coal beds of workable thickness.

In addition to the coals of the Cretaceous and Carboniferous, there is a coal bed of workable thickness in the Wasatch groups of the Tertiary.

In the description of the character of the Coals of Utah, each district will be taken as bounded by the limits of the geological subdivisions, which are as follows:—

First	Wasatch	Tertiary.
Second	Laramie	Cretaceous.
Third	Montana	
Fourth	Colorado	
Fifth	Bear River Laramie	

Wasatch.—The coal of this group was the first to be worked in this Territory. In 1855, near the small town of Wales, in San Pete county, a small mine was opened, and Captain Simpson speaks of it in 1857 as supplying coal to all the settlements and blacksmiths far and near. In 1857 an attempt was made to make coke from this coal, and the experiments were continued intermittently till 1877. By crucible tests this coal afforded as high as 66 per cent. of coke, but in practice in Coppee coke ovens the production of coke never exceeded 50 per cent. Even then, owing to its poor quality and high percentage of ash, it was difficult to find a market for it, and coke making was finally abandoned in 1877.

Analysis of coal and coke from Wales, in the San Pete Valley, Utah.

	1—Prof. F. A. Genth.	2—M. R., 1883–84.	Coke—M. S. Hanaur.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	1.16	2.05	3.30
Volatile matter	32.91	31.08	5.05
Fixed carbon	54.75	49.85	67.10
Ash	11.18	17.02	24.55
Total	100.00	100.00	100.00

Dr. C. A. White, of the United States Geological Survey, gives a good description of the Wasatch group in Bulletin 34. He places this coal about 300 feet above a coarse conglomerate which he identifies as the same which is so well exposed in Echo cañon, and known as the Wasatch Conglomerate. At a place about half way between Manti and Gunnison this same Conglomerate is magnificently exposed. From this place, by traveling east a short distance, the Laramie series is encountered, this being proved by the following fossils which the writer has obtained from them:

Ostrea glabra.	*Corbula subtrigonalis.*
Ostrea soleniscus.	*Anomia propatoris.*
Modiola regularis.	*Psidium Sp.?*

These Cretaceous rocks are brought to the surface by a fault. Following this fault north till Manti creek is reached, it will be seen that the Tertiary strata come down from the top of the Wasatch mountains in a great monoclinal sweep; and as the Manti creek cuts deeply through this monclinal fold the structure is well exposed, yet there is no Conglomerate brought to view, as it should be if this Conglomerate belong to the Wasatch group. Again, in Red narrows there is an exposure of a Conglomerate almost if not quite equal to that seen in Echo cañon; yet here on the east the Tertiary is brought up against the Conglomerate by faulting, and on the west the Conglomerate abuts against the Carboniferous. The Wales coal has been exposed in Soldier's fork, very near the place where Dr. White collected his fossils. After crossing the divide and following the headwaters of Price river till Pleasant Valley junction has been passed about two or three miles, the Wales coal is again brought to view. In this locality the writer found all the species of fossils found by Dr. White at Wales. From this place the strata are shown in an excellent and unbroken section all the way down to the base of the Jurassic, and yet no Conglomerate is seen till about the base of this last formation is reached and the coal is about 700 feet above the base of the Tertiary. The writer has not seen the Conglomerate overlying the Cretaceous, except near Coalville.

The fact that this Tertiary coal is found in workable thickness in widely separated localities is sufficient proof of its continuity, but if its character does not change it will scarcely be advisable to take it into account when computing the coal resources of Utah.

Laramie.—The Laramie group is best developed on the eastern slope of the Wasatch mountains. Throughout the whole extent of this region the Laramie is rich in coal, the beds attaining a maximum thickness of 28 feet. This group of strata is about 3,000 feet in thickness, and occupies the top of the high precipitous cliffs that bound Price river on the north, and Castle valley on the west. These cliffs are cut into deep gorges by the following streams, commencing near Green river: Grassy Trail creek, Coal creek, Soldier's cañon, Price river, Cottonwood wash, Huntington creek, Cottonwood creek, Ferron creek, Muddy creek, Queat-Chup-Pa creek, Ivie creek.

At Ivy creek the Laramie strata pass under the trachyte of Mounts Terril and Hilgard. There is also an exposure of the Laramie in Pleasant valley on the head waters of Price river.

The Laramie coal is mined at Castle Gate, Pleasant Valley, Connellsville, and in the San Pete valley. The Fairview Coal and Coke Company opened a mine at Connellsville in 1875, and built 11 beehive coke ovens. The coke made at this place was of fair quality, and was hauled by wagon to Springville, but the expense of wagon haulage proved to be too great to enable the company to compete in the open market, and so after a struggle of about three years the manufacture of coke was stopped. It has been computed that this company made 3,000 tons of coke in the three years, but from the extent of the mine workings it is probable the production far exceeded this estimate. This mine now produces but a few hundred tons of coal for local sale only. This coal has the following composition:

Analyses of coal from Connellsville, Utah.

	1.	2
	Per cent.	*Per cent.*
Moisture	3.7	43.98
Volatile matter	43.3	
Fixed carbon	48.9	52.21
Ash	4.1	3.81
Total	100.00	100.00

The Pleasant Valley Coal Company next opened a mine in this series of strata near Scofield in 1878, since which time 1,004,563 tons of coal have been extracted. The coal has an average thickness of 11 feet. The colliery is known as the Winter Quarters mine. The composition of this coal is as follows:

Analyses of coal from the Winter Quarters mine, near Scofield, Utah.

	1.	2.
	Per cent.	*Per cent.*
Moisture	9.30	6.55
Volatile matter	39.85	39.75
Fixed carbon	47.30	47.65
Ash	5.55	6.05
Total	100.00	100.00

The accompanying table will show the Quartermaster-General's tests of this coal:

Tests of bituminous coal from Winter Quarters mine, Emery county, Utah.

[2,407 pounds of this coal=1 cord of standard oak wood=3,195 pounds.]

Dates of tests.	Duration of trial.	Coal supplied to grate.	Coal withdrawn after trial.	Refuse from coal.	Coal actually consumed.	Combustibles.	Percentage of combustibles in coal.	Coal consumed per hour.	Coal consumed per square foot of grate.
	Hrs. Min.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pr. cent.*	*Pounds.*	*Pounds.*
Jan. 10, 1888	4	250	0	16.5	250	233.5	93.4	62.5	19.2
25, 1888	5	250	0	17	250	233	93.2	50	15.4
26, 1888	4 30	250	0	18.5	250	231.5	92.6	55.6	17.1
30, 1888	6	300	0	23.5	300	276.5	92.2	50	15.4

Dates of tests.	Water supplied to boiler.	Water evaporated per hour.	Water evaporated per hour per square foot of grate.	Water evaporated per pound of coal.	Water evaporated per pound of coal from atmospheric pressure and 212° (*a*).	Temperature of feed water.	Temperature of boiler room.	Temperature of external air.	Ashes.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	°*F.*	°*F.*	°*F.*	*Pr. cent.*
Jan. 10, 1888	1,347.66	336.9	103.6	5.3905	6.235	58.6	86.3	34.8	15
25, 1888	1,449.22	289.8	89.1	5.797	6.7265	56.3	76.2	27.5	12
26, 1888	1,250	277.8	85.5	5	5.85	47.6	87.9	32.6	15.5
30, 1888	1,558.694	259.8	76.3	5.1956	6.0892	46.1	82.8	37.3	21

a Mean, 6.2297.

The next mine opened is now known as the Union Pacific Coal Company's No. 1 Pleasant valley mine. It first produced coal in 1884 The vein is 28 feet thick without any partings of clay or rock. About 25 feet of the vein is mined. The coal in this mine is very much broken up by faults.

Analyses of this coal are shown in the following table:

Analyses of coal from No. 1 Pleasant Valley mine, Utah.

	28-foot vein.		10-foot vein.		
	1 (*a*). A. S. McCreath.	2 (*b*). H. B. Hodges.	1 (*c*). H. B. Hodges.	2 (*c*). H. B. Hodges.	3 (*c*). H. B. Hodges.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	5.80	5.00	6.02	4.26	5.40
Volatile matter	40.49	45.37	42.94	47.88	44.66
Fixed carbon	51.95	45.23	47.84	43.87	44.06
Ash	1.76	4.40	3.20	3.99	5.88
Total	100.00	100.00	100.00	100.00	100.00
Sulphur	....	.73	.69	.75	.79

a From upper 4½ feet.
b Average of the full thickness of vein.
c Sample taken from top, middle, and bottom of vein.

Tests of bituminous coal from Utah Central mine, Scofield, Emery county, Utah.

[2,498 pounds of this coal=1 cord of standard oak wood=3,195 pounds.]

Dates of tests.	Duration of trial.		Coal supplied to grate.	Coal withdrawn after trial.	Refuse from coal.	Coal actually consumed.	Combustibles.	Percentage of combustibles in coal.	Coal consumed per hour.	Coal consumed per square foot of grate.
	Hrs.	*Min.*	*Pounds.*	*Pounds.*	*Pounds*	*Pounds.*	*Pounds.*	*Pr. cent.*	*Pounds.*	*Pounds.*
Oct. 20, 1887	4	30	250	0	16	250	234	93.6	55.5	17.1
21, 1887	5	30	250	0	14	250	236	94.4	45.4	13.97
25, 1887	4	30	250	0	15.5	250	234.5	93.8	55.5	17.1
31, 1887	4	30	188	1.5	13.5	186.5	173	92.7	41.4	12.8

Dates of tests.	Water supplied to boiler.	Water evaporated per hour.	Water evaporated per hour per square foot of grate.	Water evaporated per pound of coal.	Water evaporated per pound of coal from atmospheric pressure and 212° F. (*a*).	Temperature of feed water.	Temperature of boiler room.	Temperature of external air.	Ashes.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	°*F.*	°*F.*	°*F.*	*Pr. cent.*
Oct. 20, 1887	1,433.59	318.5	98	5.7344	6.5659	71.7	82.8	54.8	14
21, 1887	1,210.94	211.1	64.9	4.8438	5.5510	71.3	91.1	60.5	12
25, 1887	1.316.41	292.5	90	5.2656	6.0607	66.7	81.	45.8	12
31, 1887	949.22	211	64.9	5.09	5.8331	70.8	85.4	42.9	11.5

a Mean, 6.0027.

When this mine was first opened by the Pleasant Valley Coal and Coke Company, some coke ovens were built and an attempt was made to produce coke. The coke, however, was made only from lump coal in beehive coke ovens, and in fact the volatile matter was merely driven out of the coal, as it did not lose its shape. Quite a large quantity of this kind of coke was sold, but the use of lump coal alone became too costly for the production of coke, and as the small sizes could not be used the industry was soon abandoned.

This stratum outcrops on the banks of Mud creek about 6 miles south of the town of Scofield and develops a thickness of 15 feet 6 inches. This bed also belongs to the Laramie.

Analyses of coal from Utah Central mine, Scofield, Utah.

[Samples collected by R. Forrester. Analyses by H. B. Hodges, of Omaha.]

	Top 3 feet.	Second 3 feet.	Third 3 feet.	Bottom 3 feet.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	4.93	4.95	5.20	5.04
Volatile matter	44.86	44.50	44.96	45.31
Fixed carbon	44.32	45.43	46.00	44.99
Ash	5.89	5.12	3.84	4.66
Total	100.00	100.00	100.00	100.00
Sulphur	.55	.73	1.06	.86

The next locality where coal of this age was mined is at Castle Gate, where a mine was opened in 1889 by the Pleasant Valley Coal Company; it has produced in all 369,938 tons of coal. During the same year 80 beehive coke ovens were built and 24,422 tons of coke have been manufactured and sold. The coke is of very fair quality, as may be seen from the analyses herewith:

Analyses of coal and coke from Castle Gate, Utah.

	Coal—average of 7 feet.	Coke—average of 20 ovens.
	Per cent.	*Per cent.*
Moisture	1.68	1.22
Volatile matter	44.29	2.26
Fixed carbon	48.65	82.21
Ash	5.38	14.31
Total	100.00	100.00
Sulphur	.47	.55

The coal was but 3 feet 6 inches in thickness when opened in 1889, but has increased in thickness till now it is 10 feet. This increase is obtained by the thinning out of the strata between the several thin seams of coal overlying the one excavated in this mine.

The following are some analyses of the coal found in the Edmunds mine, operated by Mr. N. Edmunds, Wales, San Pete, county:

Analyses of coal from the Edmunds mine, Utah.

[Samples by W. G. Sharp. Analyses by M. S. Hanaur.]

	Top coal.	Middle coal.	Bottom coal.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	7.07	7.15	6.38
Volatile matter	43.18	42.74	42.60
Fixed carbon	44.07	45.80	45.46
Ash	5.68	3.95	5.56
Total	100.00	100.00	100.00

Montana group.—Coal of this age is found of workable thickness in the Castle valley and Coalville districts, but is only mined at the latter place, where 620,338 tons have been produced, principally by the Union Pacific Railway and the Home Coal Company. The largest producing mine in the district to-day is that known as the Wasatch mine, operated by the Home Coal Company. This company sold 39,278 tons during 1892. The chief market is Park City and Salt Lake City.

The coal beds of this district although thick are fragile, and so full of cross joints that in mining the coal 40 to 50 per cent. of slack is produced, and were it it not for the proximity of their principal market (Park City) they would be unable to compete with the coals from Pleasant Valley and Castle Gate. The analyses of the Grass Creek and Chalk Creek coals are shown below:

Analyses of coal from near Coalville, Utah.

	Grass Creek.		Chalk Creek.	
	No. 1.	No. 2.	Wasatch mine.	Spriggs mine.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	8.97	9.00	4.30	6.50
Volatile matter	43.54	41.58	46.37	41.70
Fixed carbon	45.48	46.03	38.90	44.80
Ash	3.90	3.37	10.32	7.00
Total	101.89	99.98	99.89	100.00
Sulphur	2.11	2.06	....	....

In the Castle valley district the coals of the Montana group are found upon the Queat-Chup-Pa and Ivie creeks.

The following analyses will show the character of the coals. Samples were taken on Queat-Chup-Pa creek:

Analyses of coal from Castle valley, Utah.

[Analyses by H. B. Hodges.]

	Top vein.		Bottom vein—average of full thickness of vein.
	Top 6 feet.	Bottom 14 feet.	
	Per cent.	*Per cent.*	*Per cent.*
Moisture	11.41	10.63	6.10
Volatile matter	44.72	44.74	37.95
Fixed carbon	35.08	38.79	45.50
Ash	8.79	5.84	10.00
Total	100.00	100.00	99.55
Sulphur	1.50	.64	.87

These coal beds are not worked, for the lack of railroad facilities. The Union Pacific Railroad Company, some years ago, purchased a large tract of these coal lands and surveyed a route for a railroad from Juab to the Queat-Chup-Pa, but, in crossing the Wasatch mountains, via Salina cañon, it was found that it was necessary to climb 2,000 feet, and to come down again in a distance of 40 miles, and as this railway company has mines in Wyoming and in Pleasant valley nearer to the principal coal markets of the West, it is safe to say that it will not lay a track to the Castle valley district until its present supply of coal begins to fail.

Colorado group.—The coal mining carried on in this group is only for the supply of small farming settlements in southern Utah. Coal of this age, of workable thickness, is also found on the Dirty Devil creek, but the writer has never visited this district, and as no reliable published information regarding it can be found, the district will not be discussed in this paper.

The best exposure of coal-bearing Colorado strata is along the range of hills forming the west boundary of Parowan and Rush Lake valleys, and mines have been opened near Cedar City, and Kanara. Mr. Ellsworth Daggett has described the coals of this region in "Mineral Resources" for 1882, from which the following table of analyses has been taken:

Analyses of coal from near Cedar City, Utah.

	Specific gravity.	Sulphur.	Volatile matter.		Fixed carbon.	Ash.	Carbon in volatile matter.
			Moisture.	Other volatile matter.			
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Leyson claim	1.34	1.79	4.50	39.90	45.47	10.12	22.62
Woods claim	1.34	(*a*)	3.33	41.62	47.37	7.67	24.54
Walker No. 2	1.36	2.36	4.12	40.15	45.82	9.90	23.47
Lone Tree claim	1.31	2.45	8.17	38.55	47.27	6.00	21.09
Pollock claim	1.35	(*a*)	7.87	38.15	46.25	7.72	20.17

a No determination made.

Mr. Geo. W. Maynard, in a paper read before the American Institute of Mining Engineers in 1886, gave the following analyses of Cedar City coal and coke:

Analyses of coal and coke from Cedar City, Utah.

	Coal.	Coke.
Moisture	3.502	1.417 (Moisture and volatile matter together)
Volatile matter	43.669	
Fixed carbon	43.102	76.706
Ash	9.727	16.607
Sulphur	....	5.270
Total	100.000	100.000

This coke is readily seen to be of little value as a fuel, owing to the large amount of ash and sulphur it contains.

Bear River Laramie.—A small quantity of coal of this age has lately been mined in Kanab valley of southern Utah, and in the early history of the Piochi mining excitement and the iron smelting at Iron City a quantity of coal of this age, said to be anthracite, was mined near New Harmony and hauled by wagon to the above places. The New Harmony beds are thin; two beds are exposed, but only one of them is worth a second thought. This one is 1 foot 9 inches in thickness. The analyses of these beds are as follows:

Analyses of coal from New Harmony, Utah.

	1.	2.	3.	4.	5.(*a*)	6.(*a*)	7.(*b*)
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	2.5	3.8	3.3	2.9	2.70	2.27	3.43
Volatile matter	14.2	13.2	12.4	8.9	15.30	13.73	12.62
Fixed carbon	71.9	70.4	73.8	72.3	67.85	73.25	64.10
Ash	9.2	11.1	10.8	13.5	14.15	10.75	15.05
Total	97.8	98.5	100.3	97.6	100.00	100.00	100.00
Sulphur	1.2	1.4	0.7	2.4	4.14	4.26	4.80

a. By Thos. Price & Son, San Francisco. *b.* By M. S. Hanaur, Salt Lake City.

By the foregoing analyses it will be seen that this coal is more of a semi-bituminous than an anthracite coal.

VIRGINIA.

Total product in 1892, 675,205 short tons; spot value, $578,429.

The coal product of Virginia has shown an annual decrease since 1888, the output in 1892 being 61,194 tons less than in 1891. Practically the entire decrease is due to lessened production in Tazewell county, as of the other three producing counties two had increased outputs and the decrease in the fourth was insignificant. No production was reported from Chesterfield county, the old mines of which were flooded in 1890 and had not resumed operations at the close of 1892. Two new collieries, however, were opened during the year which will probably be producing during the present year.

The product in 1892 consisted of 657 short tons of anthracite coal, 35,862 tons of semi-anthracite, 200 tons of bituminous, and 638,486 tons of semi-bituminous. Distributed by counties the production in 1892 was as follows:

Coal product of Virginia in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Chesterfield									
Henrico	22,400	11,200		56	33,656	$42,070	$1.22	200	65
Montgomery	2,677	868	18		3,563	8,674	2.43	110	42
Pulaski	16,032	7,621			23,653	24,932	1.09	237	29
Tazewell	486,195	1,032	6,593	120,513	614,333	502,753	.82	200	700
Total	527,304	20,721	6,611	120,569	675,205	578,429	.86	192	836

In the following table is shown the annual output of the State since 1880:

Coal product of Virginia since 1880.

Years.	Short tons.	Years.	Short tons.
1880	112,000	1887	825,263
1881	112,000	1888	1,073,000
1882	112,000	1889	865,786
1883	252,000	1890	784,011
1884	336,000	1891	736,399
1885	567,000	1892	675,205
1886	684,951		

As shown above, the year of largest production was 1888, when over a million tons were obtained. Since then it has decreased annually, the output in 1892 being nearly 400,000 tons less than in 1888. But during 1892 development work was actively prosecuted on the coal lands of Wise county, rendered available by the Clinch Valley branch of the Norfolk and Western Railroad, and at the close of the year no less than nine companies were shipping coal. Shipments began in December, and it is estimated that about 2,000 tons were sent out of this field during that month. The coal land is owned by the Virginia and Tennessee Coal and Iron Company, of Asheville, of which Mr. W. J. Brown is general manager, and to whom the writer is indebted for the information contained in this report. The mining companies lease from the land company on royalty, paying a certain amount on each ton mined. About the first of July, 1893, the companies engaged in mining the coal were as follows, the name and thickness of the seam operated and the average daily output at that time being set opposite the names:

Coal-mining companies operating in Wise county, Virginia.

Names of companies.	Post-offices.	Names of seams worked.	Widths of seams.	Average daily capacity.
			Feet.	*Tons.*
Clinch Valley Coal and Coke Co.	Virginia City	Widow Kennedy	8½	130
Virginia Gas Coal Co	do	do	6	140
Speedwell Coal and Coke Co	Coeburn	Upper Banner	6	50 to 60
Kentucky Coal and Coke Co	do	do	5	40
Jones Coal and Coke Co	do	do	6	120 to 130
Swansea Coal and Coke Co	do	do	8½	65
Pine Run Coal and Coke Co	do	do	8½	65
Coeburn Coal and Coke Co	do	do	8½	65
Sexton Coal and Coke Co	do	do	8½	60

The Wise County Coke Company, of Coeburn, has also been organized for the purpose of coking all the slack coal produced from the mines.

THE CLINCH VALLEY COAL FIELDS.

[By A. S. McCreath and E. V. D'Invilliers. (*a*)]

Geographical position.—The lands in question may be readily located on any map of southwest Virginia. They lie entirely within the Clinch

a Abstracted by permission from Messrs. McCreath and D'Invilliers' report on the coal property of the Virginia and Tennessee Coal Company.

valley coal fields, and extend west from Lick creek to Tacoma, a distance of about 20 miles, and are drained by the several branches of the Clinch river, Lick, Russell, and Bull creeks and by Guest river and its two large tributaries, Big and Little Toms creeks.

The principal developments and leases have been made in the vicinity of Coeburn (formerly Guest's Station) along Big and Little Toms creeks, while openings have been made on the left fork of Russell creek preparatory for operations at two leases recently made there. A number of openings have likewise been made on the north side of Sandy ridge on various streams tributary to the Big Sandy river; but time permitted the inspection of only one of these. The main features of this district are shown on a map accompanying the report, indicating approximately the various openings made with reference to the location of the railroad. The map is somewhat general, and is omitted from this abstract.

Geological position.—The geology of the field, taken as a whole, is in the main simple.

All the Coal Measures and their included coal beds are to be referred to the Middle Coal Series of Virginia and West Virginia, identical with the Lower Productive Coal Measures of Pennsylvania, which in this part of Virginia carry at least five well-marked coal beds, separated by varying intervals of sandstone and shales, with a sixth bed, possibly belonging to a higher series, crowning the tops of the highest ridges, of which the acreage is necessarily limited. The vertical interval between these beds is necessarily somewhat different in different parts of the field; but a general section of the series, given below, will indicate the average position of the various coal seams, with their regional names and relations, one with another.

GENERAL VERTICAL SECTION.

	Ft.	In.		Ft.	In.
1. Edwards coal seam, on hill top	4	4	to	5	6
Interval—slate and thin sandstone (about)	400	0			
2. Upper Banner coal seam (averaging)	5	0	to	6	6
Interval—shales	100	0	to	125	0
3. Lower Banner coal seam (averaging)	3	0	to	4	2
Interval—slate and massive sandstone	65	0	to	75	0
4. Widow Kennedy coal seam (averaging)	5	0	to	6	0
Interval—shales and thin sandstone	165	0	to	200	0
5. Imboden coal seam (averaging)	3	4	to	4	6
Interval—largely sandstone	100	0	to	150	0
6. Jawbone coal seam (averaging)	6	0	to	11	0

1. *The Edwards seam.*—This is the highest coal bed of the series and is estimated to underlie about 2,000 acres out of the 55,000 acres in the whole property; but as it occurs very high in the series, with its outcrop somewhat scattered, it can not play a very important part for the present in an estimate of the commercial coal of the region. This bed was only personally seen at one point—along the public road facing the left

fork of Russell creek, where it showed 4 feet 4 inches of soft outcrop coal with a one-inch clay parting 10 inches from the top. It has been opened in the high ridge west of Big Toms creek, over 5 feet thick and sampled by Mr. Kent, and at several points in the main Sandy Ridge divide separating the waters of Clinch river from those of Big Sandy; but these openings had fallen shut so that the coal could not be inspected.

2. *The Upper Banner seam.*—This is the principal bed of the region tributary to Big Toms creek and its branches, north of Coeburn, where eleven leases have been contracted for to work this seam above water level by short laterals now being constructed along Big Toms creek, and on Banner, Sallies and Fuller branches. The latter branch will be used eventually for reaching the Sandy River coal field, a low gap at the head of this stream permitting a favorable access by means of a short tunnel on to the waters of that stream.

The Upper Banner coal is subject to some variations of bed section, but while it varies from 3½ feet to 9 feet in thickness in the Toms creek region, it should be relied upon to furnish from 4 to 7 feet of merchantable coal in this district, or about 7,000 tons per acre. This coal bed was also seen at the head of Bull run and Little Toms creek, 4 feet 9 inches thick, yielding about 4 feet 5 inches of coal; on Russell creek 5 to 7 feet thick, and on both branches of Lick creek 6 feet 6 inches to 7 feet thick. It nearly always carries a thin 1-inch to 1½-inch sandstone rib about 2 feet from the top, which was seen in every opening in the field except at the head of Bull run and on the left fork of Lick creek; and by that means, as well as by its relationship to the strongly characterized Kennedy seam, 200 feet below, its identity is very positively established. It is usually overlaid by a slate roof, carries a slate parting near the center, to the variation in which is largely due the increased size of the bed at places, and a little "gray bone" in the top of the lower bench. On the whole it is a handsome coal bed; and as in its structure it shows a distinct tendency to face and butt cleavage, like the Pittsburg and Ohio coals, it can be cheaply mined, and it should bear transportation well. It is estimated that this coal underlies about two-fifths of the whole property, or about 20,000 acres. South of the Sandy ridge, in the region examined, its commercial area is largely confined to the Toms Creek field, where there are about 6,000 or 7,000 acres of this coal. There is also a considerable area of this bed further east on the heads of Bull and Russell creeks, within a mile of existing railroad branches, as well as on Lick creek, not, however, now available to any present constructed railroad, the bulk of the area lying in the main Sandy ridge and its spurs.

3. *The Lower Banner bed.*—Underlying the last described seam by only 100 to 125 feet, this bed has an area but slightly greater, its outcrop following the higher coal closely.

In the Toms Creek region, where a number of openings have been made on it, the coal will not average much over 3½ feet in thickness, and therefore it is not likely to be extensively mined in the presence of the larger coal above it.

In the Lick Creek territory, ten miles further east, one opening on Big Laurel shows this coal 4 feet 4 inches thick; so that there is certainly some commercial area there. The bed shows a laminated structure, is usually without parting, and furnishes a good coal.

4. *The Kennedy seam.*—The Kennedy seam, 75 feet lower in the series, necessarily has a correspondingly increased acreage, it being considered to underlie three-fifths of the whole territory, a rather large estimate when taking into account erosion of the main water courses.

Throughout the Toms Creek region it is beneath water-level, its outcrop extending along both sides of Little Toms creek from Coeburn eastward to the tunnel, but passing beneath drainage northward on the Big Toms and its branches, approximately as shown on the map. It appears again on the headwaters of Bull run, just east of Little Toms tunnel, getting higher and higher in the hills as Bull run flows southeastward and cuts a deepening channel in the hillsides. It is exhibited in good condition on the waters of Russell creek and Lick creek, though confined largely to the hill tops in the neighborhood of the railroad.

There can be no misidentification of the Kennedy Seam wherever it is opened, for the character of its roof, as well as the physical appearance of the coal, are both strongly marked and totally different from anything in that region.

From Tacoma, a railroad station about 4 miles west of Coeburn (Guest's station), as far east as Doran, on Coal creek, through a distance of 54 miles, this bed preserves its identity and characteristics to a remarkable degree.

In a score of openings in this field it has never shown a parting of any kind, being always a clean coal bed, every pound of which can be mined. Again, the true structure, or more correctly the lack of structure, in the coal bed is a most noticeable feature, the coal appearing to be massed together, causing it to break out in rough, irregular pieces, like anthracite, due no doubt to the great weight of superincumbent sandstone, 20 or 30 feet thick, which overlies this coal everywhere to the exclusion of the ordinary slate roof. To this agency also is this handsome bed indebted for its irregularity of bed section, varying as it does from 3 to 8 feet, and with extremes in individual mines of from 2 feet 6 inches to 11 feet—variations which have led to the total abandonment at present of this bed in the region, except at one mine on Russell creek.

5. *The Imboden seam.*—The next bed in descending order in the series is the Imboden. Unfortunately it was nowhere open for inspection on the property during the examination, though there is ample evidence of the existence of a coal bed at this horizon through old openings along the southern out-crop. The bed is said to yield from 3½ to 5 feet of coal, and where opened at Tacoma it is 5 feet 4 inches thick, with, however, 1

foot of slate and mineral charcoal parting near the center and 2 to 4 inches of slate 2 inches from the top. It was a matter of regret that no further inspection could be made of this seam, inasmuch as the bed (if identical geologically) has attained a considerable reputation in the Big Stone Gap region and through the Clinch valley for its coking properties. Being so low in the coal series, its area is necessarily large, and the importance of developing this bed (if such value is rightly attached to it) becomes immediately manifest.

Buried beneath water level in the Toms Creek area, its rise southeastward elevates it above drainage in the ravines descending into Guest river west of Coeburn, so that its outcrop shows at many places along the railroad west of Tacoma.

At N. J. Horn's, about 3 miles west of Coeburn, a natural exposure of this coal shows in a spring house and in a field near by. Mr. Horn states he had opened it 6 feet thick, separated from a sandstone roof by a thin capping of slate, and carrying a slate parting 6 to 8 inches thick about 1 foot from the floor. The bed dips 6 to 8 degrees northward, soon descending beneath the high ridge along which the Wise county pike ascends to Gladeville.

The same coal appears in a railroad cutting about a mile west, and near Tacoma. East of Coeburn, along the railroad, there is no possible chance for this bed to exist above water level, as the Kennedy seam is not far above drainage on Little Toms creek; but rising rapidly through the Stone mountain south of the railroad here, its southern outcrop must show along the Dry fork of Bull creek, where indeed it was reported to have been mined to some extent for the commissary during the construction of the railroad.

The main Bull run cuts deeply into the topography east of Little Toms tunnel, so that about 1½ miles above the forks of the creek the Imboden seam outcrop rises from the stream, and several old openings show it in the bluff contiguous to the railroad before reaching the west portal of Holbrook tunnel; but it can not be much over 4 or 4½ feet thick here.

It must necessarily have some outcrop area in the territory bounded by Bull and Russell creeks and between the railroad and Clinch river; but nothing positive is known of its condition there.

On Russell creek, near the Bush house, and a short distance above the Russell Creek Coal and Coke Company mine, it is said to show 4½ feet thick, giving 10 inches of top coal, 2 inches slate, and 3 feet 6 inches of bottom coal at about 90 feet above the Jawbone seam; but this opening was likewise fallen shut, preventing inspection or sampling of the coal. It is also reported on Lick creek, although the opening exhibited savored more of the Kennedy seam in appearance than this lower coal, notwithstanding that the latter should certainly be found there.

6. *The Jawbone Seam.*—This is the lowest workable coal of the region,

occurring from 100 to 150 feet below the Imboden, and is in many respects a remarkable seam.

The Russell Creek Coal and Coke Company mine, near Virginia City, is the only commercial opening so far made on this bed; but the characteristics of the seam are very well exhibited there. It is about 6½ feet thick, carrying from 1 foot to 1 foot 2 inches of a middle bench of "greysplint," a hard, bony, carbonaceous substance, which burns readily and retains its heat for a long time, but which contains from 18 to 22 per cent. of ash, and separating an upper bench 1 foot 6 inches thick from the lower 4 feet. Elsewhere in the eastern portion of the field under discussion this bed shows as much as 12 feet thick; but the increased thickness is at the expense of the integrity of the bed, which then shows slate partings; so that while the bony material is never absent from the bed, it is sometimes interleaved with benches of bituminous coal, making separation in mining difficult and of course increasing the percentage of ash in the bed.

Various openings have been made on Bull run; but the coal is deeply under water level on Toms creek and in the country west toward Tacoma, so that its area is nearly coextensive with the property. Being a hard clean fuel and bearing transportation well, it is being gradually introduced for domestic use, especially as its large bed section and accessibility render its production comparatively inexpensive. Nevertheless, the chemical character of this coal suffers in comparison both with the Kennedy seam and the two Banner coal seams, especially in the percentage of ash. Moreover, whilst the bed is thick and can be cheaply mined, powder must be used in blowing it down, the result being the production of fully 40 per cent. of slack, for which there is no market at present.

It is manifest from individual sampling of the "gray splint," or central bone bench, that this substance contains on an average 20 per cent. of ash; and to its presence in the coal as mined and marketed at present is due the fact that the coal from this bed will yield anywhere from 12 to 15 per cent. of ash. Despite the fact that the whole product of the bed yields a "quick fire," and is a ready steam raiser, eventually the elimination of this central bench will certainly improve the fuel and enlarge its market accordingly.

BIG STONE GAP COAL FIELD.

In "Mineral Resources" for 1891 mention was made of the development work being prosecuted upon the coal beds in the region of Big Stone Gap, and known as the Big Stone Gap coal field. Development work was continued during 1892, but up to the close of the year no shipments from the field had been made. The property has been examined by Mr. James M. Hodges, formerly of the Kentucky Geological Survey, and from his report to the Big Stone Gap Colliery Company the following has been extracted:

This coal field embraces an area in Virginia of about 120 square miles, to which should be added some 30 square miles in Kentucky, also tributary to Big Stone Gap. It is made available through the construction of the Cumberland extension of the Louisville and Nashville railroad from Cumberland Gap to Norton, and by the extension of the Norfolk and Western railroad to the same point, thus giving outlets to the west and southwest over the former, and to the east over the latter road. The determination of the boundaries of the field, however, except on the south where Stone mountain forms a natural limit beyond which no coal is found, is involved in much uncertainty, for the coal extends far beyond the assumed boundaries east, north, and west, and the proportion of coal rightly belonging to this field depends largely upon what means may be adopted in the future for reaching the coal. The area in Virginia includes the region drained by the headwaters of the Powell river, north of the crest of Stone mountain, in Wise county, and in Lee county to a distance of about 10 miles from Big Stone Gap. The width of this area to the west is about 3 miles, but towards the east it reaches a width of 10 miles or more. Its length is about 20 miles. The area in Kentucky included as a part of this field, is a strip on the north side of Black and Little Black mountains, assumed to average 2 miles in width and to be about 15 miles long.

The property upon which the work of development has been prosecuted, consists of about 1,000 acres lying on the Powell river, near the eastern end of the field, extending up the river from a point 1½ miles from the Louisville and Nashville railroad to Isom branch, about 3 miles from the railroad. It reaches back from the river about 1¼ miles. The coal bed which gives this property its immediate value is that known as the Lower, supposed by many to be identical with the Imboden seam of the Big Stone Gap field. The outcrop of the bed extends but little over half a mile on the front of the property, and about one-eighth of a mile on the Stone Coal branch at the back, near which the bed has been opened. It is probable that the coal will increase as the opening is driven in from the surface.

Four openings have been made along the river outcrop, all of which give from 80 to 93 inches of coal, and borings on the property give from 79 to 85 inches, showing the property to have from 6½ to 7½ feet of coal over two-thirds of its area, and it is confidently expected that it will not average less than 5 feet thick over the remaining area, except in 20 acres of bottom land not covered by the bed and which will probably be utilized for coking ovens. The following is a rough calculation of the amount of coal which the bed may be expected to yield.

Estimated contents of the Big Stone Gap Colliery Company's property, near Norton, Virginia.

	Tons.
320 acres coal, 5 feet thick, at 1,400 tons per foot per acre	2,240,000
640 acres coal, 7 feet thick, at 1,400 tons per foot per acre	6,272,000
40 acres, containing no coal or seams not thick enough to mine	
Total 1,000 acres	8,512,000

The following analyses are given of coals from the various seams of the Big Stone Gap field, known respectively as the Upper, Middle, Imboden, and Lower. It is rather to be supposed that the samples analyzed from the lower seam are selected specimens, and do not really show the average analysis of the bed.

Analyses of coals from Big Stone Gap field.

Beds.	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Upper (*a*) (average of 2 analyses)	1.80	33.90	59.25	(*c*) 5.05	0.714
Middle (*a*) (average of 2 analyses)	1.40	34.10	59.84	(*c*) 4.66	0.566
Imboden (*b*):					
Pigeon creek	1.464	36.266	59.741	1.730	0.799
Looney creek	1.400	33.660	58.365	5.870	0.705
Looney creek	1.154	35.346	60.107	2.750	0.643
Mud Lick, Callahan creek	2.008	31.437	57.704	8.200	0.651
Black creek	1.160	34.075	54.798	8.250	1.717
Lower (*a*):					
Cooper	1.00	32.30	63.10	(*c*) 3.60	0.769
Baker	0.80	32.60	63.50	(*c*) 3.10	0.742

a Analyzed by Dr. Robert Peter, Chemist of Kentucky Geological Survey.
b Analyzed by Prof. A. S. McCreath, Chemist of Pennsylvania Geological Survey.
c Includes sulphur.

WASHINGTON.

Total product in 1892, 1,213,427 short tons; spot value, $2,763,547.

In 1891 the total amount of coal produced in Washington was 1,056,249 short tons, the increase in 1892 being 157,178 tons, or about 15 per cent. In spite of this substantial increase over the product of 1891, the yield was more than 50,000 tons less than that of 1890, and about 2,000 less than that of 1888. The depression in 1891 was due to labor troubles in King county and also to heavy importations of foreign coal into San Francisco. No strikes were reported in 1892 and the industry received additional encouragement by concessions in freights. King county especially was benefited by lower freight rates, one mine in that county being able in consequence to ship 25,000 tons of coal to Portland, thus opening a new market for the product. Several of the prospects in King and Pierce counties, of which mention was made in the preceding report, were opened, but the shipments were small and did not materially affect the total product. The indications are that most of these will be important producers during 1893, and five or six other properties developing in the current year will also probably be in operation before the close of the year.

The mines, on the whole, were operated very steadily during 1892, the average number of working days ranging from 100 in Skagit county to 305 in Whatcom county, the general average for the State being 247. The total number of men employed during the year was 2,564. In 1891, 2,447 men were employed and the mines were operated an average of 211 days.

The average price per ton was 3 cents less than in 1891, being $2.28 against $2.31. In King county prices ruled higher, the average for the year being $2.42 against $2.35 in 1891, an advance of 7 cents per ton. The prices in all the other counties declined. Thurston county, which did not produce any coal in 1891, is credited with 22,119 tons in 1892.

The following table exhibits the production in 1892 by counties:

Coal product of Washington in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
King	479, 458	4, 021	24, 988	....	508, 467	$1, 228, 262	$2. 42	265	1, 296
Kittitas	275, 471	2, 552	7, 065	....	285, 088	572, 615	2. 11	178	500
Pierce	344, 260	2, 745	5, 534	11, 755	364, 294	824, 606	2. 26	269	626
Skagit	3, 783	....	....	920	4, 703	15, 249	3. 24	100	30
Thurston	20, 817	484	818	....	22, 119	45, 790	2. 01	223	42
Whatcom	27, 076	....	1, 680	....	28, 756	77, 025	2. 68	305	70
Total	1, 150, 865	9, 802	40, 085	12, 675	1, 213, 427	2, 763, 547	2. 28	247	2, 564

The following table shows the product of the State for the past six years by counties:

Product of coal in Washington since 1887, by counties.

Counties.	1887.	1888.	1889.	1890.	1891.	1892.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons*	*Short tons.*	*Short tons.*
King	339, 961	546, 535	415, 779	517, 492	429, 778	508, 467
Kittitas	104, 782	220, 000	294, 701	445, 311	348, 018	285, 088
Pierce	229, 785	276, 956	273, 618	285, 886	271, 053	364, 294
Skagit	....	....	....	....	1, 400	4, 703
Thurston	15, 295	42, 000	46, 480	15, 000	....	22, 119
Whatcom	....	....	....	....	6, 000	28, 756
Not specified	82, 778	130, 259	....	....	....	....
Total	772, 601	1, 215, 750	1, 030, 578	1, 263, 689	1, 056, 249	1, 213, 427

The first discovery of coal in Washington was made in 1852, and the first mine was opened on Bellingham bay in 1854. The coal from this mine was shipped to San Francisco, and was the only coal shipped out of the Territory 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. The annual product since that time has been as follows:

Product of coal in Washington since 1885.

Years.	Total product.	Total value.	Average price per ton.	Total employés.	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

King county.—Coal produced in 1892, 508,467 short tons; spot value $1,228,262.

The coal product of King county in 1892 was 78,689 tons more than 1891. During 1891 the industry was disturbed by strikes among the miners and the production was curtailed in consequence. No such troubles occurred during 1892 and the production was further stimulated by concessions in freights. Prices were higher, the average for the county being 7 cents more than in 1891. The product in 1892 consisted of 293,558 tons of lignite, 203,812 tons of bituminous, and 11,097 tons of semi-bituminous.

Coal product of King county, Washington, since 1887.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1887	339, 961			
1888	546, 535			
1889	415, 779	$954, 295	$2. 55	1, 220
1890	517, 492	1, 352, 920	2. 61	1, 098
1891	429, 778	1, 009, 278	2. 35	1. 285
1892	508, 467	1, 228, 262	2. 42	1, 296

Kittitas county.—The entire product continues to be from the Roslyn mine of the Northern Pacific Coal Company. The largest production in any one year was in 1890, when 445,311 tons were obtained. The product in 1891 showed a decrease of 97,293 tons and a further decrease of 62,930 is shown in the product of 1892. The coal is classified as semi-bituminous.

Coal product of Kittitas county, Washington, since 1887.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1887	104, 782			
1888	220, 000			
1889	294, 701	$777, 450	$2. 64	
1890	445, 311	1, 229. 330	2. 76	489
1891	348, 018	772. 421	2. 22	501
1892	285. 088	572. 615	2. 11	500

Pierce county.—Coal produced in 1892, 364,294 short tons; spot value, $824,606. Six mines contributed to the product in 1892, two more than in 1891. The output increased 93,241 short tons and reached the highest figure in the history of the county. One mine produced 672 tons of semi-bituminous coal. All of the rest was bituminous. The average price per ton declined from \$2.33½ to \$2.26.

Coal product of Pierce county, Washington, since 1887.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1887	229,785	....	....	....
1888	276,956	....	....	....
1889	273,618	$578,493	$2.11½	759
1890	285,886	814,340	2.85⅓	589
1891	271,053	632,671	2.33½	601
1892	364,294	824,606	2.26	626

Skagit, Thurston, and Whatcom counties.—The coal product from each of these counties is obtained from one mine. Skagit county yielded 4,703 tons in 1892, an increase of 3,303 tons over 1891. Of the product in 1892, 920 tons were made into coke. Thurston county produced 28,756 tons in 1892 and none in 1891. Whatcom county produced 22,119 tons in 1892, against 6,000 tons in 1891, an increase of 16,119 tons.

WEST VIRGINIA.

Total product in 1892, 9,738,755 short tons; spot value, $7,852,114.

West Virginia ranks fourth in importance among the coal producing States, being preceded in this respect by Pennsylvania, Illinois, and Ohio in the order named. Since 1879 the amount of coal mined has increased steadily, the product in 1892 being 518,090 short tons larger than in 1891. While this increase was little more than one-fifth the increase in 1891 over 1890, it is still a significant amount and of sufficient importance to show the steady growth in the coal mining industry of West Virginia.

Taking the production by counties, increased outputs are shown in Fayette, Harrison, McDowell, Mercer, Monongalia, Ohio, Taylor, and Tucker counties, and Raleigh county, which appears as a producer for the first time, is credited with an output of nearly 100,000 short tons. Decreases are shown in Brooke, Kanawha, Marion, Marshall, Mason, Mineral, Preston, and Putnam counties. The counties whose product in 1892 was more than 100,000 tons in excess of that of 1891 were Fayette county, increase, 147,979 short tons, and McDowell county, increase, 369,488 tons. The larger decreases were in Marion county, decrease, 80,343 short tons, and Mineral county, decrease, 111,172 tons. No other counties showed a decrease of more than 50,000 tons.

The average price per ton ranged from 61 cents in Taylor county to

$1.11 in Putnam county, the general average for the State being 81 cents, an advance of one cent per ton over that of 1891. This slight advance, however, represents a gain of $96,187 to the State.

The total number of men employed in 1892 was 14,739, against 14,227 in 1891. The average number of working days in 1892 was 228, against 237 in 1891. The table below shows the statistics of coal production in West Virginia in 1892 distributed by counties and the disposition of the output.

Coal product of West Virginia in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Brooke	12,681	13,790	50	....	26,521	$25,029	$0.94	226	51
Fayette	1,864,754	27,960	10,995	551,691	2,455,400	2,073,277	.84	252	4,102
Harrison	194,731	12,302	274	14,419	221,726	170,871	.77	148	473
Kanawha	1,287,720	27,411	2,490	....	1,317,621	1,213,541	.92	217	2,677
McDowell	1,229,864	28,832	4,928	433,351	1,696,975	1,222,019	.73	195	2,061
Marion	537,152	10,272	13,986	358,294	919,704	682,111	.74	275	1,114
Marshall	103,414	15,000	560	....	118,974	93,573	.79	199	210
Mason	77,432	80,538	1,674	....	159,644	153,237	.96	215	338
Mercer	1,020,496	6,158	4,779	160,519	1,191,952	917,550	.76	211	1,621
Mineral	568,974	11,466	1,962	....	582,402	451,150	.77	244	500
Monongalia	35,000	250	100	13,550	48,900	35,208	.72	308	72
Ohio	41,414	77,588	1,321	....	120,323	119,660	.99	243	222
Preston	66,676	1,228	1,903	28,199	98,006	66,072	.67	209	170
Putnam	84,638	4,024	1,224	....	89,886	99,715	1.11	180	483
Raleigh	94,704	1,120	....	....	95,824	85,557	.89	167	120
Taylor	96,626	2,418	112	15,989	115,145	70,049	.61	282	128
Tucker	244,514	802	3,205	111,231	359,752	253,495	.70	306	525
Small mines	....	120,000	....	....	120,000	120,000	1.00	......	......
Total	7,560,790	441,159	49,563	1,687,243	9,738,755	7,852,114	.80	228	14,867

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

Coal product of West Virginia since 1873.

Years.	Short tons.	Years.	Short tons.
1873	672,000	1883	2,335,833
1874	1,120,000	1884	3,360,000
1875	1,120,000	1885	3,369,062
1876	896,000	1886	4,005,796
1877	1,120,000	1887	4,881,620
1878	1,120,000	1888	5,498,800
1879	1,400,000	1889	6,231,880
1880	1,568,000	1890	7,394,654
1881	1,680,000	1891	9,220,665
1882	2,240,000	1892	9,738,755

In the preceding table the figures quoted for the years prior to 1880 are largely estimated, and are therefore not included in the following statement showing the annual increase for each year:

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
Total increase in twelve years	8,170,755
Average annual increase	680,896

There are no records of the production by counties prior to 1886. The following table shows the tendency of production since that year, together with a statement of the increase or decrease in each county in 1892 as compared with 1891:

Coal production in West Virginia from 1886 to 1892, by counties.

Counties.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	Increase in 1892.	Decrease in 1892.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Brooke	22,880	40,366	11,568	31,119	36,794	33,950	26,521	....	7,429
Fayette	1,413,778	1,252,427	1,977,030	1,450,780	1,591,298	2,307,421	2,455,400	147,979	....
Harrison	234,597	154,220	109,515	174,115	144,403	150,522	221,726	71,204	....
Kanawha	876,785	1,126,839	863,600	1,218,236	1,421,116	1,324,788	1,317,621	....	7,167
McDowell	....	....	....	586,529	956,222	1,267,136	1,696,975	429,839	....
Marion	172,379	365,844	363,974	282,467	455,728	1,000,047	919,704	....	80,343
Marshall	251,333	92,368	47,702	47,706	123,669	193,703	118,974	....	74,729
Mason	150,878	140,968	72,410	185,030	145,314	159,990	159,644	....	346
Mercer	328,733	575,885	969,395	921,741	1,005,870	1,172,910	1,191,952	19,042	....
Mineral	361,312	478,636	456,361	493,464	573,684	693,574	582,402	....	111,172
Monongalia	....	....	....	74,031	31,360	31,000	48,900	17,900	....
Ohio	(*a*)	131,936	140,019	143,170	103,586	90,600	120,323	29,723	....
Preston	170,721	276,224	231,540	129,932	178,439	140,399	98,006	....	42,393
Putnam	(*b*)	53,200	145,440	218,752	205,178	94,230	89,886	....	4.344
Raleigh	....	....	....	....	....	....	95,824	95,824	....
Taylor	(*c*)	168,000	55,729	83,012	76,618	101,661	115,145	13,484	....
Tucker	22,400	24,707	62,517	173,492	245,378	358,734	359,752	1,018	....
Other counties and small mines	....	....	....	18,304	100,000	100,000	120,000	20,000	....
Total	4,005,796	4,881,620	5,498,800	6,231,880	7,394,654	9,220,665	9,738,755	846,013	327,923

a Included in product of Marshall county.
b Included in product of Mason county.
c Included in product of Harrison county.

The Norfolk and Western railroad extension from Bluefield, Virginia, to Kenova, West Virginia, was completed during 1892, giving the Pocahontas coal and coke an outlet to Ohio river boats and railroad connection to Chicago and other western cities. One immediate benefit derived from this new route was an order placed with some of the companies by the Illinois Steel Company for a large supply of coke. The extension will undoubtedly lead to the development of new coal fields in Logan and Wayne counties, while the completion of the Kanawha and Elk River railroad from Sutton to the Kanawha river will be the means of opening new fields in the central portion of the State.

Brooke county.—Coal produced in 1892, 26,521 short tons; spot value, $25,029.

The product of Brooke county in 1892 was 7,429 tons less than in 1891. The value decreased $2,971, the average price per ton advancing from 82½ cents to 94 cents. The total number of men employed was 51 in 1892 against 59 in 1891, and the average working time 226 days against 274. The loss in business was due to a strike in the mines of Forbes, Carmichael & Company at Wellsburg, lasting from June 25 to October 15, causing, in addition to the time lost during the strike, a loss of trade which decreased the output 75 per cent. after operations were resumed.

Coal product of Brooke county, West Virginia, since 1886.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1886	22,880			
1887	40,366	$37,394	$0.94	50
1888	11,568			
1889	31,119	22,828	.73	50
1890	36,794	28,520	.77½	50
1891	33,950	28,000	.82½	59
1892	26,521	25,029	.94	51

Fayette county.—Coal produced in 1892, 2,455,400 short tons; spot value, $2,073,277.

Fayette county continues to hold first place, the product in 1892 being about 800,000 tons more than that of McDowell county, which supersedes Kanawha county as the next largest producer. The product in 1892 was 147,979 tons more than in 1891, the value increasing $115,261. The number of producing mines was 28, an increase of 1 over 1891. The number of employés increased from 3,823 to 4,102, and the average number of working days from 245 to 252.

Coal product of Fayette county, West Virginia, since 1886.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1886	1,413,778			
1887	1,252,427	$1,127,184	$0.90	3,030
1888	1,977,030			
1889	1,450,780	1,302,438	.90	2,614
1890	6,591,298	1,438,612	.90	2,824
1891	2,307,421	1,958,016	.85	3,823
1892	2,455,400	2,073,277	.84	4,102

Harrison county.—Coal produced in 1892, 221,726 short tons; spot value, $170,871.

The coal product of Harrison county increased from 150,522 tons, worth $108,911, in 1891 to 221,726 tons, worth $170,871, in 1892, a gain of 71,204 tons, or 47 per cent. Two new mines were opened by the

Morris Gas Coal and Coke Company on the line of the West Virginia Central and Pittsburg railway, and the changing of this road from a narrow to a standard gauge gave operators the benefit of lower freight rates, which advanced the average price per ton from 72 to 77 cents.

Coal product of Harrison county, West Virginia, since 1886.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1886	(*a*)234, 597			
1887	154, 220	$100, 243	$0. 65	263
1888	109, 515			
1889	174, 115	114, 427	. 66	233
1890	144, 403	100, 818	. 70	305
1891	150, 522	108, 911	. 72	285
1892	221, 726	170, 871	. 77	473

a Including Taylor county.

Kanawha county.—Coal produced in 1892, 1,317,621 short tons; spot value, $1,213,541.

The product in 1892 did not differ materially from that of 1891, being 7,167 tons less. Five mines were not worked, three being exhausted and abandoned and two companies suspending. The total output declining only 7,167 tons shows the average production from the active collieries to have increased. The principal cause for the decrease in Kanawha county output was low water in the Great Kanawha river, cutting off one very important means of transportation. The number of men employed in 1892 was 2,677 against 2,802 in 1891, and the average working days remain the same.

Coal product of Kanawha county, West Virginia, since 1886.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1886	876, 785			
1887	1, 126, 839	$1, 408, 549	$1. 25	2, 496
1888	863, 600			
1889	1, 218, 236	1, 166, 038	. 96	2, 484
1890	1, 421, 116	1, 365, 585	. 96	2, 756
1891	1, 324, 788	1, 285, 164	. 97	2, 802
1892	1, 317, 621	1, 213, 541	. 92	2, 677

McDowell county.—Coal produced in 1892, 1,696,975 short tons; spot value, $1,222,019.

McDowell county began producing coal in 1889, the total yield being 586,529 short tons. In 1890 the product was 956,222 short tons, and in 1891 reached over a million and a quarter tons, and advanced the county from fourth to third place. The product in 1892 was 429,839 short tons, or 34 per cent. larger than in 1891, and put McDowell county second in importance. The average price per ton realized in 1892 was 5½ cents more than in the preceding year. The total number of employés increased from 1,536 to 2,061, but the average working time decreased from 227 to 195 days. The opening of new mines in McDowell county continues. Several began shipping in 1892, and a number will begin before the first of 1894, so that still further increased production from McDowell county may be looked for.

Coal product of McDowell county, West Virginia, since 1889.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1889	586,529	$390,232	$0.67½	764
1890	956,222	678,305	.71	1,315
1891	1,267,136	856,292	.67½	1,536
1892	1,696,975	1,222,019	.73	2,061

Marion county.—Coal produced in 1892, 919,704 short tons; spot value, $682,111.

The product of Marion county was 80,343 short tons less than in 1891. The decrease was due partly to labor troubles, the mines of the Montana Coal and Coke Company being idle about fifty days from this cause, and partly to want of cars to transport the product. The total number of employés in 1892 was 1,114 against 1,408 in 1891. The average number of working days was 275 against 279.

Coal product of Marion county, West Virginia, since 1886.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1886	172,379	....	....	....
1887	365,844	$312,675	$0.80	590
1888	363,974	....	....	....
1889	282,467	199,692	.71	333
1890	455,728	313,505	.69	865
1891	1,000,047	705,853	.70	1,408
1892	919,704	682,111	.74	1,114

Marshall county.—Coal produced in 1892, 118,974 short tons, spot value, $93,573.

Strikes interferred quite seriously with coal production in Marshall county. There are only three commercial mines in the county and in two of these strikes occurred. These two mines produce 95 per cent. of the total output. One strike lasted 3 months and the other 15 weeks. The effect is shown in a decrease of 74,729 tons or over 38 per cent. from the product of 1891. The returns show an increase of 20 in the number of men employed, but the average working time fell from 257 days to 199.

Coal product of Marshall county, West Virginia, since 1886.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1886	(a)251, 333			
1887	92, 368	$70, 200	$0.76	125
1888	47, 702			
1889	47, 706	35, 956	.75	72
1890	123, 669	100, 846	.81½	175
1891	193, 703	154, 402	.80	190
1892	118, 974	93, 573	.79	210

a Including Ohio county.

Mason county.—Coal produced in 1892, 159,644 short tons; spot value, $153,237.

The output in 1892 was practically the same as in 1891, the difference being only 346 tons. The coal is used largely for salt making at Clifton and Hartford City, nearly 50 per cent. of the product in 1892 being consumed in that way. This is included in the amount sold to local trade in the table of distribution.

Coal product of Mason county, West Virginia, since 1886.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1886	(a)150, 878			
1887	140, 968	$140, 968	$1.00	368
1888	72, 410			
1889	185, 030	167, 783	.91	363
1890	145, 314	134, 643	.93	320
1891	159, 990	144, 052	.90	311
1892	159, 644	153, 237	.96	338

a Including Putnum county.

Mercer county.—Coal produced in 1892, 1,191,950 short tons; spot value, $917,550.

The production in Mercer county was about the same as in 1891, a slight increase being noted.

Coal product of Mercer county, West Virginia, since 1886.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1886	328, 733			
1887	575, 885	$437, 673	$0.76	965
1888	969, 395			
1889	921, 741	594, 885	.64½	1, 121
1890	1, 005, 870	755, 014	.75	1, 465
1891	1, 172, 910	861, 709	.74	1, 510
1892	1, 191, 952	917, 550	.76	1, 621

Mineral county.—Coal produced in 1892, 582,402 short tons; spot value, $451,150.

The product in 1892 was 111,172 short tons less than in 1891. The average price per ton declined from 84 cents to 77 cents, and the number of employés decreased from 624 to 500. The average working time was 244 days in 1892 against 259½ in 1891.

Coal product of Mineral county, West Virginia, since 1886.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1886	361,312			
1887	478,636	$382,909	$0.80	475
1888	456,361			
1889	493,464	394,827	.80	608
1890	573,681	501,391	.87½	620
1891	693,574	581,814	.84	624
1892	582,402	451,150	.77	500

Monongalia county.—The product is from two mines operated by one company, and amounted in 1892, to 48,900 short tons, valued at $35,208. Seventy-two men were employed for 308 days.

Ohio county.—Coal produced in 1892, 120,323 short tons; spot value, $119,660.

The product of Ohio county increased from 90,600 short tons in 1891 to 120,323 tons in 1892, a gain of 29,723 tons or about 33 per cent. The average price per ton advanced from 78 cents to 99 cents. About 60 per cent. of the product of Ohio county is used at iron mills in and near Wheeling. The value of this portion of the product is taken at the price charged to the mill expenses, or at the average ruling price in the neighborhood. Two mines only produced coal for shipment.

Coal product of Ohio county, West Virginia, since 1887.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1887	131,936	$145,130	$1.10	211
1888	140,019			
1889	143,170	126,909	.88½	204
1890	103,586	100,017	.97	153
1891	90,600	70,553	.78	131
1892	120,323	119,660	.99	222

Putnam county.—Coal produced in 1892, 89,886 short tons; spot value, $99,715.

Low water in the great Kanawha river for a considerable portion of the year seriously affected shipments, and instead of the increased production predicted in the report for 1891, a decrease of 4,344 short tons is exhibited.

Coal product of Putnam county, West Virginia, since 1887.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1887	53, 200			200
1888	145, 440			
1889	218, 752	$244, 203	$1. 12	451
1890	205, 178	198, 269	. 97	375
1891	94, 230	112, 282	1. 19	526
1892	89, 886	99, 715	1. 11	483

Preston county.—Coal produced in 1892, 98,006 short tons; spot value, $66,072.

The product in 1892 was 42,393 short tons, or about 30 per cent. less than in 1891. The number of men employed decreased from 304 to 170, and the average working time from 221 days to 209.

Coal product of Preston county, West Virginia, since 1886.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1886	170, 721			
1887	276, 224			348
1888	231, 540			
1889	129, 832	$86, 024	$0. 66	239
1890	178, 439	127, 803	. 72	337
1891	140, 399	89, 829	. 64	304
1892	98, 006	66, 072	. 67	170

Taylor county.—Coal produced in 1892, 115,145 short tons; spot value, $70,049.

The product in 1892 increased 13,484 tons over 1891, and was the largest in any year since 1887. Ten more men were employed, but the average working time was five days less.

Coal product of Taylor county, West Virginia, since 1887.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1887	168, 000			225
1888	55, 729			
1889	83, 012	$52, 725	$0. 63½	96
1890	76, 618	58, 159	. 76	108
1891	101, 661	61, 488	. 60½	118
1892	115, 145	70, 049	. 61	128

Tucker county.—Coal produced in 1892, 359,752 short tons; spot value, $253,495.

Two mines produced the entire output, which was about the same as in 1891. The value increased more than $20,000, the average price advancing from 64½ to 70 cents per ton.

Coal product of Tucker county, West Virginia, since 1886.

Years.	Total product.	Total value.	Average price per ton.	Total employés.
	Short tons.			
1886	22,400			
1887	24,407	$19,526	$0.80	100
1888	62,517			
1889	173,492	120,574	.69½	229
1890	245,378	186,641	.76	353
1891	358,734	231,301	.64½	550
1892	359,752	253,495	.70	525

Raleigh county.—This county appears for the first time as a coal producer with a total output of 95,824 short tons, valued at $85,557. The entire product was from one mine, which employed 120 men and was shipping coal 167 days.

As having an important bearing on the coal mining interests of the Kanawha valley, the following description of the improvements of the Great Kanawha river has been contributed by Col. W. P. Craighill, U. S. Army, Engineer in charge:

THE IMPROVEMENT OF THE GREAT KANAWHA RIVER, WEST VIRGINIA.

[By Col. W. P. Craighill, Corps of Engineers.]

The Great Kanawha river empties into the Ohio 262 miles below Pittsburg and 205 miles above Cincinnati. It is a continuation of New river, which rises at the base of Grandfather mountain, between the Blue Ridge and Smoky ranges, in Watauga county, North Carolina. The length of the New and Great Kanawha together is about 425 miles.

The Great Kanawha is generally spoken of as being formed by the New and Gauley rivers, the latter joining the main stream 2 miles above Kanawha falls, but the Kanawha should really be regarded as beginning at the falls. The distance from the foot of the falls to the mouth of the river, measuring the surveyed line along the shore, is 95.25 miles.

This river flows through a fertile and picturesque region, filled with mineral wealth, especially coal and salt. It was by nature divided into a number of pools, some of considerable length and depth, separated by shoals of gravel and coarse sand, which were the principal obstructions to navigation in low water, there being often on them at such seasons but a few inches of water. In some of the pools were found shallow places, also obstructing navigation. There were also snags and loose rocks in the channel. The navigation was almost suspended in summer.

The coal and salt were generally sent out on rises, which enabled the boats to pass safely over the obstructions that otherwise would stop their movements entirely. The use of the river for the movement of these valuable products was therefore unsatisfactory and intermittent.

The shipment of salt, the first and for a long time the most important article of commerce, was first in canoes and next in flatboats.

The beginning of the latter was about 1808, when the first regular salt furnace was built. These flatboats increased in size until they got up to over 300 tons, carrying 2,000 to 2,200 barrels of salt. These boats were seldom pushed back, but were sold in the lower Ohio, the early upstream freighting being done in ribbed, keel-bottom boats, called bateaux.

The legislature of Virginia passed an order at the session of 1820-21 directing the James River and Kanawha Company, in which the State held large stock, to so improve the navigation of the Kanawha river as to secure not less than 3 feet of water for navigation all the year round from the mouth to the falls. The execution of this order was delayed, waiting examinations and surveys until 1825, when a system of chutes and wing dams was commenced and prosecuted for some years.

The shipment of coal for commercial purposes commenced about 1855 and soon reached considerable importance (the salt business had also grown to large proportions), and a better navigation was demanded. On account of this demand the James River and Kanawha Company took more thorough systems of improvement under consideration, and after further surveys and considering different radical plans, mainly that of Fisk by graded sluices, and Ellet's by reservoirs, practically rejected both, and decided to simply better and extend the old plan of improving the shoal by chutes and occasional wing dams.

The main feature of the new work proposed by the company at this time was the improvement of, and in most cases the making of new, chutes through the shoals by dredging, and a contract was made that embraced a large amount of this work. Four steam dredges, the first on the river, were put to work in the summer of 1860, and this was in progress when suspended in the fall of 1861 by the war.

After the war the State of West Virginia created the Kanawha River Board to carry on the improvements and collect the tolls, as the James River and Kanawha Company had done before. This board purchased two steam dredges and went on with the work begun in 1860 by the old company, and did a great deal in the way of dredging "dug chutes" through the shoals. These chutes were generally about 100 feet wide, and were used by small coal tows (from two to four barges) in medium or "dug chute" water, and by passenger and light freight steamboats in the same and lower stages.

Referring to the condition of the river about 1871, Dr. Hale (who was for some years a member of the Kanawha Board), in a history of the valley, writes: "Notwithstanding the fact that the navigation had been greatly improved within the past few years, it was manifestly inadequate to the wants of the rapidly increasing population and business of the valley. Having admittedly the finest coal fields on the continent, it was practically almost valueless for the want of safe, reliable, and economical transportation to markets.

"As there was no local financial ability equal to the task of constructing such an improvement as would fully develop this great interest and effectually serve it and the other growing interests of the valley, it was determined to apply to the general government for aid in the matter."

The first appropriation by the United States for the improvement of the Great Kanawha was made by Congress in 1872-73, and was for $25,000. Another appropriation for the same amount was made in June 1874. Both of these appropriations were expended in improvements for open navigation, mainly in building riprap dams and dikes, removing rocks and snags, and in widening and improving the channels on the shoals for towing by removing dredged walls and cutting down the bars. While this work was in progress the Kanawha river board continued to act for the State, operating the two dredge boats and collecting tolls. This board was dissolved by act of the legislature in 1883, and the improvement of the river turned over wholly to the United States.

Since the improvement by locks and dams was begun, occasional small sums have been expended on the open improvement in the way of dredging, removing obstructions, and repairing chute walls, as the interests of commerce have required or made advisable.

Improvement by locks and dams.—The first appropriation for the improvement of the river by locks and dams was made by Congress in March, 1875. Col. (then Major) William P. Craighill, the engineer officer in charge of the river, in a project for the expenditure of this appropriation, dated April 30, 1875 (Report Chief of Engineers, 1875, p. 90), says: "The system of locks and dams may be considered as affording the most reliable navigation at all seasons of the year; and, as the ordinary construction is open to the objection of delaying boats and breaking up tows, the adoption of movable dams seems the best expedient available. * * * These will furnish an unobstructed navigation during such times as the river will give sufficient depth of water, which will be not less than six months in each year. The system has not been fairly tested in this country, but its long and successful use in France would seem to supply the deficiency and justify its adoption under such favorable conditions as are found on the Kanawha.

* * * * * * *

"The profile represents approximately the position and height of the movable dams, the lifts of which vary from 6 to 8 feet up to Paint Creek shoal. Above that point the fall is greater, and it may be better that the movable dam system be not applied to it, but that the rise be overcome by three locks of 15 feet lift each.

"To meet the necessities of such economical transportation a depth of at least 7 feet of water should be secured at all times."

* * * * * * *

The first project contemplated three fixed dams of 15 feet lift each above the foot of Paint Creek shoal carrying the improvement to the foot of Kanawa falls. It was afterward deemed advisable to change the plan by reducing the lifts of the fixed dams to 12 feet, and locks and dams Nos. 2 and 3 have been so built, the No. 2 pool reaching to the foot of Loup Creek shoal. This is nearly or quite to the upper line of the best coal deposit on the Great Kanawha (being about where the Lower Coal Measures run out and the thick sandstone of the Conglomerate series appears), and it is not proposed to continue the improvement further upstream until the locks and dams are all completed below. The reduction in the lifts will make two more fixed dams necessary if the slack water is carried to the foot of the falls, making four in all instead of three as first proposed. It may be added that the experience at Nos. 2 and 3, particular in regard to the scour of the banks below the works has fully justified the change of plan and shown that the height adopted (for maximum 12-foot lifts) is as great as either of these dams should have been built.

The first project and estimate were for locks with "clear interior dimensions of about 48 to 50 feet in width and from 285 to 300 feet in length." The locks above Charleston are 50 feet wide in the clear and from 300 to 311 feet long between quoins. Before lock No. 6 was built, the first below Charleston, it was determined, in order to better accommodate the coal trade, particularly large-sized towboats in the lower river, to build all of the locks below Charleston 55 feet wide in the clear and 342 feet long between quoins. The coal barges are from 24 to 26 feet wide and about 130 feet long. The locks are designed to pass four barges at once or three barges and a towboat.

The building of the locks and dams was begun, as before stated, in 1875. Progress made to date, relative locations, lifts, etc., of each lock and dam, with some other important features and dimensions of each work, are given in the following table:

Progress made, locations, etc., of the movable dams on Kanawha river.

No. of lock and dam.	Style of dam.	Maximum lift.	Length of dam.			Lock dimensions.		Location—miles from mouth.	Remarks.
			Navigation pass.	Weir.	Total.	Clear width.	Length between quoins.		
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
2......	Fixed.......	12	....	....	524	50	308	85	Finished in 1887.
3......	....do	12	....	....	564	50	311	80	Finished in 1882.
4......	Movable ...	7	248	210	458	50	300	$73\frac{3}{4}$	Finished in 1880.
5......	....do	7	250	265	515	50	300	$67\frac{3}{4}$	Do.
6......	....do	$8\frac{1}{4}$	248	310	558	55	342	$54\frac{1}{4}$	Finished in 1886.
7......	....do	8	248	316	564	55	342	$44\frac{1}{4}$	Finished in 1892.
8......	....do	$8\frac{1}{4}$	248	292	540	55	342	36	Do.
9......	....do	$6\frac{1}{2}$	248	*a*300	*a*548	55	342	$25\frac{1}{4}$	To be finished in 1896.
10......	....do	$7\frac{1}{2}$	248	*a*290	*a*538	55	342	$18\frac{3}{4}$	To be finished in 1896.
11......	....do	10	248	*a*420	*a*668	55	342	$1\frac{3}{4}$	To be finished in 1896.

a Approximate.

The shipment of coal by river for the year ending June, 1881, was 385,148 tons. It has increased steadily, and in 1891 the river shipment was 1,030,454 tons.

In 1880 there were but two mines above the head of the Charleston pool (the site of lock No. 5) shipping by river, and they were sending out altogether not to exceed 8,000 tons per year. There are now seventeen mines above No. 5 shipping by river. The output of these seventeen mines by river in 1892 was 546,020 tons. It is evident, too, that the present output of coal from this part of the valley is but a small part of what it will become, as the coal and coke business is being increased and new mines opened all the time.

There are now twenty-one towboats and about nine hundred barges engaged in the coal trade on the river.

The ordinary freight and passenger traffic has increased and is still increasing rapidly. In 1886 these boats carried about 41,000 tons of miscellaneous freight—merchandise, farm produce, etc. Last year they carried 64,000 tons. There are now nine packets in the trade, five of them being coal boats, the others running from Charleston and above, to Cincinnati, Pittsburg, Gallipolis, or other points on the Ohio.

The movable dams.—The movable dams are of the Chanoine wicket type, operated from trestle service-bridges. The experience with movable dams on this river has on the whole been very satisfactory. They are easily and rapidly maneuvered (in these respects dam No. 6 and those now under construction have considerable advantage over those first built), the expense of operation and maintainance is but little if any more than with fixed dams, and they prove highly satisfactory to the river interests.

The movable dams are kept up whenever there is not water enough in the river for coal-boat navigation and down at other times. Their advantages over the ordinary fixed-dams for a commerce and river like the Great Kanawha are decided, furnishing the benefits of the usual slack water without its most serious drawbacks. With fixed dams everything must pass through the locks; with them navigation is entirely suspended too, when the river is near or above the top of the lock walls. With movable dams the locks are only used when the discharge of the river is so small as to make them necessary. At all other times they are down, practically on the river bottom, out of the way, affording unobstructed, open navigation. This is of great advantage to all classes of commerce, and is particularly so with coal, transported as it is, in "fleets" of large barges, the empty barges being returned in the same way. More barges can, of course, be taken by a towboat and much better time made by all kinds of craft in "open river," when there is water enough for such navigation, than when the stage or discharge compels the use of the locks.

The movable dams being down in high water, there is comparatively little difficulty in protecting the banks about the works from scour. In this respect they have considerable advantage, too, over the fixed dams.

Concert of action is necessary in maneuvering the dams and regulating the pools, and the different works are connected with each other and with the central office at Charleston by telephone. The line is also extended to Kanawha falls to give notice of floods, and daily communication by mail, and by telegraph when necessary, is had with Hinton at the mouth of the Greenbrier sixty miles above the Falls.

A light service boat, furnished with a derrick, capstan, and cabin is required at each movable dam to assist in in the maneuvers, transport bridge rails, tools, etc. A complete diving outfit is also necessary at each.

On the bank, in addition to the houses for the men, a drum house and tramway to handle apparatus and tools, a carpenter shop, blacksmith shop, and a storehouse are required. Such buildings, except the drumhouse are in use at the fixed dams as well. All of the ordinary repairs are made by the regular lock hands.

The following statement shows the number of tons of coal, including also that manufactured into coke, mined and shipped from the Great Kanawha valley, below Kanawha falls, for the several years named:

Coal shipments from the Kanawha valley for a series of years.

Years.	Shipments.			Years.	Shipments		
	By river.	By railroad.	Total.		By river.	By railroad.	Total.
	Tons.	*Tons.*	*Tons.*	Years ending June 30—	*Tons.*	*Tons.*	*Tons.*
1875	161,932	(a)231,717	393,649	1886	714,465	558,150	1,272.615
1876	200,962	(a)264,386	465,348	1887	929,335	766,436	1,695,771
1877	207,346	(a)310,352	517,698	1888	804,025	838,507	1,642,532
Years ending June 30—				1889	1,076,872	881,245	1,958,117
1881	385,148	265,266	650,414	1890	966,462	1,097,337	2,063,799
1883	614,818	531,610	1,146,426	1891	1,030,454	1,146,721	2,177,175
1884	736,843	482,367	1,219,210	1892	1,071,511	1,233,764	2,305,275
1885	712,493	581,889	1,231,382				

a The shipments by railroad for the first three years given, viz: 1875, 1876, and 1877, include the New river mines above Kanawha falls.

In comparing the shipments by river and railroad, the unfinished river improvements should not only be taken into account, but also the fact that the railroad shipments include two roads, the Chesapeake and Ohio and the Kanawha and Michigan, carrying to eastern, western, northern, and southern markets.

Tonnage of the Great Kanawha river for the year ending June 30, 1892.

	Tons.		Tons.
Coal, 26,787,788 bushels	1,071,511	Shingles, 2,750,000	4,125
Timber, 39,585,000 feet, B. M.	65,975	Brick, 150,000	337
Oak staves, 755,000	2,265	Merchandise and produce by steamboats	74,800
Tanbark, 590 cords	590		
Railroad ties, 924,650	138,697		
Hoop poles, 980,000	2,450	Total tonnage	1,360,750

Total tonnage for 1890 (Report of Chief of Engineers, p. 2246)	1,127,232
Total tonnage for 1891 (Report of Chief of Engineers, p. 2425)	1,225,355
Total tonnage for 1892 as above	1,360,750

There are also immense coal fields on the headwaters and tributaries of the Great Kanawha, notably on the New, Gauley, Elk, and Coal rivers.

The mouth of the Great Kanawha being so much nearer Cincinnati and the lower Ohio than that of the Monongahela, the Kanawha shippers will have a manifest advantage when the improvement of the Kanawha is complete; and this is expected to be in 1896, Congress having in 1892 authorized contracts to be made for the whole of the remaining work.

WYOMING.

Total product in 1892, 2,503,839 short tons; spot value, $3,168,776.

The product of coal in Wyoming in 1891 was 2,327,841 short tons, valued at $3,555,275. This indicates an increase in the product of 1892 of 175,998 short tons, but a loss in value of $386,499. The average price per ton, obtained by dividing the total value by the total product, shows a decline from $1.53 in 1891 to $1.27 in 1892. The principal losses were sustained in Carbon and Sweetwater counties, the two largest producers in the State. In the former, the total product of which in 1892 was 499,787 tons, the average price per ton, which in 1891 was $1.50, declined to $1.11 in 1892. Sweetwater county, with a product of over a million and a quarter tons, shows a decline in the average price from $1.48 in 1891 to $1.16 in 1892. No satisfactory explanation is forthcoming for this falling off in values, though probably due to sharp competition. Some operators complain of an advance in freight rates by the railroads which made a cut in price necessary in order to secure trade.

The statistics of production in 1892, by counties, is shown in the following table:

Coal product of Wyoming in 1892, by counties.

Counties.	Loaded at mines for shipment.	Sold to local trade and used by employés.	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 employés.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*				
Carbon	479,693	1,456	18,638	....	499,787	$553,555	$1.11	241	505
Converse	42,918	1,089	1,900	....	45,907	74,655	1.63	210	105
Fremont	....	8,000	....	....	8,000	20,000	2.50	200	3
Johnson	....	10,290	10	....	10,300	27,606	2.68	236	15
Sweetwater	1,218,480	1,381	45,580	....	1,265,441	1,462,571	1.16	198	1,643
Uintah	326,266	3,838	....	....	330,104	513,939	1.56	243	462
Weston	311,300	1,000	30,000	2,000	344,300	516,450	1.50	297	400
Total	2,378,657	27,054	96,128	2,000	2,503,839	3,168,776	1.27	225	3,133

The following table shows the output of the State from the beginning of mining in 1868 to the close of 1892;

Coal product of Wyoming since 1868.

Years.	Short tons.	Value.	Years.	Short tons.	Value.
1868	6,925	....	1881	628,181	....
1869	49,382	....	1882	707,764	....
1870	105,295	....	1883	779,689	....
1871	147,328	....	1884	902,620	....
1872	221,745	....	1885	807,328	$2,421,984
1873	259,700	....	1886	829,355	2,488,065
1874	219,061	....	1887	1,170,318	3,510,954
1875	300,808	....	1888	1,481,540	4,444,620
1876	334,550	....	1889	1,388,276	1,748,617
1877	342,853	....	1890	1,870,366	3,183,669
1878	333,200	....	1891	2,327,841	3,555,275
1879	400,991	....	1892	2,503,839	3,168,776
1880	527,811	....			

Carbon county.—Coal produced in 1892,499,787 short tons; spot value, $553,555.

Carbon county produced 67,607 short tons more coal in 1892 than in 1891, but the value of the output shows a loss of $94,625. This loss in value is discussed at the beginning of the Wyoming report.

Coal product of Carbon county, Wyoming, since 1868.

Years.	Short tons.	Years.	Short tons.
1868	6,560	1881	156,820
1869	30,482	1882	200,123
1870	54,915	1883	248,380
1871	31,748	1884	319,883
1872	59,237	1885	226,863
1873	61,164	1886	214,233
1874	55,880	1887	288,758
1875	61,750	1888	338,947
1876	69,060	1889	199,276
1877	74,343	1890	305,969
1878	62,418	1891	432,180
1879	75,424	1892	449,787
1880	100,433		

The product of Carbon county in 1892 consisted of 197,215 tons of bituminous coal, 200 tons of semi-bituminous, and 302,372 tons of lignite.

Converse county.—Coal produced in 1892, 45,907 short tons; spot value, $74,655. Converse county began production in 1888 with an output of 29,933 short tons. The coal is a lignite, and used to considerable extent in Fort Fetterman, Douglas, and other points along the line of the Fremont, Elkhorn and Missouri Valley railroad.

Coal product of Converse county, Wyoming, since 1888.

Years.	Short tons.	Value.
1888	29,933	....
1889	17,393	$30,955
1890	25,748	44,696
1891	27,897	49,258
1892	45,907	74,655

Fremont county.—The output in 1892 was 8,000 short tons, valued at $20,000, against 900 tons in 1891. The coal is bituminous, and used entirely for local consumption, *Johnson county.*—The total product in 1892 was 10,300 short tons, valued at $27,606, against 4,865 short tons, worth $7,714, in 1892. The county has no railroad, and the coal, which is a lignite, is mined for the local demand at Buffalo, and for supplying Fort McKinney, three miles distant.

Sheridan county.—A very small amount was mined for home consumption. The quantity was not reported.

Sweetwater county.—Coal produced in 1892, 1,265,441 short tons; spot value, $3,168,776.

Sweetwater county is the banner coal-producing county in the State, its output in 1892 being a little more than 50 per cent. of the total product of the State. The amount of coal mined in 1892 was 63,424 tons more than 1891, but, as was the case in Carbon county, the value of the product shows a decided decrease, being $310,843 less than the preceding year. The principal mines are the Rock Springs collieries, operated by the Coal Department of the Union Pacific railroad, the output of these mines in 1892 being 1,084,572. The other producers in 1892 were the Rock Springs Coal Company, the Sweetwater Coal Mining Company, and the Van Dyke Coal and Mining Company, all of Rock Springs, and the Black Butte Mining Company, Black Butte.

The Coal Department of the Union Pacific Railway Company has mined from the Rock Springs field the tonnage given in the following table:

Product of the Rock Springs mines, Wyoming.

Years.	Short tons.	Years.	Short tons.
1868	365	1881	270,425
1869	16,933	1882	287.510
1870	20,945	1883	304,495
1871	40,566	1884	318,197
1872	24.677	1885	328.601
1873	44,700	1886	359.234
1874	58,476	1887	465,441
1875	104.664	1888	662,277
1876	134,952	1889	777,213
1877	146,494	1890	652,408
1878	154,282	1891	993,478
1879	193.252	1892	1,084,572
1880	244,460		

Prior to 1888 the output of these mines constituted the total product of the county. Since that time the annual production has been as follows:

Coal product of Sweetwater county, Wyoming, since 1888.

Years.	Short tons.	Value.
1888	732,327	....
1889	857,213	$1,025,067
1890	978,827	1,666,068
1891	1,202,017	1,773,414
1892	1,265,441	1,462,571

According to the classification by the producers 111,552 tons of the product in 1892 were bituminous and 1,153,889 tons semi-bituminous.

Uinta county.—Coal produced in 1892, 330,104 short tons; spot value, $513,939.

There are but two corporations operating in the county, the Coal Department of the Union Pacific railroad at Almy and the Rocky Mountain Coal and Iron Company at Red Canyon. The former has been operating since 1869, the latter beginning production in the year following.

Product of the Union Pacific mines at Almy, Wyoming.

Years.	Short tons.	Years.	Short tons.
1869	1,967	1881	110.157
1870	12,454	1882	117,211
1871	21,171	1883	111.713
1872	22.713	1884	150,880
1873	22,847	1885	164,441
1874	23,006	1886	155,547
1875	41.805	1887	196,913
1876	60,756	1888	160,035
1877	54,643	1889	118,629
1878	59,096	1890	176,131
1879	71,576	1891	143,932
1880	100,234	1892	157,897

Since the date of opening the Rocky Mountain Coal and Iron Company has produced up to January 1, 1893, the following tonnage of coal:

Product of the Rocky Mountain Coal and Iron Company's mines at Red Canyon, Wyoming.

Years.	Short tons.	Years.	Short tons.
1870	16,961	1882	94,065
1871	53,843	1883	78,450
1872	105.118	1884	68.471
1873	130.989	1885	70.216
1874	181.699	1886	100,341
1875	92.589	1887	164.510
1876	69,782	1888	209,298
1877	67.373	1889	190,589
1878	57,404	1890	174.147
1879	60.739	1891	188,395
1880	82,684	1892	172,207
1881	90,779		

Both of these properties have been described in previous volumes of "Mineral Resources." All of the product is classed as semi-bituminous.

Weston county.—Coal produced in 1802, 344,300 short tons; spot value, $516,450.

The output of Weston county in 1892 was 18,145 tons larger than in 1891. The value increased proportionately, the average price per ton being the same for both years. The mines at Cambria, in this county, began production in 1890 with an output of 200,024 short tons. The development of these mines is the most notable achievement in the history of coal-mining in Wyoming. The mines are fully described on page 285 of "Mineral Resources, 1889 and 1890."

Recapitulation.—The following table shows in brief the annual product of each county since 1868, and the total output of the State for each year:

Total product of coal in Wyoming, by counties.

Years.	Carbon county.	Sweetwater county.	Uinta county.	Weston county.	Converse county.	Other counties.	Total.
	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
1886	214,233	359,234	255,888	....	....	....	829,355
1887	288,358	465,444	361,423	....	....	55,093	1,170,318
1888	338,947	732,327	369,333	....	29,933	11,000	1,481,540
1889	199,276	857,213	309,218	....	17,393	5,847	1,388,276
1890	305,969	978,827	350,278	200,024	25,748	9,520	1,870,366
1891	432,180	1,202,017	332,327	326,155	27,897	7,265	2,327,841
1892	499,787	1,265,441	330,104	344,300	45,907	18,300	2,503,839

MANUFACTURE OF COKE.

By Joseph D. Weeks.

[The ton used in this report is uniformly the short ton of 2,000 pounds.]

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 is quite small, but about 473,649 tons of the total production in 1892 of 12,010,829 tons, or less than 4 per cent., being produced outside of this field. Considered apart from amount of production, however, the coke industry in the fields other than the Appalachian is by no means an unimportant one. Especially is this true of the coke made from the Cretaceous coals of the Colorado, Montana, and Utah districts in the Rocky Mountain field, and the cokes from Washington on the Pacific coast. These are of great value even at the present time in smelting ores of the far West and the Pacific coast, and must be of still greater importance as these sections develop more generally their mineral and manufacturing possibilities.

A brief general description of each of these districts will be of importance to render clear the conditions under which coke is produced, as well as the character of the coal from which it is made.

The Appalachian coking 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, Alabama, where it loses itself. 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 Allegheny mountains formed and still forms the eastern border of this basin, while the Cincinnati anticlinal hems it in 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 considerably at its termination in Alabama, though it is here by no means so broad as in Pennsylvania, Ohio, and West Virginia.

Along nearly the entire length of this great coal field from Blossburg, Pennsylvania, to Birminghan, Alabama, on the south, the coke industry has been established. The ovens following the zone of best coking coal are generally found near the eastern limits of the field; that is, hugging the mountains, the coal in the middle or western part of the basin being, as a rule, not so well adapted to coking as that of the eastern.

In this field are found the Connellsville, Pennsylvania, the New River, Virginia, the Pocahontas Flat Top, Virginia and West Virginia, the Sewanee, Tennessee, and the Birmingham, Alabama, coal fields, together with other though less important fields. The production of bituminous coal in this field in 1892 was 83,122,190 short tons out of a total of 126,856,567 tons for the whole country. The production of coke in this district during the same period was 11,537,179 tons out of a total of 12,010,829 tons, or very close to 96 per cent. of the total production. The total amount of coal used in the production of this coke was 18,813,337 tons, of which 18,071,651 tons were from the measures of the Appalachian fields.

Central coking 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 1892 being not over 12,000 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. But all attempts to make such a fuel have been abandoned and what little coke is made in these States, with the exception of that made in western Kentucky, is from slack coal, chiefly for use in the manufacture of water gas and for domestic use as crushed coke.

The Western coking field.—The Western field, which includes the States of Missouri and Kansas and the Indian Territory, as a producer of coke is of but little more importance than the Central. A little coke, exactly 20,000 tons in 1892, was made from these coals, and this was chiefly in the New Pittsburg district of Kansas and in the lead district of Missouri for use by the lead smelters in the neighborhood. A smaller amount was made at McAlester, Indian Territory, from which place it is shipped chiefly for domestic use to Kansas City and other places in Kansas and Missouri.

Rocky Mountain coking 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. In this field the production in 1892 was 414,595 tons; that is, all but 59,054 tons of the coke made in the United States outside of the Appalachian field was made in the Rocky Mountain district.

Geological horizon of the coals.—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 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.

Coals and ovens used.—In many parts of the United States in which coking is carried on coke is made chiefly for the purpose of utilizing the slack or fine coal which results from the mining and preparation of coal for steam, household, and the other purposes of the general market. All of the coals used in Georgia, Illinois, Indiana, Indian Territory, Kansas, Missouri, and Washington are 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 some ten per cent. of the total amount of coal used is slack. It is a fact, however, that by far the largest amount of coal used is run-of-mine—14,453,638 tons of the 18,813,337 tons used in 1892 being run-of-mine. This is due to the fact that the larger coking operations in Pennsylvania and Alabama are carried on for the purpose of making coke and not of utilizing slack.

Another interesting feature in connection with coke production in the United States is that the solid-wall oven, usually of the beehive form, is practically the only one used in the country. A few retorts were reported as used in Colorado in 1892 and some flue ovens were reported in Pennsylvania, but the number of these is insignificant compared with the total number of ovens. It should be said, however, that at the close of 1892 two blocks of flue ovens for the utilization of by-products were in the course of construction and will be operated in 1893. One of these, on the Semet-Solvay principle, is erected at Syracuse, New York, near the works for making soda ash on the Solvay principle, the design of these ovens being chiefly to collect the ammonia for use in the Solvay or ammonia process of soda making. The second bank is erected at Winifrede, West Virginia, and is a modified Heissner oven. All of the by-products will be recovered at these ovens. Accompanying these ovens is the Slocum benzole plant. It is also true that there is more inquiry than ever, even in the Connellsville region, regarding the possibility of using the flue ovens in coking the better coking coals of the country. Coke manufacturers are realizing that the smoke which they have been discharging into the air, to the great disgust of the surrounding country, contains a large amount of products that should be utilized greatly to the financial benefit of the coking operations, always provided, of course, that in saving these by products there is no deterioration of the character of the coke for blast furnace and other metallurgical uses.

Another feature of interest is that certain expensive and costly experiments, undertaken in the past looking to the coking of what may be termed inferior coals, either because these coals have an inferior coking power or because they were high in ash or impurities, have been abandoned. It has been ascertained in certain sections where this coal exists that even for local purposes it is better to bring in cokes from those districts making a high grade than to attempt to use the cokes made from the inferior coals. The coke of the inferior coals has been practically abandoned in those sections of country where the distance from the great centers of coke production along the Appalachian mountains is not too great. This is especially true of the States of Ohio, Indiana, and Illinois. Another important indication in connection with coke making in the United States is that the coke makers, using a 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 coking. Quite a number of machines, many on the principle of the old Carr disintegrater, have been erected for the purpose of disintegrating or finely dividing the coal before putting it into the ovens. The effect of disintegration is to disseminate the ash which exists in the coal, largely in the shape of 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 seriously 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, than is required when it is thoroughly disseminated through the mass of the coke.

In this report, as in previous ones of the series, the word "coke" is used to denote only that coke made from bituminous coal in ovens, pits, ricks, or on the ground, which for convenience we have termed "oven coke." It does not include what may be termed "gas coke," or that coke made in connection with the production of illuminating gas.

Statistics of the production of coke from 1880 to 1892.—In the following table are shown the statistics of the manufacture of coke in the United States from 1880 to 1892, inclusive. During this time the production of coke has increased from 3,338,300 tons in 1880 to 12,010,829 tons in 1892, the production in 1892 being the largest in the history of the trade by some 500,000 tons. During this time the number of ovens has increased from 12,372 to 42,002. The value of the coke produced has increased from $6,631,267 to $23,536,141.

Statistics of the manufacture of coke in the United States, 1880 to 1892, 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	64.2
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	2.00	63
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	1.959	64

In the following tables are consolidated by States and Territories the statistics of production of coke in the United States for 1891 and 1892, the former being given for comparison. These statements cover not only production but certain information regarding ovens, the amount of coal used, the total value of coke per ton, and the yield of coal in coke.

From this table it appears that the total production of coke in 1892 was 12,010,829 tons, of a total value of $23,536,141, practically $1.96 a ton. In the production of this coke 18,813,377 tons of coal were used, the yield of the coal in coke being 64 per cent.; that is, it required 1.57 tons of coal to make one ton of coke. At the close of 1892 42,002 ovens were built and 1,893 were in the course of construction.

Manufacture of coke in the United States, by States and Territories, in 1891.

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	21	5,086	50	2,144,277	60	1,282,496	$2,986,242	$2.33
Colorado	7	948	21	452,749	61	277,074	896,984	3.24
Georgia	1	300	....	164,875	62.5	103,057	231,878	2.25
Illinois	1	25	....	10,000	52	5,200	11,700	2.25
Indiana	2	84	....	8,688	44	3,798	7,596	2.00
Indian Territory	1	80	....	20,551	46	9,464	30,483	3.22
Kansas	6	72	....	27,181	52	14,174	33,296	2.34
Kentucky	7	303	24	64,390	52	33,777	68,281	2.02
Montana	2	140	....	61,667	47	29,009	258,523	8.91
Missouri	3	10	....	10,377	66	6,872	10,000	1.45
New Mexico	1	Pits.	....	4,000	57.5	2,300	10,925	4.75
Ohio	9	421	....	69,320	56	38,718	76,901	1.99
Pennsylvania	109	25,324	11	10,588,544	66	6,954,846	12,679,826	1.82
Tennessee	11	1,995	....	623,177	58	364,318	701,803	1.92
Utah Territory	1	80	....	25,281	31	7,949	35,778	4.50
Virginia	2	550	250	285,113	58.7	167,516	265,107	1.58
Washington	2	89	....	10,000	60	6,000	42,000	7.00
West Virginia	55	4,621	555	1,716,976	58.7	1,009,051	1,845,043	1.83
Wisconsin	1	120	....	52,904	65	34,387	192,804	5.61
Wyoming	1	24	....	4,470	60	2,682	8,046	3.00
Total	243	40,245	911	16,344,540	63	10,352,688	20,393,216	1.97

Manufacture of coke in the United States, by States and Territories, in 1892.

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	20	5,320	90	2,585,966	58	1,501,571	$3,464,623	$2.307
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	51,818	112,907	2.18
Pennsylvania	109	25,366	269	12,591,345	66.1	8,327,612	15,015,336	1.803
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	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	1.959

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.

Pennsylvania still maintains its supremacy as the chief coke-producing State in the Union, its production for 1892 being 8,327,612 tons, or over 69 per cent. of the total. Alabama came second, producing 1,501,571 tons, or 12.5 per cent., and West Virginia was third with a total production of 1,034,750 tons, or 8.6 per cent. These were the only States that produced 1,000,000 tons or over. Colorado was the fourth State in point of production, its output being 373,229 tons. Tennessee followed not far after with an output of 354,096 tons, while Virginia showed a production of but 147,912 tons. These are the only States that produced over 100,000 tons.

A comparison of the production of 1891 and 1892 gives some interesting results. There was an increase of total production in 1892 over 1891 of 1,658,141 tons, or some 16 per cent. The most of this increase was in Pennsylvania, the production of this State having risen from 6,954,846 tons to 8,327,612 in 1892, an increase 1,372,766 tons or within 285,375 tons of the total increase in production in the United States. The small production in 1891, which was below the average, was due to the great strike in the Connellsville region of that year and the stopping of production of pig iron at the furnaces in the Mahoning and Shenango valleys. In 1892 Alabama increased its production over 1891, 319,075 tons, or about 25 per cent. Colorado's increase was very nearly 100,000 tons, or from 277,074 tons in 1891 to 373,229 tons in 1892, or 34.7 per cent. Tennessee's production dropped some 10,000 tons, while West Virginia's increase was some 30,000 tons, or about 3 per cent. The changes in the other States are not notable.

While there was an increase in the total value of the coke produced in the United States in 1892 over 1891 of some $3,000,000, it was due to the increased production of coke rather than to any increase in price, the average value of the coke produced in 1892 being one cent a ton less than that produced in 1891, having been $1.97 in the latter year and $1.96 in the former.

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 1892 by States:

Number of establishments in the United States manufacturing coke on December 31 of each year, from 1880 to 1892.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
Alabama	4	4	5	6	8	11	14	15	18	19	20	21	20
Colorado	1	2	5	7	8	7	7	7	7	9	8	7	9
Georgia	1	1	1	1	1	2	2	2	1	1	1	1	1
Illinois	6	6	7	7	9	9	9	8	8	4	4	1	1
Indiana	2	2	2	2	2	2	4	4	3	4	4	2	2
Indian Territory	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
Kentucky	5	5	5	5	5	5	6	6	10	9	9	7	5
Missouri	0	0	0	0	0	0	0	1	1	3	3	3	3
Montana	0	0	0	1	3	2	4	2	1	2	2	2	2
New Mexico	0	0	2	2	2	2	2	1	1	2	2	1	1
Ohio	15	15	16	18	19	13	15	15	15	13	13	9	10
Pennsylvania	124	132	137	140	145	133	108	151	120	109	106	100	109
Tennessee	6	6	8	11	13	12	12	11	11	12	11	11	11
Texas	0	0	0	0	0	0	1	0	0	0	0	0	0
Utah	1	1	1	1	1	1	1	0	0	1	1	1	1
Virginia	0	0	0	1	1	1	2	2	2	2	2	2	2
Washington	0	0	0	0	1	1	1	1	3	1	2	2	3
West Virginia	18	19	22	24	27	27	29	39	52	53	55	55	72
Wisconsin	0	0	0	0	0	0	0	0	1	1	1	1	1
Wyoming	0	0	0	0	0	0	0	0	0	0	1	1	1
Total	186	197	215	231	250	233	222	270	261	252	253	243	261

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	1885, December 31	233
1860 (census year)	21	1886, December 31	222
1870 (census year)	25	1887, December 31	270
1880 (census year)	149	1888, December 31	261
1880, December 31	186	1889, December 31	252
1881, December 31	197	1890, December 31	253
1882, December 31	215	1891, December 31	243
1883, December 31	231	1892, December 31	261
1884, December 31	250		

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 1892, together with the total number of ovens in the United States at the close of each of these years. In addition to the coke made in ovens some small amounts have been made in pits and on the ground. In the earlier years of coke making in the United States a considerable portion of pit coke was made, as in these years experiments were in progress as to the adaptability of certain coals to the manufacture of coke and until this was determined ovens were not built. It has been found, however, that the manufacture of coke in pits does not always determine the value of the coal in coking purposes, and even in experimental work it is now customary to erect ovens.

Number of coke ovens in the United States on December 31 of each of the years from 1880 to 1892.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
Alabama	316	416	536	767	976	1,075	1,301	1,555	2,475	3,944	4,805	5,068	5,320
Colorado	200	267	344	352	409	434	483	532	602	834	916	948	*b*1,128
Georgia	140	180	220	264	300	300	300	300	290	300	300	300	300
Illinois	176	176	304	316	325	320	335	278	221	149	148	25	24
Indiana	45	45	37	37	37	37	100	119	103	111	101	84	84
Indian Territory	20	20	20	20	20	40	40	80	80	78	78	80	80
Kansas	6	15	20	23	23	23	36	39	58	68	68	72	75
Kentucky	45	45	45	45	45	33	76	98	132	166	175	303	287
Missouri	0	0	0	0	0	0	0	4	4	9	10	10	10
Montana	0	0	0	2	5	2	16	27	40	90	140	140	153
New Mexico	0	0	0	12	70	70	70	70	70	70	70	*a*0	50
Ohio	616	641	647	682	732	642	560	585	547	462	443	421	436
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
Tennessee	656	724	861	992	1,105	1,387	1,485	1,560	1,634	1,639	1,664	1,995	1,941
Texas	0	0	0	0	0	0	0	0	0	0	0	0	0
Utah	20	20	20	20	20	20	20	0	0	34	80	80	83
Virginia	0	0	0	200	200	200	350	350	550	550	550	550	594
Washington	0	0	0	0	0	2	11	30	30	30	30	80	84
West Virginia	631	689	878	962	1,005	978	1,100	2,080	2,792	3,438	4,060	4,621	5,843
Wisconsin	0	0	0	0	0	0	0	0	50	50	70	120	120
Wyoming	0	0	0	0	0	0	0	0	0	0	20	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	40,245	42,002

a Includes 36 gas retorts. *b* Coke was made in pits.

As compared with 1891 the above table shows a considerable increase in the number of ovens in Alabama, Colorado, and West Virginia. There has been but little change in the other States. The increase in the number of ovens in Pennsylvania was quite small, being only 42. Pennsylvania, however, has the largest number of ovens, 25,366 out of 42,002. West Virginia has the second largest number of ovens, being 5,843, while Alabama has but 5,320. As more coke was made in Alabama in 1892 than in West Virginia, it is evident that the ovens of the former State were more fully occupied than the latter. Indeed, the conditions under which coke manufacture is carried on in West Virginia tends to an increase of the number of ovens much in excess of the demands upon them.

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.

At the close of 1892, as stated above, two banks of flue ovens were in course of construction. In the term flue ovens are included all ovens in which the coking operation is performed in whole or in part by heat applied externally to the inner wall of the oven by means of the waste gasses which are burned usually in flues contained in the walls of the ovens. There is a great demand in this country for tar and ammonia water which the illuminating gas works are not able to supply, especially in view of the fact that the amount of these by-products has been considerably lessened by the use of enriched water gas. The two banks of ovens which were in course of erection at the close of 1892 were intended to save these by-products, the Semet-Solvay oven being erected at Syracuse, New York, being chiefly designed to save the ammonia water, while the modified Heissner ovens, being erected at Winifrede, West Virginia, will produce benzole as well as save the other by-products. It is believed that there are certain coals in the United States which are largely used in coke making at the present time the coke from which could be very much improved and the cost of production very much reduced by the use of some form of flue oven with the saving of by-products.

Number of ovens building in the United States.—The following table gives the number of ovens actually in course of construction in the United States at the close of each year from 1880 to 1892. It should be understood that this table does not indicate the increase of the total number of these during the year; it only gives the number of ovens reported as being in course of construction at the close of each year, and indicates only the rapidity of the extension of the industry at the date when comparatively little oven building is in progress. It will be noted that for a number of years a considerable number of ovens have been in course of construction at the close of the year in West Virginia and Virginia. This number is very large in proportion to the number of ovens already in operation in these districts, and so far as the large number of ovens in course of construction in West Virginia is concerned, it grows out of the fact that the leases under which all coal operations in the Pocahontas Flat Top district are worked require the erection of a certain number of ovens; that is, the erection of ovens does not grow out of a demand for coke but out of the requirements of the leases in order that the slack coal may be utilized. Colorado also shows a very large number of ovens in course of construction in proportion to the number in operation. This grows out of the necessities of the case and the demand upon the ovens of Colorado for coke to be used in smelting.

A most interesting study in connection with the table showing the number of ovens and the production is the difference in the yearly production per oven in the State. In Alabama the average production per oven for the year was 282 tons; in Colorado 331 tons; in Pennsylvania nearly 330 tons; while in Virginia it was but 250 tons, and in West Virginia it was less than 180 tons. The explanation of this is that given above, namely, that the leases under which all the coal mined in the Flat-Top district of West Virginia is produced requires the erection of coke ovens to utilize the slack coal.

Number of coke ovens building in the United States at the close of each of the years from 1880 to 1892.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
Alabama	100	120	0	122	242	16	1,012	1,362	406	427	371	50	90
Colorado	50	0	0	0	24	0	0	0	100	50	30	21	220
Georgia	40	40	44	36	0	0	0	0	0	0	0	0	0
Illinois	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
Indian Territory	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
Kentucky	0	0	0	0	0	0	2	0	2	100	115	24	100
Missouri	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
New Mexico	0	0	12	28	0	0	0	0	0	0	0	0	0
Ohio	25	0	0	0	0	0	0	223	12	0	1	0	0
Pennsylvania	836	761	642	211	232	317	2,558	802	1,565	567	74	11	269
Tennessee	68	84	14	10	175	36	126	165	84	40	292	0	0
Virginia	0	0	0	0	0	0	100	300	0	250	250	250	206
Washington	0	0	0	0	0	0	21	0	100	0	80	0	30
West Virginia	40	0	0	0	127	63	317	742	318	631	334	555	978
Wisconsin	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
Total	1,159	1,005	712	407	812	432	4,154	3,594	2,587	2,115	1,547	911	1,893

Production of coke in the several States from 1880 to 1892.—The production of coke in the several States and Territories from 1880 to 1892 is shown in the following table:

Amount of coke produced, in short tons, in the United States, 1880 to 1892, inclusive, by States and Territories.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.
Alabama	60, 781	109, 033	152, 940	217, 531	244, 009	301, 180	375, 054
Colorado	25, 568	48, 587	102, 105	133, 997	115, 719	131, 9 0	142, 797
Georgia	38, 041	41, 376	46, 602	67, 012	79, 268	70, 669	82, 680
Illinois	12, 700	14, 800	11, 400	13, 400	13, 095	10, 350	8, 103
Indiana	0	0	0	0	0	0	6, 124
Indian Territory	1, 546	1, 768	2, 025	2, 573	1, 912	3, 584	6, 351
Kansas	3, 070	5, 670	6, 080	8, 430	7, 190	8, 050	12, 493
Kentucky	4, 250	4, 370	4, 070	5, 025	2, 223	2, 704	4, 528
Missouri	0	0	0	0	0	0	0
Montana	0	0	0	5	75	175	0
New Mexico	0	0	1, 000	3, 905	18, 282	17, 940	10, 236
Ohio	100, 596	119, 469	103, 722	87, 834	62, 709	39, 416	34, 932
Pennsylvania	2, 821, 384	3, 437, 708	3, 945, 034	4, 438, 464	3, 822, 128	3, 991, 805	5, 406, 597
Tennessee	130, 609	143, 853	187, 695	203, 691	219, 723	218, 842	368, 139
Utah	1, 000	0	250	0	0	0	0
Virginia	0	0	0	25, 340	63, 600	49, 139	122, 352
Washington	0	0	0	....	400	311	825
West Virginia	138, 755	187, 126	230, 398	257, 519	223, 472	260, 571	264, 158
Wisconsin	0	0	0	0	0	0	0
Wyoming	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

States and Territories.	1887.	1888.	1889.	1890.	1891.	1892.
Alabama	325, 020	508, 511	1, 030, 510	1, 072, 942	1, 282, 496	1, 501, 571
Colorado	170, 698	179, 682	187, 638	245, 756	277, 074	365, 920
Georgia	79, 241	83, 721	94, 727	102, 233	103, 057	81, 807
Illinois	9, 198	7, 410	11, 583	5, 000	5, 200	3, 170
Indiana	17, 658	11, 966	8, 301	6, 013	3, 798	3, 207
Indian Territory	10, 060	7, 502	6, 639	6, 639	9, 464	3, 569
Kansas	14, 950	14, 831	13, 910	12, 311	14, 174	9, 132
Kentucky	14, 565	23, 150	13, 021	12, 343	33, 777	36, 123
Missouri	2, 970	2, 600	5, 275	6, 136	6, 872	7, 299
Montana	7, 200	12, 000	14, 043	14, 427	29, 009	34, 557
New Mexico	13, 710	8, 540	3, 460	2, 050	2, 300	0
Ohio	93, 004	67, 194	75, 124	74, 633	38, 718	51, 818
Pennsylvania	5, 832, 849	6, 545, 779	7, 659, 055	8, 560, 245	6, 954, 846	8, 327, 612
Tennessee	396, 979	385, 693	359, 710	348, 728	364, 318	354, 096
Utah	0	0	761	8, 528	7, 949	7, 309
Virginia	166, 947	149, 199	146, 528	165, 847	167, 516	147, 912
Washington	14, 625	0	3, 841	5, 837	6, 000	7, 177
West Virginia	442, 031	531, 762	607, 880	833, 377	1, 009, 051	1, 034, 750
Wisconsin	0	500	16, 016	24, 976	34, 387	33, 800
Wyoming	0	0	0	0	2, 682	0
Total	7, 611, 705	8, 540, 030	10, 258, 022	11, 508, 021	10, 352, 688	12, 010, 829

The following table gives the relative rank of the States and Territories in the production of coke in the years 1880 to 1892, both inclusive:

Rank of the States and Territories in production of coke in 1880 to 1892.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
Pennsylvania	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
West Virginia	2	2	2	2	3	3	4	2	2	3	3	3	3
Tennessee	3	3	3	4	4	4	3	3	4	4	4	4	5
Colorado	7	6	6	5	5	5	5	5	5	5	5	5	4
Georgia	6	7	7	7	6	6	7	8	7	7	7	7	7
Virginia	......	......	......	8	7	7	6	6	6	6	6	6	6
Ohio	4	4	5	6	8	8	8	7	8	8	8	8	8
New Mexico	......	......	12	12	9	9	10	13	14	18	19	20	......
Illinois	8	8	8	9	10	10	11	15	16	13	18	17	18
Kansas	10	9	9	10	11	11	9	10	11	11	12	12	12
Indiana	......	......	......	......	......	......	13	9	13	14	16	18	17
Kentucky	9	10	10	11	12	13	14	12	9	12	11	10	9
Indian Territory	11	11	11	13	13	12	12	14	15	15	14	13	16
Washington	......	......	......	......	14	14	15	11	10	17	17	16	15
Montana	......	......	......	......	15	15	......	16	12	10	10	11	10
Missouri	......	......	......	......	......	......	......	17	17	16	15	15	14
Wisconsin	......	......	......	......	......	......	......	......	18	9	9	9	11
Utah	12	......	13	......	......	......	......	......	......	19	13	14	13
Wyoming	......	......	......	......	......	......	......	......	......	......	......	19	......

An inspection of this table indicates that the rank in 1892 of the States which produced over 100,000 tons of coke was as follows: Pennsylvania, Alabama, West Virginia, Colorado, Tennessee, and Virginia. In all of the years covered by this report Pennsylvania has always ranked first. For most of the years Alabama has occupied a second place, but at times it has dropped as low as the fourth, while West Virginia has assumed the second.

In the thirteen years covered by this report the production of Alabama has increased some twenty fold; of Colorado, ten fold; of Georgia, three fold; of Indian Territory, six fold; of Kansas, four and a half fold; of Kentucky, eight fold; of West Virginia, seven fold; while Pennsylvania has increased but about three fold. In 1880 there were but twelve States producing coke; in 1892 there were eighteen. Indiana, Missouri, Montana, Virginia, Washington, and Wisconsin, which were not producers in 1880, made coke in 1892.

In 1892, as compared with 1880, the actual increase in production of coke in the several important producing States has been as follows: The increase in production in Alabama in 1892 over 1880 was 1,440,790 tons; in Colorado, 340,325 tons; in Georgia, 43,766 tons; in Indian Territory, 2,023 tons; in Kansas, 6,062 tons; in Kentucky, 31,873 tons; in Tennessee, 223,487 tons; in West Virginia, 895,995 tons; and in Pennsylvania, 5,506,228 tons. It will thus appear that the States whose increase in tonnage has been the greatest have been those States whose percentage increase in some instances has been the least.

Value and average selling price of coke.—In the following table is given the total value of the coke produced in the United States for each year from 1880 to 1892, inclusive:

Total value at the ovens of the coke made in the United States in the years from 1880 to 1892, inclusive, by States and Territories.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.
Alabama	$183,063	$326, 819	$425, 940	$598, 473	$609, 185	$755, 645	$993, 302
Colorado	145. 226	267, 156	476, 665	584 578	409, 930	512, 162	569, 120
Georgia	81, 789	88, 753	100, 194	147, 166	169, 192	144, 198	179, 031
Illinois	41, 950	45, 850	29, 050	28, 200	25, 639	27, 798	21, 487
Indiana	0	0	0	0	0	0	17, 953
Indian Territory	4, 638	5, 304	6, 075	7, 719	5, 736	12, 902	22, 229
Kansas	6, 000	10, 200	11, 460	16. 560	14, 580	13, 255	19, 204
Kentucky	12, 250	12, 630	11, 530	14, 425	8, 760	8, 499	10, 082
Missouri	0	0	0	0	0	0	0
Montana	0	0	0	0	909	2, 063	0
New Mexico	0	0	6, 000	21, 478	91, 410	89. 700	51. 180
Ohio	255. 905	297, 728	266. 113	225, 660	156, 294	109, 723	94, 042
Pennsylvania	5, 255, 040	5, 898 579	6, 133, 698	5, 410, 387	4, 783, 230	4, 981, 656	7, 664, 023
Tennessee	316. 607	342, 585	472, 505	459, 126	428, 870	398, 459	687, 865
Utah	10, 000	0	2, 500	0	0	0	0
Virginia	0	0	0	44, 345	111, 300	85, 993	305, 880
Washington	0	0	0	0	0	0	0
West Virginia	318, 797	429, 571	520, 437	563, 490	425, 952	485, 588	513, 843
Wisconsin	0	0	9	0	0	0	0
Wyoming	0	0	0	0	0	0	0
Total	6, 631, 267	7, 725, 175	8, 462, 167	8, 121, 607	7, 240, 978	7, 627, 641	11, 149, 241

States and Territories.	1887.	1888.	1889.	1890.	1891.	1892.
Alabama	$775. 090	$1, 189, 679	$2, 372, 417	$2, 589, 447	$2, 986, 242	*a*$3, 464, 623
Colorado	682, 778	716, 305	643, 479	959, 246	896. 984	1, 234, 320
Georgia	174, 410	177, 907	149, 059	150, 995	231, 878	163, 614
Illinois	19, 594	21, 038	29, 764	11, 250	11, 700	7, 133
Indiana	51, 141	31, 993	25, 922	19. 706	7, 596	6, 472
Indian Territory	33, 435	21, 755	17, 957	21, 577	30, 483	12, 402
Kansas	28, 575	29, 073	26, 593	29, 116	33, 296	19, 906
Kentucky	31, 730	47, 244	29, 769	22, 191	68, 281	72, 563
Missouri	10, 395	9. 100	5, 800	9, 240	10, 000	10, 949
Montana	72, 060	96, 000	122, 023	125, 655	258, 523	311, 013
New Mexico	82, 260	51, 240	18, 408	10. 025	10, 925	0
Ohio	245, 981	166, 330	188, 222	218, 090	76, 901	112, 907
Pennsylvania	10, 746, 352	8, 230, 759	10, 743, 492	16, 333, 674	12, 679, 826	15, 015, 336
Tennessee	870, 900	490, 491	731, 496	684, 116	701, 803	724, 106
Utah	0	0	3, 042	37, 196	35, 778	0
Virginia	417, 368	260, 000	325, 861	278, 724	265, 107	322, 486
Washington	0	0	30, 728	46, 696	42, 000	50, 446
West Virginia	976, 732	905, 549	1, 074, 177	1, 524, 746	1, 845. 043	1, 821, 965
Wisconsin	0	1, 500	92, 092	143, 612	192, 804	185, 900
Wyoming	0	0	0	0	8, 046	0
Total	15, 218, 741	12, 445, 963	16, 630, 301	23, 215, 302	20, 393, 216	23, 536, 141

a Includes Utah's production.

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.

For the more intelligent information as to the value and selling price of coke the following table showing the average selling price for each of the years from 1880 to 1892 for each State and Territory is given. These are actual averages found by dividing the total amount received for the coke or the amount at which it is valued by the total amount of coke produced.

Average value per short ton at the ovens of the coke made in the United States in the years from 1880 to 1892, inclusive, by States and Territories.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
Alabama	$3.01	$3.00	$2.79	$2 75	$2.50	$2.50	$2.65	$2.39	$2.34	$2.30	$2.413	$2.33	$2.307
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
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
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
Indiana	......	......	......	......	......	......	2.93	2.81	2.68	3.12	3.277	2.00	2.02
Indian Territory	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
Kansas	1.95	1.80	1.70	1.96	2.02	1.65	1.54	1.91	1.96	1.91	2.365	2.34	2.18
Kentucky	2.88	2.89	2.83	2.87	3.94	3.14	2.23	2.18	2.04	2.28	1.797	2.02	2.01
Missouri	......	......	......	......	......	......	......	3.50	3.50	1.10	1.51	1.45	1.50
Montana	......	......	......	......	12.00	11.72	......	10.00	8.00	8.69	8.71	8.91	9.00
New Mexico	......	......	6.00	5.50	5.00	5.00	5.00	6.00	6.00	5.32	4.89	4.75	0
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
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	1.803
Tennessee	2.42	2.33	2.52	2.25	1.95	1.31	1.87	2.19	1.27	2.03	1.96	1.92	2.05
Utah	10.00	......	10.00	......	......	......	......	......	......	4.00	4.36	4.50	......
Virginia	......	......	......	1.75	1.75	1.75	2.50	2.50	1.74	2.22	1.68	1.58	2.18
Washington	......	......	......	......	......	......	......	......	......	8.00	8.00	7.00	7.03
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
Wisconsin	......	......	......	......	......	......	......	......	3.00	5.75	5 75	5.61	5.50
Wyoming	......	......	......	......	......	......	......	......	......	......	......	3.00	0
Total 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	1.959

An inspection of this table shows the average value of coke in 1892 to range from $1.50 a ton in Missouri to $9 a ton in Montana. These high prices are not always arbitrary, the character of the coal in Montana and Washington, where the highest price rules, the higher price of labor and the other elements of cost rendering the manufacture of coke in these districts not as remunerative as the price given would indicate

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 1892:

Amount of coal used (short tons) in the manufacture of coke in the United States from 1880 to 1892, inclusive, by States and Territories.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.
Alabama	106,283	181,881	261,839	359,699	413,184	507,934	635,120
Colorado	51,891	97,508	180,549	224,089	181,968	208,069	228,060
Georgia	63,402	68,960	77,670	111,687	132,113	117,781	136,133
Illinois	31,240	35,240	25,270	31,370	30,168	21,487	17,806
Indiana	....	....	....	....	....	....	13,030
Indian Territory	2,494	2,852	3,266	4,150	3,084	5,781	10,242
Kansas	4,800	8,800	9,200	13,400	11,500	15,000	23,062
Kentucky	7,206	7,406	6,906	8,437	3,451	5,075	9,055
Missouri	....	....	....	....	....	....	....
Montana	....	....	....	....	165	300	....
New Mexico	....	....	1,500	6,941	29,990	31,889	18,194
Ohio	172,453	201,145	181,577	152,502	108,164	68,796	59,332
Pennsylvania	4,347,558	5,393,503	6,149,179	6,823,275	6,204,604	6,178,500	8,290,849
Tennessee	217,656	241,644	313,537	330,961	348,295	412,538	621,669
Utah	2,000	....	500	....	....	....	....
Virginia	....	....	....	39,000	99,000	81,899	200,018
Washington	....	....	....	....	....	....	....
West Virginia	230,758	304,823	366,653	411,159	385,588	415,533	425,002
Wisconsin	....	....	....	....	....	....	....
Wyoming	....	....	....	....	....	....	....
Total	5,237,741	6,546,762	7,577,646	8,516,670	7,951,974	8,071,126	10,688,972

States and Territories.	1887.	1888.	1889.	1890.	1891.	1892.
Alabama	550,047	848,608	1,746,277	1,809,964	2,144,277	2,585,966
Colorado	267,487	274,212	299,731	407,023	452,749	*a*509,200
Georgia	158,482	140,000	157,878	170,388	164,875	158,978
Illinois	16,596	13,020	19,250	9,000	10,000	4,800
Indiana	35,600	26,547	16,428	11,753	8,688	6,456
Indian Territory	20,121	13,126	13,277	13,278	20,551	7,138
Kansas	27,604	24,934	21,600	21,809	27,181	15,437
Kentucky	29,129	42,642	25,192	24,372	64,390	70,783
Missouri	5,400	5,000	8,485	9,491	10,377	11,088
Montana	10,890	20,000	30,576	32,148	61,667	64,412
New Mexico	22,549	14,628	7,162	3,980	4,000	0
Ohio	164,974	124,201	132,828	126,921	69,320	95,236
Pennsylvania	8,938,438	9,673,097	11,581,292	13,046,143	10,588,544	12,591,345
Tennessee	655,857	630,099	626,016	600,387	623,177	600,126
Utah	....	....	2,217	24,058	25,281	....
Virginia	235,841	230,529	238,793	251,683	285,113	226,517
Washington	....	....	6,983	9,120	10,000	12,372
West Virginia	698,327	863,707	1,001,372	1,395,266	1,716,976	1,709,183
Wisconsin	....	1,000	25,616	38,425	52,904	54,300
Wyoming	....	....	....	....	4,470	0
Total	11,859,752	12,945,350	15,960,973	18,005,209	16,344,540	18,813,337

a Includes Utah's production.

In regard to this table it is to be noted that in most 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.

	Tons.	Pounds.
1880	1.57	3,140
1881	1.59	3,180
1882	1.58	3,160
1883	1.55	3,100
1884	1.63	3,260
1885	1.58	3,160
1886	1.56	3,120
1887	1.56	3,120
1888	1.51	3,032
1889	1.55	3,100
1890	1.58	3,160
1891	1.58	3,160
1892	1.57	3,140

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 1892. 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 remained as coke, and in the coke after the process of coking.

While these tables show an average of something like 63 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 1892, inclusive, by States and Territories.

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Alabama	57	59	58	60	60	59	59	59	60	59	59	60	58
Colorado	49	50	57	60	64	63	62.6	64	65.6	63	60	61	63.9
Georgia	60	60	60	60	60	60	60	50	60	60	60	62.5	51.5
Illinois	41	42	45	43	43	48	46	55½	56.9	60	55	52	66
Indiana	0	0	0	0	0	0	47	50	45	51	51	44	49.7
Indian Territory	62	62	62	62	62	62	62	50	57	50	50	46	50
Kansas	64	64.4	65	62.9	62¼	53⅔	54.2	54	59	64	56	52	59.2
Kentucky	60	60	59	60	64	53	50	50	54	52	51	52	51
Missouri	0	0	0	0	0	0	0	55	52	62	65	66	65.8
Montana	0	0	0	0	46	58½	0	66⅔	60	46	45	47	53.6
New Mexico	0	0	66⅔	57¼	57½	56¼	56	61	58	48	51.5	57.5	0
Ohio	58	59	57	58	58	57	59	56	54	56	59	56	54
Pennsylvania	65	64	64	65	62	64.6	65.2	65¼	68	66	65	66	66.1
Tennessee	60	60	60	62	63	53	59	61	61	57	58	58	59
Texas	0	0	0	0	0	0	50	0	0	0	0	0	0
Utah	50	0	50	0	0	0	0	0	0	34	35	31	0
Virginia	0	0	0	64½	64¼	60	61.1	70.8	64.7	61	66	58.7	65.3
Washington	0	0	0	0	0	0	0	0	0	55	64	60	58
West Virginia	60	61	63	63	62	63	62	63.3	61.6	61	59	58.5	60.5
Wisconsin	0	0	0	0	0	0	0	0	50	62.5	65	65	62
Wyoming	0	0	0	0	0	0	0	0	0	0	0	60	0
Total average	63	63	63	64	61	63	64	64.2	66	64	63	63	64

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.

The value of coal used per ton of coke.—In the following tables will be found a statement of the amount and value of coal used in the manufacture of coke in the United States in 1891 and 1892. While more coal was used in 1892 than in 1891, a larger amount of coke was produced, and while the value of it increased somewhat there was but little change either in the value of the coal per ton, the amount of coal required to make a ton of coke, or the value of the same. The average value of the coal per ton in 1891 was 76½ cents; in 1892 it was 75 cents. The amount of coal used per ton of coke in 1891 was 1.58 tons; in 1892 it was 1.57 tons. The value of the coal necessary to make a ton of coke in 1891 was $1.21; in 1892 it was $1.18.

Amount and value of coal used in the manufacture of coke in the United States in 1891 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	2,144,277	$2,186,707	$1.00	1.67	$1.67
Colorado	452,749	573,052	1.26	1.63	2.05
Georgia	164,875	148,388	.90	1.60	1.44
Illinois	10,000	1,500	.15	1.92	.29
Indiana	8,688	2,172	.25	2.28	.57
Indian Territory	20,551	5,138	.25	2.17	.54
Kansas	27,181	13,820	.51	1.91	.97
Kentucky	64,390	16,278	.25	1.91	.48
Missouri	10,377	4,143	.40	1.51	.60
Montana	61,667	128,864	2.09	2.12	4.43
New Mexico	4,000	6,600	1.65	1.72	2.84
Ohio	69,320	56,056	.81	1.79	1.43
Pennsylvania	10,588,544	7,318,697	.69	1.52	1.05
Tennessee	623,177	525,571	.84	1.71	1.45
Utah	25,281	19,198	.76	3.18	2.42
Virginia	285,113	227,935	.80	1.70	1.36
Washington	10,000	22,500	2.25	1.66	3.74
West Virginia	1,716,976	1,084,428	.63	1.74	1.10
Wisconsin	52,904	158,712	3.00	1.54	4.62
Wyoming	4,470	....	....	1.66	....
Total	16,344,540	12,499,819	.765	1.58	1.21

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	$0.987	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	.537	1.69	.91
Kentucky	70,783	19,681	.28	1.96	.55
Missouri	11,088	4,165	.376	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	.665	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	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 into which coal is charged into ovens.—In the following table will be found a statement of the condition of the coal when charged into the ovens; that is, whether it was used as run-of-mine or slack, washed or unwashed. The tables for 1891 and 1892 are given. The results shown are somewhat of a surprise, as it was generally supposed that a much larger percentage of slack was used. When it is noted, however, that such a large percentage of coal used for coking in Alabama and Pennsylvania the object of which is to produce coke and not to save coal, the proportion of run-of-mine will not seem so great.

The headings of the tables 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 1891.

States and Territories.	Run-of-mine, unwashed.	Run-of-mine, washed.	Slack, unwashed.	Slack, washed.	Total.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Alabama	1,943,469	0	192,238	8,570	2,144,277
Colorado	90,000	0	362,749	0	452,749
Georgia	106,131	0	0	58,744	164,875
Illinois	0	0	10,000	0	10,000
Indiana	0	0	0	8,688	8,688
Indian Territory	0	0	9,500	11,051	20,551
Kansas	0	0	27,181	0	27,181
Kentucky	11,000	0	3,500	49,890	64,390
Missouri	0	0	10,377	0	10,377
Montana	0	34,000	0	27,667	61,667
New Mexico	4,000	0	0	0	4,000
Ohio	5,200	0	64,120	0	69,320
Pennsylvania	9,470,646	256,807	558,106	302,985	10,588,544
Tennessee	184,556	0	377,914	60,707	623,177
Utah	3,752	0	21,529	0	25,281
Virginia	107,498	0	177,615	0	285,113
Washington	0	0	10,000	0	10,000
West Virginia	276,259	0	1,116,060	324,657	1,716,976
Wisconsin	0	52,904	0	0	52,904
Wyoming	0	0	4,470	0	4,470
Total	12,202,511	343,711	2,945,359	852,959	16,344,540

Character of coal used in the manufacture of coke in 1892.

States and Territories.	Run-of-mine, unwashed.	Run-of-mine, washed.	Slack, unwashed.	Slack, washed.	Total.
	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	226,517
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.

Of the total amount of coal used the run-of-mine was 77 per cent. in 1891 and 78.5 per cent. in 1892, and of slack 23 per cent. in 1891 and 21.5 per cent. in 1892. But 7 per cent. of the total was washed in 1891 and 6 per cent. in 1892.

Imports and exports of coke.—The following table gives the quantities and value of coke imported and entered for consumption in the United States from 1869 to 1892, inclusive. In the statement is included not only that coke which is entered for consumption through the custom-houses, but the withdrawals from warehouses for consumption. In the reports of the Treasury Department the quantities are long tons. These have been reduced to short tons to make the table consistent with the other tables in this chapter.

Coke imported and entered for consumption in the United States, 1869 to 1892, inclusive.

Fiscal years ending—	Quantity.	Value.	Fiscal years ending—	Quantity.	Value.
	Short tons.			*Short tons.*	
June 30, 1869		$2,053	June 30, 1881	15,210	$64,987
1870		6,388	1882	14,924	53,244
1871		19,528	1883	20,634	113,114
1872	9,575	9,217	1884	14,483	36,278
1873	1,091	1,366	1885	20,876	64,814
1874	634	4,588	1886	28,124	84,801
1875	1,046	9,648	1887	35,320	100,312
1876	2,065	8,657	1888	35,201	107,914
1877	4,068	16,686	1889	28,608	88,008
1878	6,616	24,186	1890	20,808	101,767
1879	6,035	24,748	1891	50,753	223,184
1880	5,047	18,406	1892	24,482	86,350

Value of coke exported from the United States, 1882 to 1886, inclusive.

Fiscal years ending June 30.	Value.
1882	$1,123
1883	3,281
1884	4,042
1885	5,062
1886	0

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. This region is divided into three distinct districts which take their names from the chief rivers draining them; that portion drained by the Warrior river and its tributaries and the Tennessee river and its tributaries in Alabama, constitutes the Warrior coal field. The Coosa field is drained by the Coosa river and is situated in Saint Clair and Shelby counties. The Cahaba field lies along the Cahaba river, 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 iron blast-furnace industry is located. Of the 5,320 ovens in Alabama, 4,683 are in the Warrior field, 567 in the Cahaba field, and 70 in the Coosa field. Of the 1,501,571 tons of coke produced in the State in 1892, 1,411,693 tons were from the Warrior field, 68,218 from the Cahaba field, and 21,160 from the Coosa field.

As a rule the coke made in Alabama is not equal, either in purity, calorific power, or as a metallurgical fuel, to that made in Pennsylvania, Virginia, and West Virginia, though it is by no means a bad fuel, generally, while the coke from certain seams, not large or extensive ones, to be sure, is an excellent fuel. 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, Alabama, are as follows:

Analyses of coke produced by the Mary Lee Coal and Railway Company, Jefferson, Alabama.

	Per cent.		Per cent.
Phosphorus	0.217	Volatile matter	0.120
Sulphur	.73	Fixed carbon	91.702
Ash	9.20	Sulphur	.878
Fixed carbon	90.15	Ash	9.300

This certainly indicates a good fuel, and the results obtained in the blast furnaces using this coke justify the belief. A coke made from the unwashed run-of-mine from the ovens of the Trussville Furnace and Mining Company at Bradford, Coosa county, Alabama, showed 9.36 per cent. ash and 0.632 per cent. sulphur.

The following are the statistics of the manufacture of coke in Alabama from 1880 to 1892, inclusive:

Statistics of the manufacture of coke in Alabama, 1880 to 1892, 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	2.307	58

a One establishment made coke on the ground.

COLORADO.

Colorado is still the most important coke-producing State outside of those which draw their supplies from the coal beds of the Appalachian field and ranks fourth in the list of coke-producing States, being exceeded only by Pennsylvania, Alabama, and West Virginia. It is the only one of the States of the Far West which is a large producer of coke, though Montana is continually increasing its output.

The largest part of the coke produced in the State is from what is known as the El Moro or Trinidad district, which is located near the southern boundary of the State, close to the line of New Mexico, in the neighborhood of the town of Trinidad. This district produced in 1892, 250,966 tons of the total of 373,229 tons. The Crested Butte district, which includes the coal fields near the place of that name and from which a very high grade of coke is produced, made 99,424 tons, while the San Juan district produced 10,000 tons in 1892.

The cokes from Colorado differ greatly in value. The coke is chiefly made from slack unwashed; 517,102 tons of the 599,200 tons of coal used in the manufacture of coke in Colorado in 1892 being unwashed slack. 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 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 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	100.30	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. At the Sopris works of the Colorado Fuel and Iron Company a 13-foot beehive oven, into which air is admitted by an annular duct, has been erected. This has resulted in a great improvement in the quality of the coke made and a great increase in the yield. The coal is always weighed into the oven at Sopris and the coke weighed out. The yield is never less than 65 per cent., sometimes reaching 69 per cent., in the standard beehive.

In the new 13-foot beehive oven, where the air enters from an annular duct high above the charge, a run for one month showed 71 per cent. of forked coke, 600 pounds of the weight per car of coal being deducted for moisture. Mr. R. C. Hills, the geologist of this company, writes: "In some recent experiments in crushing slack much better results were obtained. An oven was charged with 10,150 pounds of slack coal. The resulting coke weighed 7,575 pounds, a practical yield of 75 per cent." This extraordinary percentage is partly due to the small quantity of small coke formed, and to the probability that the usual 1½ per cent. was not deducted for moisture.

This company has 122 of these new ovens with the annular duct. The charge is 5½ tons of coal for 48 hours and 7 tons for 72 hours. The yield of coal in coke is greater than ordinary, owing to the fact that the air is admitted high up above the coal and in small currents all around instead of comparatively large currents at the door. In this oven, also, the charge is made to coke all over from the beginning, so that more coal can be coked per square foot of floor space. This oven was originally designed to coke Coal Basin coal, which is low in volatile matter.

The results obtained by the use of this oven are of great interest and seem to justify its use in other sections.

The following are the statistics of the manufacture of coke in Colorado for the years 1880 to 1892, inclusive.

Statistics of the manufacture of coke in Colorado, 1880 to 1892.

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	452,740	277,074	896,984	3.24	61
1892	9	*a* 1,128	220	572,904	365,920	1,201,429	3.28	63.9

a Includes 36 gas retorts.

GEORGIA.

Coking in Georgia is an industry of but comparatively little importance. The extreme northwestern portion of the State is cut by the extreme outline of the eastern border of the Appalachian coal field. In this district a small amount of coke is produced.

The statistics of the production of coke in Georgia, 1880 to 1892, are as follows:

Statistics of the manufacture of coke in Georgia, 1880 to 1892.

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	....	132,113	79,268	169,192	2.13	60
1885	2	300	....	117,781	70,669	144,198	2.04	60
1886	2	300	....	136,133	82,680	179,031	2.17	60
1887	2	300	....	158,482	79,241	174,410	2.20	50
1888	1	299	....	140,000	83,721	177,907	2.12	60
1889	1	300	....	157,878	94,727	149,059	1.57	60
1890	1	300	....	170,388	102,233	150,995	1.48	60
1891	1	300	....	164,875	103,057	231,878	2.25	62.5
1892	1	300	0	158,978	81,807	163,614	2.00	51.5

ILLINOIS.

The attempts to make coke on a large scale in Illinois have been practically abandoned, at least for the present, and until some more satisfactory way of dealing with coals like those of Illinois has been developed. Extraordinary efforts have been made in this State to establish a coke industry, chiefly with a view to utilizing the large amount of slack coal that now goes to waste. The chief difficulty is in the character of the coal, which does not coke readily, and the impurities, chiefly sulphur. In view of this all the coke made in Illinois, which in 1892 was but 3,170 tons, is for domestic purposes and the manufacture of water gas.

The following are the statistics of the manufacture of coke in Illinois for the years from 1880 to 1892:

Statistics of the manufacture of coke in Illinois, 1880 to 1892.

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	....	31,240	12,700	$41,950	$3.30	41
1881	6	176	....	35,240	14,800	45,850	3.10	42
1882	7	304	....	25,270	11,400	29,050	2.55	45
1883	7	316	....	31,170	13,400	28,200	2.10	43
1884	9	325	....	30,168	13,095	25,639	1.96	43
1885	9	320	....	21,487	10,350	27,798	2.68	48
1886	9	335	....	17,806	8,103	21,487	2.65	46
1887	8	278	....	16,596	9,198	19,594	2.13	55.5
1888	8	221	....	13,020	7,410	21,038	2.84	56.9
1889	4	149	....	19,250	11,583	29,764	2.57	60
1890	4	148	....	9,000	5,000	11,250	2.25	55
1891	1	25	....	10,000	5,200	11,700	2.25	52
1892	1	24	....	4,800	3,170	7,133	2.25	66

From the above table it will be seen that the coke industry in Illinois is a rapidly declining one. The highest production in the thirteen years covered by the table being in 1881, when 14,800 tons were produced. In 1892 but 3,170 tons were made.

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 non-coking 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.

The statistics of the manufacture of coke from 1886 to 1892, both inclusive, are given in the following table. No coke was made in Indi, ana from 1879 to 1885, both inclusive.

Statistics of the manufacture of coke in Indiana, 1886 to 1892.

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	....	35,600	17,658	51,141	2.81	50
1888	3	103	....	26,547	11,956	31,993	2.68	45
1889	4	111	....	16,428	8,301	25,922	3.12	51
1890	4	101	....	11,753	6,013	19,706	3.277	51
1891	2	84	....	8,688	3,798	7,596	2.00	44
1892	2	84	....	6,456	3,207	6,472	2.02	49.7

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, Indian Territory.

	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 1892 are as follows :

Statistics of the manufacture of coke in the Indian Territory, 1880 to 1892.

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	....	2,494	1,546	$4,638	$3.00	62
1881	1	20	....	2,852	1,768	5,304	3.00	62
1882	1	20	....	3,266	2,025	6,075	3.00	62
1883	1	20	....	4,150	2,573	7,719	3.00	62
1884	1	20	....	3,084	1,912	5,736	3.00	62
1885	1	40	....	5,781	3,584	12,902	3.60	62
1886	1	40	....	10,242	6,351	22,229	3.30	62
1887	1	80	....	20,121	10,060	33,435	3.33	50
1888	1	80	....	13,126	7,502	21,755	2.90	57
1889	1	78	....	13,277	6,639	17,957	2.70	50
1890	1	78	....	13,278	6,639	21,577	3.25	50
1891	1	80	....	20,551	9,464	30,483	3.22	46
1892	1	80	....	7,138	3,569	12,402	3.47	50

KANSAS.

The production of coke in Kansas is chiefly for domestic purposes and the smelting of lead, most of the coke made in the State being produced by the lead smelters for their own use. The coke industry of this State is, therefore, only of local importance.

The statistics of the manufacture of coke in Kansas from 1880 to 1892 are as follows:

Statistics of the manufacture of coke in Kansas, 1880 to 1892.

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	2.365	56
1891	6	72	....	27,181	14,174	33,296	2.34	52
1892	6	75	....	15,437	9,132	19,906	2.18	59.2

KENTUCKY.

While Kentucky is rapidly assuming a position of considerable importance as a coke-producing State, chiefly by reason of the developments in Bell county, in the southeastern part of the State, in the neighborhood of Middlesboro and Pineville, it has not grown in importance as was expected. The coke from the Pineville region is among the best cokes of the South, and would give most excellent results in the blast furnace. The mines are well located and will permit of an almost indefinite expansion of production in the future. Recently disintegrators for preparing the coal before coking have been introduced at the Middlesboro ovens with a most gratifying result, the value of the coke for a blast-furnace fuel being greatly improved. The coal fields in the neighborhood of Middlesboro are located just on the line between Kentucky and Tennessee, and the production of some of the ovens of this district are reported in connection with the coke operations of the latter State. Most of the coke produced in Kentucky in 1892 was from the western district; the balance was from the Pineville. None was produced in 1892, either at Cincinnati or Louisville, from the screenings from the coal yards of these two cities.

The statistics of the manufacture of coke in Kentucky from 1880 to 1892 are as follows:

Statistics of the manufacture of coke in Kentucky, 1880 to 1892.

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	45	....	7,206	4,250	$12,250	$2.88	60
1881	5	45	....	7,406	4,370	12,630	2.89	60
1882	5	45	....	6,906	4,070	11,530	2.83	59
1883	5	45	....	8,437	5,025	14,425	2.87	60
1884	5	45	....	3,451	2,223	8,760	3.94	64
1885	5	33	....	5,075	2,704	8,489	3.14	53
1886	6	76	2	9,055	4,528	10,082	2.23	50
1887	6	98	....	29,129	14,565	31,730	2.18	50
1888	10	132	2	42,642	23,150	47,244	2.04	54
1889	9	166	100	25,192	13,021	29,769	2.28	52
1890	9	175	303	24,372	12,343	22,191	1.797	51
1891	7	115	24	64,390	33,777	68,281	2.02	52
1892	5	287	100	70,783	36,123	72,563	2.01	51

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 24 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 1892 are as follows:

Statistics of the manufacture of coke in Missouri, 1887 to 1892.

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

MONTANA.

Montana is rapidly assuming a position of some prominence as a coke-producer in the Rocky Mountain States. Quite a number of deposits of coal well adapted to coke-making have been found in the coal field near the entrance, or at least not far distant from the entrance, of the Yellowstone park, the two fields from which coke is made being known as the Gardner and the Bozeman fields. It can be said of the coke in a general way that it averages from 9 to 17 per cent. in ash, with a slight trace of sulphur, and finds a ready market at Butte, Anaconda, Helena, and other places in its immediate neighborhood. Coke is made only when coal contracts leave a surplus.

The statistics of the manufacture of coke in Montana from 1883, when ovens were first reported, to 1892 are as follows:

Statistics of the manufacture of coke in Montana, 1883 to 1892.

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	61,067	29,009	8.91	258,523	47
1892	2	153	0	64,412	34,557	9.00	311,013	53.6

NEW MEXICO.

The coke industry in New Mexico has never assumed any importance. A small amount has been produced in the past for the use of the silver smelters of the Territory. So far as has been learned none was produced in 1892. The table, however, is inserted as usual, in order to carry forward the statistics from year to year. The statistics of the manufacture of coke in New Mexico from 1882, when coke ovens were first reported, until 1892 are as follows:

Statistics of the manufacture of coke in New Mexico, 1882 to 1892.

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	66⅔
1883	2	12	28	6,941	3,905	5.50	21,478	57¼
1884	2	70	0	29,990	18,282	5.00	91,410	57¼
1885	2	70	0	31,889	17,940	5.00	89,700	56¼
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

a At one works there are ten stone pits, with an average capacity of 10 tons each.

OHIO.

The production of coke in this State has been divided into two districts, the Cincinnati district, including the ovens near that city, and the Ohio district, which includes all the ovens in the remainder of the State.

Cincinnati district.—All of 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 Pittsburg and the Kanawha region of West Virginia.

The statistics of the manufacture of coke in the Cincinnati district from 1880 to 1892 are as follows:

Statistics of the manufacture of coke in the Cincinnati district, Ohio, 1880 to 1892.

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	12,545	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	56,733	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

Ohio district.—This district includes all of the ovens coking Ohio coal, and comprises the ovens of the Cherry Valley Iron Works, at Leetonia; the Federal Valley Coal Company, in the Hocking valley, and the coke works in the vicinity of Steubenville and Bridgeport.

The important establishment in this district is the Cherry Valley, at Leetonia, which produced considerably more than half of the coke made in the district in 1892.

The following table gives the statistics of the production of coke in the Ohio district for the years 1880 to 1892.

Statistics of the manufacture of coke in the Ohio district, Ohio, 1880 to 1892.

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	40,899	1.68	57¾
1887	10	435	203	108,251	60,110	130,227	2.12	55½
1888	9	391	0	60,984	31,326	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	31,355	46,242	1.47	53.4
1891	6	291	0	55,917	29,638	45,372	1.53	53
1892	6	290	0	63,905	32,498	48,588	1.50	50.9

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 1892 are consolidated:

Statistics of the manufacture of coke in Ohio, 1880 to 1892.

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

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 Allegheny Mountain district includes the ovens along the line of the Pennsylvania railroad from Gallitzin eastward over the crest of the Alleghenies to beyond Altoona. The Allegheny 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 Flat 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.

All of these twelve districts produced coke in 1892 except the Allegheny Valley. The production of 1892 shows a great increase over that of 1891, being 8,327,612 tons in 1892, and 6,954,846 tons in 1891. All of this increase is accounted for by the increase in the production of the Connellsville region. There was a slight increase in the production of the Allegheny Mountain region, a considerable addition to the coke made in the Broad Top and Pittsburg, but the other important regions showed a decline. In almost every case, this was due to the great strike in the Connellsville region in 1891, and the closing down of the blast-furnaces in the Mahoning and Shenango valleys of western Pennsylvania and eastern Ohio in the same year. The strike in the Connellsville region decreased the production of the district in 1891, and permitted the others to considerably increase their output, while the resumption of operations in Connellsville took the markets from the other districts.

The statistics of the production of coke in Pennsylvania by districts in 1891 and 1892 are given in the following tables:

Coke production in Pennsylvania in 1891, 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.*
Allegheny Mountain	16	1,201	0	708,523	448,067	$782,175	$1.74	63
Allegheny Valley	3	148	0	21,833	11,314	25,909	2.29	52
Beaver	3	88	0	4,224	2,332	6,663	2.85	55
Blossburg	2	407	0	46,084	24,351	66,195	2.72	53
Broad Top	5	448	0	146,008	90,728	197,048	2.17	62
Clearfield-Center	7	666	0	293,542	183,911	339,082	1.84	63
Connellsville	33	17,551	0	7,083,705	4,760,665	8,903,454	1.87	67
Greensburg	2	58	0	38,188	22,441	36,627	1.63	59
Irwin	4	696	0	323,099	197,082	266,061	1.35	61
Pittsburg	13	590	11	154,054	94,160	201,458	2.14	61
Reynoldsville-Walston	7	1,747	0	769,100	470,479	744,098	1.58	61
Upper Connellsville	14	1,724	0	1,000,184	649,316	1,111,056	1.71	65
Total	109	25,324	11	10,588,544	6,954,846	12,679,826	1.82	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.*
Allegheny Mountain	16	1,260	0	724,903	448,522	$775,927	$1.73	61.9
Allegheny Valley	3	148	0	0	0	0	0.	0.
Beaver	2	10	0	3,925	2,154	6,270	2.911	54.9
Blossburg	2	404	0	30,746	16,675	45,855	2.75	54.2
Broad Top	5	448	8	185,600	117,554	216,090	1.838	63.3
Clearfield-Center	7	731	0	231,357	147,819	264,422	1.789	63.9
Connellsville	31	17,309	0	9,389,549	6,329,452	11,598,407	1.832	67.4
Greensburg	2	58	0	15,005	9,037	13,173	1.458	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	2.135	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	1.803	66.1

It will be seen that out of a total production of coke in the United States in 1892 of 12,010,829 tons, Pennsylvania produced 8,327,612 tons, or over 69 per cent. There were four districts in this State, namely, the Allegheny Mountain, Connellsville, the Reynoldsville-Walston, and the Upper Connellsville, that produced more coke than any of the other States of the Union except Alabama, and West Virginia, while but six States of the Union produced more coke than the Broad Top, Clearfield-Center, Irwin, and Pittsburg districts. In the production of these 8,327,612 tons of coke 12,591,345 tons of coal were used, or 1.512 tons of coal to a ton of coke. The average value of this coal was 66½ cents per ton, making the value of coal to a ton of coke $1.01. Of this coal 11,237,253 tons were run of mine unwashed and 1,059,994 tons slack coal unwashed; 159,698 tons of run-of-mine were used washed and 134,400 tons of slack.

In the following tables are given the statistics of the production of coke in Pennsylvania for the years 1880 to 1892:

Statistics of the manufacture of coke in Pennsylvania, 1880 to 1892.

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	65¼
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
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

The 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. It is a slender prong, separated from the upper Coal Measures, and may be regarded as extending from south of Latrobe, on the Pennsylvania railroad, in a southwesterly direction, to the Virginia line, forming a basin some 3 miles wide and 50 miles long, almost without a fault, the beds yielding from 8 to 10 feet of workable coal. The same trough that contains the Connellsville coal extends northwesterly from Latrobe, but the Connellsville region proper is regarded as extending no farther north than the vicinity of Latrobe. The district north of the Connellsville proper has been designated in these reports as the "Upper Connellsville;" it is known locally as the "washed-coal district."

In this district there are approximately 55,000 to 60,000 acres of coking coal still unworked. This refers to the Connellsville seam alone. There are in this district several other seams 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.

The following are the statistics of the manufacture of coke in the Connellsville region from 1880 to 1892:

Statistics of the manufacture of coke in the Connellsville region, Pennsylvania, 1880 to 1892.

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	65½
1881	70	8,208	654	4,018,782	2,639,002	4,301,573	1.63	65⅔
1882	72	9,283	592	4,628,736	3,043,394	4,473,789	1.47	65¾
1883	74	10,176	101	5,355,380	3,552,402	4,049,738	1.14	66⅓
1884	76	10,543	200	4,829,054	3,192,105	3,607,078	1.13	$66\frac{1}{10}$
1885	68	10,471	48	4,683,831	3,096,012	3,776,388	1.22	$66\frac{1}{10}$
1886	36	11,324	1,895	6,305,460	4,180,521	5,701,086	1.36	$66\frac{3}{10}$
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	1.832	67.4

Prices of Connellsville coke.—The following table gives the ruling prices of blast-furnace coke free on board at the ovens for the past twelve years:

Monthly prices of Connellsville blast-furnace coke free on board at ovens.

Months.	1881.	1882.	1883.	1884.	1885.
January	$1.50-$1.75	$1.70-$1.80	$1.15-$1.20	$1.00	$1.10
February	1.50- 1.75	1.70- 1.80	1.20- 1.10	1.00	1.10
March	1.50- 1.75	1.70- 1.75	1.05	1.00	1.10
April	1.60- 1.75	1.70- 1.75	1.05	1.10	1.20
May	1.60- 1.65	1.65- 1.70	.95- 1.05	1.10	1.20
June	1.60- 1.65	1.50- 1.65	.90	1.10	1.20
July	1.50- 1.60	1.35- 1.50	.90	1.10	1.20
August	1.60	1.35	.90	1.10	1.20
September	1.60	1.25- 1.35	1.00	1.10	1.20
October	1.60- 1.65	1.25	1.00	1.10	1.20
November	1.60- 1.65	1.25- 1.35	1.00	1.10	1.20
December	1.60- 1.70	1.15- 1.35	1.00	1.10	1.20

Months.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
January	$1.20	$1.50	$1.75	$1.25	$1.75	$1.90	$1.90
February	1.20	2.00	1.75	1.25	1.75	1.90	1.90
March	1.35	2.00	$1.25- 1.50	1.25	2.15	1.90	1.90
April	1.35	2.00	1.00	1,15	2.15	1.90	1.90
May	1.50	2.00	1.00	1.10	2.15	1.90	1.80
June	1.50	2.00	1.00	1.10	2.15	1.90	1.80
July	1.50	2.00	1.00	$1.00- 1.10	2.15	1.90	1.75
August	1.50	2.00	1.00	1.00	2.15	1.90	1.75
September	1.50	2.00	1.00	1.25- 1.50	2.15	1.85	1.75
October	1.50	2.00	1.00	1.50	2.15	1.85	1.75
November	1.50	2.00	1.25	1.75	2.15	1.80	1.75
December	1.50	2.00	1.25	1.75	2.15	1.80	1.75

The Upper Connellsville district.—This district, as stated in previous reports, includes that portion of the trough or basin in which the Connellsville coke is found that is located northerly from a point just below Latrobe. The coal differs somewhat from that found in the lower part of the basin, and, as stated previously, the district is known as the "washed-coal district." It is one of the most important coking districts in the amount of product in the country. Its product among the districts of Pennsylvania is surpassed only by the Connellsville.

The following analysis was made by Mr. A. S. McCreath of coke produced by the Alexandria Coal Company of Unity Township, Westmoreland county, Pennsylvania, 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

The following are the statistics of the manufacture of coke in the Upper Connellsville region for the years 1880 to 1892:

Statistics of the manufacture of coke in the Upper Connellsville district, 1880 to 1892.

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	1.746	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

Allegheny Mountain district.—This district is now the third in importance in Pennsylvania, it having surpassed in production in 1892 the Reynoldsville-Walston district. It approaches very closely in production that of the Upper Connellsville district, the production of this district being 451,975 tons in 1892 as compared with 448,522 tons in the Allegheny Mountain district in the same year. This district includes not only the ovens along the Pennsylvania railroad from Gallitzin eastward in Cambria and Blair counties, but the ovens in Somerset county as well.

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 Allegheny 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 Allegheny Mountain district from 1880 to 1892 are as follows:

Statistics of the manufacture of coke in the Allegheny Mountain district of Pennsylvania, 1880 to 1892.

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	1.74	782,175	63
1892	16	1,260	0	724,903	448,522	1.73	775,927	61.9

Clearfield-Center district.—This district, formerly known as the Snow Shoe, is one of the important districts in Pennsylvania, though its production has declined during the last few years. About half the coal used in this district is run-of-mine, though many of the ovens were built originally to use slack, but the quality of the coke has proved so good that it has been found profitable to use a large proportion of run-of-mine.

The statistics of the manufacture of coke in the Clearfield-Center district for the years 1880 to 1892 are as follows:

Statistics of the manufacture of coke in the Clearfield-Center district, Pennsylvania, 1880 to 1892.

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	330,082	63
1892	7	731	0	231,357	147,819	1.789	264,422	63.9

The Broad Top district.—In this district are included all the ovens in what is known as the "Broad Top coal fields," the ovens being situated in Bedford and Huntingdon counties.

The statistics of the manufacture of coke in the Broad Top region, Pennsylvania, for the years 1880 to 1892, are as follows:

Statistics of the manufacture of coke in the Broad Top region, Pennsylvania, 1880 to 1892.

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	1.838	216,090	63.3

Pittsburg district.—Practically all the coal used in this district is slack, mostly from the several levels of the Monongahela river, which is brought to Pittsburg by barges. The Pittsburg seam of coal at Pittsburg does not make a good coke. It contains too much volatile matter and makes a spongy coke. The district includes the ovens at and near Pittsburg. The ovens in Washington county that use slack from the mines of that county are also included in the Pittsburg district. The statistics of the manufacture of coke in the Pittsburg district, Pennsylvania, for the years 1880 to 1892, are as follows:

Statistics of the manufacture of coke in the Pittsburg district, Pennsylvania, 1880 to 1892.

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	2.135	376,613	60.3

Beaver district.—A small amount of coke is made in this district each year for use in local manufactories. The demand fluctuates greatly at times.

The following are the statistics of the manufacture of coke in the Beaver district, Pennsylvania, for the years 1880 to 1892:

Statistics of the manufacture of coke in the Beaver district, Pennsylvania, 1880 to 1892.

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	2.85	55
1892	2	10	....	3,925	2,154	6,270	2.91	54.9

Allegheny Valley district.—This 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 statistics of the manufacture of coke in the Allegheny Valley district for the years 1880 to 1892 are as follows:

Statistics of the manufacture of coke in the Allegheny Valley district, Pennsylvania, 1880 to 1892, 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	2.14	56.6
1891	3	148	0	21,833	11,314	35,909	2.29	52
1892	3	148	0	0	0	0	0	0

Reynoldsville-Walston district.—This district continues to hold its position as one of the most important coking districts in the United States. In production it was surpassed in 1892 in Pennsylvania only by the Connellsville, Upper Connellsville, and Allegheny Mountain districts, and outside of Pennsylvania its production was surpassed in 1892 only by the States of Alabama and West Virginia.

The district includes all of the ovens on the Rochester and Pittsburg railroad, as well as those of the low-grade divisions of the Allegheny

Valley road and the Dagus mines of the New York, Lake Erie, and Western.

The following are the statistics of the manufacture of coke in the Reynoldsville-Walston district for the years 1880 to 1892:

Statistics of the manufacture of coke in the Reynoldsville-Walston district, Pennsylvania, 1880 to 1892.

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	1.345	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	1.395	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

The following analysis was made of coke produced by the Rochester and Pittsburg Coal and Iron Company, Young Township, Jefferson county, Pennsylvania. (Analysis by McCreath.)

Analysis of coke from the Reynoldsville-Walston district, Pennsylvania.

	Per cent.
Water	0.427
Volatile matter	.753
Fixed carbon	87.695
Suphur	.897
Ash	10.288
Total	100.060

Blossburg district.—In this district are included the two establishments making coke from the coal of the Blossburg coal field. All of the coal used is washed slack.

The following are the statistics of the manufacture of coke in the Blossburg, Pennsylvania, district from 1880 to 1892:

Statistics of the manufacture of coke in the Blossburg district, Pennsylvania, 1880 to 1892.

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	62, 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	2.70	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

TENNESSEE.

The coal fields of Tennessee are a continuation of the great coal deposits of western Pennsylvania and West Virginia. The fields extend through the State from northeast to southwest and are coextensive with the Cumberland table lands. The most important, as well as the best known coke-producing seam of Tennessee is that known as the Sewanee in the little Sequatchie coal field. This coal seam is in the Upper Measures and is supposed to correspond with bed B of the Geological Survey of Pennsylvania, and is to Tennessee what the Pittsburg seam is to Pennsylvania. The Tennessee Coal, Iron and Railroad Company, the largest producers of coke in the State, mine most of the coal used in their ovens from this seam. The Roane Iron Company, a large producer of coke, makes the fuel for its blast furnaces from a seam nearly if not quite identical with the Sewanee, of an average thickness of about five feet. At the works of the Dayton Coal and Iron Company a large amount of coal is made into coke from the coal beds in the neighborhood of their furnaces. At these works disintegration of the coal previous to coking is carried on with great success. The value of the coke as a blast-furnace fuel is greatly increased thereby; it carries a heavier burden and the amount used per ton of pig iron has been greatly reduced.

In Tennessee is now 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. At the works in this district also disintegration prior to coking is in use, and the coke produced is stronger, brighter, and a much better blast-furnace fuel.

In the following tables are found analyses of cokes from several fields of this State.

Analysis of coke from Buckeye Coal Company, Pioneer, Tennessee.

[Coal washed before crushing.]

	Per cent.
Carbon	88.300
Ash	11.700
Sulphur	.372
Total	100.372

This company is erecting machinery to wash the coal after crushing, which will materially increase the carbon, probably to 91 or 92 per cent., and reduce the ash to 7 or 8 per cent.

Analysis of coke produced from unwashed slack by the Glen Mary Coal and Coke Company, of Glen Mary, Tennessee.

	Per cent.
Fixed carbon	91
Ash	9
Total	100
Sulphur	.60

Analysis of coal produced by Glen Mary Coal and Coke Company, of Glen Mary, Tennessee.

	Per cent.
Carbon	61.63
Gas	36.73
Ash	1.64
Total	100
Sulphur	.29

Analysis of coke produced by the Mingo Mountain Coal and Coke Company in Claiborne county, Tennessee.

	Per cent.
Moisture and volatile matter	0.76
Fixed carbon	89.96
Ash	8.92
Sulphur	.89
Phosphorus	.008
Total	100.538

The following are the statistics of the manufacture of coke in Tennessee for the years 1880 to 1892:

Statistics of the manufacture of coke in Tennessee, 1880 to 1892.

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. 92	58
1892	11	1, 941	0	600, 126	354, 096	724, 106	2. 05	59

a One establishment made coke in pits.

UTAH.

In the following table will be found the statistics of the production of coke in Utah from 1880 to 1892:

Statistics of the manufacture of coke in Utah Territory, 1880 to 1892.

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, 000	1, 000	$10, 000	$10. 00	50
1881	1	20	0	0	0	0	0	0
1882	1	20	0	500	250	2, 500	10. 00	50
1883	1	20	0	0	0	0	0	0
1884	1	20	0	0	0	0	0	0
1885	1	20	0	0	0	0	0	0
1886	1	20	0	0	0	0	0	0
1887	1	0	0	0	0	0	0	0
1888	1	0	0	0	0	0	0	0
1889	1	34	0	2, 217	761	3, 042	4. 00	34
1890	1	80	0	24, 058	8, 528	37, 196	4. 36	35
1891	1	80	8	25, 281	7, 949	35, 778	4. 50	31
1892	1	83	0	....	7, 309	....	....	....

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 & 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 1892:

Statistics of the manufacture of coke in Virginia, 1883 to 1892.

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	25,310	$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	58.7
1892	2	594	206	226,517	147,912	322,486	2.18	65.3

WASHINGTON.

Some coke is still being made from the coal of the Wilkerson coal field, near Tacoma. These coals, like all of those in Colorado and Montana and westward, are Cretaceous, and still preserve at many places the lignite characteristics. At some places they have been altered locally in character and are true coking coals. The coke made in Washington is a fair fuel, but does not equal that brought from Europe at a high cost. It is all made from unwashed slack and commands a good price for local uses.

During 1892 a third coke works was added to the number in this State, the works of the Sedro Coal Company. These added but four ovens at the close of the year and made but a small amount of coke.

In the following table will be found a recent analysis of coke from the Skagit Coal and Transportation Company, of Fair Haven, Washington, which proposes to enter into the manufacture of coke. This coke was produced from unwashed coal, and if it is a fair average analysis of the coke made from the entire vein it is an exceedingly good one for the section of country.

Analysis of coke produced at Fair Haven, Washington.

[Coke made of unwashed coal.]

	Per cent.
Moisture	0.44
Fixed carbon	86.76
Sulphur	.841
Ash	11.22
Total	99.261

The following are the statistics of the manufacture of coke in Washington for the years 1884 to 1892, the only years in which coke has been made:

Statistics of the production of coke in Washington, 1884 to 1892.

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

WEST VIRGINIA.

The division of West Virginia into districts is precisely the same as that followed in previous volumes of "Mineral Resources." These districts are known as the Kanawha, the New River, the Flat Top, the Northern, 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 Quinnimont to the Kanawha valley. The Flat Top region includes the ovens in the Pocahontas Flat Top district, which are located in West Virginia. The ovens in this district which are located in Virginia are reported under that State. This Flat Top district is in reality a part of the New River district. The fourth district, the Northern, which may also be called the Upper Monongahela district, is a scattered one, including the ovens in Preston, Taylor, Harrison, and Marion counties, and in previous volumes those in Wheeling, West Virginia. Most of the coke made in Wheeling in previous years has been used in glass manufacture. The advent of natural gas has entirely stopped the production of coke in Ohio county, in which Wheeling is situated. The fifth district, the Upper Potomac, includes the ovens along the line of the West Virginia Central and Pittsburg railway, in what may be called the Upper Potomac basin.

Pocahontas Flat Top district.—By reason of the completion of the Elkhorn extension of the Norfolk and Western railroad to the Ohio river, the Pocahontas Flat Top district has acquired an additional importance. 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, Virginia;

(2), the Bluestone district, including the workings on the Bluestone, near Bramwell, in Mercer county, West Virginia, on the southeast slope of Flat Top mountain; (3), the Elkhorn district, including the workings in McDowell county, West Virginia, on the northeast slope of the Flat Top mountain, on the headwaters of the Elkhorn.

The coals of this region belong to the lowest measure of the Coal Measures, No. VIII, of Rogers, the Pottsville Conglomerate of Pennsylvania. It has usually been believed that the coal of the Flat Top is the equivalent of the Quinnimont series of the New River. Prof. I. C. White expresses the opinion that the Pocahontas seam is possibly lower than the Quinnimont or any of the New River coals. The thickness of the vein is at its best at Pocahontas and diminishes toward the northwest and northeast from this town. The coal is semi-bituminous, 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 sub-districts:

Analysis of Pocahontas Flat Top coal.

	Per cent.
Water	1.011
Volatile matter	18.812
Fixed carbon	72.708
Sulphur	0.787
Ash	5.191

Recent analyses of the coke made in the ovens of the Southwest Virginia Improvement Company at Pochontas 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 1892 are as follows:

Statistics of the manufacture of coke in the Flat Top district of West Virginia from 1886 to 1892, 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	1.685	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	1.688	59.4

New River district.—The New River coking district includes the ovens along the line of the Chesapeake and Ohio railroad from Quinnimont to Nuttallburg. The coal is very much of the same character as that of the Flat Top region.

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
	100.000	100.000

The statistics of the manufacture of coke in the New River district from 1880 to 1892 are as follows:

Statistics of the manufacture of coke in the New River district, West Virginia, 1880 to 1892.

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. 16	63
1891	13	787	102	309, 073	193, 711	426, 630	2. 20	62
1892	13	965	0	315, 511	196, 359	429, 376	2. 19	62

Kanawha district.—In this district are included all the ovens from Ansted down the Kanawha river. It has been thoroughly described in previous volumes particularly in "Mineral Resources of the United States, 1886."

The statistics of the manufacture of coke in the Kanawha district from 1880 to 1892 are as follows:

Statistics of the manufacture of coke in the Kanawha district, West Virginia, 1880 to 1892.

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	63⅓
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	64⅔
1884	6	(*a*) 177	15	60, 281	39, 000	76, 070	1. 95	64⅔
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. 88	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

a Eighty of these ovens are Coppée. the balance beehive.
b Sixty of these ovens are Coppée, the balance beehive.

Upper Monongahela district.—There has been a notable increase in the production of coke in the district, which for want of a better name has been called the Northern district. Possibly, in view of the fact that most of the coke is produced on the Upper Monongahela river, a better name would be the Upper Monongahela district, though it is frequently known as the Fairmount district. The great increase in the production of coke in this district has been due to the great developments that have taken place in the new coking district on the Upper Monongahela on the new line of railroad between Fairmount and Clarksburg. The coke produced is a good fuel, and, though it is made largely from washed slack, it is finding a place in the markets of the country. In their endeavors to find this market the coke producers of this region are greatly aided by the liberal policy of the Baltimore and Ohio Railroad Company, as the New River and Kanawha districts are aided by the Chesapeake and Ohio Railroad Company, and the Pocahontas Flat Top by the Norfolk and Western.

The following is an analysis of the foundry coke produced by the Monongah Coal and Coke Company, of Monongah, West Virginia, one of the largest coke producers in this region:

Analysis of foundry coke produced by the Monongah Coal and Coke Company, of Monongah, West Virginia.

	Per cent.
Moisture	0.35
Volatile matter	.70
Ash	8.54
Fixed carbon	90.41
Total	100.00
Sulphur in above	.872

The following is an analysis of coke made from unwashed run-of-mine coal by the Austen Coke Works in the same district.

Analysis of coke made from coal (unwashed run-of-mine) produced by the Austen Coke Works, Austen, West Virginia.

	Per cent.
Moisture	0.542
Fixed carbon	87.550
Phosphorus	....
Sulphur	.653
Ash	11.255
Total	100.00

The statistics of the production of coke in the Upper Monongahela district of West Virginia from 1880 to 1892 are as follows:

Statistics of the manufacture of coke in the Upper Monongahela district, West Virginia, 1890 to 1892.

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	....	62. 3
1887	15	646	0	211, 330	132, 192	268, 990	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. 55	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

The Upper Potomac district.—Quite a large amount of coke is being produced in what has been termed the Upper Potomac district, which includes the ovens along the line of the West Virginia Central and Pittsburg railroad, running south from near Cumberland. This coke is largely used for foundry purposes and has acquired a most favorable reputation for its ability to melt a large amount of ore per pound of fuel. The coke is made from two, if not more, benches of coal, and the coke from these two benches differs somewhat in quality. This district promises to be an important coke-producing center in the near future. It was coke from the neighborhood of Cumberland that was used in the first successful coke blast furnace run continuously in the United States.

Statistics of the manufacture of coke in the Upper Potomac district of West Virginia, 1887 to 1892.

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

Production of West Virginia by districts.—In the following table will be found consolidated the statistics of the production of coke in West Virginia in the two years especially covered by this report, viz., 1891 and 1892, by districts:

Production of coke in West Virginia in 1891, 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	474	0	241,427	134,715	$276,420	$2.05	56
New River	13	787	102	309,073	193,711	426,630	2.20	62
Flat Top	19	1,889	358	537,847	312,421	545,367	1.70	58
Northern	15	1,081	56	517,615	291,605	462,677	1.58	56
Upper Potomac	2	390	39	111,014	76,599	133,949	1.75	69
Total	55	4,621	555	1,716,976	1,009,051	1,845,043	1.83	58.7

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	1.688	59.4
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 production of coke in West Virginia.—Consolidating the statistics of the five different districts given above, the following is a statement of the product of coke in West Virginia for the years 1880 to 1892:

Statistics of the manufacture of coke in West Virginia, 1880 to 1892.

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	1.70½	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	1.82	59
1891	55	4,621	555	1,716,976	1,009,051	1,845,043	1.83	52
1892	72	5,843	978	1,709,183	1,034,750	1,821,965	1.76	6.05

WISCONSIN.

All the coke made in Wisconsin is from Connellsville (Pennsylvania) 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	....	52,904	34,387	192,804	5.61	65
1892	1	120	....	54,300	33,800	185,900	5.50	62

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, 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 and 1892 are as follows:

Statistics of the production of coke in Wyoming for 1891 and 1892.

	1891.	1892.
Number of establishments	1	1
Number of ovens built	24	24
Number of ovens building	0	0
Amount of coal used .....short tons..	4,470	0
Coke produced ....short tons..	2,682	0
Total value of coke at ovens	$8,046	0
Value of coke, per ton	$3.00	0
Yield of coal in coke.......per cent..	60	0

PETROLEUM.[a]

By Joseph D. Weeks.

Petroleum has been found in nearly every State and Territory in the Union. The localities, however, in which it has been produced in paying quantities are but few. These are the well-known oil regions of western Pennsylvania and New York; the Turkey Foot, Mount Morris, Mannington, and other districts in West Virginia; the Eureka, Macksburg, and Sistersville districts of eastern Ohio, and the Lima, of western Ohio; the newly discovered districts of Indiana, producing an oil similar to that of Lima, and which for the first time appears in 1892 as a producer to any considerable extent; the Florence oil district of Colorado, and the oil fields of California. Practically all of the petroleum produced in the United States is from the districts named above, though a few thousand barrels were produced in 1892 in Kentucky, Missouri, Texas, and the Indian Territory.

What may be the future localities in which petroleum will be produced in quantities in the United States can not now be foreseen. There are possibilities that the oil-producing regions of West Virginia may be continued still farther southwardly, they having rapidly advanced towards the southward from Pennsylvania in the last five years. Indeed, the chief oil-producing districts in what may be termed the Appalachian oil field, that is, the field extending from New York to West Virginia, is now in the southwestern part of Pennsylvania, the northeastern portion of West Virginia, and the eastern portion of Ohio, a practical connection between the older oil fields of Pennsylvania and that of Macksburg having been made in the last few years.

Of the 27,149,034 barrels of crude petroleum produced in Pennsylvania in 1892 over 13,000,000 were produced in Washington, Beaver, Greene, and Allegheny counties, Allegheny county alone producing 10,196,856 barrels. The production of West Virginia has increased from 492,578 barrels in 1890 to 3,810,086 barrels in 1892, chiefly owing to the increased production of oil from the southwestern extension of the Pennsylvania oil fields, while the production of eastern Ohio, outside of the Macksburg district, increased from 22,859 barrels in 1891 to

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a For much information used in this report the writer is indebted to the previous publications of Mineral Resources of the United States, to the Mineral-Industries volume of the Eleventh Census, to the Oil City Derrick, to the American Manufacturer and Iron World, and to Stowell's Petroleum Reporter, of Pittsburg.

992,746 barrels in 1892, this also being due to the still further extension of the Pennsylvania fields southwestwardly through West Virginia and eastern Ohio. The possibility of this field in the future no one can tell.

There are also indications that Wyoming may be a large producer of oil in the future, and Indiana may increase its product greatly. At present the Kentucky and other southern oil fields, which at one time it was supposed would be factors of some importance in oil production, give no such indications. From the Kansas and Texas fields we are only justified at present in predicting that a few thousand barrels of high-grade lubricating oil may be produced each year. However, there have been so many surprises in petroleum that these statements must be regarded as only setting forth the indications at the present time.

TOTAL PRODUCTION AND VALUE OF CRUDE PETROLEUM IN THE UNITED STATES IN 1891 AND 1892.

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 1891 and 1892, by States and important districts:

Total amount and value of crude petroleum produced in the United States in 1891 and 1892.

States and districts.	1891.		1892.	
	Barrels.	Value.	Barrels.	Value.
New York	1,585,030	$1,061,970	1,273,343	$708,297
Pennsylvania:				
Pennsylvania	31,330,021	20,991,114	27,061,575	15,053,001
Franklin	65,185	215,111	58,459	233,836
Smith's Ferry	29,000	34,510	29,000	16,131
	31,424,206	21,240,735	27,149,034	15,302,968
West Virginia:				
West Virginia	2,404,218	1,610,826	3,807,086	2,117,692
Burning Springs	2,000	2,000	3,000	2,209
	2,406,218	1,612,826	3,810,086	2,119,901
Ohio:				
Macksburg	400,024	268,016	197,556	109,891
Eastern	22,859	15,316	992,746	552,215
Lima	17,315,978	5,281,373	15,169,507	5,555,832
Mecca-Belden	1,440	12,000	3,112	21,101
	17,740,301	5,576,705	16,362,921	6,239,039
Indiana	136,634	54,787	698,068	260,620
Kentucky	9,000	9,000	6,500	16,400
Missouri	25	84	10	40
Kansas	1,400	9,800	....	....
Colorado	665,482	559,005	824,000	692,160
California	323,600	401,264	385,049	561,333
Texas	54	227	45	225
Indian Territory	30	150	80	480
Total	54,291,980	30,526,553	50,509,136	25,901,436

From the above table it will be seen that the total production of oil in the United States in 1892 was 50,509,136 barrels, as compared with 54,291,980 barrels in 1891; a decrease of 3,782,844 barrels. The production of New York has decreased from 1,585,030 barrels in 1891 to 1,273,343 barrels in 1892. In Pennsylvania the Franklin and Smith's

Ferry districts practically held their own, while the production of the State outside of these districts declined from 31,330,021 barrels in 1891 to 27,061,575 barrels in 1892.

In West Virginia the increase in production was from 2,406,218 barrels in 1891 to 3,810,086 in 1892.

In Ohio there is an apparent decline in production in the Macksburg region, but this may be due to the fact that oil which in 1891 was reported as from the Macksburg region, is reported in 1892 from the Eastern region. Taking the Macksburg and the Eastern districts as a whole, the increase in production has been from 422,883 barrels in 1891 to 1,190,302 barrels in 1892. The production of Lima decreased from 17,315,978 barrels in 1891 to 15,169,507 barrels in 1892.

The production of Indiana increased from 136,634 barrels in 1891 to 698,068 barrels in 1892. Colorado increased from 665,482 barrels in 1891 to 824,000 barrels in 1892, while the increase in California was only from 323,600 barrels in 1891 to 385,049 barrels in 1892.

No record of the production of any oil in Kansas in 1892 was secured. The production of oils in other districts was insignificant.

With the exception of those produced in Franklin (Pennsylvania), Burning Springs (West Virginia), Mecca-Belden (Ohio), and the oil from Missouri, Texas, and Indian Territory, the petroleums of the United States are primarily illuminating or fuel oils—those from the districts named being chiefly lubricating oils, either natural or for the production of lubricators in small quantities. The Indiana and Lima oils have in the past been regarded chiefly as fuel oils. They still yield a smaller percentage of illuminating oil. This oil, however, is of a very high character, the recent methods adopted for refining it being such as to deprive it thoroughly of its offensive odor and to make from it an illuminating oil better in character to that produced from Pennsylvania crude.

The total value of the 50,509,136 barrels of crude petroleum produced in the United States in 1892 was $25,901,436. Most of the oil produced was from the New York-Pennsylvania, West Virginia, and Ohio fields. The crude for the production of illuminating oils from these districts sold on an average at 55⅝ cents a barrel. The Lima oil sold at an average of 36⅝ cents a barrel. The average value of all oil produced in the United States in 1892 was 51¼ cents a barrel, as compared with 56¼ cents in 1891. The average price in 1892 ranged from 36⅝ cents in the Lima and Indiana districts to $7 a barrel in the Mecca-Belden.

TOTAL PRODUCTION OF CRUDE PETROLEUM IN THE UNITED STATES FROM 1889 TO 1892.

In the following table will be found a statement of the total production of crude petroleum of all grades in the United States, by States, in the years from 1889 to 1892, both inclusive. These more recent years are grouped thus for convenience.

Production of petroleum in the United States from 1889 to 1892.

[Barrels of 42 gallons.]

States.	1889.	1890.	1891.	1892.
Pennsylvania and New York	21,487,435	28,458,208	33,009,236	28,422,377
Ohio	12,471,466	16,124,656	17,740,301	16,362,921
West Virginia	544,113	492,578	2,406,218	3,810,086
Colorado	316,476	368,842	665,482	824,000
California	303,220	307,360	323,600	385,049
Indiana	33,375	63,496	136,634	698,068
Kentucky	5,400	6,000	9,000	6,500
Illinois	1,460	....	....	....
Kansas	500	1,200	1,400	....
Texas	48	54	54	45
Missouri	20	278	25	10
Indian Territory	....	....	30	80
Total	35,163,513	45,822,672	54,291,980	50,509,136

GEOLOGICAL OCCURRENCE OF PETROLEUM IN THE UNITED STATES.

While petroleum has been found in all the geological formations from the Silurian up to the Tertiary, it is not uniformly distributed through them, but is found principally in the rocks of the Silurian and Devonian ages and to a less extent in the Mesozoic and Tertiary. Cases are known where petroleum has been found in rocks older than the Silurian, but it is in small quantities. The great deposits of western Pennsylvania are in the Devonian, the Venango, Warren, and McKean groups being of this age, though the place of the Venango group is somewhat open to question, some geologists placing it in the Chemung, others in the Catskill, and some even as high as the Pocono. Considerable oil is produced in Pennsylvania, however, from the Carboniferous, the oil on Dunkard creek, in Greene county, being from the Mahoning. Some of the oil sands of Washington, Beaver, and Lawrence counties are from the conglomerate, while the Pocono, or No. X of Rogers, holds the Berea grit, which produces oil and gas in Lawrence and Beaver counties and a large quantity of gas in Butler. The oil, however, found in the Carboniferous in Pennsylvania is in small amounts compared with that found in the Devonian. It may be also assumed that the statements regarding the oil horizons of Pennsylvania will apply to the entire oil-producing territory of the western slopes of the Appalachian range.

The oil horizon of western Ohio and Indiana is the Trenton limestone, which is by far the most important single source of petroleum in the United States at the present time. All of the oil produced in the new fields of Ohio and Indiana is from this single horizon, while, as pointed out above, the oil produced in Pennsylvania is from several distinct strata of sandstone of very unequal value, distributed through several thousand feet of the Devonian and Carboniferous.

The horizon in which the heavy lubricating oils of Kansas and Texas are found has not been determined.

According to Mr. George H. Eldridge, of the United States Geological Survey, the chief oil-bearing formation in the Florence oil field is the Pierre of the Montana group of the cretaceous, though he states that small amounts may come from the Fox Hills member of the Montana group. This statement of Mr. Eldridge differs from the best previously published report of the Florence oil field, but as it is the latest and the result of careful investigation his statement should be accepted.

Contrary to the opinion usually accepted Mr. Eldridge also believes that both the source and reservoir of the oil lie within the Pierre formation itself.

Mr. Eldridge has thoroughly discussed these questions in a paper on The Florence Oil Field read before the American Institute of Mining Engineers, October 1891.

The oils of California, according to Prof. S. F. Peckham, are found in the Miocene of the Tertiary.

CHARACTER AND COMPOSITION OF AMERICAN PETROLEUM.

While the petroleum from different wells in the same district usually differs but little in character, there is a marked variation in many cases in the oils from different districts. The most notable distinction is in the solid constituents of the oil. The "basis" of all the petroleums in the United States, except a portion of those found in the southern part of California, is paraffin; of those of southern California, in most cases, asphaltum.

In most of the oils a varying quantity of the lighter hydrocarbons, known in a general way as naphtha, is found. In others these lighter products are almost entirely wanting, or at least in refining all of the distillate is sold as illuminating oil. The composition of certain oils is also such that a large amount of lubricating oil, or heavy oils adapted to lubricating, is produced. For example, the Kansas and Texas oils are natural lubricating oils and can be used without any preparation except straining to remove any grit, while other so-called natural lubricating oils have to be prepared by a process of distillation, the various grades of density being used for various kinds of lubrication.

It may be said in a general way that the products of petroleum are: naphthas, or the lighter hydrocarbons; illuminating oils; heavy oils, or lubricants; residuum, paraffin or asphaltum, and water.

Regarding the oils of western Pennsylvania, New York, West Virginia, and the Macksburg district of Ohio, which are chiefly used for the production of illuminating oil, it may be said that the petroleums of these districts as they come from the ground are clear, semitransparent oils, generally of an amber color, but varying somewhat in this regard with their density. When allowed to stand, however, a thick emulsion, reported in the tables of stocks as "B. S.", or sediment, separates itself from the oil. The amount of this sediment varies greatly, the longer the oil is allowed to stand the greater being the proportion of sediment, and the less the proportion of the lighter hydrocarbons. It is for this reason that fresh oil, or oil just produced, has commanded a premium over old oil or that which had been allowed to stand in the tanks, its yield of the lighter hydrocarbons and of the better grades of illuminating oil being greater when fresh than after having been stored.

The percentages of the products of fresh oil in refining will depend largely upon the methods of refining. This can be carried on so as to make the product of heavy oils almost nothing. From a refinery in western Pennsylvania the following statement as the results of their operations for two years has been received:

Percentage of products from Pennsylvania petroleum.

Products.	Per cent.	Per cent.
Naphthas	10.34	10.89
Illuminating oils	75.00	78.20
Heavy oils	2 to 6	2 to 4
Residuum	4.05	2.86
Water and loss	5 to 8	5 to 8

But little Lima or, better, Trenton limestone oil produced in western Ohio and eastern central Indiana had been refined in a commercial way prior to 1889. The chief obstacle to this use of the oil was the difficulty of removing the sulphur compounds present in it and the small percentage of illuminating oil which could be produced from the crude. At least two refineries have succeeded in overcoming the difficulties in the way of the sulphur compounds, and Trenton limestone oil has become a factor in the market to some extent and promises to be a much more important one in the future. The actual facts, however, as to the yield of different products from this oil have been very difficult to obtain. In a general way it may be said to yield a comparatively large percentage of the lighter products and a small percentage of illuminating oil. In general it is customary to assume a yield of 22 per cent. in illuminating oils and 15 per cent. of naphtha.

In a recent number of the Journal of the American Chemical Society appears an analysis of Lima petroleum, made in the laboratory, however, which shows a yield as follows:

Products from Lima, Ohio, petroleum.

	Per cent.
Naphtha at 70° B	16
Burning oil	68
Paraffin oils	6
Solid residuum	10
Total	100

These results are never reached in actual practice. Another sample of Lima petroleum gave the following results:

	Per cent.
Distillate at 59° B	13.75
Distillate at 57° B	35.11
Distillate at 39° B	7.93
Distillate at 36.5° B	13.40
Distillate at 36° B	18.60
Residuum	9.65
Water	0.70
Total	99.14

The foregoing would indicate a production of oils approximately as follows:

		Per cent.
Naphtha and burning oil		56.80
Heavy oils		32.00
Residuum		9.60
Water		0.70
Sulphur, first determination	0.63	
Sulphur, duplicate	0.68	
Sulphur, average		0.65
Total		99.75

The petroleum from the Florence oil field in Colorado seems to be lacking in the lighter hydrocarbons or naphthas, or at least in refining it, all of the distillate is sold as illuminating oil, the whole product of refining being divided into only two classes, illuminating oil and residuum. It yields in refining from 34 to 44 per cent. of this illuminating oil of about 125° fire test. This oil contains no sediment.

As has already been pointed out, most of the oil of southern California differs from that of all other sections of the country in having asphaltum as its base instead of paraffin. The oils from the different fields of this section also differ greatly in their character, some being practically liquid bitumens, yielding a very small amount of illuminating oils on distillation, while others have less asphaltum, producing larger percentages of illuminating oil. Here also the results of distillation are only two, one illuminating oil, of which about 35 per cent. is produced from the crude charge, the other residuum, which is sold for fuel.

The approximate classification of the distillates of California oil, as given by Mr. Durand Woodman in the Journal of the American Chemical Society, is as follows:

Products from California petroleum.

	Per cent.
Naphtha under 0.73 specific gravity	10 +
Illuminating oils	40 ±
Lubricating oils	40 ±
Residuum	10 +
Sulphur	0.18
Water	0.27
Paraffin	None separable.

A word regarding the composition of foreign oils. The constituents of American petroleum, with the exception of that from California, are almost entirely members of the paraffin series. While some of the oil from California has paraffin as its base much the larger proportion has asphaltum, which would take these oils, at least in their solid constituents, out of the class of paraffins. On the other hand, Russian oil, our chief competitor in the markets of the world, is regarded as belonging to the olefines, or at least the composition of many of its constituents would indicate this, they being C_nH_{2n} instead of C_nH_{2n+2}. The constituents of the Russian oil, however, are usually regarded by Russian chemists as being what they term naphthenes instead of olefines.

PRODUCT OF CRUDE PETROLEUM IN THE UNITED STATES FROM 1859 TO 1892.

The history of petroleum production in the United States, as is well known, is regarded as having begun with the striking of oil in the Drake well at Titusville in 1859. Though petroleum had been known to exist in the country before this, and especially in what is now known as the Pennsylvania petroleum regions, and had been used for various purposes, even for illuminating oil, it was not until the completion of this well that it assumed any commercial importance. From 1859 to 1869 the years were prolific in the formation of companies to prospect for oil in the various States with capital aggregating hundreds of millions of dollars, some of it representing actual money invested, most of it an inflated idea as to the possibilities of the discovery of petroleum. Some of the important fields of the country were discovered shortly after 1859. The Macksburg field, in Ohio, which may be regarded as representing the eastern Ohio field, produced oil as early as 1860, but assumed but little importance until 1884. Oil was found in West Virginia in 1861 or 1862, but not in any considerable quantities until 1865. The first wells in Colorado were sunk in 1862, though it was not until 1883 that production here became large. Southern California was quite thoroughly exploited early in the sixties and operations there have been continuous ever since, though it was not until early in 1870 that the production assumed any importance.

The year 1885, however, seems to have marked a new era in the history of petroleum. The importance of the Trenton limestone as a producer in the United States was first recognized at this time, and this year marked the discovery of the Lima, Ohio, and the Indiana fields. Nearly one-third of all the oil produced in the United States in 1892 was taken from the Lima field.

Another remarkable feature of the closing of the eighties and the beginning of the nineties was the developments in southwestern Pennsylvania, in a territory which was supposed had been thoroughly exploited for oil in previous years without any great return. Writing, in September, 1885, the late Dr. Ashburner expressed the opinion that the boundaries of the oil regions of Pennsylvania were well established, and that there were no reasonable expectations that any new or extensive field would be found. At this time only a small amount of oil had been found in isolated pools to the south and southwest of Beaver county. One of these pools was in the vicinity of Washington, though at this time the so-called McDonald pool was not known. Allegheny and Washington counties, in which the McDonald field is situated, produced in 1892 nearly 12,650,000 barrels of oil—not quite half of all that produced in Pennsylvania. These facts show the uncertainty of making predictions in regard to localities in which petroleum will be found in quantities in future.

In the following table will be found consolidated the statistics of the production of petroleum in the United States from the beginning of operations in the various fields, so far as can be ascertained:

Product of crude petroleum in the United States from 1859 to 1892.(a)

[Barrels of 42 gallons.]

Years.	Pennsylvania and New York.	Ohio.	West Virginia.	Colorado.	California.	Indiana.
1859	2,000					
1860	500,000					
1861	2,113,609					
1862	3,056,690					
1863	2,611,309					
1864	2,116,109					
1865	2,497,700					
1866	3,597,700					
1867	3,347,300					
1868	3,646,117					
1869	4,215,000					
1870	5,260,745					
1871	5,205,234					
1872	6,293,194					
1873	9,893,786					
1874	10,926,945					
1875	8,787,514	b 200,000	b 3,000,000		b 175,000	
1876	8,968,906	31,763	120,000		12,000	
1877	13,135,475	29,888	172,000		13,000	
1878	15,163,462	38,179	180,000		15,227	
1879	19,685,176	29,112	180,000		19,858	
1880	26,027,631	38,940	179,000		40,552	
1881	27,376,509	33,867	151,000		99,862	
1882	30,053,500	39,761	128,000		128,636	
1883	23,128,389	47,632	126,000		142,857	
1884	23,772,209	90,081	90,000		262,000	
1885	20,776,041	650,000	91,000		325,000	
1886	25,978,000	1,782,970	102,000		377,145	
1887	22,356,193	5,018,015	145,000	76,295	678,572	
1888	16,488,668	10,010,868	119,448	297,612	690,333	
1889	21,487,435	12,471,466	544,113	316,476	303,220	38,375
1890	28,458,208	16,124,656	492,578	368,842	307,360	63,496
1891	33,009,236	17,740,301	2,406,218	665,482	323,600	136,634
1892	28,422,377	16,362,921	3,810,086	824,000	385,049	698,068
Total	458,178,367	80,740,420	12,036,443	2,548,707	4,299,271	931,573

a Some oil was produced in other States than New York and Pennsylvania previous to 1875, but no record has been secured except that contained in note b.
b Includes all production prior to 1876.

Product of crude petroleum in the United States from 1859 to 1892—Continued.

[Barrels of 42 gallons.]

Years.	Kentucky and Tennessee.	Illinois.	Kansas.	Texas.	Missouri.	Indian Territory.	Total United States.
1859							2,000
1860							500,000
1861							2,113,609
1862							*a* 3,056,690
1863							2,611,309
1864							2,116,109
1865							2,497,700
1866							3,597,700
1867							3,347,300
1868							3,646,117
1869							4,215,000
1870							5,260,745
1871							5,205,234
1872							6,293,194
1873							9,893,786
1874							10,926,945
1875							*b* 12,162,514
1876							9,132,669
1877							13,350,363
1878							15,396,868
1879							19,914,146
1880							26,286,123
1881							27,661,238
1882	*c* 160,933						30,510,830
1883	4,755						23,449,633
1884	4,148						24,218,438
1885	5,164						21,847,205
1886	4,726						28,064,841
1887	4,791						28,278,866
1888	5,096						27,612,025
1889	5,400	1,460	500	48	20		35,163,513
1890	6,000		1,200	54	278		45,822,672
1891	9,000		1,400	54	25	30	54,291,980
1892	6,500			45	10	80	50,509,136
Total	216,513	1,460	3,100	201	333	110	558,956,498

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 558,956,498 barrels of commercial crude petroleum have been produced in the United States since the beginning of operations at Titusville, Pennsylvania, in 1859. By far the largest proportion of this has been produced in what is known as the New York and Pennsylvania oil fields. These produced 458,178,367 barrels, or nearly 82 per cent. of the total. Ohio's production has been 80,740,420 barrels, or over 14 per cent. of the total. West Virginia has produced 12,036,443 barrels, or 2 per cent. of the total. The next two States in amount of production are California and Colorado, the latter having produced 2,548,707 barrels and the former 4,299,271 barrels. It is worthy of note that one-third of the total production of Colorado was in 1892.

EXPORTS.

In the following table is given the exports of crude petroleum and its products from the United States from 1864 to 1892 compared with the product in the United States:

Quantity of crude petroleum produced in, and the quantity and value of petroleum products exported from, the United States during the fiscal years 1864 to 1884, and calendar years 1885 to 1892.

Years ended—	Production.		Exports.											
	Barrels (of 42 gallons) produced.	Gallons produced.	Mineral, crude (including all natural oils without regard to gravity).		Mineral, refined or manufactured. Naphthas, benzine, gasoline, etc.		Mineral, refined or manufactured. Illuminating.		Mineral, refined or manufactured. Lubricating (heavy paraffin, etc.).		Residuum (tar, pitch, and all other from which the light bodies have been distilled).		Total.	
			Gallons.	*Value.*	*Gallons.*	*Value.*	*Gallons.*	*Value.*	*Gallons.*	*Value.*	*Gallons (a)*	*Value.*	*Gallons.*	*Value.*
June 30, 1864..	2,478,709	104,105,778	9,980,654	$3,864,187	438,197	$154,091	12,791,518	$6,764,411	....	....	....	....	23,210,368	$10,782,689
1865..	2,424,905	101,846,010	12,293,897	6,868,513	480,947	173,943	12,722,005	9,520,957	....	....	....	....	25,496,849	16,563,413
1866..	3,165,700	132,959,400	16,057,943	6,015,921	673,477	188,825	34,255,921	18,626,141	....	....	....	....	50,987,341	24,830,887
1867..	3,591,900	150,859,800	7,344,248	1,864,001	224,576	34,175	62,686,657	22,509,466	....	....	....	....	70,255,481	24,407,642
1868..	3,613,709	151,775,778	10,029,659	1,564,933	1,517,268	267,873	67,999,961	19,977,870	....	....	....	....	79,456,888	21,810,676
1869..	4,046,558	169,955,436	13,425,566	2,994,404	2,673,094	445,770	84,403,492	27,636,137	b134,532	$51,122	....	....	100,636,684	31,127,433
1870..	4,411,016	185,262,672	10,403,314	2,237,292	5,422,604	564,864	97,902,505	29,864,193	b6,871	2,611	....	....	113,735,294	32,668,960
1871..	5,558,775	233,468,550	9,859,038	1,971,847	7,209,592	746,797	132,608,955	34,138,736	b59,632	22,660	b155,474	$14,770	149,892,691	36,894,810
1872..	5,842,497	245,384,874	13,559,768	2,307,111	8,092,635	932,160	122,539,575	30,566,108	541,419	211,287	438,186	41,724	145,171,583	34,058,390
1873..	7,242,343	304,178,406	18,439,407	3,010,050	9,743,593	1,487,439	158,102,414	37,195,735	748,699	277,966	781,074	79,506	187,815,187	42,050,756
1874..	11,188,741	469,927,122	17,776,419	2,099,696	9,737,457	1,038,622	217,220,504	37,560,995	1,244,305	404,243	1,827,798	142,299	247,806,483	41,245,815
1875..	10,083,828	423,520,776	14,718,114	1,406,018	11,758,940	1,141,440	191,551,933	27,030,361	1,173,473	313,646	2,752,848	187,103	221,955,308	30,078,568
1876..	8,823,142	370,571,964	20,520,397	2,220,268	14,780,236	1,442,811	204,814,673	28,755,638	963,442	303,863	2,581,404	193,206	243,660,152	32,915,786
1877..	10,822,871	454,560,582	26,819,202	3,756,729	15,140,183	1,816,682	262,441,844	55,401,132	1,601,065	497,540	3,196,620	317,355	309,198,914	61,789,438
1878..	14,738,262	619,007,004	26,936,727	2,694,018	16,416,621	1,411,812	289,214,541	41,513,676	2,304,624	639,381	3,968,790	316,087	338,841,303	46,574,974
1879..	16,917,606	710,539,452	25,874,488	2,180,413	15,054,361	1,258,780	331,586,442	35,999,862	2,487,681	655,468	3,307,038	210,726	378,310,010	40,305,249
1880..	22,382,509	940,065,378	28,297,997	1,927,207	18,411,044	1,192,229	367,325,823	31,783,575	5,162,835	1,039,124	4,767,000	276,490	423,964,699	36,218,625
1881..	25,805,363	1,083,825,246	39,984,844	3,065,464	17,292,310	1,693,975	332,283,045	34,317,695	4,852,203	1,054,064	3,247,860	184,411	397,660,262	40,315,609
1882..	28,650,181	1,203,307,602	41,304,997	3,129,511	20,213,098	1,809,143	498,213,033	44,588,854	6,508,100	1,492,396	3,715,362	212,802	559,954,590	51,232,706
1883..	26,662,808	1,119,837,936	52,712,306	3,914,941	17,070,537	1,302,286	419,821,081	36,926,574	10,182,342	2,326,63[illegible]	6,145,356	442,646	505,931,622	44,913,079
1884..	23,744,924	997,286,808	67,186,329	5,302,974	15,045,411	1,072,651	415,615,693	38,195,349	10,515,535	2,179,595	5,297,124	352,679	513,660,092	47,103,248
Dec. 31, 1885..	20,776,041	872,593,722	81,435,609	6,040,685	14,739,469	1,160,999	445,531,386	39,439,034	13,327,584	2,690,258	7,319,130	311,656	562,353,178	49,642,632
1886..	25,798,000	1,083,516,000	76,342,480	5,068,409	14,474,951	1,264,736	485,120,680	39,012,922	13,948,367	2,689,464	1,993,824	119,673	591,880,302	48,155,204
1887..	21,478,883	902,113,086	80,650,286	5,141,833	12,382,203	1,049,043	485,242,107	37,007,336	20,582,613	3,559,280	2,989,098	141,350	601,846,307	46,898,842
1888..	16,491,084	692,625,528	77,609,452	5,461,305	13,481,706	1,083,429	454,985,784	37,229,551	24,510,437	4,215,449	1,870,596	116,009	572,457,975	48,105,743
1889..	21,487,435	902,472,270	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..	28,458,208	1,195,244,736	95,450,653	6,744,235	12,937,433	1,134,799	523,295,090	38,640,638	30,162,522	4,763,347	2,222,472	120,070	664,068,170	51,403,089
1891..	53,936,318	2,267,425,146	96,722,807	5,365,579	11,424,993	868,137	531,445,099	34,879,759	33,310,264	4,999,978	1,002,540	61,382	673,805,703	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

a Barrels reduced to gallons at the rate of 42 gallons to the barrel.

b Estimated.

STATISTICS OF THE PRODUCTION OF PETROLEUM IN PENNSYLVANIA AND NEW YORK.

A few words as to the character of the rocks from which petroleum is produced in New York and Pennsylvania may not be uninteresting at this point. According to Mr. John F. Carll, all the petroliferous rocks thus far profitably developed in western Pennsylvania and the contiguous portions of New York and West Virginia—and this can now be extended to eastern Ohio—are found in sediments of Devonian and Carboniferous age; hence it is only necessary to consider that part of the geological column which overlies the Silurian system. The chart of these Upper Paleozoic rocks now generally accepted is as follows:

TABLE OF THE PALEOZOIC ROCKS.

Number.	
XVII.	Greene county series: From surface to top of Washington upper limestone.
XVI.	Washington county series: From top of Washington upper limestone to top of Waynesburg sandstone.
XV.	Monongahela series: From top of Waynesburg sandstone to base of Pittsburg coal.
XIV.	Pittsburg series: From base of Pittsburg coal to base of Mahoning sandstone.
XIII.	Allegheny series: From base of Mahoning sandstone to top of Homewood sandstone.
XII.	Pottsville series: From top of Homewood sandstone to base of Olean conglomerate.
XI.	Mauch Chunk: From base of Olean conglomerate to top of sub-Olean conglomerate.
X.	Pocono series: From top of sub-Olean to top of Venango-Butler oil group.
IX.	Catskill series: Venango-Butler oil group.
VIII.	Chemung, Portage, Genesee, Tully limestone, Hamilton, Marcellus, Upper Helderberg. } From base of Venango-Butler oil group to top of Oriskany sandstone.
VII.	Oriskany sandstone.

The formations Nos. XVII, XVI, and XV, all lying above the Pittsburg coal bed, are found only in the southwestern part of the State. None of these rocks have ever produced oil or gas in paying quantities in Pennsylvania.

The bottom member of No. XIV, the Mahoning sandstone, has produced some oil, but cannot be regarded as a very profitable oil bearing rock.

No. XIII, though it carries the valuable Freeport, Kittanning, Brookville, and Clarion coals, produces no oil.

No. XII, the Pottsville series, as an oil-bearing group is pockety, unreliable, and deceptive, permanently rewarding few of the operators who engaged in its development. The dip of the Olean conglomerate of this series represents approximately the dip of its associated rocks and consequently of the oil-bearing sands. If an oil well at Bradford, commencing at the base of the Olean conglomerate, requires to be sunk 1,850 feet to reach the Bradford oil sand, one to reach the same horizon anywhere at the southwest must go 1,850 feet, plus whatever thickness of cover may be above the conglomerate.

No. XI, the Mauch Chunk, is of little importance as an oil-bearing stratum in Pennsylvania, but in West Virginia and Kentucky the indications are more promising.

To No. X belongs the Shenango sandstone, the Berea grit, and the Butler gas sand. The Shenango sandstone, in common with all other producing strata, has different names applied to it in different localities. It is the sub-Olean conglomerate of the northern counties, the Shenango sandstone of Crawford and Mercer, and the Big Injun of Greene county and West Virginia; the Logan sandstone of Ohio, and the salt water rock of Macksburg. The Berea grit is of little importance in Pennsylvania, but in Ohio it furnishes considerable oil. The Butler gas sand of this stratum is almost exclusively a gas-bearing sand.

No. IX, the Catskill, is the great oil-bearing stratum of Pennsylvania. It holds the world-renowned First, Second, Stray, and Third sands of Oil creek, now called the Venango-Butler oil group. The sand rocks lying in the horizon of the First sand have been variously called in different districts as follows:

First sand horizon: Quinn sand, Amber-oil sand, Franklin lubricating-oil sand, Second Fifty-foot, Hundred-foot, Salt-water rock, Gantz, Murrysville gas sand, Grapeville gas sand.

Second sand horizon: Lytle sand, Amber oil sand, Salt-water sand, Stray Third, Third, Fourth, Thirty-foot, Blue Monday, Bowlder, Hickory, Gordon, Pine Run.

Stray sand horizon: Gray rock, Bowlder, Blue Monday, Hickory, Clover seed, Black-oil sand, Second, Third, Fourth.

Third sand horizon: Gordon, Weister, Hickory, Green-oil sand, Fourth, Fifth, Sixth.

Many other names have been used, but these are sufficient to show how utterly impossible it is for one to satisfactorily locate an oil or gas bearing horizon if he has nothing but the popular local names to guide him. The terms Fourth, Fifth, and Sixth are particularly misleading, since they carry the inference that these sands lie below the regular Third sand and add three productive members to the group, which is clearly not the case.

No. VIII, as numbered in Pennsylvania, includes seven divisions of the geological chart of New York, its cover being the Catskill, its base the Oriskany.

The several oil and gas sands of the counties of McKean, Warren, Forest and Elk lie in the Chemung division of No. VIII, and no commercial oil or gas has been found in Pennsylvania in any of the deeper rocks. In this group are included the several sands given in the following table, which shows the oil and gas producing horizons of Pennsylvania in geological sequence:

No. XIV.	Mahoning sandstone.
No. XIII.	Barren.
No. XII.	Homewood sandstone.
	Olean conglomerate.
No. XI.	Barren.
No. X.	Big Injun.
	Berea grit.
	Butler gas sand.
No. IX.	First sand and its divisions.
	Second sand and its divisions.
	Stray sand and its divisions.
	Third sand and its divisions.
No. VIII.	North Warren and Bradford "slush oil."
	Warren sand.
	Clarendon sand.
	Cherry Grove—Balltown sand.
	Cooper sand.
	Bradford "Third sand."
	Wilcox lower gas sands.
	Kane sand.
	Elk county sands, extending to a depth of about 1,700 feet beneath group No. IX.

As far as known at present the interval between the Elk county sands and No. VII is barren.

Of the Silurian rocks nothing is known from practical well drilling in western Pennsylvania except in one locality. In the city of Erie the Presque Isle well was successfully bored down to the Trenton limestone, the great oil and gas producing rock of Lima and Findlay, Ohio, but no encouraging indications of either oil or gas were developed. The Trenton rock contained nothing but salt water. It was struck at 4,310 feet from the surface, or 3,710 feet below ocean level. At 1,325 feet the corniferous limestone was found, hence from its top to the Trenton there is an accurately measured interval of 2,985 feet. From this it would seem probable that the Trenton limestone could not be reached at Pittsburg at a depth of less than 8,000 feet, and possibly the overlying shales may thicken in that direction and make the depth considerably greater.

In the following table is given a statement of the production of crude petroleum in New York and Pennsylvania in 1892 by districts and months. It is well nigh impossible to separate the production of New York from that of Pennsylvania. The production of Allegany district, New York, is given as 908,603 barrels. In the same table the production of the Bradford, Pennsylvania, field is given as 4,291,061 barrels. It has been estimated that the production of Cattaraugus county, New York, which is usually included in the reports of the Bradford field, is about 8½ per cent. of the Bradford field, the remaining portion of this field being from Pennsylvania localities. On this basis the production of Cattaragus county, New York, would be 364,740 barrels, which added to the production of Allegany county, New York, would make the total production of New York, 1,273,343 barrels and of Pennsylvania 27,149,034 barrels.

Production of crude petroleum in Pennsylvania and New York in 1892, by districts and months.

[Barrels of 42 gallons.]

Districts.	January.	February.	March.	April.	May.	June.
Allegany, N. Y	73, 244	83, 918	80, 473	83, 012	82, 829	83, 047
Bradford, Pa	359. 127	394, 788	385, 150	382, 649	376, 997	380. 987
Middle district	100, 168	99, 303	104, 574	95, 378	101, 516	94, 878
Clarendon and Warren	21, 074	21, 264	26, 099	21, 160	19, 111	31, 768
Tiona	41, 728	41, 705	39, 667	47, 710	45, 952	36, 376
Tidioute and Titusville	55, 066	59, 723	54, 118	60, 940	58, 791	56, 479
Grand Valley	11, 085	13, 239	10, 436	11, 953	11, 265	11, 624
Second sand	21, 564	24, 996	24, 838	26, 255	22, 082	25, 059
Lower district	641, 576	626, 499	644, 968	605, 061	612, 637	577, 539
Washington county	257, 530	228, 483	216. 826	216, 732	211, 610	207, 294
Beaver county	60, 233	53, 203	60, 627	55, 809	52, 977	54, 382
Greene county	8, 906	10, 437	10, 526	8, 933	8, 394	9, 432
Allegheny county	1, 128, 801	1, 038, 420	991, 822	951, 152	873, 835	861, 912
	2, 780, 102	2, 695, 978	2, 650, 124	2, 566, 744	2, 477, 996	2, 430, 777
Franklin district	4, 009	5, 268	4, 891	5, 653	4, 627	6, 152
Smith's Ferry district	2, 417	2, 417	2, 417	2, 417	2, 417	2, 417
Total	2, 786, 528	2, 703, 663	2, 657, 432	2, 574, 814	2, 485, 040	2, 439, 346

Districts.	July.	August.	September.	October.	November.	December.	Total.
Allegany, N. Y.	77, 744	75, 944	72, 617	65, 335	63, 552	66, 888	908, 603
Bradford, Pa	352, 414	356, 131	333, 255	320, 654	321, 654	327, 257	4, 291, 061
Middle district	92, 759	93, 210	84, 375	85, 637	81, 965	111, 557	1, 145, 320
Clarendon and Warren	19, 438	27, 498	21, 260	28, 598	16, 080	19, 173	272, 523
Tiona	36, 851	36, 013	33, 821	34, 595	32, 761	48, 529	475, 708
Tidioute and Titusville	55, 165	53, 517	50, 270	51, 709	48, 149	25, 237	629, 164
Grand Valley	11, 186	11, 574	9, 642	10, 637	10, 460	5, 000	128, 101
Second sand	23, 860	23, 075	22, 253	18, 583	19, 257	20, 189	272, 011
Lower district	574, 629	574, 949	526, 986	508, 970	476, 070	467, 819	6, 837, 703
Washington county	203, 984	198, 345	189, 060	169, 887	178, 393	174, 244	2, 452, 388
Beaver county	50, 129	52, 278	49, 560	46, 478	44, 342	43, 354	623, 372
Greene county	6, 827	8, 941	7, 127	7, 658	7, 486	7, 441	102, 108
Allegheny county	849, 225	809, 892	718, 749	716, 073	641, 803	615, 172	10, 196, 856
	2, 354, 211	2, 321, 367	2, 118, 975	2, 064, 814	1, 941, 970	1, 931, 860	28, 334. 918
Franklin district	4, 258	4, 812	4, 120	4, 792	6, 167	3, 710	58, 459
Smith's Ferry district	2, 417	2, 417	2, 416	2, 416	2, 416	2, 416	29, 000
Total	2, 360, 886	2, 328, 596	2, 125, 511	2, 072, 022	1, 950, 553	1, 937, 986	28, 422, 377

The districts grouped in the above table are quite well known to the trade. A word about them may not be inappropriate. The Allegany district is entirely in Allegany county, New York.

The Bradford district lies chiefly in Pennsylvania, in McKean county, but the main field extends some 5 or 6 miles into New York. An outlying basin of oil rock, which properly belongs to the Bradford basin, is situated for the greater part in Carrollton township, Cattaraugus county, New York. This field also includes the small outlying district of Kinzua, which lies southwest from the main district, and contains large and long-lived wells, and the Windfall Run field, lying in Pennsylvania, near Eldred, which has only small wells. The sand from which the oil in the Allegany, New York, and Bradford districts is ob tained is a gray, black, dark brown, or chocolate-brown sand of about the coarseness of the ordinary beach sand of the New Jersey coast. The oil obtained is dark amber green and occasionally black. Its gravity is generally slightly greater than that of the oil usually obtained from the Venango and Butler districts.

The Middle field, the Warren and Forest, is located in the counties from which it takes its name. It includes such pools as Cherry Grove, Balltown and Cooper, Stoneham, Clarendon, Tiona, Kane, Grand Valley, and others in these two counties. The oil in this district comes from sands of varying geological horizons, having somewhat the general appearance of the Bradford and Allegany sand, but frequently coarser grained. The late Dr. Ashburner was of the opinion that the Allegany (New York), Bradford, Warren, and Forest district oil sands were of the Chemung (Devonian) age. The oils from the several Warren and Forest pools differ very greatly in color and gravity, but they are generally spoken of as amber oils.

The Lower field begins with a few pools in the southwestern corner of Warren and the western end of Forest counties, and embraces all the oil-producing territory southward, including the fields of Venango, Clarion, and Butler counties, the field on the Ohio river in Beaver county, and the fields in Lawrence county. The oil of the Venango subdivision of the Lower district is obtained from three principal sand beds, known, respectively, as the first, second, and third oil sands, contained within an interval of about 350 feet. These sands are believed to belong to the Catskill (Devonian) formation. These sands were the first discovered in Pennsylvania, and drillers from this field operating in other districts designated the sands which were found in the new districts as the first, second, and third sands, irrespective of their geological position. The Venango sands generally consist of white, gray, or yellow pebble rock. The oils vary, though generally they are green in color, sometimes black, and in a few instances amber. The gravity varies from 30° to 51°, 48° being about the average of the oil obtained from the third sand, which is the greatest producer. The Butler subdivision of the Lower district includes oil pools in Butler, Clarion, southeastern Venango, and Armstrong counties. The character of the sands and oils are very much the same as the Venango district. The Beaver subdivision of the Lower district includes chiefly the Slippery Rock and Smith's Ferry fields. In both of these pools heavy oil is obtained from the representative of the Pottsville conglomerate and amber oil from the Berea grit, in the sub-Carboniferous series.

The Southwestern district includes the wells in Allegheny, Washington, and Greene counties, in southwestern Pennsylvania. The general character of the sands and oil is similar to that of the Lower district.

As compared with 1891 there has been a falling off in nearly every district. Allegany has declined from 1,121,574 barrels in 1891 to 908,603 barrels in 1892. The Bradford district has declined nearly 1,200,000 barrels, or from 5,452,418 barrels in 1891 to 4,291,061 barrels in 1892. The Middle district has reduced its production from 1,536,606 barrels in 1891 to 1,145,320 barrels in 1892. The decrease of production in the Lower district was very small, being slightly above 100,000 barrels, or from 6,952,539 barrels to 6,837,703. Washington county declined from 2,997,278 barrels to 2,452,388 barrels. Beaver county declined from 943,223 barrels to 623,372 barrels, and Greene from 341,813 barrels to 102,108 barrels, while Allegheny county (Pennsylvania) declined but slightly, or from 10,317,258 barrels to 10,196,856 barrels.

In the following table is given the total production of crude petroleum in Pennsylvania and New York oil fields for the twenty-two years from 1871 to 1892:

Total product of crude petroleum in the Pennsylvania and New York oil fields from 1871 to 1892, 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	835, 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

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, 354, 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

a Not including 877,310 barrels dump oil and oil shipped by private lines.
b Pipe line runs.

For some years previous to and including 1887 the total production, as given in the above table, is simply the total of pipe line runs, it being difficult in these years to get any information as to what is known as dump oil, or oil sent to market without passing through the pipe lines. The statistics of early years, as indeed all of the figures up to the close of 1887, are those given in Stowell's Reporter.

Since 1887 the figures of production given in the above table are not the same as pipe line runs, but represent more nearly the actual production of the field. As, however, the pipe line runs are of great importance to the trade, these runs for 1891 are given below by lines and months. In this table are included the pipe line runs of that portion of the oil field located in Pennsylvania and New York and that portion of West Virginia and eastern Ohio contiguous to the southwestern Pennsylvania field.

By runs are meant the amounts of oil which the pipe line receives from the wells. If all oil was sent from the wells by pipe lines the pipe line runs would indicate the total production of petroleum, less the amount of 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 the year would be the shipments plus the stock of oil on hand at wells at the close of the year minus the same well stocks at the beginning of the year.

Pipe-line runs in the Appalachian oil field in 1892, by lines and months.

[Barrels.]

Months.	National transit.	Tide water.	Octave.	Southwest.	Franklin.	Western and Atlantic.
January	1,028,049	117,660	2,415	1,349,225	4,009	121,573
February	1,056,816	129,626	3,027	1,182,860	5,268	135,206
March	1.064,761	126,329	2,134	1.073,307	4,891	136,666
April	1,033,592	124,605	3,033	1,005,601	5,653	148,687
May	1.022,702	125,124	2.391	944,144	4,627	132,276
June	980,267	125,588	2,482	919,408	6,152	124,762
July	950,588	116,376	2.520	895.219	4,258	118,194
August	945,948	116,464	2,391	876,318	4.812	118,842
September	879,297	105,266	2,128	742,167	4,120	102.853
October	838,300	105,225	2,647	660,635	4,792	106,544
November	778,443	127,179	2,232	604,636	6,167	101,154
December	784,215	139,020	2,237	575,726	3,710	95,402
Total	11,362,978	1,458,462	30,137	10,829,246	58,459	1,442,160

Months.	Chas. Miller.	Elk.	Producers' pipe line.	Emery.	Mellon.	Total.
January	6,234	30,235	....	20,163	60,752	2,740,315
February	6,006	27,254	23.107	23,082	91,736	2,683,988
March	6,543	27,897	33,390	22,283	84,800	2,583,001
April	6,077	26,759	30,385	24,155	155.096	2.563.643
May	6,210	27,045	22,407	26,735	146,730	2,460,891
June	6,045	26,386	20,728	27,564	149,889	2,389,272
July	6,386	24,488	20,966	29,421	150,209	2,318,625
August	5.837	27,581	16,041	32,427	148,299	2,294,960
September	5,710	25,698	15,744	30,811	178,412	2,092,206
October	5,277	27,051	22,086	30,524	205,059	1,008,140
November	4,596	25,994	25,628	31,810	212,500	1,920,339
December	3,967	27,831	18,597	30,483	229,781	1,910,969
Total	68,888	324,219	249,079	329,458	1,813,263	27,966,349

It will be noticed that the total pipe-line run in Pennsylvania and New York is given in the above table as 27,966,349 as compared with the total production in these two States given on page 606 as 28,422,377 barrels. The larger total is regarded as the correct one, as some oil not run through pipe lines is included in the report of total production and the pipe-line figures have been checked by figures derived from other sources.

Average daily production of petroleum in the Pennsylvania and New York oil fields.—To the dealer in petroleum the feature regarding production that is most prominent is the average daily production. As usually given this only includes the average daily receipts published by the pipe lines, or runs, as they are usually termed. In the following table these for 1892 and several years previous are given, the total production including some oil that is not reported in the daily returns:

Average daily product of crude petroleum in the Appalachian field each month for the years 1871–'92, 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

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	4,272	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

[Yearly average is the total product divided by the number of days in the year, *not* an average of monthly averages.]

As will be seen from the above table there has been a decided drop in the average daily production of petroleum during the year as compared with 1891. Practically the whole year has shown a declining production. Starting with 89,888 barrels a day in January, it had dropped to 62,516 barrels in December, making the average for the year 77,657 barrels as compared with 90,436 barrels for 1891 and 79,810 barrels in 1890. These two years, 1890 and 1891, with 1882, are the only three years that show a higher average production than 1892. It will be also noted by examining the table that the production in November, 1892, was but very little over half of the production of the corresponding month of 1891.

Shipments of petroleum from Pennsylvania and New York.—In the following table will be found a statement of the number of barrels of crude petroleum and refined petroleum reduced to its equivalent shipped out of the Pennsylvania and New York oil regions, either by pipe line or railroad, from 1871 to 1892, inclusive. In some years, especially in the earlier ones covered by this table, a considerable portion of the oil was shipped as refined. In this table that is reduced to its equivalent in crude. A barrel of refined is 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–'92, 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	741, 512	846, 632	960, 894	1, 135, 119	1, 330, 454
1879	663, 998	702, 729	973, 879	1, 136, 183	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

Shipments of crude petroleum and refined petroleum, reduced to crude equivalent, out of the Pennsylvania and New York oil fields, etc.—Continued.

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
1887	2, 220, 768	2, 342, 227	2, 573, 008	2, 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

For the latest years shipments are pipe-line deliveries. In 1892, for the first time for several years, the shipments equaled production, which indicates a reduction of stocks. The shipments from Pennsylvania and New York oil fields in 1892 were 29,972,861 barrels, something over a million and a half barrels in excess of production—28,422,377 barrels.

These figures of shipments must not be taken as showing the actual consumption of oil. To them must be added, in order to ascertain what becomes of the oil produced in the oil regions, all of the sediment, the dump oil, or oil that does not pass through the pipe line, as well as the amount of oil destroyed by fire and disposed of in other ways than by refining or direct consumption. There is also a certain amount of loss by evaporation and otherwise. This is provided for by the pipe lines in receiving the oil from the producers, a certain number of gallons per barrel being allowed for such loss. Forty-four gallons are generally delivered by the producer to the pipe line as a barrel, but certificates are issued for barrels of 42 gallons only.

Prices of crude petroleum in Pennsylvania.—In the following table from Stowell's Petroleum Reporter are given the monthly and yearly averages of pipe-line certificates or price of crude petroleum at primary markets from 1860 to 1892, in barrels of 42 gallons.

These averages, it is to be understood, are not true averages—that is, the average which considers the price and the quantity sold at that price—but they are the averages of the prices obtained from day to day. It is probable that the true average prices are slightly under the averages usually obtained by averaging the prices. These averages, however, under the circumstances, are the only ones that can be ascertained and do not vary much from the average of the prices. It is also to be noted, as is stated elsewhere, that certain oils in Pennsylvania and New York were at a premium for a portion of the year, the premiums on oils of certain districts being removed in August, all oil after this date being subject to the certificate price.

Monthly and yearly average prices of pipe-line certificates of crude petroleum at wells from 1860 to 1892.

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	0.62½	0.50	0.50	0.50	0.25	0.20	0.10	0.10	0.10	0.49
1862	0.10	0.15	0.22½	0.50	0.85	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	6.70	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	3.22	3.40	3.84
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	3.63
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	1.87
1874	1.20	1.40	1.60	1.90	1.62½	1.32½	1.02½	0.95	0.95	0.85	0.55	0.61½	1.15
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	1.36
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	0.98¾	1.01	0.86⅝	0.82½	0.89⅜	1.16	1.19
1879	1.03	0.98	0.86¼	0.78½	0.76	0.68⅜	0.69⅞	0.67⅛	0.69⅜	0.88⅛	1.05⅝	1.18⅓	0.85⅞
1880	1.10¼	1.03⅛	0.88¾	0.78	0.80	1.00	1.06¼	0.91	0.96	0.96⅞	0.91⅞	0.91⅝	0.94½
1881	0.95½	0.90⅜	0.83⅜	0.86¼	0.81⅞	0.84¼	0.76⅞	0.78⅛	0.97⅛	0.91¼	0.85¼	0.84⅜	0.85⅞
1882	0.83⅛	0.84½	0.81⅜	0.78⅜	0.71½	0.54⅜	0.57⅜	0.58⅝	0.72⅛	0.93¾	1.14	0.96	0.78⅛
1883	0.93¾	1.01	0.97⅝	0.94⅜	1.00⅛	1.16⅜	1.05⅞	1.08	1.12½	1.11⅛	1.14½	1.14¾	1.05¾
1884	1.11	1.04⅜	0.98⅓	0.94	0.85⅝	0.68⅝	0.63½	0.81⅞	0.78	0.71⅛	0.72½	0.74⅜	0.83½
1885	0.70⅞	0.72⅜	0.80⅜	0.78½	0.79	0.82	0.92½	1.00¼	1.00¾	1.05½	1.04⅜	0.89⅝	0.87⅞
1886	0.88⅜	0.79⅞	0.77¼	0.74⅛	0.70	0.66½	0.66	0.62⅛	0.63⅜	0.65⅛	0.71⅝	0.70⅝	0.71¼
1887	0.70	0.64⅝	0.63⅜	0.64⅞	0.64⅓	0.62⅝	0.59¼	0.60⅛	0.67	0.70⅞	0.73⅞	0.80¾	0.66¾
1888	0.91¼	0.91⅝	0.98⅝	0.82⅝	0.86¾	0.75⅞	0.80⅝	0.90⅛	0.93⅝	0.90⅝	0.85⅜	0.89¼	0.87⅝
1889	0.86⅝	0.89¼	0.90⅞	0.88	0.83⅛	0.8 ⅞	0.95⅛	0.99½	0.99⅛	1.01⅜	1.08½	1.04⅓	0.94⅛
1890	1.05¾	1.05⅛	0.90	0.82⅝	0.88⅞	0.89¼	0.89⅛	0.89¼	0.81⅞	0.80⅛	0.72⅜	0.67¼	0.86¾
1891	0.74¼	0.78⅜	0.74¼	0.71½	0.69¾	0.68⅛	0.66½	0.64	0.58⅓	0.60½	0.58¾	0.59⅝	0.67
1892	0.62⅜	0.60¼	0.57⅛	0.57⅞	0.57⅜	0.54⅛	0.52½	0.55	0.54⅜	0.51⅜	0.52	0.53¼	0.55⅝

From the above table it will be seen that the average price of oil in 1892 was lower than it has been in any year since 1860, except in 1861, when the average was 49 cents a barrel, the average for 1892 being 55⅝ cents.

Stocks of crude petroleum.—In the following table is given a statement showing the total stocks of crude petroleum in the Pennsylvania and New York oil fields from 1871 to 1892, inclusive, by months and years:

Total stocks of crude petroleum in the Pennsylvania and New York oil fields from 1871 to 1892, by months and years.

[Barrels of 42 gallons.]

Years.	January.	February.	March.	April.	May.	June.	July.
1871	537, 751	587, 021	642, 000	771, 000	605, 000	554, 000	511, 220
1872	532, 971	579, 793	662, 497	877, 832	950, 803	1, 010, 302	990, 229
1873	1, 183, 728	1, 265, 373	1, 244, 657	1, 178, 643	1, 192, 541	1, 324, 493	1, 433, 620
1874	1, 948, 919	2, 283, 032	2, 648, 210	2, 623, 534	2, 594, 286	2, 701, 625	2, 279, 479
1875	4, 011, 703	4, 546, 188	4, 592, 364	4, 537, 843	4, 552, 672	4, 502, 896	4, 386, 720
1876	3, 585, 143	3, 734, 835	3, 829, 250	3, 900, 703	3, 989, 904	3, 791, 642	3, 326, 726
1877	2, 604, 128	2, 860, 636	3, 210, 454	3, 279, 731	3, 173, 008	2, 912, 674	3, 004. 728
1878	3, 555, 342	3, 875, 964	4, 342, 832	4, 692, 090	4, 996, 058	5, 078, 189	5, 031, 600
1879	5, 321, 222	5, 813, 663	6, 318, 099	6, 689, 111	6. 980, 064	7, 263, 150	7, 353, 382
1880	8, 724, 194	9, 004, 062	9, 606, 683	10, 780, 153	11, 916, 577	13, 099, 934	14, 116, 753
1881	20,110, 903	21, 108, 003	22, 105, 789	22, 963, 171	23, 793, 028	24, 441, 191	24, 888, 337
1882	26, 716, 188	27, 059, 611	27, 822, 825	28, 547, 481	29, 206, 697	29, 859, 952	30, 715, 144
1883	35, 187, 116	35, 692, 480	35, 881, 255	37. 789, 406	35, 755, 824	35, 985, 935	36, 371, 922
1884	35, 884, 509	36, 041, 898	36, 220, 270	36, 642, 794	38, 631, 203	38, 665, 838	38. 985, 767
1885	37, 214, 274	36, 757, 137	36, 508, 236	36, 464, 800	36, 139, 072	35, 872, 257	35, 686, 909
1886	34, 186, 238	34, 082, 775	33, 954, 493	33, 823, 385	33, 969, 486	34, 187, 377	34, 428, 490
1887	33, 835, 389	33, 288, 630	32, 932. 502	32, 955, 084	32, 642, 330	32, 389, 750	32, 289, 269
1888	26, 927, 634	26, 084, 574	25, 404, 276	24, 893, 223	24, 653, 043	24, 219, 496	23, 586, 951
1889	18, 165, 607	17, 240, 428	16, 634, 437	16, 076, 501	15, 668, 331	15, 258, 863	14, 541, 696
1890	11, 060, 220	10, 990, 417	11, 170, 997	11, 178, 990	11, 062, 100	10, 866, 587	10, 663, 497
1891	10, 383, 059	10, 836, 863	10, 939, 164	11, 313, 241	11, 684, 538	12, 021, 857	12, 239, 422
1892	16, 511, 609	16, 947, 539	17, 126, 762	17, 566, 369	17, 988, 510	18, 609, 217	18, 989, 265

Years.	August.	September.	October.	November.	December.	Averages.
1871	530, 146	541, 330	495, 102	502, 960	532, 000	567, 468
1872	997, 166	951, 410	914, 423	886, 909	1, 084, 423	869, 897
1873	1, 513, 890	1, 521, 185	1, 452, 777	1, 493, 875	1, 625, 157	1, 369, 162
1874	2, 932, 444	2, 758, 504	3, 134, 902	3, 449, 845	3, 705, 639	2, 755, 035
1875	4, 223, 397	3, 812, 945	3, 672, 101	3, 701, 235	3, 550, 207	4, 174, 189
1876	3. 304, 405	2, 930, 456	3. 040, 108	2, 955, 092	2, 551, 199	3, 411, 622
1877	2, 852, 544	2, 503, 657	2, 504, 012	2, 471, 798	3, 127, 837	2, 875, 434
1878	4, 717, 877	4, 599, 362	4. 221, 769	4, 289, 309	4, 615, 299	4, 501, 308
1879	7, 114, 195	7, 620, 525	7. 794, 634	8, 051, 469	8, 470, 490	7, 065, 834
1880	15, 063, 651	16, 157, 316	16. 877, 019	18, 025, 409	18, 928, 430	13, 525, 015
1881	25, 005, 187	25, 066, 657	25, 309, 361	25. 509, 285	26, 019, 704	23, 860, 051
1882	31, 772, 094	32, 400, 303	32, 608, 533	33, 728, 555	34, 596, 612	30, 419, 500
1883	36, 164, 881	35, 752, 677	35, 613, 915	35, 506, 653	35, 745, 632	35, 953, 975
1884	39, 084, 561	38, 740, 734	38. 192, 317	37, 925, 756	37, 366, 126	37, 698, 481
1885	35, 343, 771	34, 939, 902	34, 763, 857	34. 668. 437	34, 428, 841	35, 732, 291
1886	34, 800, 397	35, 061, 614	35, 027, 877	34, 525, 871	34, 156, 605	34, 350, 384
1887	32, 003, 536	31, 340, 939	30, 662, 583	29, 325, 951	28, 006, 211	31, 806, 015
1888	22, 825, 298	21, 876, 681	20, 722, 024	19, 734, 132	18, 995, 814	23, 326, 929
1889	13, 859, 267	13, 198, 452	12, 468, 969	12, 021, 924	11, 562, 593	14, 724, 756
1890	10, 526, 613	10, 346, 878	10, 263, 258	10, 080, 538	9, 993, 600	10, 682, 807
1891	12, 412, 300	12, 650, 375	13, 504, 659	14, 952, 827	16, 002, 857	12, 411, 763
1892	19, 101. 330	18, 952, 748	18, 604, 588	18, 097, 631	17, 615, 244	18, 009, 234

In the following two tables will be found statements showing the number of wells completed in each district in the Appalachian oil fields during each month of 1892 by months and districts, together with the initial daily production of new wells:

Total number of wells completed in the Appalachian oil fields in 1892.

Months.	Bradford.	Allegany.	Middle field.	Venango and Clarion.	Butler and Armstrong	Southwest district.	Total.
January	7	2	15	3	25	123	175
February	6	2	11	15	37	100	171
March	2	5	11	7	33	79	137
April	3	1	10	10	43	100	167
May	3	0	7	19	41	100	170
June	2	2	9	12	24	105	154
July	3	0	13	9	23	126	174
August	3	0	10	14	23	91	141
September	0	1	10	12	23	96	142
October	1	4	10	9	26	108	158
November	3	3	15	13	26	100	160
December	4	1	10	8	18	102	143
Total	37	21	131	131	342	1,230	1,892

Initial daily production of new wells in the Appalachian oil fields in 1892.

[Barrels of 42 gallons.]

Months.	Bradford.	Allegany.	Middle field.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Total.
January	37	9	27	16	1,466	10,634	12,189
February	20	7	39	60	1,152	8,562	9,840
March	7	20	35	30	1,019	7,157	8,268
April	5	2	21	63	1,013	5,582	6,686
May	13	0	28	58	1,230	6,173	7,502
June	10	7	26	34	610	8,873	9,560
July	15	0	56	32	1,278	8,645	10,026
August	15	0	55	23	645	7,121	7,859
September	0	3	61	74	386	5,823	6,347
October	5	15	63	35	885	7,810	8,813
November	15	4	50	72	707	5,967	6,815
December	10	10	25	37	277	7,221	7,580
Total	152	77	486	534	10,668	89,568	101,485

These tables do not include any wells drilling in the Franklin lubricating oil district nor the initial production of wells drilled in this district.

The districts in the above tables have been described in other parts of the report. Here it may be said briefly that the Bradford district includes a portion of Cattaraugus county, New York, and forms with Allegany, New York, district the northern field. The middle field is chiefly in Warren and Forest counties, though the lower field includes a small portion of Warren county. The Venango and Clarion and the Butler and Armstrong are the chief districts of what is known as the lower field. The southwest field includes the wells in Allegheny and Washington counties, as well as the wells in northern West Virginia.

The above tables show in the most graphic manner the localities from which new production in the oil fields was derived in 1892. It will be noted that in the most northern districts, Bradford and Allegany, but little drilling was done in 1892, the total number of wells completed in these two districts in that year being but 58, or a little more than 1 a week. In the Middle and the Venango and Clarion fields the average for each was about 2½ a week. Coming still farther south, in the Butler and Armstrong district, the average was about 6½ wells a week, while in the Southwestern district the average was less than 25 a week, or 100 a month.

The table also shows the difference in the producing capacity of the wells drilled in the several districts. The average daily initial production of the new wells in the Bradford district was five barrels; in the Allegany district, 3½ barrels; in the Middle field, 3 barrels; in the Venango and Clarion district, 4 barrels; in the Butler and Armstrong district, 31 barrels; and in the Southwestern district, 73 barrels.

This table also shows that drilling was carried on with considerable regularity during the year in the fields as a whole, the average of the last part of the year, however, being somewhat smaller than the first half.

The average daily initial production of new wells completed in the Appalachian oil fields from 1889 to 1892 is as follows:

Average daily initial production of new wells in the Appalachian oil fields from 1889 to 1892.

[Barrels.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1889..	2, 800	2, 987	6, 666	6, 287	6, 478	7, 650	7, 022	8, 004	6, 958	6, 235	8, 458	6, 919
1890..	7, 180	10, 484	7, 644	8, 056	8, 507	11, 097	10, 537	9, 469	16, 215	10, 453	12, 297	8, 396
1891..	13, 364	6, 618	7, 751	7, 710	7, 875	5, 263	6 543	13, 536	18, 118	46, 712	33, 395	15, 468
1892..	12, 189	9, 840	8, 268	6, 686	7, 502	9, 560	10, 026	7, 859	6, 347	8, 813	6, 815	7, 580

The initial daily production of the wells in 1892 shows considerable difference from the production of 1891, though if the remarkable increases of September, October, and November of 1891 were not considered the average initial daily production in 1892 would not differ much from that of 1891.

The following table gives the number of drilling wells completed in each month from January, 1872, to the close of 1892:

Number of drilling wells completed in the Pennsylvania, New York, and northern West Virginia oil fields each month from 1872 to 1892, 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, 939
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

a Including 36 wells drilled in Franklin district, data for which by months were not obtainable.

It will be noted that the number of wells completed in 1892 is the smallest number for four years, and the smallest number, with the exception of the years 1887 and 1888, since 1873. This shows the effect of low prices and the enormous production in the previous year on the number of drilling wells.

In the following table will be found a statement of the number of dry holes drilled in each district of the Appalachian oil field in 1892. This table should be compared with the table given above, showing the total number of wells completed in the Appalachian oil fields by districts. The number of producing wells in each district for each month of the year will be ascertained by subtracting the number of dry holes given in the above table from the number of completed wells. A study of these two tables—that is, the table showing the number of completed wells and the table showing the number of dry holes—is interesting as indicating the differing proportions of producing wells to the total number of wells drilled in the different districts. For example, in the Bradford district 37 wells were completed in 1892. Of these 10 were dry holes, say one-fourth. In 1891 but one-sixteenth were dry holes. In the Allegany district 21 wells were drilled, of which 6, or about one-third, were dry holes. In the Southwest district 1,230 wells were drilled, of which 243, or about one-fifth, were dry holes. In 1891 the proportion of dry holes in the Southwest district was about one-fourth.

Total number of dry holes drilled in Pennsylvania, New York, and northern West Virginia in 1892.

Months.	Bradford.	Allegany.	Middle field.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Total.
January	3	0	6	1	4	21	35
February	4	0	6	3	9	11	33
March	0	2	4	2	11	15	34
April	2	0	7	3	8	16	36
May	1	0	2	7	15	19	44
June	0	0	3	3	9	13	28
July	0	0	0	2	5	35	42
August	0	0	3	5	9	14	31
September	0	0	2	1	9	24	36
October	0	0	1	3	6	26	36
November	0	0	0	4	3	29	36
December	0	4	1	6	6	20	37
Total	10	6	35	40	94	243	428

In the following table will be found a statement of the number of dry holes drilled in each month from 1889 to 1892:

Dry holes drilled from 1889 to 1892.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1889	75	87	62	81	90	104	92	73	69	76	70	53	932
1890	71	71	98	102	83	95	105	81	78	107	94	64	1,049
1891	46	61	52	59	48	72	67	66	41	45	54	39	650
1892	35	33	34	36	44	28	42	31	36	36	36	37	428

The earnestness with which new work is being prosecuted in the various fields and districts of the Appalachian oil fields at the close of each month is shown by the number of rigs or derricks building and wells drilling. In the following table will be found a statement of the number of rigs in course of construction at the close of each month in 1892 for each of the districts of the Appalachian oil fields. It will be noted that rig building was a little more active at the close of the year than at the beginning.

Rigs building in the Pennsylvania, New York, and northern West Virginia fields in 1892.

Months.	Bradford.	Allegany.	Middle field.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Total.
January	0	0	8	11	29	44	92
February	0	1	2	11	38	63	115
March	1	3	1	16	17	59	97
April	3	2	4	7	13	58	87
May	1	2	6	10	18	50	87
June	1	2	5	7	14	50	79
July	1	1	2	13	17	54	88
August	1	1	1	4	14	42	63
September	0	1	4	11	21	48	85
October	1	0	2	5	19	75	102
November	0	2	3	10	24	78	117
December	0	2	3	9	12	83	109
Average	1	1	3	10	20	59	93

The average number of rigs building at the close of each month during the year 1892 was 93, as compared with 179 in 1891.

In the following tables will be found a statement of the rigs building in the entire Appalachian field at the close of each month 1889 to 1892:

Rigs building in Pennsylvania, New York, and northern West Virginia since 1889.

Years.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1889	221	233	322	283	287	281	252	358	357	440	473	433	328
1890	391	416	426	400	353	361	374	371	351	365	278	245	361
1891	233	195	218	186	208	234	182	188	131	136	122	108	179
1892	92	115	97	87	87	79	88	63	85	102	117	109	93

In the following tables will be found statements regarding the number of wells drilled, but not completed, at the close of each month in 1892, and also from 1871 to 1892:

Wells in process of drilling in Pennsylvania, New York, and northern West Virginia in 1892.

Months.	Bradford.	Allegany.	Middle field.	Venango and Clarion.	Butler and Armstrong.	Southwest district.	Total.
January	4	1	9	8	54	173	249
February	6	1	15	4	67	165	258
March	0	1	6	8	60	164	239
April	2	2	8	8	43	158	221
May	2	2	10	5	38	162	219
June	3	0	20	9	44	173	249
July	1	2	13	9	37	136	198
August	0	3	10	7	38	180	238
September	4	4	10	8	39	165	230
October	4	3	8	7	36	178	236
November	1	0	5	7	32	176	221
December	3	3	7	9	41	166	229
Average.	3	2	10	7	44	166	232

Number of wells drilling in the Pennsylvania, New York and northern West Virginia oil fields at the close of each month from 1871 to 1892, by months and years.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Averages.
1871	140	173	240	279	356	303	329	330	439	486	477	394	329
1872	363	369	313	302	386	391	359	392	301	311	354	318	347
1873	361	349	227	177	228	395	340	267	197	163	137	60	242
1874	37	55	99	213	225	210	180	128	107	82	57	54	121
1875	40	40	45	64	127	162	118	96	132	170	179	168	112
1876	142	151	230	267	307	340	353	374	511	565	618	493	363
1877	457	463	395	448	512	395	365	417	535	573	565	426	463
1878	334	326	379	409	376	266	188	185	240	282	297	218	292
1879	265	323	406	468	460	384	329	258	270	313	372	440	357
1880	540	535	577	580	460	440	452	515	491	469	475	408	495
1881	383	420	437	446	470	408	379	352	388	445	475	468	423
1882	422	438	408	405	381	226	240	194	177	184	154	138	281
1883	126	151	205	199	216	228	262	315	314	341	301	263	243
1884	270	273	260	284	244	123	123	91	79	100	86	78	168
1885	97	109	139	190	228	209	242	308	382	355	359	277	241
1886	320	337	356	318	358	403	349	290	322	272	285	238	321
1887	201	177	155	155	157	142	135	137	107	104	114	88	139
1888	64	72	65	59	82	106	124	106	166	187	327	273	136
1889	341	350	453	487	574	612	598	598	600	698	659	610	548
1890	597	608	645	603	585	617	643	683	632	644	542	445	604
1891	407	410	401	387	380	407	420	406	397	371	337	276	383
1892	249	258	239	221	219	249	198	238	230	236	221	229	232

OHIO.

In the previous volumes of Mineral Resources the oil-producing territory of Ohio has been divided into three districts, namely: Lima, Macksburg, and Mecca-Belden. The extension of the oil fields of New York, Pennsylvania, and West Virginia southward has developed large producing territory north of Macksburg in the Sistersville, Eureka and other districts. This has led to somewhat of a change in the reports, and while but three districts are still named, the Macksburg, and the Eastern Ohio district have been consolidated and are known as the Eastern Ohio district.

The Eastern Ohio district is really a portion of the western West Virginia district. The Sistersville, Eureka, and other districts are on both sides of the Ohio river, some of the wells being in West Virginia and others in Ohio. This makes it extremely difficult to distribute the production properly between the two States. In the accompanying tables the best distribution possible has been made.

In the report on natural gas, which appears elsewhere in this volume, will be found a very complete description of the various natural gas and oil fields of Ohio as they existed at the close of 1892. A brief résumé may be necessary to a proper understanding of the statistics which follow.

The first and most important of the oil-producing districts of Ohio is the Lima or Northwestern, which includes the remarkable developments in the section of country of which Lima may be regarded as the center and which extends in a southwesterly direction into Indiana.

The oil in this district is found in the Trenton limestone. Quite a number of distinct pools have been noted, and it is found that the oil in these different pools varies somewhat in character, that of certain pools having more of the sulphur compounds than that of the others.

The Eastern Ohio district includes the wells along the extreme eastern boundary of Ohio contiguous to Pennsylvania and West Virginia. Most of the oil produced from this district in past years, 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 that have been such large producers in western Pennsylvania and eastern Ohio, notably in the Big Injun. The oil from the Mecca-Belden field is entirely a lubricating oil, derived from the Berea grit.

Until quite recently all the oil produced in the Lima district was classed as fuel oil. This is no longer true, owing to the improved methods of distillation. The illuminating oils produced from the limestone oils of the Lima field are considered better than those produced from the sandstone oils of the Appalachian field. The percentage yield of the Lima oil in illuminants, however, is still considerably less than the yield of the Appalachian oils.

The total amount and value of the petroleum produced in Ohio in the years 1889, 1890, 1891, and 1892 is shown in the following table:

Total amount and value of petroleum produced in Ohio in 1889, 1890, 1891, and 1892.

Districts.	1889.		1890.	
	Total production.	Total value.	Total production.	Total value.
	Barrels.		*Barrels.*	
Lima	12,153,189	$1,822,978	15,014,882	$4,504,465
Macksburg	317,037	340,683	1,108,334	1,127,730
Eastern Ohio				
Mecca-Belden	1,240	10,334	1,440	12,000
Total	12,471,466	2,173,995	16,124,656	5,644,195

Districts.	1891.		1892.	
	Total production.	Total value.	Total production.	Total value.
	Barrels.		*Barrels.*	
Lima	17,315,978	$5,281,373	15,169,507	$5,555,832
Macksburg	400,024	283,332	197,556	662,106
Eastern Ohio	22,859		992,746	
Mecca-Belden	1,440	12,000	3,112	21,101
Total	17,740,301	5,576,705	16,362,921	6,239,039

From this table it appears that the production of petroleum in Ohio in 1892 was about 1,400,000 barrels less than in 1891, though the value was $700,000 more. This is due in part to the increased value of Lima oil and also to the greatly increased production and consequent value of the Eastern Ohio oil.

Of the total production of petroleum in Ohio in 1892 of 16,362,921 barrels, 15,169,507 barrels, or nearly 93 per cent., came from the Lima district. This is a reduction from 17,315,978 barrels in 1891, or something over 2,000,000 barrels. The total production of eastern Ohio and Macksburg oil in 1892 was 1,190,302 barrels, as compared with 422,823 barrels in 1891. The Mecca-Belden district shows an increase from 1,440 barrels in 1891 to 3,112 barrels in 1892, an increase of over 100 per cent., but not a material one in the actual number of barrels. In the following table will be found a statement of the total production of crude petroleum in Ohio in 1890, 1891, and 1892, by months and districts. In determining the total by months an average production for each month in the Mecca-Belden has been assumed. This average is 120 barrels a month in the years 1890 and 1891 and 259 barrels a month for some of the months in 1892, and 260 for others.

Total production of crude petroleum in Ohio in 1890, by months and districts.

[Barrels of 42 gallons.]

Months.	Lima.	Eastern Ohio and Macksburg.	Mecca-Belden.	Total.
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 in 1891, by months and districts.

Months.	Lima.	Eastern Ohio and Macksburg.	Mecca-Belden.	Total.
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

Total production of crude petroleum in Ohio in 1892, by months and districts.

Months.	Lima.	Eastern Ohio and Macksburg.	Mecca-Belden.	Total.
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

The following table gives the production of petroleum in Ohio from the beginning of operations in that State to the close of 1892:

Production of petroleum in Ohio.

Years.	Barrels.	Years.	Barrels.
Previous to 1876	200,000	1885	650,000
1876	31,763	1886	1,782,970
1877	29,888	1887	5,018,015
1878	38,179	1888	10,010,868
1879	29,112	1889	12,471,466
1880	38,940	1890	16,124,656
1881	33,867	1891	17,740,301
1882	39,761	1892	16,362,921
1883	47,632		
1884	90,181	Total	80,740,420

This shows that the total production of the State has been 80,740,420 barrels, of which more than 72,500,000 barrels have been produced within the last 5 years.

Lima district.—Possibly the most remarkable oil district ever developed in this country is that known as the Lima, or Northwestern Ohio district. Not only has its development been most rapid since it began to assume prominence in 1885, but it has been found that the oil produced in this district, which, because of its peculiar character, it containing a portion of sulphur, it was believed could not be used for illuminating purposes, now furnishes most of the illuminating oil used in the United States, though the yield of the oil in illuminants is less than from Pennsylvania oil.

This region has been so thoroughly described in Mineral Resources that little need be said here. The reservoir of the oil is the Trenton limestone which lies as near a level terrace as an area of this sort ever becomes. The oil is found at Lima at a depth of 1,300 feet. The oil is dark or black and rather heavy, and contains sulphur compounds, in these respects resembling the oils of Canada and Tennessee.

The production of petroleum in the Lima, Ohio, oil fields from 1886 to 1892 is as follows:

Production of petroleum in the Lima, Ohio, district from 1886 to 1892.

Years.	Barrels.
1886	1,064,025
1887	4,650,375
1888	9,682,683
1889	12,153,189
1890	15,014,882
1891	17,315,978
1892	15,169,507

In the following table is found the production of petroleum in the Lima, Ohio, field from 1887 to 1892, by months, so far as the same was obtainable:

Product of petroleum in the Lima, Ohio, field from 1887 to 1892.

[Barrels of 42 gallons.]

Months.	1887.	1888.	1889.	1890.	1891.	1892.
January	131,011	422,125	....	911,947	1,471,858	1,090,173
February	206,026	479,824	....	888,978	1,355,734	1,127,481
March	303,084	586,781	....	955,620	1,455,628	1,200,305
April	352,798	629,932	....	1,040,924	1,470,661	1,128,253
May	449,062	745,896	....	1,142,954	1,446,284	1,165,750
June	474,535	862,106	....	1,175,821	1,491,228	1,210,523
July	389,997	905,218	....	1,354,672	1,514,607	1,300,197
August	490,862	995,938	....	1,411,998	1,509,262	1,461,020
September	465,743	979,943	....	1,559,473	1,492,115	1,422,534
October	444,941	1,036,712	....	1,660,069	1,499,834	1,379,909
November	458,612	988,997	....	1,495,099	1,271,189	1,328,548
December	483,704	1,049,211	....	1,417,327	1,337,578	1,354,814
Total	4,650,375	9,682,683	12,153,189	15,014,882	17,315,978	15,169,507

In the following tables will be found a statement of the pipe-line runs and shipments in the Lima, Ohio, district from 1889, the date from which these figures were given to the public. It should be remarked regarding the pipe-line runs that these do not indicate the production. The runs, which are chiefly if not entirely those of the Buckeye pipe line, showing but 13,657,737 barrels, while the production as given in the preceding table in 1892 is 15,169,507 barrels.

Regarding the shipments it should be noted that they are very much in excess of the production. The pipe-line runs were, as stated above, 13,657,731 barrels, while the shipments from the same pipe lines were 16,504,880 barrels, the shipments by this line being nearly three million barrels in excess of the runs.

Pipe-line runs, Lima district, Ohio, from 1889 to 1892.

[Barrels of 42 gallons.]

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.
1889	973,980	800,828	830,559	845,377	932,067	843,844
1890	683,750	622,799	676,175	842,416	887,590	916,289
1891	1,241,154	1,147,947	1,255,611	1,202,583	1,191,147	1,207,884
1892	971,607	1,008,069	1,083,801	1,042,087	1,064,478	1,099,145

Pipe line runs, Lima district, Ohio, from 1889 to 1892—Continued.

Years.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1889	805, 744	968, 449	875, 201	850, 077	774, 073	755, 553	10, 255, 752
1890	1, 105, 885	1, 149, 877	1, 289, 577	1, 342, 158	1, 215, 960	1, 186, 434	11, 918, 910
1891	1, 236, 291	1, 240, 841	1, 252, 375	1, 257, 986	1, 070, 131	1, 211, 820	14, 515, 770
1892	1, 190, 015	1, 346, 949	1, 132, 385	1, 264, 536	1, 209, 953	1, 244, 712	13, 657, 737

Shipments of crude petroleum and refined petroleum, reduced to crude equivalent, from the Lima, Ohio, district from 1889 to 1892.

[Barrels of 42 gallons.]

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.
1889	367, 524	362, 807	391, 026	340, 889	309, 238	352, 886
1890	156, 085	111, 604	123, 125	115, 223	169, 662	700, 422
1891	968, 887	837, 928	330, 448	336, 854	1, 078, 489	923, 605
1892	1, 355, 362	1, 346, 541	1, 532, 606	1, 512, 358	1, 427, 753	1, 492, 543

Years.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1889	361, 694	464, 325	626, 207	715, 386	759, 702	750, 244	5, 801, 928
1890	874, 121	846, 360	813, 817	723, 725	657, 614	907, 548	6, 199, 306
1891	997, 681	1, 166, 054	1, 260, 598	1, 408, 343	1, 391, 400	1, 454, 578	12, 154, 865
1892	1, 389, 501	1, 342, 949	1, 125, 335	1, 315, 994	1, 323, 204	1, 340, 734	16, 504, 880

The number of completed wells in the Lima district in 1892, as shown in the following table, was 1,446, a reduction from 1,575 in 1891. The total initial daily production of all the wells for the year was 94,460 barrels as compared with 74,738 barrels in 1891; that is, with 129 less wells completed the total initial daily production was 19,722 barrels more. These tables also show how great has been the increase in the initial daily production of some of these wells as compared with 1891. In July, 1892, 134 wells were completed with an initial daily production of 11,648 barrels. In July, 1891, 144 wells, ten more than in 1892, were completed, but the initial daily production was but 8,461 barrels, or something over 3,200 barrels a day less. In August, 1892, 166 wells were completed with an initial daily production of 14,631 barrels. In August, 1891, but 138 wells were completed with an initial daily production of 8,427 barrels.

Total number of wells completed in the Lima, Ohio, district in 1892.

Months.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Miscellaneous.	Total.
January	0	17	4	6	37	3	67
February	0	13	9	10	43	7	82
March	1	16	8	11	49	8	93
April	1	15	9	7	54	7	93
May	4	20	4	10	53	2	93
June	5	15	9	21	62	9	121
July	5	9	10	38	67	5	134
August	5	14	5	76	62	4	166
September	4	17	10	60	75	5	171
October	7	12	11	52	73	19	174
November	5	16	9	22	83	12	147
December	1	12	3	6	74	9	105
Total	38	176	91	319	732	90	1,446

Initial daily production of wells completed in the Lima, Ohio, district in 1892.

Months.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Miscellaneous.	Total.
January	0	591	85	122	1,880	175	2,853
February	0	937	233	360	2,805	150	4,485
March	50	1,105	213	220	2,030	355	3,973
April	50	940	575	285	2,705	110	4.665
May	78	792	90	895	2,890	5	4.750
June	255	447	1,595	2.305	3,582	130	8,314
July	125	390	330	6,046	4,697	60	11,648
August	96	414	225	9.879	3,765	252	14,631
September	50	693	370	6,293	5,432	70	12,908
October	195	526	425	6.045	6.245	336	13,772
November	198	378	460	810	5,418	290	7,554
December	20	177	65	505	4,025	115	4,907
Total	1,117	7,390	4,666	33,765	45,474	2,048	94,460

As will be seen from the following table, of the 1,446 wells completed in 1892, 183 were dry holes. The dry holes drilled in 1891 were 250.

Total number of dry holes drilled in the Lima, Ohio, district in 1892.

Months.	Allen.	Auglaise.	Hancock.	Sandusky.	Wood.	Miscellaneous.	Total.
January	0	3	1	1	4	0	9
February	0	1	2	1	3	2	9
March	0	1	0	2	3	2	8
April	0	2	1	1	6	3	13
May	0	3	1	1	4	1	10
June	0	1	1	1	9	6	18
July	0	1	2	2	8	3	16
August	1	3	2	4	7	1	18
September	2	0	1	9	12	3	27
October	0	0	2	8	4	8	22
November	0	2	0	4	9	3	18
December	0	2	0	0	8	5	15
Total	3	19	13	34	77	37	183

The number of rigs building and the number of wells drilling in the Lima, Ohio, field at the close of each month in 1891 is shown in the two following tables. Similar remarks as to the significance of these tables as were made in connection with the well records of Pennsylvania can be made regarding the well records of the Ohio field as well.

Total number of rigs building in the Lima, Ohio, field in 1892.

Months.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Miscellaneous.	Total.
January	4	17	10	10	46	8	95
February	5	25	13	10	55	7	115
March	4	21	10	12	54	5	106
April	3	22	13	11	55	8	112
May	4	18	11	18	54	8	113
June	7	16	12	19	45	5	104
July	7	14	11	38	49	9	128
August	6	12	11	32	53	12	126
September	7	14	5	27	54	14	121
October	7	17	6	17	53	12	112
November	5	16	7	11	63	10	112
December	1	8	2	4	33	1	49
Average	5	17	9	17	51	8	108

Total number of wells drilling in the Lima, Ohio, field in 1892.

Months.	Allen.	Auglaize.	Hancock.	Sandusky.	Wood.	Miscellaneous.	Total.
January	0	9	5	9	33	5	61
February	1	17	5	10	43	2	78
March	1	12	5	7	45	6	76
April	3	12	1	7	25	3	51
May	4	6	3	10	36	5	64
June	0	7	8	20	51	9	95
July	5	10	10	33	38	5	101
August	5	11	9	39	42	6	112
September	7	10	11	28	49	15	120
October	6	7	8	12	68	13	114
November	4	13	9	9	61	10	106
December	2	5	2	7	62	3	81
Average	3	10	6	16	46	7	88

Eastern Ohio district.—The second largest oil-producing district in Ohio is what has been termed in this report the Eastern Ohio district, which includes the old Macksburg field and the new developments in West Virginia and western Pennsylvania. As previously noted the production of this district increased greatly in 1892, though the production in 1891 was much in excess of that of 1890.

The production of the Macksburg, or Eastern Ohio, district for the last eight years is given in the following table:

Production of petroleum in the Macksburg, Ohio, district, from 1885 to 1892.

Years.	Barrels.
1885	661,580
1886	703,945
1887	372,257
1888	291,585
1889	317,037
1890	1,108,334
1891	*a*422,883
1892	*b*1,190,302

a This includes 22,859 barrels of petroleum produced in Eastern Ohio.
b This includes 992,746 barrels of petroleum produced in Eastern Ohio.

In the following table the pipe-line runs and the shipments from the Eastern Ohio district are given from 1889 to 1892:

Pipe-line runs in the Eastern Ohio district, from 1889 to 1892.

[Barrels of 42 gallons.]

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1889	18,174	16,239	19,676	20,144	20,283	18,536	16,705	16,607	16,875	21,555	25,415	28,567	238,776
1890	29,872	34,022	45,362	53,905	72,158	90,827	111,584	121,349	138,310	129,717	106,552	87,955	1,021,613
1891	86,058	45,618	23,055	25,070	24,263	21,689	24,858	24,432	27,006	23,428	23,073	28,682	377,232
1892	24,801	27,620	39,010	40,424	43,569	50,007	64,107	106,082	135,353	212,470	176,852	196,852	1,117,147

Shipments of crude petroleum and refined petroleum reduced to crude equivalent from Eastern Ohio district, from 1889 to 1892.

[Barrels of 42 gallons.]

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1889 ..	11,847	16,168	23,939	8,611	9,027	8,934	15,269	14,507	22,669	50,447	47,924	47,090	276,432
1890 ..	44,306	38,898	35,041	30,975	13,070	22,851	46,394	107,175	73,469	57,780	54,540	53,704	578,203
1891 ..	54,363	27,160	1,040	2,094	1,060	41,725	820	2,318	3,283	3,040	2,700	2,236	141,839
1892 ..	2,594	2,200	1,763	1,600	252	37,989	1,834	1,555	2,102	3 773	4,358	6,443	66,463

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 field of the Eastern Ohio district in 1892:

Well record in the Macksburg, Ohio, district in 1892.

Months.	Wells completed.	Initial production.	Dry holes.	Wells drilling.	Rigs building.
		Barrels.			
January	7	60	2	15	18
February	9	152	3	15	17
March	12	393	4	12	14
April	7	65	4	9	13
May	4	291	4	14	21
June	8	25	5	9	10
July	5	43	1	6	8
August	2	2	0	6	11
September	4	0	4	6	13
October	2	20	1	10	16
November	14	117	4	7	13
December	2	0	2	9	13
Total	76	1,168	34	....	....

Mecca-Belden district.—The wells in this district are located in Lorain and Trumbull counties, and include the Grafton and Mecca-Belden districts. The oil here is a lubricating oil, and is from a few shallow wells. There were but thirteen wells yielding oil at the close of 1892. In the following table is given the production and value of crude petroleum in these districts in 1892:

Production and value of crude petroleum in the Mecca-Belden district of Ohio in 1892.

	Barrels of 42 gallons.	Value.	Price per barrel.
Lorain county, Belden district	1,732	$9,280	$5.36
Trumbull county, Mecca district	1,380	11,821	8.57
Total	3,112	21,101	6.78

Stocks at wells in the Mecca-Belden district of Ohio.

	Barrels.
Stock at wells December 31, 1891	4,048
Stock at wells December 31, 1892	161

WEST VIRGINIA.

The oil fields of West Virginia, with the exception of the Volcano and Burning Springs districts, are closely allied. Indeed they are extensions of the fields of southwestern Pennsylvania and form a part of what we have elsewhere called the Appalachian oil fields. The character of the oils is identical with those of Pennsylvania except a portion of that from the Volcano and Burning Springs districts, in which a quantity of lubricating oil is produced.

It is exceedingly difficult to separate the production of West Virginia from that of western Pennsylvania and eastern Ohio. Certain districts, as the Sistersville and Eureka, are on both sides of the Ohio river and the oil is run indiscriminately into pipe lines and storage tanks. The best statement that it has been possible to secure shows that the production of West Virginia in 1892 was 3,810,086 barrels as compared with 2,406,218 barrels in 1891, or an increase of 18 per cent.

The following table gives the total amount and value of petroleum produced in West Virginia from 1889 to 1892:

Total amount and value of petroleum produced in West Virginia in 1889, 1890, 1891, and 1892.

Districts.	1889.			1890.		
	Total production.	Total value.	Price per barrel.	Total production.	Total value.	Price per barrel.
	Barrels.			*Barrels.*		
Turkey Foot	199,460	$243,192	$1.21⅞			
Mount Morris	174,758	194,949	1.11½			
Volcano and Eureka	165,735	211,526	1.27⅝			
Burning Springs	4,160	4,160	1.00			
Total	544,113	653,827	1.20⅛	492,578	$501,198	1.01¾

Districts.	1891.			1892.		
	Total production.	Total value.	Price per barrel.	Total production.	Total value.	Price per barrel.
	Barrels.			*Barrels.*		
Turkey Foot						
Mount Morris	2,404,218	$1,610,826	$0.67	3,807,086	$2,117,692	$0.55⅝
Volcano and Eureka						
Burning Springs	2,000	2,000	1.00	3,000	2,209	.736
Total	2,406,218	1,612,826	.67	3,810,086	2,119,901	.556

The production of crude petroleum in West Virginia by months from 1890 to 1892 is shown in the following table:

Total production of crude petroleum in West Virginia by months in 1890, 1891, and 1892.

Months.	1890.	1891.	1892.
January	38, 644	48, 902	195, 512
February	38, 061	123, 841	186, 455
March	44, 842	229, 966	185, 468
April	39, 804	226, 020	181, 708
May	39, 160	232, 076	206, 142
June	35, 610	223, 734	261, 900
July	34, 096	221, 127	328, 485
August	31, 505	238, 451	411, 114
September	50, 342	219, 528	420, 882
October	46, 387	220, 076	451, 157
November	45, 062	207, 477	467, 446
December	49, 065	215, 020	513, 817
Total	492, 578	2, 406, 218	3, 810, 086

It will be noted that in the last five months of 1892 there has been a marked increase in production over the corresponding months of 1891, the production being from two to two and a half times greater in 1892 than in 1891.

In the following table is given the production of oil in West Virginia from the beginning of operations, so far as obtainable:

Production of petroleum in West Virginia.

Years.	Barrels.	Years.	Barrels.
Previous to 1876	3, 000, 000	1885	91, 000
1876	120, 000	1886	102, 000
1877	172, 000	1887	145, 000
1878	180, 000	1888	119, 448
1879	180, 000	1889	544, 113
1880	179, 000	1890	492, 578
1881	151, 000	1891	2, 406, 218
1882	128, 000	1892	3, 810, 086
1883	126, 000		
1884	90, 000	Total	12, 036, 443

From the above table it will be noted that the total production of this State is given at 12,036,443 barrels, of which 6,216,204 barrels, or nearly one-half, have been produced in the last two years. Three million barrels are reported as produced prior to 1876, which leaves less than 3,000,000 barrels as the total production from 1876 to 1890.

INDIANA.

Judged by percentages, no State in the Union made the progress in the production of petroleum in 1892 that was made by Indiana, the production in this year being 698,068 barrels, as compared with 136,634 barrels in 1891, an increase of over 400 per cent. This puts Indiana the sixth in the list of producing States, Pennsylvania being first, Ohio second, West Virginia third, New York fourth, and Colorado fifth.

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 field of Ohio. The wells are included in the counties of Blackford, Jay, Wells, Adams, and Grant. As will be seen from the table of initial daily production of wells given below, the chief production is in Jay, Wells, and Adams counties, the initial production of wells in Grant county being but 50 barrels per day, and in Blackford county but 113 barrels.

In the following tables will be found a statement of the production of petroleum in Indiana from 1889 to 1892.

Product of petroleum in Indiana in 1889, 1890, 1891, and 1892.

	1889.	1890.	1891.	1892.
Total production (barrels of 42 gallons)	33,375	63,496	136,634	698,068
Total value at wells of all oils produced, excluding pipage	$10,881	$32,462	$54,787	$260,620
Value per barrel	$0.32⅝	$0.51⅛	$0.40	$0.37

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 1892.

Total number of wells completed in Indiana in 1892, by counties.

Months.	Blackford.	Jay.	Wells.	Adams.	Grant.	Total.
January	1	4	5	1	0	11
February	0	6	5	2	0	13
March	1	6	10	1	0	18
April	1	3	7	2	0	13
May	2	4	5	5	1	17
June	1	5	8	4	1	19
July	0	7	7	2	1	17
August	0	7	8	15	0	30
September	0	9	6	10	0	25
October	1	29	15	7	0	52
November	0	14	11	8	0	33
December	2	23	9	13	0	47
Total	9	117	96	70	3	295

Initial daily production of wells completed in Indiana in 1892, by counties.

Months.	Blackford.	Jay.	Wells.	Adams.	Grant.	Total.
January	10	87	185	60	0	342
February	0	105	145	0	0	250
March	0	129	140	20	0	289
April	13	160	58	85	0	316
May	30	95	280	100	0	505
June	0	155	260	100	30	545
July	0	170	345	60	20	595
August	0	365	435	495	0	1,295
September	0	1,060	705	380	0	2,145
October	0	2,830	1,010	315	0	4,155
November	0	2,025	720	305	0	3,050
December	60	2,290	350	460	0	3,160
Total	113	9,471	4,633	2,380	50	16,647

Total number of dry holes drilled in Indiana in 1892, by counties.

Months.	Blackford.	Jay.	Wells.	Adams.	Grant.	Total.
January	0	1	1	0	0	2
February	0	4	0	2	0	6
March	1	1	4	0	0	6
April	0	0	2	0	0	2
May	0	1	1	0	1	3
June	1	1	1	1	0	4
July	0	1	0	1	0	2
August	0	1	1	1	0	3
September	0	2	0	1	0	3
October	1	14	1	2	0	18
November	0	6	0	0	0	6
December	0	15	2	4	0	21
Total	3	47	13	12	1	76

Total number of wells drilling in Indiana in 1892, by counties.

Months.	Blackford.	Jay.	Wells.	Adams.	Grant.	Total.
January	0	9	6	2	0	17
February	1	5	8	1	0	15
March	1	3	6	1	0	11
April	0	6	3	3	0	12
May	1	6	5	1	0	13
June	0	7	6	3	0	16
July	0	4	3	4	0	11
August	0	6	7	3	0	16
September	1	10	8	4	0	23
October	0	11	8	4	0	23
November	1	9	10	6	0	26
December	5	14	5	0	0	24
Average	1	8	6	3	0	17

Total number of rigs building in Indiana in 1892, by counties.

Months.	Blackford.	Jay.	Wells.	Adams.	Grant.	Total.
January	0	5	3	0	0	8
February	0	9	9	0	0	18
March	0	13	5	5	0	23
April	1	15	4	3	0	23
May	0	10	3	3	1	17
June	0	11	7	3	0	21
July	0	8	4	4	0	16
August	0	8	3	4	0	15
September	0	15	13	1	0	29
October	1	17	8	5	0	31
November	1	22	10	6	0	39
December	5	12	2	0	0	19
Average	1	12	6	3	0	22

In the following tables are given the well records in the Indiana oil fields for 1891 and 1892:

Number of wells completed in the Indiana oil fields in 1891 and 1892, 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

Initial daily production of new wells in Indiana oil fields in 1891 and 1892, by months.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
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

Total number of dry holes drilled in Indiana oil fields in 1891 and 1892, 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

Number of wells completed in the Indiana oil fields at the close of each month in 1891 and 1892, 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

Rigs building in the Indiana oil fields in 1891 and 1892, 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

COLORADO.

All of the oil produced in Colorado is from what is known as the Florence field. This field extends from near Cañon 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 towards Pueblo.

The geology of the country near Florence is very simple. The Arkansas valley at Florence has cut through the Laramie group, the upper member of the Cretaceous, exposing the upper portion of the Colorado group, the middle member of the Cretaceous. East and west of Florence the rocks of the Laramie, sandstones and shales, with beds of coal lying nearly horizontal, are exposed on the mountain side. In the valley at Florence, where the wells have been put down, the formation consists almost entirely of blue or bluish-black shale, having a thickness of from 3,000 to 4,000 feet. The wells are all sunk in this shale, no well that has yet been put down having passed through it, though some wells have been drilled 3,500 feet or more. Farther up the valley of the Arkansas these sedimentary strata are uplifted and rest against a granite axis of the Greenhorn range. The slate or shale in which the oil is found dips southwest about 10°. As stated above, the wells drilled in this district have never gone through the shale, which lies just below the drift, but it is questionable if the origin of the oil is in the shale. The indications are that it drains into the shale probably from the direction of Cañon City. It is noted in drilling that when the shale seems to be solid and unbroken no oil is found, but when in drilling crevices are struck and the strata appears broken oil is almost sure to be discovered. A well at a given point, which, when drilled, shows crevices and broken strata, may produce 150 to 200 barrels a day, while another well 100 feet from it, drilled through solid shale, will not give the least indication of oil. About one well in three has proved a producer.

The depth at which oil is found varies greatly. There are producing wells as deep as 1,960 feet, and others not over 1,000 feet. In one case there are two wells within 300 feet of each other, in one of which oil was found at a depth of 1,630 feet, and in the other no oil was found until 1,960 feet had been reached. The earlier wells of the Florence field were drilled 1,000 to 1,200 feet. In many cases these wells, after producing for awhile, ceased, but upon drilling deeper they began producing again. No water is found in the wells after leaving the surface.

It will thus be seen that the conditions under which oil is found in Colorado are very different from those of its occurrence in Pennsylvania and Ohio. There are no pools as the word is understood in the east, but the oil seems to flow through the crevices or shattered strata to the drill hole. It is also a remarkable fact that the wells, instead of decreasing, actually increase in production. A certain well on the property of one of the companies, which began producing 90 barrels of oil, now produces 150, the maximum being reached within a short time after the well was struck, it gaining every day for about two weeks. Another well that began with a production of 100 barrels ran up in five days to 210, and has been producing at this rate for months. On the other hand, sometimes increase in production is very gradual, wells that are now several years old having recently increased their production. One well that started off producing 40 barrels in this way has recently run up to 150. The life of wells in the Florence district is also very long, and some wells have been remarkable producers, one having produced up to May 1, 1891, over 6,000,000 gallons. The large production and long life of the wells of this district may be due to the fact that it is a new field, and comparatively few wells have as yet been put down.

It is also a fact that it does not hurt these wells to shut them down for a period. Often when the demand for oil has not been equal to the production the wells have been shut in, starting off again with full production when pumped. This will account for the variation in the number of producing wells shown in the table given elsewhere. This variation is not due to the drilling of new wells and the abandonment of old, but to stopping of production by shutting in the wells.

The Florence oil has a number of peculiarities as compared with Pennsylvania. It is a heavy oil, being about 31° Baumé. It contains little or no lighter hydrocarbon, all the products that pass over in refining being sold as illuminating oil. Nor does the oil deposit any B. S. It yields in refining about 35 to 44 per cent. water-white illuminating oils of about 125° fire test.

There is little or no market for the residuum from refining other than for fuel, for which purpose it is sold at 25 cents a barrel. The demand for this purpose has not been equal to the supply; it is run into a depression near the refinery in such quantities that it has formed a lake of petroleum residuum.

In the following table will be found a statement of the production of crude oil in Colorado from 1887 to 1892:

Product of crude oil in Colorado from 1887 to 1892.

Years.	Barrels.
1887	76,295
1888	297,612
1889	316,476
1890	368,842
1891	665,482
1892	824,000

From this it will appear that Colorado is the fifth State in production in the Union, it being exceeded by Pennsylvania, Ohio, West Virginia, and New York.

CALIFORNIA.

The petroleum fields of California, where oil was found in merchantable quantities in 1892, were exclusively within the boundaries of the southern counties, though oil has been found in many other parts of the State. The most important of these districts are the Santa Paula region, in which are found the Ojai, Sespe, Ex-Mission (which includes the Adams and other districts), the Torry Cañon, in the San Fernando mountains, 22 miles west of Newhall, the San Fernando district, including the Pico, Wiley, and Elsemere fields, and the Puente district, in which only one field, the Puente, is found; the wells in the Santa Paula subdistrict of the southern fields are in Ventura county; the Puente and Pico subdistricts are in Los Angeles county.

The petroleum fields of California are the most interesting in the United States. In many respects they differ entirely from any other fields yet opened. The oil, with the exception of that from Santa Clara, has usually, as its base, asphaltum instead of paraffin. The Pacific Coast Oil Company at one time pressed paraffin wax from the Santa

Clara oil, but the low price of the wax and the reduction in the production of the crude compelled them to discontinue this product. The strata in which the oil is found are tilted at a high angle. Drilling is difficult and expensive, owing to the character of the rock and angle at which the oil-bearing strata stand. The oil, while carrying but a small proportion of the illuminating hydrocarbons, finds a ready market as fuel, owing to the high price of coal in California, and it contains practically no sediment.

While there is a certain general resemblance in all of the southern fields, there are certain important differences which make a description of each field of importance.

Describing the most northwesterly, the Santa Paula, first, it may be said that this field includes, as has been stated above, a number of small subdivisions, such as the Ex-Mission, Adams, Sespe, Ojai, Santa Paula, Torrey Cañon, and others. These cañons are sharp ravines cut laterally in the sides of the mountains and usually at right angles with the course of the range. The strata in these various districts stand at an angle of about 75 degrees. In sinking wells the drills pass through shales until the oil sand is struck, which is from 2 to 40 feet in thickness. This sand is believed to be in the Tertiary, though of this there is some doubt. A red sand that used to be regarded as barren is now giving some very good wells.

The great angle at which the strata stand in this district makes drilling exceedingly difficult, resulting often in crooked holes, causing the drills to lodge in the wells and requiring torpedoing and reaming out and very expensive work in recovering them. This liability of the wells to become crooked suggested the employment of the diamond drill in boring. A well was bored in this way at Pico, but it was not a success, though a straight hole was secured. The fine mud that results from the use of the diamond drill seemed to fill up the interstices in the rock and prevented production. The reaming out of the well by a drill resulted in a very largely increased production. The same fact regarding the tilting strata also suggested the use of tunnels in producing petroleum. Indeed, some of the earliest work in mining for petroleum in California was by the use of tunnels. In fact, in the early history of this field and of all southern California prospecting for petroleum was by these tunnels, which were driven into the sides of the mountains where the surface indications, such as tar springs or seepage from asphaltum deposits, gave any prospect of getting oil. Many of these tunnels are still in existence and some are producing. One of these tunnels was driven in 1864 by a company of which Senator Stanford was a member. This produced at first 25 barrels of oil a day. Twelve years later the production had fallen to 8 barrels a day, and when Messrs. Hardison & Stewart purchased the property, in 1885, it was producing 5 barrels a day, and at the present time 2 barrels a day.

This method of producing oil has never been in great favor in California. It is somewhat dangerous, as is all tunneling. It is known locally as "coyoting." There are many things, however, to commend it for these fields. As suggested above, the difficulty and expense of drilling, and especially the caving in of the wells, owing to the peculiar structure of the shale through which the wells are drilled, makes it difficult and expensive, not only to put down wells, but to case off the water. In these tunnels there is no caving in of strata, no casing, no pumping, and, in fact, no expense after the tunnel is once driven.

The first or Stanford tunnel was driven 350 feet. One driven some four years ago was 625 feet long. The oil, found in different strata, paid for it before it was finished. The yield of this tunnel was about 60 barrels a day when first finished; now it is 8 barrels a day. The cost of driving these tunnels is from $5 to $10 a running foot. The wells cost as much as this at times. The size of the tunnel is usually 4 by 6 feet.

Another peculiarity of these wells, growing out of the tilting of the strata above referred to, is the great increase in the production of different wells put down to reach the strata at different depths. As has already been stated, these strata dip about 75 degrees. A series of five wells has been put down at one place in the Adams cañon, the wells being started on the surface at different heights up the mountain side above the stream at its base. The first well was put down a short distance above the point where the oil-bearing rock came to the surface, the presence of the oil showing itself by seepage from the outcropping rock. The sand rock was struck at a depth of 110 feet and produced 20 barrels a day. The second well was started a little higher up the mountain side, the rock pitching toward the mountain, striking the oil-bearing rock at a depth of 130 feet, giving a production of 25 barrels a day, draining or, perhaps better, stopping production entirely in No. 1. A third well was started still farther up the mountain side, which struck the rock at a depth of 330 feet, producing 75 barrels a day and stopping production in the second well. A fourth well, started still higher up the mountain side, struck the rock at a depth of 682 feet and started off producing 300 barrels a day, stopping production in No. 3. The fourth well described above produced up to a given period 123,000 barrels, the production of the four wells being for the same time 250,000 barrels. Another peculiarity is noticed in these wells. Sometimes the depth of shale is very slight, the well being drilled entirely through sand (not sand rock), a little oil being produced all the way down. It is customary to case the well and perforate the casing, the oil flowing in from the sand almost the entire depth of the well. In a short time, however, the sand packs around the casing, the oil begins to percolate through it, and, to use the expression of the region, the well "gets its pace and is a stayer."

The oil of the Santa Paula field produces about 15 per cent. of distillate; 35 per cent. can be secured, but the quality of the illuminant is not satisfactory. But little oil from this district is refined, most of it being sold for fuel purposes. The gravity is from 16 degrees to 32 degrees, the average being about 26 degrees. The oil from the same region differs greatly in its character. In putting down wells up the sides of a hill six or seven different grades of oil will be found in as many ledges. In one case six wells were put down, beginning at the bottom of the hill and going up the sides 400 feet. In the first well going up the hill a black oil of 26 degrees gravity was found; in the second well the oil was black and of 28 degrees gravity; in the third it was a heavy oil and brown; in the fourth well the oil was 18 degrees gravity, tarry and black; in the fifth well the gravity was 18 degrees, heavy and green, and in the sixth well the gravity was 30 degrees, and the oil was light green in color, with some yellow.

The strata in the other districts are not pitched as in the Santa Paula, where they stand at an angle of some 75 degrees. In the Pico field they are 65 degrees and in the Puente 30 degrees. This excessive tilting makes drilling difficult and expensive.

Not only are the strata very much tilted, but they are so much so all through southern California that but little dependence can be placed in their continuity. This resulted in the early history of mining for oil in California, in the spending of very large sums of money, but with very little result, but in later years it has led to very cautious explorations. It has also resulted in very small fields, with the exception of the Santa Paula. In this field there are practically continuous deposits for a distance of some 40 miles, though the deposits are in pools. The Pico producing field is but a few hundred feet, possibly a mile in length by 700 or 800 feet broad, though developments are being made for 8 miles, while the Puente, as developed, is but 3,500 feet long by 800 feet broad. This also is probably much larger.

Many of the conditions existing in the Pico cañon are similar to those in the Santa Paula district. But there are a number of conditions that are more manifest here than in Santa Paula. The San Fernando district, as stated above, comprises three subfields, the Pico, which is the most important, the Wiley, and the Elsemere, which are recent developments. The Pico field is some 7½ miles west of Newhall, which is on the Southern Pacific railroad; the Wiley some 5½ miles southwest, and the Elsemere 2½ miles to the southeast. These are all connected with Newhall by pipe lines.

As has already been stated, drilling was begun in this field in 1875, August 22 being the date of the beginning of the first well, which was finished September 8. This well was drilled to a depth of 120 feet with a spring pole. At the depth of 30 feet oil was struck in a shale, giving a production of 2 barrels a day. At the depth of 120 feet oil was found, also in shale, the production being 10 to 12 barrels a day. In 1887 this well was deepened with modern drilling tools to a depth of 600 feet. At a depth of 175 feet the well produced by pumping 30 barrels a day. In 1882 this well was still farther deepened to 735 feet, but there was no increase in production. The best sand was found in this well at a depth of 170 feet. Well No. 2, very close to No. 1, was drilled in November, 1875, also with a spring pole. The best sand was struck at a depth of 250 feet, the well flowing from 20 to 25 barrels a day. At 520 feet the production was 40 barrels, the well being pumped. In well No. 3 sand producing 4 barrels a day was struck at 90 feet, another at 145 feet producing 8 barrels a day, while at 170 feet one producing 11 barrels a day was struck. In well No. 5 the first oil-producing sand was struck at 900 feet, while in No. 7 sand was found at 850 feet, giving a flowing well. The deepest producing wells in this district are from 1,400 to 1,730 feet.

The same difficulty in drilling wells exists here as in the Santa Paula district. The wells are put down on the sides of very steep cañons, requiring very expensive work in securing a level place to begin drilling, oftentimes requiring blasting in the mountain side. Crooked holes are not infrequent, and it is nothing uncommon for wells to cost from $6,000 to $20,000 each. Contracts have been taken in this district to put down wells at $6 a foot, the company owning the land furnishing fuel, water, and casing.

The wells in this district never suffer from drowning out by water, though some of the wells produce both water and oil. The average proportion of water to oil is very small. In some wells the water contains material in solution that eats the casing, making it thin, like paper. In this district, as in others, considerable gas is found in the wells, which is utilized for pumping and drilling, saving possibly in this district 20 tons of coal a day. Wells are never shot for production. Sometimes when a hole is crooked and tools are stuck in them they are shot to release the tools, but not to increase the yield of oil.

The oil of the Pico field is in some respects better than that of the other fields, some of it containing a little paraffin occasionally, and it yields a larger percentage of illuminants in refining than the Santa Paula oil, crude being about 40 degrees gravity.

In the Wiley subdivision of the Pico field two different oils are found, taken from the same well, a green and a black. The production of these two oils is about 4½ barrels a day, and was found at a depth of from 600 to 800 feet. In drilling this well sand, not sandstone, was struck at a depth of from 400 to 600 feet. This sand followed the drill up the well fully 50 feet. It is from this sand that the oil comes. It had to be shut off from the well by casing and the casing perforated. A similar phenomenon is noticed in the Santa Paula district.

The Puente field is located in the Puente hills, 7 miles from Puente station, on the Southern Pacific railroad. Oil in some instances is found in a shale just above the sand, but mostly in the sand. It has asphaltum as its base, carrying about 15 per cent. Wells are struck at various depths, but the best producers begin at 500 feet. It is difficult to drill below 1,200 feet, owing to the caving in of the strata, noticed in connection with the remarks on other fields. One well has been drilled in this district to a depth of 1,200 feet, but the deepest producer is at 1,000 feet.

The strata are very much pitched and broken, dipping about 30 degrees north, the strike being a little northwest of west. The field as at present developed is 3,500 feet long by 800 feet wide.

The first well was drilled in this field in 1883. The occasion of drilling the well was the discovery of a large amount of seepage near where the well was first put down. No. 2 and No. 3 were drilled early in 1884, and no others were drilled until 1886. The earlier wells up to No. 3 were drilled to the depth of 200 feet, and produced a heavy oil to the amount of 3 or 4 barrels a day. These are still producing, but in smaller amounts, from 1 to 2 barrels daily. No. 4 well, which was drilled in 1886, was also a small producer, yielding 15 barrels a day. No. 5, drilled in 1886, began with a production of 75 barrels. Three wells were drilled in 1888 and three in 1889. The same difficulty in drilling noted in other districts in this State obtain here also, such as crooked holes, caving in of sides, losing of tools, etc. The cost of drilling is from $3 to $6 a foot or more. In this district what is known as stovepipe casing is used. This is a thin riveted casing, two joints being put together, one being smaller than the other. The inner casing on one end projects beyond the outer casing, while the outer casing projects at the other end beyond the inner, forming a socket at one end, into which the projection at the other fits. The casing is ticked together at the joints, requiring no nuts or screws or couplings. The casing is sometimes jacked down into place. All of the oil from this district is piped over the hills to near Puente station, loaded in tank cars and sent to Los Angeles, and consumed for fuel.

No dry holes have ever been found in this district. Every well that has ever been sunk was a producer and is still producing. The wells are all pumped by heads. Though one or two spouters have been struck, they soon dropped production and are now pumping.

The following is an analysis of various tests made of the oil from these wells, having a gravity of 32 degrees:

Analysis of oil from the Puente field, California.

	Per cent.
Benzine, from 80° to 58°	15
Illuminating, 58° to 42°	26
Lubricating, 42° to 30°	14
Lubricating, 30° to 24°	27
Asphalt (maltha)	18
Total	100

In the table below are the consolidated statistics of the production of petroleum in California in 1892. It will be noted that there has been but little change in the statistics of production during the last four years, though there has been a slight increase each year.

Production of petroleum in California.

Years.	Barrels.	Years.	Barrels.
Previous to 1876	175,000	1884	262,000
1876	12,000	1885	325,000
1877	13,000	1886	377,145
1878	15,227	1887	678,572
1879	19,858	1888	690,333
1880	40,552	1889	303,220
1881	99,862	1890	307,360
1882	128,636	1891	323,600
1883	142,857	1892	385,049

OTHER STATES.

For statements regarding the production of petroleum in States other than those already described, in which the production has been exceedingly small, those interested are referred to previous volumes of Mineral Resources and the report of the Eleventh Census on the Mineral Industries in the United States. The statements regarding production in these States in 1892 will be found on page 604, and for the years prior to 1892 in the table on the production of petroleum in the United States given on page 606.

NATURAL GAS.

By Joseph D. Weeks.

The questions of the origin, occurrence, composition, and history of natural gas have been so thoroughly discussed in the reports of the geological surveys of the various states and of the U. S. 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 enter greatly into the details of these questions in this report. The investigator, therefore, 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 regarding the geological occurrence of natural gas; to the Indiana Geological Survey reports, especially those of Mr. S. S. Gorby; to the monographs of the U. S. Geological Survey, chiefly the report on Ohio natural gas by Prof. Orton; 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, as noted above. 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. At the same time, however, it is proper to briefly refer to the several questions noted above, though this report will be chiefly devoted to the technical and statistical facts regarding natural gas.

"Natural gas" in the popular sense is the gas that is procured by drilling wells to certain geological strata, chiefly to the sandstones of the Upper Coal Measures of Pennsylvania and the Trenton limestones of Ohio and Indiana. Chemically, natural gas is methane (CH_4) the lowest member of the paraffin series of hydrocarbons, with, as analyzed, 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 Prof. Phillips, above mentioned, which are most thorough and complete, fail to show the presence of the least trace of free hydrogen in the natural gas of western Pennsylvania. In his examinations Prof. 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.

The best and most thorough analyses of natural gas yet made are those of Prof. Phillips. In the following table are found the analyses of nine of these gases. The Fredonia gas is from the mains of the Fredonia Natural Gas Light Company, at Fredonia, New York. The Sheffield wells are in Warren county, Pennsylvania, and supplied at one time Sheffield, Iona, Brookston, Clarendon, Warren, Corry, and Erie, Pennsylvania, and Jamestown, New York. The Kane well is in Kane, McKean county; the Wilcox well is in Wilcox, in the same county; the Speechley well is near Oil City, in Venango county; the Lyons run well is at Murrysville; Raccoon creek is near Rochester, Pennsylvania; Baden is in Beaver county, near Rochester, while the Houston well is 2 miles south of Cannonsburg, in Washington county, Pennsylvania.

Analyses of Pennsylvania natural gas.

Constituents.	Fredonia.	Sheffield.	Kane.	Wilcox.	Speechley.	Lyons run near Murrysville.	Raccoon creek.	Baden.	Houston.
Nitrogen	9·54	9·06	9·79	9·41	4.51	2·02	9·91	12·32	15·30
Carbon dioxide	0·41	0·30	0·20	0·21	0·05	0·20	Trace.	0·41	0·44
Hydrogen	....	....	....	....	0·02	....	....	....	....
Ammonia	....	....	....	....	....	....	....	....	Trace.
Oxygen	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.
Sulphureted hydrogen	....	....	....	....	....	....	Trace.	....	....
Paraffins	90·05	90·64	90·01	90·38	95·42	97·70	90·09	87·27	84·26
Total	100·00	100·00	100·00	100·10	100·00	99·92	100·00	100·00	100·00

The paraffins contained in the above gas samples have the following composition by weight:

Constituents.	Fredonia.	Sheffield.	Kane.	Wilcox.	Speechley.	Lyons run near Murrysville.	Raccoon creek.	Baden.	Houston.
Carbon	78·14	76·69	76·77	76·52	77·11	74·96	76·42	76·48	76·68
Hydrogen	21·86	23·31	23·23	23·48	22·89	25·04	23·58	23·52	23.32
Total	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

The analysis of Trenton limestone gas, given by Prof. Edward Orton in his report on Ohio gas, is as follows:

Composition of natural gas from the Trenton limestone, Ohio.

Constituents.	Findlay.	Fostoria.	St. Marys.
Hydrogen	1·64	1·89	1·74
Marsh gas	93·35	92·84	93·85
Olefiant gas	0·35	0·20	0·20
Carbonic oxide	0·41	0·55	0·44
Carbonic acid	0·25	0·20	0·23
Oxygen	0·39	0·35	0·35
Nitrogen	3·41	3·82	2·98
Sulphureted hydrogen	0·20	0·15	0·21
Total	100·00	100·00	100·00

HISTORY OF THE USE OF NATURAL GAS IN THE UNITED STATES.

The earliest economic use of natural gas in this country was probably in the year 1821, in lighting the village of Fredonia, Chautauqua county, New York. For many years prior to this, even as early as the date of the survey of the Holland Land Company, gas had been observed issuing from the crevices of the slate rocks along the banks of the Canadaway creek, on which Fredonia is built. In 1821 a well 1½ inches in diameter and 27 feet deep was put down near the Main street bridge, which crosses this creek. This was probably the first well sunk for the purpose of obtaining natural gas. This well produced gas sufficient for some 30 burners, the burner being made by drilling a hole the size of a small knitting needle in a pipe. The light from one of these burners was regarded as equal to that of "two good candles." Gas of two-candle power would hardly answer the demand of to-day. The gas was conveyed from the well to the buildings in which it was used in wooden pipes. In 1824, on the occasion of Lafayette's visit, the village was lighted with natural gas.

The existence and utilization of this gas at Fredonia became widely known both in this country and abroad, and excited the liveliest interest among scientific men; but so little suspected was the presence of the enormous volume of gas since developed, that it was pronounced "unparalleled on the face of the globe," and Humboldt is quoted as declaring it the eighth wonder of the world.

Shortly after gas was found at Fredonia, Judge Campbell, of Westfield, New York, used natural gas from a spring near by for the light-house at Barcelona, a small harbor on Lake Erie. The contract to supply the light-house was abandoned in 1856, though the gas is still used, supplying all the churches, public halls, schools, and about 20 families. In 1827 a contract was made by Walter Smith, of Dunkirk, New York, with the government to supply the light-house at that place or a term of years, and a ½-inch pipe was laid 2½ miles from the Matteson gas spring at Fredonia; but owing to the size of the pipe no flow was obtained, and after many trials of other means of transportation the enterprise was abandoned.

The existence of marsh gas, the modern natural gas, was well known to the earliest explorers of the Kanawha valley. In 1775 Washington, while on a visit to the Kanawha to locate lands granted him for his military services, set apart and deeded to the public forever a square acre of land on which was located a "burning spring." Through some informality his intention in this gift was frustrated. The "burning spring" mentioned by Mr. Jefferson in his "Notes on Virginia" was probably this same spring.

The boring for salt water in the Kanawha valley, which was begun in the winter of 1807–1808, not only resulted in finding brine, but nearly every salt well became a gas well, the gas in many cases jetting the water into the air and taking fire. From wells only 15 to 20 feet deep the gas escaped in quantities, burning a long time. As early as 1815 a gas well was struck within the present city limits of Charleston. This well was bored for salt, and upon striking the gas reservoir it gave out a great volume of gas, which caught fire from a grate near at hand. Those boring the well conceived that it would be reckless to drill deeper, and abandoned it.

It is worthy of notice that many of the methods and appliances that have made deep well-boring possible were developed and perfected at these salt gas wells. The chisel bit, the "jar," sectional tubing, made then of tin and soldered, instead, as now, of iron with screw joints, and the "seed bag" were used at the Kanawha valley salt wells before oil was found in western Pennsylvania.

So far as has been ascertained, the first use of gas in manufacturing was in "boiling salt," in the Kanawha valley of West Virginia, by William Tompkins, in 1841, some twenty years after its use for lighting at Fredonia, New York. While boring a well for salt a short distance up the Kanawha river from the "burning spring" above alluded to he struck a large and steady flow of gas, which was strong enough to force the salt water into a reservoir, from which it could be distributed to his furnace pans. He determined to use this gas as a fuel to "boil his furnace," and for this purpose extemporized a gasometer from a hogshead placed over the reservoir. Into this primitive receptacle he conveyed the escaping water and gas, the water falling into the reservoir. The gas, conveyed through a pipe to the mouth of his furnace a "salt block" 100 feet long by 6 feet deep and 4 wide, produced an intense heat under the whole row of kettles. In 1843 gas was struck in a well bored near Mr. Tompkins's well at the depth of 1,000 feet. The force of the gas was so great as to throw a column of salt water 150 feet above the mouth of the well. This is the first "gasser" and "roarer" on record.

From the beginning of the drilling of oil wells in Pennsylvania in 1859 natural gas has been obtained in greater or less quantities, either accompanying the oil or in wells that were true gas wells; that is, yielding little or no oil. In most of the flowing oil wells the pressure which forces up the oil is this gas. The attention of oil producers was first directed to the danger connected with this gas by the explosion at the Rouse well, on Oil creek, one of the first flowing wells struck. Eighteen persons lost their lives by the explosion of gas at this well. At first this gas was considered not only of no value, but a dangerous nuisance, and was carefully led away from the wells in pipes and burned to get rid of it. After a little, however, it began to be used for fuel under the boilers in drilling and pumping and for light and fuel in the towns and villages in the immediate vicinity of the wells. The proportion of the gas so used, however, until some two years since was very small. The apparatus for collecting this gas for use in raising steam in drilling was at first quite simple. The oil and gas as they came from the well were led into a barrel or hogshead, the oil being drawn off by a pipe at the bottom and the gas by a pipe at the top.

The so-called Leechburg gas well, the gas from which was the first used in iron-making, was bored for oil in 1870 and 1871, the gas vein being struck in the latter year at a depth of 1,200 feet. This well is situated on the south side of the Kiskiminitas river, in Armstrong county, Pennsylvania, opposite Leechburg. For some months the gas was allowed to escape, without any attempt to utilize it, until in April, 1873, Messrs. Rogers & Burchfield bought the well and piped the gas across the river to their works on the north bank. The gas was accompanied by a large flow of salt water. To separate the gas from the water it was conveyed from the well by a $5\frac{3}{8}$-inch pipe into a common cylindrical boiler, furnished with an ordinary safety valve. The water was drawn off at the bottom of the boiler through a quarter-inch pipe, it being forced out in a spray. From the top of this boiler receiver the gas was led across the river and distributed by a network of pipes through the mill. As noted above, this was the first use of gas in iron works.

The first gas piped any considerable distance was from what is known as the Harvey well, near Lardens mills, in Butler county, Pennsylvania. This, at the time it was bored, in the fall of 1874, was the most powerful gas well in the section. In 1875 it was purchased by the Natural Gas Company, limited, the first natural gas company formed, and piped 17 miles, through a 6-inch pipe made of iron one-fourth of an inch thick, to the mill of Messrs. Spang, Chalfant & Co., at Etna, near Pittsburg. The gas was turned into the pipe in October, 1875, and traversed the 17 miles in twenty minutes, the observed pressure at the wells being 119 pounds.

The most important fields in western Pennsylvania are the Murrysville and Grapeville, both in Westmoreland county. The first of the wells in the Murrysville district, Haymaker No. 1, was put down in 1878, and for five years its product was allowed to go to waste. In

1883 other wells were drilled, and pipe lines were laid to East Liberty and Pittsburg, which mark the beginning of the present extensive use of natural gas in that city.

It was not until 1883, with the piping of the gas of the Murrysville district to Pittsburg and the striking of gas in the Westinghouse well at Homewood, Pittsburg, that natural gas began to be used extensively as a fuel. Prior to this time its use had been exceptional and at isolated works, but with the piping of this gas and the striking of the Westinghouse well the extension of its use became instant and well-nigh universal for manufacturing purposes in the neighborhood of Pittsburg. Its introduction into the rolling mills of Wilson, Walker & Co. and Shoenberger & Co. and the flint glass furnace of the Fort Pitt glass works was rapidly followed by its adoption in other establishments until in 1889 few of the important manufactories of Pittsburg that are so situated as to obtain a supply of gas cheaply use any other fuel.

The Grapeville district was first developed in 1885. The first well in the Hickory district, Washington county, known as the McGuigan, was struck in March, 1882. The gas was allowed to waste for more than a year, when a 6-inch main was laid to Birmingham, a part of Pittsburg, situated on the south side of the Monongahela. The line was 22 miles long. In 1884 two other wells were struck, and later two more. The supply from these four wells was enormous. A second portion of the Washington county field is the Cannonsburg. Some five wells had been drilled at the close of 1885. In that year five gas wells were drilled in the town of Washington. These supplied the town with fuel. The gas from the wells of the Hickory, McGuigan, and Cannonsburg districts, all lying a little northwest of Washington, have been piped to Pittsburg.

The discovery of gas at Findlay, in the Trenton limestone, in 1885, was of the greatest importance geologically and commercially. It seems, however, that gas had been known to exist in Findlay as early as October, 1836. In 1838 gas from a water well was conducted by wooden tubes into the fireplace in one of the living rooms of the house of Daniel Foster. The gas was burned from an old gun barrel as a burner. Following the discoveries in Pennsylvania, the Findlay Natural Gas Company began drilling in August, 1884, and in November of that year it struck gas in the limestone rock at a depth of 1,100 feet. But it was not until the "drilling in" of the great Karg well in 1886 that the possibilities of the field were made evident. The excitement following the striking of this well can hardly be conceived. Its immense production, the force with which the gas escaped and its velocity, the light of the blazing gas, which could be seen at night 40 miles distant, all conspired to lead to that vigorous search for gas which immediately followed.

The discovery of natural gas in Indiana followed closely the production of gas at Findlay. Without doubt the Indiana gas region is to-day, in some respects, the most important and gives promise of being the greatest producer of gas of any of the important fields.

It is not deemed wise to follow the discovery of natural gas and its development in other localities, as it is of too little importance. The strata and conditions under which natural gas is produced in the different important localities will be discussed in connection with each district.

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 higest 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 the question of the geological distribution of natural gas will be discussed in connection with the report on the several gas fields, it is not necessary to enter into a further discussion of the subject here.

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 is the development of these districts that has 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 in 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, with of course 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, West Virginia. 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 necessity, 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 conditions 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 neighborhood 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 same is true in the Findlay district. For example, the actually observed daily production of four wells in this district, as given by Prof. 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

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, Pennsylvania, the first pressure was about 575 pounds; in Butler county, 450 pounds; in Allegany county, New York, 450 pounds, and in Illinois 400 to 450 pounds, which was rapidly reduced to 125 pounds. This original pressure is rapidly declining. Prof. Orton has paid more attention to this subject than any other of our geologists. 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. Prof. 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. 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 had February 2, 1891, 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, Pennsylvania, 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.

STORAGE OF NATURAL GAS.

The waste of gas, especially in western Pennsylvania and in the Ohio fields, in which high-pressure gas is found, was at first simply enormous, the amount reaching a total so marvelous that it is impossible to form any accurate conception of it. It is estimated, for example, that the waste of gas at the Haymaker well No. 1, the first struck in the Murrysville district, during the five years when it was not used was the equivalent of 1,000 tons of coal a day. The Harvey well, the gas from which was piped to Spang, Chalfant & Co.'s in 1875, blew millions of feet of this valuable fuel into the air before it was utilized, and the gas from the McGuigan well, in the Washington county district of western Pennsylvania, was not used for over a year after it was struck. The waste of gas in Ohio and Indiana in the early history of these fields was simply incalculable. Very soon, however, measures were taken to stop this form of waste. At first it was sought to confine the high-pressure gas by placing caps with gates on the top of the well casing, but it was found in many instances that the pressure rapidly accumulated to a point where there was danger of blowing the casing out of the well, and this system was temporarily abandoned.

Two methods have been adopted for storing gas, one adapted to territory where the prospect of obtaining gas by drilling is reasonably certain, and the other applicable to all wells of ordinary pressure. The first consists simply in drilling as near as possible to the depth at which the gas reservoir is supposed to be and then "holding the well," as it is termed, and bringing it in by drilling a little deeper whenever the demand for gas or the decrease in other wells requires it. Recently, however, a method of storage by packing the wells has been adopted. This confines or stores the gas in its own reservoirs. The packer most largely in use is the same that is used in oil wells, only in putting the packer together for gas wells it is necessary to use extra precautions to prevent the gas from blowing off the rubber. This is done by fitting the rubber tightly to the inner pipe and wiring the end securely in place.

Another method is to securely anchor the casing by attaching it to a framework securely bolted to the rock adjacent. In such cases the gas is held in place by a valve screwed on the top of the casing, and as the demand increases or diminishes the valve is opened or closed.

TRANSPORTATION OF NATURAL GAS.

When natural gas was first struck in quantity the location of manufactories that were to use it was such as to require the conduction of the gas some distance, and it still holds that most of the gas consumed in manufacturing and for domestic purposes is 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. The great pressure at first complicated the matter of conveyance, making it much more difficult to prevent leakage, though at the same time this great pressure made it possible to conduct gas to a greater distance than if the pressure had been less.

In view of the danger from leakage great precautions have been taken in laying pipes to provide, first, against leakage as far as possible, and, second, to provide means of removing that gas which may escape before it shall accumulate in sufficient quantity to be dangerous. In the system of laying pipes adopted by the Philadelphia Company in Pittsburg each joint of the pipe, which it is assumed will sooner or later leak more or less, is surrounded by a conical pile of broken stone inclosed in a covering of thick tarred paper, through which rises a vertical trumpet-mouthed pipe, intended to gather the gas which may leak from the joints into the interstices of the broken stones and to convey it away by a small pipe, which extends horizontally over the main pipe which conveys the main volume of the gas. This leakage or escape pipe is led at intervals of about 300 feet into a lamp-post, where the gas may escape without harm into the open air, or, as is frequently the case, may be lighted for the purpose of illumination. Other methods have been adopted, but in all cases great care has been taken to provide against the danger resulting from leakage; and in view of the enormous amount of gas transported and the ignorance as to the necessary conditions to secure safety when many of the pipes were first laid, also in view of the explosive character of the gas when mixed with the proper proportion of air, the small number of accidents that have happened is truly remarkable.

While it is true that in the early days, when the pressure of the wells was great, protections like those named above, as well as the use of valves for reducing the pressure, were necessary in order to convey the gas with safety through the streets of towns and cities and into manufacturing establishments as well as houses and offices, 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, 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. Other companies have adopted this method. The Kentucky Heating and Lighting Gas Company operates wells in Meade county, Kentucky, furnishing gas for the city of Louisville. The line is an 8-inch pipe, and is 30 miles long. At West Point, 10 miles from the gas fields and 20 miles from Louisville, is located the pumping plant, which contains three boilers and two Clayton duplex compressors with 22-inch steam cylinder, 18-inch gas cylinder, and 30-inch stroke. It was originally intended to use gas under the boilers, but as the compressors were never needed except when gas was scarce, it was decided to use coal instead. The plant has been in operation for over two years, the pump being used only in cold weather. It has been the experience of this company that the amount of gas needed by the consumers varies with certain known conditions, primarily with the temperature, and also with the day of the week and the time of day. The variation due to temperature generally lags about a day behind the change. A record is kept of the pressure each hour at the field, at the low and high side of the compressor at West Point and at Louisville. When the thermometer is no lower than 38 degrees, 14 pounds at the discharge end of the compressor at West Point gives good service at Louisville, but as the temperature falls the pressure must be increased, according to a table in the hands of the engineer. When the thermometer falls to 25 degrees, 17 pounds are needed to maintain the supply.

During the last two years the pressure on the low side at West Point has varied from 17 pounds down to a vacuum of 3 pounds. The line pressure at the wells has averaged about 15 pounds; but, although the number of customers of the company has very nearly doubled recently, this has increased from 36 to 45 pounds, according to the temperature. The improvement has been due mainly to taking care of the field and stopping leaks as far as possible. It has not been found necessary to use more than one of the compressors at a time, but it is expected, in view of the rapidly increasing consumption of gas in Louisville, that soon it will be necessary to run both compressors in order to supply the demand, and at much higher pressures. As a general conclusion, it may be said that in cases where the rock pressure is too low to carry the gas through a long main the use of a good compression or natural-gas pump to supply the needed pressure will be found advantageous, but in cases where the effort is made to obtain by a pump a greater volume of gas than would flow if the well were blowing off into the air, suction is introduced, reducing the rock pressure at the wells, it may be, to less than zero, and difficulty may be experienced from water or oil being drawn up. If the water comes from strata above the gas seam casing may be employed, but if it be below there is no remedy. As such a state of affairs does not occur very often, it is not of much importance. It has been found by those using pumps in the Pittsburg region that a pump operating a well in a locality where the rock pressure is very low may exhaust all wells within a radius of, say, a mile; for in some cases the suction at a well several hundred feet away has been sufficient to draw a bat into it, thus showing clearly the economic value of a pump to the one operating it.

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 only for measuring gas in small quantities, and in many cases no attempt is made to measure gas at all. At many large works, consuming hundreds of thousands of cubic feet an hour, no meter has ever been applied. The most complete statement ever made in connection with the consumption of natural gas is given in the report on the Mineral Industries in the United States at the Eleventh Census, 1890. This is of so much importance as indicating certain technical facts regarding not only the total production of natural gas for the year but also the consumption in various industries that it is reproduced in full.

The largest producer of natural gas in the United States is the Philadelphia Company, of Pittsburg. Its statement of the number of fires, mills, and works supplied in 1889, and the estimated number of cubic feet consumed for each purpose, is as follows:

Fires, etc., supplied with natural gas in 1889 by the Philadelphia Company.

Uses.	Number of each.	Total consumption.
		Cubic feet.
Fires for cooking and heating	150,000	15,000,000,000
Iron and steel mills	30	65,000,000,000
Glass works	32	2,000,000,000
Other industrial establishments	638	98,000,000,000
Total		180,000,000,000

This would be at the following rate of consumption by each per year:

	Cubic feet.
Fires for cooking and heating	100,000
Iron and steel mills	2,166,666,667
Glass works	62,500,000
Other industrial establishments	153,605,016

Through the courtesy of the same company the writer has been furnished with a very careful estimate of the amount of gas actually consumed by twenty-one mills at Pittsburg, based on meter tests extending over a few hours, which is given in detail as follows:

Measured daily consumption of natural gas by 21 mills at Pittsburg.

Mill No.—	Cubic feet.	Mill No.—	Cubic feet.
1	3, 800, 000	13	2, 597, 900
2	1, 866, 600	14	3, 010, 240
3	1, 666, 210	15	7, 432, 960
4	3, 393, 480	16	2, 526, 280
5	1, 947, 000	17	14, 583, 460
6	791, 240	18	5, 362, 080
7	2, 303, 640	19	2, 173, 140
8	3, 474, 900	20	9, 005, 160
19	1, 986, 380	21	18, 000, 000
10	11, 181, 260		
11 and 12	17, 640, 860	Total	114, 742, 790

This would be an average of 5,463,942 cubic feet a day, or on a basis of 300 days in the year, of 1,639,182,600 cubic feet a year actually consumed in work. Now, as these furnaces are kept hot the entire 24 hours, including Sundays, and as these estimates were made in 1890, when gas was used more economically than in 1889, the figures given by the Philadelphia Company in the first estimate do not seem excessive.

Altogether, reports have been received of the estimated consumption at 33 iron mills, 32 in Pennsylvania and one in Ohio. These statements are as follows:

States.	Number of mills.	Total consumption.	Average consumption per mill per year.
		Cubic feet.	*Cubic feet.*
Pennsylvania	32	66, 425, 000, 000	2, 075. 781, 250
Ohio	1	1, 031, 579, 000	1, 031, 579, 000
Total	33	67, 456, 579, 000	2, 044, 138, 758

The total number of iron and steel works reported as using gas in the United States in 1889 was 95, of which 73 were in Pennsylvania, 10 in Ohio, 6 in Indiana, and 6 in West Virginia. The directory of the American Iron and Steel Association, published early in 1890, gives the number of iron and steel mills in the United States using natural gas as 104. The discrepancy between the number of mills reported to the census and in the directory doubtless comes from the fact that in some cases what is reported as a mill in the census returns may be reported as two or more in the iron and steel directory, and it is also possible that the special agent has failed to receive returns from one or two small mills. The Pennsylvania works are as a rule very much larger consumers of gas than the Ohio and Indiana works. Of the ten Ohio works, five are quite small steel works, using on an average not over 500,000,000 cubic feet a year. If it is assumed that the Pennsylvania and West Virginia iron and steel works consumed 2,000,000,000 cubic feet a year as an average, the five Ohio and six Indiana iron mills 1,000,000,000, and the five Ohio steel mills 500,000,000, the estimate will at least be large enough to cover the actual consumption and some wastage. This will give the following estimate of the total consumption of gas in iron and steel works in the United States in 1889:

Total consumption of natural gas in the iron and steel works of the United States in 1889, in cubic feet.

States.	Mills.	Number of works.	Average consumption per year per works.	Total consumption for 1889.
Pennsylvania	Iron and steel	73	2,000,000,000	146,000,000,000
West Virginia	Iron	6	2,000,000,000	12,000,000,000
Ohio	Iron	5	1,000,000,000	5,000,000,000
Do	Steel	5	500,000,000	2,500,000,000
Indiana	Iron	6	1,000,000,000	6,000,000,000
Total		95	1,805,263,158	171,500,000,000

It is not so easy to arrive at an average consumption of gas in glass-making as in some other industries. The estimate, as previously given, of the Philadelphia company of the average consumption at each glass-works (a glassworks being understood to be a furnace) is 62,500,000 cubic feet per year. The consumption of three other Pennsylvania glassworks shows a total use of 158,250,000 cubic feet, or 52,750,000 cubic feet each, or about 10,000,000 cubic feet a year less; but these were at smaller works, and are evidently underestimates.

Some very important tests have been made both in Pittsburg and in Ohio as to the amount of gas consumed in glassworks. Below are given the results of a series of meter tests made by the Philadelphia company at Pittsburg glasshouses. The tests continued over 160 hours in each case. Tests were made at four 10-pot window-glass furnaces and at seven 10-pot flint-glass furnaces.

Daily consumption of natural gas at a 10-pot window-glass furnace at Pittsburg.

	Cubic feet.
Melting furnace	270,000
2 blow furnaces	60,000
1 flattening oven	27,000
Stoves, pot arch, sand furnace, etc	2,000
Total	359,000

Daily consumption of natural gas at a 10-pot flint-glass furnace at Pittsburg.

	Cubic feet.
Melting furnace	164,000
5 glory holes	36,000
2 leers	32,000
1 boiler	24,000
Stoves, pot arches, mold ovens, etc	2,000
Total	258,000

These are averages for every day in the month, and would make the monthly consumption of gas at a 10-pot window factory, on the basis of thirty days to a month, 10,770,000 cubic feet, and of a 10-pot flint house 7,740,000 cubic feet. This is probably under the actual figures.

In Ohio some very thorough tests of consumption of natural gas in glasshouses have been made. Tests were made at five window-glass and bottle houses with the following results (the figures include all the gas used per pot for twenty-four hours):

Consumption of natural gas at five window-glass and bottle factories in Ohio.

	Cubic feet.
1	58,800
2	60,000
3	61,200
4	61,360
5	60,270

These tests were made with the Robinson pipe-line gauge. Test No. 4 in the above table shows the average run of a 10-pot window factory. The number of pots measured at the five factories ranged from 8 to 18. The supply pipes varied in size, being 4, 5, and 6 inches in diameter, and the pressure from 16 to 60 ounces. In view of these facts the close agreement of these measurements is remarkable; but at the same time they differ materially from the consumption at the Pittsburg factories. The consumption at the Pittsburg window factory is but 36,000 cubic feet per pot for twenty-four hours, as against 60,000 in Ohio. The probability is that this difference does not come from an error, but from the greater wastefulness with which gas is used in Ohio. Prof. Orton, from whose report the figures concerning Ohio are taken, says: "It might be expected * * * that 40,000 cubic feet of gas would suffice for a day's run per pot; but, whether from lavish use or other causes, about 50 per cent. additional is actually used. There can be but little doubt that if the glass manufacturers were required to pay 5 or 6 cents per 1,000 cubic feet by meter or gauge a large economy would at once be effected." The Ohio tests of flint-glass furnaces were made at eight works. The results were as follows per pot for twenty-four hours:

Consumption of natural gas at flint-glass works in Ohio.

	Cubic feet.		Cubic feet.
1	31,230; 39,270	5	41,230
2	37,430	6	41,370
3	38,470	7	44,450; 49,875
4	40,530	8	50,100

In explanation of the disparity of results at these tests it is stated that some of the works were run to their full capacity, while others were not. At the two factories for which two measurements are given the tests were made at different times. The figures show a consumption of from 35,000 to 45,000 cubic feet per pot per day. It will be safe to place the average at 40,000 cubic feet. And here again the great disparity between Pittsburg and Ohio measurements is seen. Pittsburg shows an average per pot for twenty-four hours of, say, 26,000 cubic feet, as against 40,000 cubic feet in Ohio. According to the Ohio figures a window-glass pot consumes 1,800,000 cubic feet a month and 18,000,000 cubic feet a year of ten months. According to the Pittsburg figures the consumption is 1,080,000 cubic feet a month or 10,800,000 cubic feet a year. An Ohio flint house consumes per pot 1,200,000 cubic feet per month, or 12,000,000 cubic feet a year, while a pot at a Pittsburg house requires but 780,000 cubic feet a month, or 7,800,000 cubic feet a year.

The number of glassworks reported as using gas in 1889 is 111. In some cases a works as reported has two furnaces, and in one case five. The number of furnaces in these 111 works is estimated at 150. Assuming that the consumption of each furnace is 125,000,000 cubic feet, the total consumption of gas in glass-making in 1889 was 18,750,000,000 cubic feet.

The number of industrial establishments in the United States other than iron, steel, and glass works reported as using gas was 2,369. These include some very large establishments, as pipe works, machine shops, foundries, brick works, electric-light plants, breweries, nail mills, wire mills, kilns for burning pottery, tiles, bricks, etc., as well as planing mills, small wood-working establishments, etc. Of these 2,369 establishments, returns of the estimated amount of gas consumed have been received from 1,075, which are reported in 1889 as consuming 113,557,478,750 cubic feet, or an average of 105,634,864 cubic feet each. Of these 1,075 works, 895 were in Pennsylvania, with a reported consumption of 118,767,357 cubic feet each; 77 in Ohio, with an average consumption of 61,481,224 cubic feet each; and 103 in Indiana, with an average amount consumed of 24,527,762 cubic feet each. Assuming the average amount consumed at each industrial establishment other than iron, steel, or glass works at 100,000,000 cubic feet, the total consumption in the United States in the 2,369 works would be 236,900,000,000 cubic feet.

The number of domestic fires, or fires for cooking and heating, using natural gas in the United States is reported as 466,034. It is evident from the schedules that in some cases a domestic consumer who may have from five to ten fires is counted as one fire, while in other cases each fire in a house is called a fire. It is estimated that the total number of fires supplied with natural gas is at least 500,000. These fires include ranges, cook stoves, furnaces, and heaters, which are large consumers, as well as grates and small heating stoves.

Returns of the estimated consumption of gas in 236,939 of these fires have been received, showing a total consumption of 40,545,338,550 cubic feet, an average of 171,121 cubic feet each per year. This is perhaps an overestimate. Returns for 190,939 fires in Pennsylvania were received, which show an average amount consumed of 121,730 cubic feet; of 30,872 fires in Ohio, with an average amount consumed of 249,792 cubic feet; while from Indiana returns for 15,128 fires were received, showing a consumption of 633,907 cubic feet. The Pennsylvania report is probably most nearly right. Assuming 125,000 cubic feet as the average amount consumed by a fire and seven months as the average time each fire is burned, this would make the average daily consumption for the 210 days nearly 600 cubic feet per fire. This would be 50 feet per hour for twelve hours. On the basis of 500,000 fires and an average yearly consumption of 125,000 cubic feet per fire, the total amount of gas consumed in 1889 in cooking and heating would be 62,500,000,000 cubic feet:

Returns of the use of 5,482,125,000 cubic feet in pumping oil by pipe lines have been received. It is estimated that this use consumed 7,500,000,000 cubic feet.

It is also estimated that 30,000,000,000 cubic feet of gas were consumed in the oil and gas regions in drilling and operating oil and gas wells of which no record has been obtained.

Further, it is estimated that at least 25,000,000,000 cubic feet of gas were used for purposes for which no record has been kept, or of which no details have been supplied to the Census Office.

From the figures given above we have the following as the estimated consumption of natural gas in the United States in cubic feet:

Total consumption of natural gas in the United States in 1889.

	Cubic feet.
Iron and steel mills	171, 500, 000, 000
Glass works	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 equal in heating power 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, given elsewhere, 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 1892 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.

PRODUCTION AND VALUE OF NATURAL GAS IN 1892.

The proper unit for measuring the production of natural gas would, of course, be cubic feet. The conditions of its production are such that it is utterly impossible to arrive at a correct statement of the number of cubic feet of natural gas produced. The same remark will apply to its distribution and sale. Recently considerable attention has been paid to the measurement of the production of certain wells. Two methods have been adopted—the anemometer for small wells producing 1,000,000 cubic feet a day or less, and a modification of Pitot's tubes for larger wells.

The most carefully observed pressures and productions have been made in Ohio in the Findlay field. The actual production of wells varied in 1885 from 80,000 cubic feet at the Adams wells to 12,080,000 cubic feet at the Karg well. It was estimated from measurements that in 1886 the great wells of the Murrysville district, Pennsylvania, yielded 15,000,000 cubic feet a day on an average; the Tarentum wells about 1,500,000. In the Findlay field in 1889 the new wells produced about the same as in 1885, while in Indiana the high-pressure wells produced from 1,000,000 cubic feet upward.

In 1889 some of the wells drilled in the Trenton limestone early in the year in Upper Sandusky yielded from 1,000,000 to 1,500,000 cubic feet of gas a day, while later in the summer a large well, yielding 15,000,000 cubic feet a day, was struck. The Mellott well, near Stewartsville, had a daily production of 28,000,000 cubic feet, while one near Bairdstown is reported to have shown the amazing open pressure of 45 pounds, which would be equivalent to a daily production of 33,000,000 cubic feet; but while individual wells of greater volume than any that had ever before been drilled were found in Ohio in 1889, the Findlay field as a whole was steadily losing its pressure, and consequently its production.

Conceding, therefore, that it is impossible to get the actual production of natural gas in cubic feet, it is believed that the best basis of calculation of the value of natural gas consumed in the United States is that of fuel displacement adopted heretofore in these reports. The amount of coal necessary to perform a given work—that is, to raise steam in boilers to produce a ton of iron or steel, to operate an 8 or 10 pot glass furnace, or a glasshouse containing one or more furnaces with a given number of pots—is quite accurately known, and the value of the coal or wood required to do this work is assumed to be the value of the natural gas used to perform the same work, whatever may be the amount of money paid for this gas. For instance, in Pittsburg it is quite generally conceded that it requires about 38 bushels of coal of 76 pounds to the bushel to puddle a ton of iron, about 14 bushels to heat a ton of iron, and 12 bushels of slack to raise steam required in a mill to produce a ton of iron. The cost of fuel for running a 10-pot glassworks in Pittsburg for 45 weeks was ascertained to be $5,682.55, which would be assumed as the value of the gas necessary to operate the furnace. It is also estimated that 40 bushels of coal per pot are enough to run a window-glass furnace for 24 hours. This will indicate the method pursued in arriving at the value of the natural gas produced and consumed in the United States.

During recent years, especially in 1891 and 1892, there have been notable changes in the method of selling gas and a marked increase in the prices charged. Gas companies, as a rule, are insisting upon the use of meters, not only to make remunerative their large investments, but to compel economy in the use of gas, so that the day of its exhaustion might be postponed. We have therefore for the years 1889, 1890, 1891, and 1892, where it has been possible, secured statements as to the actual amount of money received by certain corporations for the gas supplied by them to consumers. For the years 1889, 1890, and 1891 we have reports from 190 persons, firms, or corporations engaged in supplying gas. We give below the results of the investigation as to the number of companies reporting in each State, the amount received for gas, the number of producing wells from which reports were received, and the total number of feet of pipe used in the transportation of gas on the 31st of December in each of these years. For 1892 we have reports from 350 companies. It should be definitely understood that the figures given below do not give the total production of gas, but only the figures of production of these 190 companies in 1889, 1890, and 1891, and of the 350 companies in 1892. We shall elsewhere give the results of our investigations as to the total value of the production of natural gas.

Production of natural gas by 190 persons, firms, and corporations in 1889.

States.	Number of companies or persons reporting.	Amount received for sale of gas.	Number of producing wells Dec 31.	Total number feet of pipe Dec. 31.
Pennsylvania	37	$4, 285, 609	373	6, 659, 187
Indiana	93	396, 026	217	2, 858, 744
Kentucky	5	3, 664	14	254, 000
New York	8	83, 716	80	738, 128
Ohio	36	62. 750	83	320, 765
Illinois	2	2, 205	2	21, 120
Kansas	2	250	2	5, 200
Arkansas	1	250	2	....
Missouri	2	75	1	30
California	2	20	1	200
Texas	1	0	1	100
West Virginia	1	0	0	0
Total	190	4, 834, 565	776	10, 857, 474

Production of natural gas by 190 persons, firms, and corporations in 1890.

States.	Number of companies or persons reporting.	Amount received for sale of gas.	Number of producing wells Dec. 31.	Total number feet of pipe Dec. 31.
Pennsylvania	37	$3,964,997	435	7,720,891
Indiana	93	709,760	267	3,468,690
Kentucky	5	24,866	22	257,000
New York	8	104,202	96	769,288
Ohio	36	71,957	99	392,318
Illinois	2	5,527	3	21,120
Kansas	2	500	4	6,200
Arkansas	1	250	2	....
Missouri	2	375	3	930
California	2	20	1	290
Texas	1	0	1	100
West Virginia	1	612	1	2,000
Total	190	4,883,066	934	12,638,737

Production of natural gas by 190 persons, firms, or corporations in 1891.

States.	Number of companies or persons reporting.	Amount received for sale of gas.	Number of producing wells Dec. 31.	Total number feet of pipe Dec. 31.
Pennsylvania	37	$3,311,209	556	8,051,655
Indiana	93	1,482,795	305	3,874,071
Kentucky	5	28,993	38	263,500
New York	8	108,161	106	783,556
Ohio	36	86,238	110	518,720
Illinois	2	3,434	4	21,120
Kansas	2	700	5	8,200
Arkansas	1	250	2	....
Missouri	2	1,275	3	2,030
California	2	1,649	2	100,200
Texas	1	0	1	100
West Virginia	1	1,443	1	2,000
Total	190	5,026,147	1,133	13,625,152

Production of natural gas by 350 persons, firms, or corporations in 1892.

States.	Number of companies or persons reporting.	Amount received for sale of gas.	Number of producing wells Dec. 31.	Total number feet of pipe Dec. 31.
Pennsylvania	79	$4,273,002	965	12,779,558
Indiana	159	1,378,811	570	9,013,587
Kentucky	4	42,967	48	266,500
New York	9	112,792	131	852,864
Ohio	75	617,993	304	1,883,484
Illinois	3	8,377	7	44,500
Kansas	5	31,620	28	142,120
Arkansas	1	100	1	0
Missouri	4	2,900	5	2,830
California	10	39,384	12	41,900
Texas	1	100	1	0
West Virginia	0	0	0	0
Total	350	6,508,046	2,072	25,027,343

Consolidating these four tables we have the following:

Production of natural gas by 190 persons, firms, or corporations in 1889, 1890, and 1891, and 350 in 1892.

Years.	Number of companies or persons reporting.	Amount received for sale of gas.	Number of producing wells Dec. 31.	Total number feet of pipe Dec. 31.
1889	190	$4,834,565	776	10,857,474
1890	190	4,883,066	934	12,638,737
1891	190	5,026,147	1,133	13,625,152
1892	350	6,508,046	2,072	25,027,343

It will be noted that the returns in 1892 are very much more complete than those for any previous year. Indeed, the companies, as a rule, are keeping their records in a much better condition, and are not only willing, but able, to give more detailed reports than in any previous year. It will be seen, however, that though we have returns from 350 companies, operating 2,072 wells in 1892 and but 190 operating 1,133 wells in 1891, the value of the production returned by these 350 companies in 1892 is only about $1,500,000 more, or some 29 per cent, than the amount received from the sale of gas by the 190 companies in 1891.

An examination of these tables by States will show a decided relative falling off in all of the important producing States. For example, in 1891 Pennsylvania, with 37 companies, operating 556 wells, received $3,311,209 for the natural gas produced. With practically double the number of companies and nearly double the number of wells in 1892 the amount received for natural gas in Pennsylvania was but about $1,000,000 more. In Indiana, though a larger number of companies, with a larger number of wells, reported in 1892, the amount received for gas was about $1,000 less. The report from Ohio shows that the amount received for gas from the 75 companies reporting in 1892 was seven times the amount received by the 36 companies reporting in 1891. This no doubt grows out of the fact that in a great many instances where gas was given away in 1891 and previous years it was paid for in 1892.

VALUE OF NATURAL GAS CONSUMED IN THE UNITED STATES.

As has already been explained, in arriving at the value of natural gas in the early years of its production, that is, down to 1890, its value was estimated on what has been termed fuel displacement. For 1891 and 1892 the method of fuel displacement with the statements of the actual value received for gas have been combined.

On the basis of the best information obtainable the conclusion is reached that the total value of the natural gas consumed in the United States in 1892 was $14,800,714, as compared with a value of $15,500,084 in 1891. The largest value was in 1888, when the value of the gas consumed in that year was $22,629,875. Of the $14,800,714 in value of gas consumed in 1892 all but $200,000 is reported by States—that is, $200,000 is supposed to be the value of gas used in drilling, pumping, and operating wells—and the gas from sections from which it has not been possible to obtain any returns or to make any estimate as to the value of the gas consumed.

In the following table is given the total value of natural gas consumed in the United States from 1885 to 1892, with its value by localities as far as it could be ascertained:

Value of natural gas consumed in the United States, 1885 to 1892.

Localities.	1885.	1886.	1887.	1888.
Pennsylvania	$4,500,000	$9,000,000	$13,749,500	$19,282,375
New York	196,000	210,000	333,000	332,500
Ohio	100,000	400,000	1,000,000	1,500,000
West Virginia	40,000	60,000	120,000	120,000
Indiana		300,000	600,000	1,320,000
Illinois	1,200	4,000		
Kentucky				
Kansas		6,000		
Michigan		12,000		
Missouri				
Arkansas				
Texas				
Utah				
South Dakota				
California				
Elsewhere	20,000	20,000	15,000	75,000
Total	4,857,200	10,012,000	15,817,500	22,629,875

Localities.	1889.	1890.	1891.	1892.
Pennsylvania	$11,593,989	$9,551,025	$7,834,016	$7,376,281
New York	530,026	552,000	280,000	216,000
Ohio	5,215,669	4,684,300	3,076,325	2,136,000
West Virginia	12,000	5,400	35,000	500
Indiana	2,075,702	2,302,500	3,942,500	4,716,000
Illinois	10,615	6,000	6,000	12,988
Kentucky	2,580	30,000	38,993	43,175
Kansas	15,873	12,000	5,500	40,795
Michigan				
Missouri	35,687	10,500	1,500	3,775
Arkansas	375	} 6,000	} 250	100
Texas	1,728			100
Utah	150			
South Dakota	25			
California	12,680	33,000	30,000	55,000
Elsewhere	1,600,000	1,600,000	250,000	200,000
Total	21,107,099	18,792,725	15,500,084	14,800,714

PENNSYLVANIA.

A very interesting and complete statement regarding the geological horizons from which natural gas and petroleum have been produced in Pennsylvania was prepared by Mr. John F. Carll, of the Pennsylvania Geological Survey, for the report on the mineral industries in the United States at the Eleventh Census, 1890. It is impossible within the limits of this report to reproduce Mr. Carll's statement. Only the portions bearing more directly on the production of natural gas can be given.

According to this all the petroliferous rocks thus far developed in western Pennsylvania and the contiguous portions of Ohio and West Virginia are found in sediments of Devonian and Carboniferous age. These rocks in geological sequence are as follows:

No. XIV. Mahoning sandstone.
XIII. Barren.
XII. Homewood sandstone.
Olean conglomerate.
XI. Barren.
X. Big Injun.
Berea grit.
Butler gas sand.

No. IX. First sand and its divisions.
Second sand and its divisions.
Stray sand and its divisions.
Third sand and its divisions.
VIII. North Warren and Bradford "slush oil."
Warren sand.
Clarendon sand.
Cherry Grove, Balltown sand.
Cooper sand.
Bradford "Third sand."
Wilcox lower gas sands.
Kane sand.
Elk county sands, extending to a depth of 1,700 feet beneath group No. IX.
VII. Oriskany sandstone.

As far as known at present the interval between the Elk county sands and No. VII is barren. The most prolific gas-bearing rocks in these strata are from No. X downwards, *i. e.:* the Big Injun, Butler gas sand, the world-renowned sands of No. IX and those of No. VIII. No very great amount of gas has been produced in the rocks above No. X.

In the first sands of No. IX are found the Murrysville and the Grapeville gas sands, from which the chief supply of gas in western Pennsylvania is obtained.

It is impossible within the limits of this report to enter into a discussion of the geology of this region, nor is it necessary to call attention to the various gas pools that have been discovered. These are nearly coextensive with the petroleum fields of Pennsylvania, though the largest amounts of gas have been found in the neighborhood of Pittsburg; chiefly in Murrysville and Grapeville, in Westmoreland county; in Hickory and Cannonsburg, in Washington county; and Brownsville, in Fayette county. In the old districts the pressure of gas, and consequently the supply, is gradually falling off. More wells have to be drilled in order to produce a given amount of gas. It is true that from time to time new districts, or what may be called new pools in the old districts, are being discovered, so that at present there seems to be abundant gas for many purposes in western Pennsylvania. The enormous demand for manufacturing can not be supplied any longer, and the use of gas in western Pennsylvania is chiefly confined to domestic uses, small manufacturing establishments, and glassworks.

A brief statement of these several strata, condensed from the report of Mr. Carll, previously referred to, and from information secured from Prof. Orton, may not lack interest, though, as stated above, the important gas-producing rocks begin with the Big Injun, No. X of the above scale. A word about the horizons Nos. XII and XI may not be without interest, as No. XII includes the celebrated Olean conglomerate. No. XII, in which the Homewood sandstone of the Olean conglomerate appears, is the Pottsville series, which in western Pennsylvania is a composite formation from 250 to 300 feet in thickness, consisting of three sandstones separated by beds of shale carrying the Mercer and Sharon coal seams and limestones. This group, well defined and persistent all across the western end of the state, lies at the base of the Productive Coal Measures, and probably represents the millstone grit of England. In the northern counties of Pennsylvania this series is not under sufficient cover nor deep enough below the river drainage to fit it for oil production, but in Slippery Rock, in Lawrence county, and at Smiths Ferry, in Beaver county, some heavy oil has been taken from its bottom member. In Washington county it sometimes produces gas, and it is also productive in many localities in West Virginia and Ohio.

The Olean conglomerate, a massive pebbly stratum measuring from 40 to 70 feet in thickness, lies completely uncovered along its northern outcrop, up in the highlands near the Pennsylvania and New York state line, at an elevation of 2,340 feet above ocean level. Toward the south it plunges under cover at an average rate of about 19 feet to the mile. At Pittsburg it is found 850 feet below the river level, which is 150 feet below tide, and 2,490 feet below its northerly outcrop. Continuing onward southwesterly its dip is more variable, but it gradually sinks until it is buried in some places more than 2,400 feet below the surface.

A dip of this Olean conglomerate represents, approximately, the dip of all its associate rocks both above and below it. Hence, if a well at Bradford, commencing at the base of the Olean conglomerate, requires to be sunk 1,850 feet to reach the Bradford oil sand, one to reach the same horizon anywhere at the southwest must go 1,850 feet plus whatever thickness of cover may be above the conglomerate. This calculation, which is that of Mr. Carll, he states to be a broad theoretical one, which can not always be depended upon except in certain bounds and along lines running in the proper direction; but it serves to show why the wells in the southwestern fields require to be so much deeper than those of the northeastern.

Three oil and gas bearing horizons are to be credited to No. X, the Pocono series, to wit: (1) the Shenango sandstone, (2) the Berea grit, and (3) Butler gas sand.

The Shenango sandstone has different names applied to it in different localities. It is the sub-Olean conglomerate of McKean and Crawford, the Shenango sandstone of Mercer and Crawford, the Big Injun in the Greene county and West Virginia oil fields; the Logan sandstone of the Ohio reports, and the salt water rock of the Macksburg oil region. North of Pittsburg it has never given any promising indications, but in Fayette county a gas field of considerable pressure and volume has been obtained. The first great and really prolific pool of oil and gas in this Big Injun sand was discovered by E. M. Hukill, in the Dunkard creek region. The Mount Morris well No. 1 was struck in October, 1886, but it was nearly a year later before actual work commenced. A large number of oil and many powerful gas wells have been obtained in this sand in Pennsylvania and West Virginia, and according to Prof. Orton[1] it is the Big Injun Sand, or what is known in Ohio as the Logan sandstone, from which the oil in the new field of Monroe county, Ohio, known as Sistersville field, is obtained.

The Berea grit is of little importance in Pennsylvania, but in Ohio is quite a producer in a small way, as will be seen from Prof. Orton's statement regarding the gas sands of that state.

The Butler gas sand has its best development in southern Butler, Allegheny, and the eastern part of Westmoreland counties. It varies in thickness from 30 to 60 feet. This sand is almost exclusively a gas-bearing sand, producing comparatively little oil.

In No. IX, the Catskill, are found the world-renowned First, Second, Stray, and Third sands of Oil creek. Speaking in general terms, this group reaches from Tidioute, in Warren county, to Waynesburg, in Greene county, being about 130 miles in length and from 10 to 20 miles in breadth. The sandstones in this group, like all other sandstones, are subject to variations in thickness, composition, and method of stratification. In one place three well-defined sands may appear; in another, five or six; still, the six sands when found are almost always in exactly the same geological horizon as the three.

The sand beds lying in the horizon of the regular First sands have been variously called in the different districts as follows:

First sand horizon: Quinn sand, Amber oil sand, Franklin lubricating oil sand, Second, Fifty-foot, Hundred-foot, Salt-water rock, Gantz, Murrysville gas sand, Grapeville gas sand.

Second sand horizon: Lytle sand, Amber oil sand, Salt-water sand, Stray Third, Third, Fourth, Thirty-foot, Blue Monday, Bowlder, Hickory, Gordon, Pine Run.

Stray sand horizon: Gray Rock, Bowlder, Blue Monday, Hickory, Clover seed, Black oil sand, Second, Third, Fourth.

Third sand horizon: Gordon, Weister, Hickory, Green oil sand, Fourth, Fifth, Sixth.

Many other names have been used, but these are sufficient to show how utterly impossible it is for one to satisfactorily locate an oil or gas bearing horizon if he has nothing but the popular local names to guide him. The terms Fourth, Fifth, and Sixth are particularly misleading, since they carry the inference that these sands lie below the regular Third sand and add three productive members to the group, which is clearly not the case.

No. VIII of the Catskill group numbers seven divisions in Pennsylvania. The several oil and gas sands in the counties of McKean, Warren, Forrest, and Elk lie in the Chemung division of No. VIII, and no commercial oil or gas has been found in Pennsylvania in any deeper rocks. The Speechley sand in eastern Venango, which underlies the

[1] See American Manufacturer and Iron World, May 26, 1893.

middle ground between the Venango and Clarion fields, is largely productive of gas.

To quote Mr. Carll regarding these sands:

"Reviewing what is said above, it seems that all along the Venango-Butler oil belt, from Tidioute southwestward, the Portage-Chemung is simply a homogeneous mass of slates or slaty shales with no sandy layers worthy of note; that under the Warren and Forest district it contains in its upper 1,200 feet several beds of coarse white or gray oil sands, the first one lying about 300 feet below the top of the mass, this 300 feet, the intervals between the sandstones and the measures below the Cooper sand, as far as the drill has gone, being occupied by grayish slates or shales, with some bands of red similar to those underlying the Venango belt; that under the Bradford district, to a depth of about 1,300 feet (and Allegany, New York, may be included here), similar conditions to those of Warren and Forest exist, except that the most productive sands of Bradford are brownish black instead of white or gray; that in Potter, southeastern McKean, and Elk other brown sands are found to the depth of about 400 feet below the horizon of the Bradford sand, and that in these fields, as in the pools along the Venango belt, the productive portion of one range never, as a general rule, overlaps the productive portion of another."

The gas and oil producing horizons of Pennsylvania have thus been briefly sketched. Topographically it may be said that most of the oil-bearing districts produce a greater or less amount of natural gas. The chief gas-producing districts are in the neighborhood of Pittsburg and southwest from it. Taking Pittsburg as a center, large supplies of gas have been found at almost all points of the compass. North, are the fields of Butler county; northeast, the original Tarentum, Leachburg, and the Armstrong county pools; west, the Murrysville and Grapeville fields; south, Elizabeth and Belle Vernon, and southwest, the Hickory, Cannonsburg, McDonald, and Linden fields, of Washington county, and west, Robinson, Moon township, and Beaver fields.

From Venango and the adjacent territory a great deal of natural gas is still produced for use in the oil countries, although the amount by no means equals that supplied in previous years.

The statements as to the production of natural gas in Pennsylvania are given under the head "Production and Value of Natural Gas in 1892."

The following statement regarding natural gas in Ohio is an abstract of a paper by Prof. Edward Orton, published in the American Manufacturer and Iron World, Pittsburg, Pa.:

OHIO.

Though the subject of natural gas can hardly be said to have been an absorbing question in Ohio lately, still it has occupied a good deal of attention in several districts of the State, and considerable progress has been made in these districts in learning its true character and value. It is obviously a good time in which to review the situation. The brief history of the experience of Ohio towns in this line, for the last five years, is replete with instruction, but the lessons may come too late for the service of the towns themselves. For communities, however, that have yet to discover large and available supplies of this best of fuels, the facts will prove of the greatest value.

In the present paper I will briefly review the gas rocks and gas fields of Ohio, and will sketch with equal brevity the history of each to the present time.

THE GAS ROCKS OF 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. Named in descending order, they are as follows: The Berea grit, the Ohio shale, the Clinton group, the Trenton limestone.

The second formation of the list differs in important respects from the rest, and will be considered first.

The Ohio shale as a source of gas.—Cropping out on the shore of Lake Erie, and 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, which it reaches in the vicinity of Portsmouth, with an average breadth of 10 to 15 miles, a series of beds of shale, black, blue, or gray in color, constitutes the surface rock. The formation has been known to be a source of petroleum and gas ever since it has been occupied by man. Weak outflows of gas or oil occur all along the line and have been noted alike by the uncivilized and the civilized occupants of the region. Natural gas was first turned to useful account in this country in 1821, at Fredonia, New York, the gas being derived from springs that issue from this shale formation.

Along the shore of Lake Erie, in the belt just described, there are scores, and probably hundreds, of shale gas wells. These are found in every township of the State on the lake shore within the limits named. The wells are shallow, rarely exceeding 300 or 400 feet in depth. It costs but little to drill a 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 will sometimes maintain its production for a score or more of years. A single well will often supply the needs of a household. The pressure of the gas is low, seldom rising to, and rarely exceeding, 30 or 40 pounds to the inch. The use of this shale gas is essentially private use. All schemes for undertaking a public or manufacturing supply from this source have failed, and must necessarily fail. Considerable comfort and service, however, are derived from the gas of the Ohio shale at the present time in the ways indicated above. The facts pertaining to the shale gas remain unchanged from year to year. What is true to-day was true of it fifty years ago and will be true fifty years hence.

The remaining gas rocks of the State belong in a very different category. They all hold high-pressure gas and furnish it in quantity enough to encourage and support public and manufacturing supplies.

The Berea grit as a source of gas.—This formation, in its outcrops of Berea, Amherst, Elyria and many other points in northern Ohio, is a stratum of great economic interest and value, furnishing as it does the finest building stone and grindstones of the country. The annual production of the quarries established on it exceeds $1,000,000 in value. As the stratum dips slowly to the southward and eastward it becomes a repository of gas, oil, and salt water, the gas and oil being obviously derived by slow percolation from the shale formation previously described, which directly underlies the sandstone. The Berea grit has wonderful persistence, as it is followed by the records of deep wells, below the surface. When it has descended far enough to take 800 feet or more of cover it becomes, under proper conditions of structure, a reservoir of high-pressure gas and flowing oil wells. To provide an effective separation of the salt water, oil, and gas, which the stratum always contains, it is necessary that the rock series should be traversed by low folds, arches, or terraces. Such structure is occasionally found in Ohio from about the line of the Baltimore and Ohio Railway southward and eastward from the Muskingum valley, including, also, Harrison, Jefferson, and Columbiana counties, in part. Cambridge, Guernsey county; Cadiz, Harrison county; Barnesville, Belmont county; Macksburg, Noble county; Marietta, Washington county; Brilliant, Jefferson county; East Liverpool, Columbiana county, are points located on or in the vicinity of these low arches, and all of these localities are or have been centers of more or less production of high pressure gas. Several of these towns have undertaken the utilization of this gas for domestic fuel or for manufactures. Cambridge, Barnesville, East Liverpool, and Marietta may be named in this list, but only the last-named town has an effective supply at the present time.

A good deal of money has been expended in seeking a fuel supply for Cambridge from the source above named. Wells have been drilled by the dozen. The town has been piped by two companies—a home company, which has pursued a cautious and conservative policy, and which without any large outlay has furnished the unspeakable luxury of gaseous fuel to a small part of the population; and a company principally composed of eastern capitalists that has made large and, as the event has proved, unprofitable investments. The wells of the home company are not more than 1½ miles from the town. The wells of the other company are 8 or 10 miles distant. Both of the companies suffer more or less trouble from the invasion of salt water and oil.

From these two corporations a fraction of the population of Cambridge enjoys a somewhat inadequate supply of fuel for nine or ten months of the year. During the winter months it becomes necessary to reenforce the gas by the grosser forms of fuel, and more or less discomfort and exposure are entailed on the people in making the transition. Uncertain and deficient as is the supply, it is still highly valued.

Barnesville likewise has a home supply of gas sufficient for a small part of its population in mild weather, but entirely inadequate to cope with the temperatures of the past (1892–'93) winter. The supply is derived from wells about 2 miles distant from the town, the average production of which does not exceed 150,000 cubic feet per day. The rock pressure is, however, fairly good, and whatever gas there is, is sent promptly to its destination. The work has been carried on by a home company and with due economy.

Marietta has a much more promising supply than the towns named above, derived from wells located on fairly developed arches within a few miles of the town. The original daily production of several of the wells reached into millions of feet and the initial rock pressure was reported at 700 pounds. The writer has heard no complaint from this town during the last month, and therefore concludes that the supply has been fairly maintained.

The new oil fields opposite Sistersville, West Virginia, depend on a different stratum for their supply, viz, the "Big Injun" or Logan conglomerate. Gas is also yielded from this field and is used in a few small villages of Monroe county.

Bellaire, Steubenville, Wellsville, Toronto, East Liverpool, and other smaller towns in the Ohio valley have been dependent on gas derived from the Berea grit, but mainly brought into the State from wells located on the east side of the Ohio river in West Virginia and Pennsylvania. These towns have had a capricious and generally inadequate supply almost from the beginning. Even in moderate weather the service in them has been latterly unsatisfactory; but when it comes to winter weather like that of the past year the failure is so pronounced that reinforcement of fuel from the coal banks becomes imperative. In spite of the urgent need of gas for domestic use by thousands of families, a few manufactories established in the district have obtained a supply of gas from the same fields that supply the towns.

On the whole, the Berea grit in Ohio does not at present hold out brilliant promise of furnishing fuel on any large and generous scale to any considerable part of our population. Still less does it promise to furnish supplies for manufactories of any sort. But, as has been frequently pointed out, there is no ground for surprise when new fields of oil or gas are discovered within the limits of the formation. Its petroliferous contents are universally distributed, and the slightest warping of the rocks in the accidents of their long history may produce conditions essential for the separation of its contents and the accumulation of oil and gas in the arches or terraces into which the rocks are bent. The weakness of these structural features, wherever they are found, fully accounts for the weakness of the gas fields and oil fields, as well as for their brief duration. The same fact also accounts for the difficulty that driller and geologist alike experience in finding the localities where the oil and gas lie concealed. There is but very little to mark the presence of the favored spots.

The Clinton limestone as a source of gas.—Ohio led the way in introducing the world to two new and entirely unexpected sources of gas and oil, viz., the Clinton and the Trenton limestones. The latter she has been obliged to share with Indiana, but so far as known, the Clinton formation is a source of oil and gas in Ohio only. But one gas field is to be credited to the formation at the present time, but this is a field of decided economic importance and promise. It has a considerable area and its wells show good volume and high pressure.

The original discovery of the new horizon simply followed from one of scores of ventures undertaken by Ohio towns in search of Findlay gas after its discovery in northwestern Ohio. The failure of almost all of these towns in their search was utter and unrelieved. Two that started out on exactly the same basis as the rest, and whose original task was a hopeless one from the beginning, succeeded in bringing to light a new source of gas, as unexpected as the Trenton limestone, but a thousand feet above it in the scale. To Lancaster and Newark fortune gave the right to lead the way. Starting, just as all the towns around them had, to find the Findlay gas rock, these two, at depths of 2,000 and 2,400 feet, respectively, below the surface, each reached a small supply of high-pressure gas, which, from the record of the formations passed, and from the testimony of the drillings furnished, have been referred to the Clinton formation of Upper Silurian age. At this point in the search sagacity and experience were brought into play.

To two gentlemen in particular, we are principally indebted for the subsequent development of the Clinton gas field, viz. to Mr. J. O. Johnston, a well driller and oil producer, and to Mr. John G. Deshler, a capitalist of Columbus. Mr. Johnston took note of the northeast line that seemed to be indicated by the experience of Lancaster and Newark. On this fact of structure he placed great reliance, and, as the result has shown, the reliance was not misplaced. A company, largely influenced by the courage and confidence of Mr. Deshler, was organized in Columbus, and proceeded to lease territory in large blocks between the towns above named on a line bearing north 20 degrees east. When many thousands of acres of what seemed the most desirable territory had been covered, a test well was drilled at Thurston, halfway between Lancaster and Newark. This well also found gas in the new rock in moderate but promising quantity and under high pressure.

The point at which this well is located may be taken as practically the center of the Columbus supply. It is 30 miles distant from the city. The pipe line and the city service by which it is utilized are of the best construction. Gas was turned on in Columbus in January,

1890. During the following summer the company injudiciously undertook to furnish fuel to iron mills, brickkilns, limekilns, and various manufacturing industries, and by the end of the year a serious failure of the supply then available was experienced, and gas was shut off from Columbus. But after the company got rid of its large consumers and the gas could be strictly confined to domestic use, and several new wells had been drilled and the selling price of the gas had been doubled, the valves were opened again in May, 1891. From that date to the present, Columbus has enjoyed an uninterrupted and almost perfect supply. Even during the severe and prolonged cold of January, 1893, there has been little ground of complaint in any quarter of the city. At least half of the population are now enjoying the indescribable comfort and service of natural gas.

Lancaster has for the last two years also enjoyed an abundant and thoroughly satisfactory supply of gaseous fuel. Its first wells were within the corporation limits, and none have been drilled as yet at more than two miles distant from the center of the town. The distribution was undertaken and carried on by the municipal corporation. The line was opened in 1888, and after an experience which was discouraging but educatory, several great wells have been brought in that have divested the problem of gas supply of all difficulty. Fortunately for the people of Lancaster, their earnest attempts to establish iron mills, glasshouses, and other industries in the town on the promise of free gas have all, or mainly all, come to naught. Not having been able to persuade manufacturers to burn up the gas of the town in their factories and pay for it, they find it possible to enjoy the luxury of gas in their own homes, at rates which are at present far below the real value of the service.

Gas was introduced into Newark as domestic fuel by a private corporation in 1889. The supply reaches but a small part of the population, and even this restricted service has always been, in a measure, inadequate. The wells of the company are mostly situated within 2 miles of the town. The most distant are not more than 5 miles away. The rock pressure is fairly high, but the volume of the wells is comparatively small, the average daily production of the individual wells not exceeding 250,000 feet.

Extent and character of the Clinton gas field.—The Clinton gas field, as at present defined, extends from Lancaster to Newark in a northeasterly direction, and with a length of about 25 miles and a maximum breadth, as thus far proved, of 2 or 3 miles. The underlying rock structure, upon which the gas field must at last depend, has not, unfortunately, been accurately made out. It is obvious, however, that a terrace or low arch is connected with the gas production. The central part of the field, in the vicinity of Thurston, is covered with heavy beds of drift, sometimes 300 feet in thickness, but both ends of the line extend beyond the boundaries of the drift. The gas rock in the Lancaster wells is reached at an approximate depth of 2,000 feet, in the Thurston wells at a depth of 2,200 feet, and in the Newark wells at a depth of 2,400 feet. The drilling of wells in this field is costly, principally on account of the occurrence of a strong vein of salt water near the bottom of the section, and which must be shut out by casing of unusual length.

The gas rock is neither regular in structure nor uniform in production, but the field is essentially a spotted one. About one-third of the wells that are drilled prove unproductive.

Salt water, presumably from the gas rock, is struck in wells of both Newark and Lancaster, but the central field has thus far been put to little trouble on this account. Oil appears but very sparingly, and no oil field of any promise has as yet come to light in connection with this great stock of gas. Compensation for the lack of uniformity in the gas rock is found, in part, in the independence of even adjacent wells in the matter of rock pressure. The rock pressures of the different divisions of the field do not fall together. A well may maintain 700 or 800 pounds pressure, while another one not half a mile distant from it may fall to nothing. The broken and irregular condition of the Clinton rock, alluded to above, is such as to obstruct the full efficiency of hydrostatic pressure on the gas contained within it. The highest rock pressure reported in the Clinton field is 800 pounds to the square inch, and this figure has been reached in but few wells. The full normal pressure, however, computed on the basis of the depth of the rock below the level of its nearest outcrops, should exceed this amount by something like a hundred pounds.

In the volume of the wells there is a considerable range. None have been struck that produce less than 100,000 feet per day, but the largest wells that are found in the vicinity of Lancaster have yielded 7,000,000 or 8,000,000 feet a day. In the Thurston field the usual range is from 2,000,000 to 5,000,000 feet per day. The gas is superior in quality to that derived from Trenton limestone, especially because of the smaller percentage of sulphur compounds that appear in it. It is also a better source of artificial light.

The wells of the Clinton group seem to have a fair measure of vitality. In other words, they show a good thickness of porous rock in which the gas lies compressed.

As to the duration of the gas supply from this horizon, it seems probable that Lancaster can maintain, with proper economy in use, a satisfactory supply for several years to come. It has no large acreage outside of the town, it is true, but the territory directly adjacent to the corporation has proved very prolific, and the gas trustees will no doubt be able to secure sites for wells at such points as would seem most profitable.

The Columbus supply gives excellent promise as to duration, by far the best of any town in Ohio. The company owns a large and practically unbroken body of gas land and is thus able to protect itself against intrusion and the inevitable waste that follows promiscuous drilling. Better than this, however, it has mastered its business and learned the real nature of the form of wealth with which it has to do. It has made use of all available experience in the management of its field, its lines, and its city service. It has no place for large consumers of fuel of any sort, but holds its store in trust for the only service to which natural gas ever ought to be applied, viz, household fuel.

The Trenton limestone as a source of gas.—We reach, at length, the great gas field of the State, the only one, in fact, that is thought of when Ohio gas is mentioned. Its early history has been told so many times that it is not necessary to repeat it here. Suffice it to say, that in November, 1884, a gas vein was struck at a depth of 1,100 feet below the surface, and with a rock pressure of 450 pounds to the square inch, at Findlay; that in a little more than a year from this date there had been brought to light the existence of a great gas field, with wells equal in production to the great wells of western Pennsylvania, and an oil field that was already proved to extend through parts of at least four counties. By an examination of the record and the drillings of the first Findlay well, it has been possible to determine that the rock from which the gas was derived was the Trenton limestone of Lower Silurian age. The name was caught up at once, and forthwith it became a household word in half a dozen States, and multitudes of people now use the term who doubtless suppose that they always knew that the Trenton limestone was a great source of oil and gas. But, in point of fact, this identification of the Findlay gas rock with the Trenton limestone was the greatest surprise to the intelligent oil producers of the country that their business had ever brought them, and to the geologist the discovery was almost equally unexpected and surprising. All the oil rocks and gas rocks previously known are sandstones, but the Findlay gas rock is a magnesian limestone of exceptional purity. Again, no rock of an earlier age than the Devonian had heretofore been found productive in petroleum or its derivatives, but the horizon of the new rock is near the bottom of the Lower Silurian division.

Of the development of the industries that followed the discovery of Findlay gas, and of the speculative excitement that accompanied, it is not necessary to attempt any extended account. In the course of four years from the discovery of the new gas field Findlay had become one of the important centers of glass manufacture in the country.

In the several glasshouses that had been established here, 124 glass pots were in use. Eight machine shops and foundries, 7 boiler shops, 15 planing mills, 3 brickyards, 4 limekilns, 7 stone quarries, 1 clay-working factory, and a number of other industries were introduced into the town, most of them on the promise of practically free fuel. The population of the town expanded in the same time from 6,000 to 18,000 people. All of the population was supplied with fuel at nominal rates.

The city was lighted most of this time with torches, the consumption of which was several hundred cubic feet per hour, and for several years the lights were never extinguished. The daily consumption of gas in Findlay during the year 1890 was not less than 30,000,000 cubic feet, of which from 4,000,000 to 5,000,000 was used by the population as domestic fuel, the balance of it going to the glasshouses and the other factories above-named.

A similar though less remarkable growth went forward in the other towns that could reach the gas field by wells of their own or by short pipe lines. Among these towns may be named Bowling Green, North Baltimore, Fostoria, and Tiffin. In the course of the two years following the discovery of the Findlay field several subdivisions of the Trenton limestone gas field were brought to light in northern Ohio. The Findlay gas field was found to extend bodily to the northward and eastward, occupying Allen, Marion, and Cass townships of Hancock county, in part, and Bloom, Perry, Henry, and other townships of Wood county, also in part. It soon became the fashion, however, to distinguish the Wood county and Findlay fields as separate. They are generally so spoken of to-day, but in reality they are parts of a common reservoir. To the southwestward, however, a distinct gas field was brough to light in Mercer county, and which is known as the Mercer gas field. The ground of separation of the Findlay and the Mercer fields is based upon the existence of a trough of oil and salt water in the Trenton limestone between the two fields. They differ in several important particulars; for example, in the depth of the gas rock below sea level, in the original rock pressure which belonged to the gas, in the average and the maximum volumes of the wells which they support, and in their relations to the oil fields. The initial rock pressure of the Findlay field was 450 pounds, while in the Mercer wells the figures did not rise above 350 pounds. The largest wells of the Findlay field reached in one or two cases an outflow of 30,000,000 cubic feet per day, and were probably equal to any wells that have ever been found in the country. The average production of the wells of considerable tracts was not less than 5,000,000 cubic feet a day. On the other hand, the production of the largest wells of the Mercer field did not exceed 10,000,000 cubic feet a day, while the average was less than 2,000,000 feet.

A third gas field, though of small importance, has been developed in Sandusky county, in the neighborhood of Gibsonburg. The gas rock lies deeper here than in the Findlay field and the rock pressure is consequently higher, but the volume of the wells is small.

Gas has been found at many localities besides these in northwestern Ohio during the last five years, but there are no others that really deserve the name of gas fields.

In addition to the reduction of the original gas supply by the various uses already noted, one other great agency in the depletion must be taken account of, viz., that of furnishing gas to the villages and cities that were unable to find a supply of their own and that were nearest to the great fields, for use as household fuel, and in some cases for manufacturers also. The Findlay field, including in this term the gas territory of Hancock and Wood counties, was drawn upon to supply Toledo, Bowling Green, Fostoria, Carey, Upper Sandusky, Tiffin, Fremont, Bellevue, Norwalk, and Sandusky, and a score of smaller towns besides. A line was subsequently extended to Detroit, Michigan. The Mercer field was called upon to furnish gas to Lima, Van Wert, Celina, Wapakoneta, Greenville, Sidney, Urbana, Piqua, Troy, Dayton, and Springfield, and to many villages besides; or, in other words, to every thriving town in the ten counties nearest the Mercer field.

Under this tremendous draft the gas field has behaved as well as could be expected. During 1887 and 1888 the pressure even in the Findlay field fell but slowly; but in 1889 a marked decline set in throughout both fields. The decline has gone on steadily, and in some portions of the gas territory even rapidly, to the present time. As the pressure declined the gas came to be overrun by oil and salt water so seriously that it was no longer practicable to supply pipe lines from it, but this difficulty has been overcome, to a considerable extent, by the introduction of "separators," by means of which dry gas is sent to the lines. Gas pumps also have been attached to every important line, or are now being attached, but the office of the latter is not to lengthen the life of the gas field, but rather to shorten the agonies of its dissolution.

Recently factories of all sorts have been shut off from most of the lines, for the sake of maintaining a fuel supply for domestic consumption. This has been done even in Findlay. The only way in which Findlay can get her share of the gas is to burn it up as fast as possible. If she can make her factories pay for it, the better for her. The discomfort and even the suffering, in some cases, of many of the towns above named during the latter part of last winter, it would be difficult to exaggerate. The distress was in proportion to their dependence on gas as fuel, which in many instances was universal and absolute. There have been differences in the behavior of the different fields and different lines, but almost every one has failed to furnish anything like an adequate supply of fuel to its patrons. This is, in reality, the first winter since gas has been largely introduced in northwestern Ohio, in which anything like a fair test of the supply has been possible. The preceding winters, for several seasons, have been exceptionally mild and the cold waves have all been of short duration, while at the same time the pressure of the gas had not been reduced to the figures which now obtain.

All northwestern Ohio now understands that the end of the gas supply is near at hand. Summer fuel may be supplied for household use for several years, it is to be hoped, but not a town will venture to enter upon another winter without some efficient means for reinforcing its gas supply.

Towards the close of 1889 public utterance was given on two occasions to estimates of the probable duration of the gas fields of northwestern Ohio. The estimates were based on the facts that had been accumulated up to that time. In one statement the opinion was expressed that the number of years that the gas would last, on the scale of use then in force, could be covered by a number written with one digit; in the other the limit of large use was put at five to eight years. Even the shorter estimate was too long. It does not seem probable, at the present time, that a single natural gas line will be in effective operation by the winter of 1894. Certainly there will never again be a resumption of the large and lavish use that was in force in 1889. The life of the gas fields on that scale terminated in 1892.

INDIANA.

There is no doubt that to-day the most important gas field in any state of the Union is that of Indiana. It is estimated that this State possesses about 2,500 square miles of what may be regarded as productive gas territory; that is, territory in which gas has been or probably will be obtained in paying quantities. While the supply of natural gas is falling very far below the demand in other notable gas fields of the country, especially in Ohio and Pennsylvania, the supply of gas in Indiana seems to be well sustained, and factories that have been located in other gas territories are moving and seeking their supplies in Indiana.

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.

As stated, this Cincinnati arch is the reservoir for the gas. The Trenton limestone being higher on this arch than in territory adjacent, the gas has not only found its way into it, but has sought the highest portion that was sufficiently porous to act as a reservoir. Over the greater portion of the arch, where the upper surface of the Trenton limestone lies lower than about 125 feet below sea level, it contains a porous stratum which is usually found near its upper surface at a depth ranging from 4 to 50 feet. This porous stratum is continuous over the whole gas area and over a large area adjacent to it, and where not filled with gas or oil contains salt water. Its thickness varies from 1 to 30 feet. Dr. Phinney thinks it probable that the different portions of the Indiana field are in communication through this porous rock. Prof. Orton has shown that the gas-bearing porous stratum of the Trenton limestone is magnesian, while the more compact rock is a carbonate.

The Cincinnati arch is largely confined to the Trenton limestone and underlying formations.

Quoting from Dr. Phinney, in his report on the natural gas fields of Indiana, found in the Eleventh Annual Report of the Director of the U. S. Geological Survey:

"The principal axis of this arch after reaching the Ohio river between Cincinnati and Point Pleasant, Ohio, turns gradually to the northwest, and enters Indiana between Lawrenceburg and Liberty. A portion of the main uplift seems to continue northward from Cincinnati at a much lower level, its eastern slope being the more abrupt, and all becoming gradually lower and less distinctly marked until it becomes lost in the Lima axis. This Lima axis seems to be an offshoot from or possibly a crosscut arch to the main body. Its southwestern extremity seems to be near Rushville, Rush county, from which point it extends in a northeasterly direction through Cambridge City and Dublin, Hagerstown, Losantsville, and Fountain City, probably passing into Ohio south of Union City at a much lower level. The main body of the arch enters Indiana with an altitude for the upper surface of the Trenton of about 175 feet above sea level; it becomes reduced to 150 feet at Brookville and to 120 feet at Connersville, but the northwesterly dip is broken by the crosscut axis just mentioned, since the Trenton rises to 176 feet above tide at Cambridge City, and 186 feet at Hagerstown. North of these points the dip of the Trenton is again to the northwest until it is 338 feet below sea level at Monticello, White county. Northwest of Monticello it begins to rise, being 210 feet below tide at Francesville. In Indiana the Cincinnati arch is not a simple ridge or broad dome, but is complicated by spurs or offshoots, one of which has a westerly direction, Noblesville being situated upon it. It is also probable that the elevation of the Trenton shown at Wabash is due to a spur having a northerly direction. Logansport appears to be situated near a low spur that probably extends northward to Royal Center. Delphi and Kentland are both probably located on local swells subordinate to and connected with the main body.

"The Lima axis, popularly called the Findlay arch, after entering Ohio as already indicated, extends northeasterly in a broken line to Findlay, where it takes a northerly course to Lake Erie. The data so far developed seem to indicate that this axis is only one, though the most marked one, of the spurs or subordinate anticlines characteristic of the dome in Indiana."

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 anticline 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.

Quoting again from Dr. Phinney:

"Although the Trenton limestone is the principal reservoir of gas and oil in Ohio and Indiana, the formation is not everywhere and in all portions of its mass a reservoir for gas or petroleum, as it is only locally and under certain conditions that it becomes gas-bearing.

"The requisites for gas yield in any rock are: (1) a carbonaceous stratum within which the hydrocarbons are generated; (2) a porous rock overlying it or adjacent to it; (3) an impervious cover to prevent its escape; (4) the presence of the necessary structural relief to enable a separation of the gas, oil, and salt water to take place; (5) the absence of extensive deformation and fracture of the strata that would afford avenues of escape; and (6) absence of outcrop whereby the products might escape. The failure of any one of these necessary structural or textural conditions would render the accumulation of large quantities of the hydrocarbons impossible.

"The Trenton limestone meets the second of these requisites over only a portion of Ohio and Indiana, for over all that portion of the Cincinnati arch that lies south of Mercer county, Ohio, and south and west of the gas area and on the flanks of the arch the Trenton is not generally a porous rock.

"The Utica shale is over most of Indiana and Ohio a perfect cover, especially where the Trenton is otherwise properly conditioned, and it is only where the latter fails in its requisites that the Utica also fails to meet the requirements. The Cincinnati arch meets the other necessary requirements, and fortunately all these requisites of all the elements are present over a large area of Indiana.

"Within the area of the Lima axis in Ohio the gas is generally found between 300 and 400 feet below sea level, varying only with the altitude of different portions of the arch. This axis is, however, sharp and comparatively high, and its continuity with the higher portion to the south is so broken that there is no natural vent for the gas. The broken ridge or isolated arch acts as a trap in which the gas accumulates, the pressure of the salt water on all sides preventing its escape after having once risen into the arch.

"In Indiana the conditions are somewhat different. The arch is broad and gently sloping, and so far as now known it is practically unbroken, so that all portions of the arch and territory adjacent to it lower than 100 feet below sea level undoubtedly have free communication with the crest. Thus the gas generated over northern Indiana and in the deep basin south and west of the Cincinnati arch would accumulate under the cover of the impermeable Hudson river shales, in the crest of the arch, or the highest porous portion of the Trenton, where it has been forced and is now retained under a pressure determined by artesian pressure of the salt water surrounding the field.

"Between its outcrops in New York and Pennsylvania on the east, Kentucky and Tennessee on the south, Iowa and Wisconsin on the west, and Michigan and Canada on the north the Trenton limestone forms a great basin, in the center of which the Cincinnati arch rises. Throughout the greater part of its extent this limestone is a reservoir of water, which accumulates about the rim of the basin and flows downward toward its center, becoming brine in its progress by taking into solution the saline matters already in the rock. It then rises into the central dome until an equilibrium is established. The flow of water into the center of deepest depression of the basin is interrupted on the east by the Lima axis, which is located between deeper portions of the basin on the northwest and east. The salt water would doubtless fill every crevice and pore in that anticlinal if it were not already occupied by gas and oil. In Indiana the arch is higher and the salt water forced into it in obedience to hydrostatic laws rises to a higher level, driving the gas and oil before it until the resistance from the compressed gas within is equal to the weight of the column of water without or the hydrostatic pressure of the column of water on the opposite side of the basin. The height to which the salt water rises depends upon the elevation of its source, the porosity of the rock, and the altitude of the arch. The Utica shales are everywhere in Indiana impervious to gas and water, and hence the horizon of the salt water in any arch is largely dependent upon the altitude of the reservoir, as the water horizon must rise or fall with the elevation or depression of the Trenton. In Indiana the salt-water horizon is, on the west, northwest, and north of the gas area, about 100 feet below sea level, though a few feet of variation must be allowed for the local swells outside of the main field, where it may be found a little lower. If the rock is not uniformly porous the salt-water horizon may be expected to vary considerably, even within short distances. If it were not for the presence of the gas and oil in the highest part of the porous portion of the dome the salt water would completely fill it; hence it follows that the salt-water horizon, or the 100-foot dead line, is determined largely by the quantity of gas in the reservoir, and it has no relation whatever to the sea level. The salt-water horizon of every gas field varies with the altitude of the reservoir and the volume of gas and oil in it, and as the gas and oil are exhausted the water will rise and ultimately fill the whole arch.

"It has already been stated that the Trenton limestone is not throughout its whole extent or thickness a gas-producing rock, the productive portion being confined to the upper 50 feet within which the porous gas-bearing stratum varies from 1 to 20 feet in thickness. The porous stratum is usually overlain by a hard nonporous cap rock varying in thickness from 1 to 15 feet. In this porous stratum, which is dolomitic so far as known, the Trenton yields gas abundantly. But it is only where such conditions exist, combined with favorable structural conditions, that the potency of this factor is evident.

"The relation between rock texture and flow is proved by the behavior of wells, for the flow, feeble at first, gradually increases as the drill sinks into the porous stratum and culminates when the base of the porous stratum is reached. It is only in rare instances where the gas comes with a gush, as though a cavity or open space had been found. There is no foundation for the popular belief that the gas of the Trenton is accumulated in caverns or open fissures formed by fracture of the strata during upheavals, for the drillers have failed to find caverns, fissures, or other vacant spaces of any considerable dimensions in the Trenton. There can be no reasonable doubt that the gas is simply accumulated under pressure within the minute pores and interstices of the coarse-grained dolomite."

Regarding the area yielding gas and oil we can not do better than to quote again from Dr. Phinney:

"In the description of the topography of the Trenton limestone it was shown that the gas-bearing rock is one continuous stratum of porous dolomite or magnesian limestone occurring near the summit of the Trenton limestone, and within that portion of its area uplifted by the Cincinnati arch. So there is properly but a single important gas field in Indiana. The irregularity of its boundaries are due to local swells and intervening depressions near the salt water horizon, or to irregular variations in the porosity of the dolomite in the higher portion of the field. The local reservoirs adjacent to the field may properly be considered a part of it."

The principal field is somewhat irregular in its boundaries and quite large in comparison with the few isolated tracts in other portions of the state. This principal field varies in productiveness in different localities. Thus far the narrow southern prolongation has not proved rich, for although nearly all wells drilled find gas the flow is generally feeble. Southeast of a line connecting Knightstown and Winchester the rock is also compact and has so far, with the exception of a small area just east of Knightstown and at Hagerstown, proved unproductive. Feeble flows are found, it is true, all over the southeastern portion of Indiana; but with the exception of a small area at Brookville and Lawrenceburg none of the bores can be considered as paying wells. The wells in Rush, Shelby, and Decatur counties are all weak producers, although if the flow proves persistent enough they may be found of considerable value. It is quite probable that the small area at Hagerstown is connected with the main body through the southern part of Henry county; it may prove, however, to be an independent field.

The absence of gas in large quantities from the highest portion of the arch and its western slope in southern Indiana is due to lack of porosity in the rock. The porous stratum is not of equal thickness over the whole gas area, nor is the rock everywhere of equal porosity; but as a rule toward the southern and eastern borders the porous stratum gradually becomes thinner, and finally becomes reduced to narrow strips or patches with intervening compact rock. The capacity of the wells varies with the thickness and porosity of the gas-bearing stratum, a thickness of 1 or 2 feet yielding wells of feeble flow. while from 2 to 6 feet gives fairly vigorous wells of from 1,000,000 to 2,500,000 cubic feet per day, the larger wells being found only where the porous rock is thickest.

"It has already been indicated that under the theory of accumulation developed during this investigation, and independently by Profs. I. C. White and Edward Orton, the petroleum should be found in the same porous stratum as the gas, and in close proximity to but below it and above the brine; and geographically about the flanks of the dome, into which the gas is forced by the hydrostatic pressure of the brine. So far as revealed by the drill, this hydrocarbon has been found in these places; and thus far no extensive accumulations of petroleum have been found except around the margins of the field or in the local depressions within its margins and apparently in local pools or reservoirs. The slopes of the Cincinnati arch are so gentle that the petroleum seems to be widely diffused throughout the horizon between the gas and salt water, but the conditions do not seem to be favorable for its accumulation in large quantities. The only paying pools of oil found so far are at Montpelier and Portland; but in neither of these cases does the production exceed 75 barrels per day, and usually it is much less. The small pools of oil on the flank of the arch at Francesville and Royal Center suggest the existence of gas in the vicinity, but thus far very little has been found after repeated drilling.

"As already stated, gas is not usually found in the main field in the Trenton where its upper surface is more than 100 feet below sea level, though some very productive local fields are found where the rock is 10 or 15 feet lower. This fact of distribution was stated in 1887. *a* This limit has been shown to be correct, though it must be borne in mind that the dead line for gas is now rising as the reservoir is being drawn upon, and will continue to change in the future, though the change will be slow. The horizon of the salt water is now about 130 feet below sea level.

"The gas field at Auburn, Dekalb county, is a separate field, and its dead line or salt-water horizon is determined by the structural conditions existing there and the local altitude of the Trenton formation.

"The great extent and moderate height of the Cincinnati arch in Indiana has provided one of the most extensive reservoirs for gas that has yet been found in any country. The area of productive territory is not less than 2,500 square miles. This estimate is of course only approximate, but is more likely to prove too small than too large. The

a American Manufacturer and Iron World, September 2, p. 19.

area by counties is shown in the accompanying table, those counties in which only feeble flows are found being omitted. It is quite likely, too, that some larger wells have been overlooked. The aggregate capacity of the wells must only be considered approximately correct. It is of course possible that the estimate given of some wells may be too small and of others too large, though every effort has been made to obtain reliable information, and any error in the result has crept in despite conscientious efforts to obtain at least an approximation to the truth."

Area of Indiana gas field.

Counties.	Square miles.	Producing wells.	Aggregate daily flow.
			Cubic feet.
Blackford	180	8	21, 700, 000
Jay	150	16	22, 000, 000
Delaware	350	55	97, 000, 000
Randolph	80	9	6, 000, 000
Wayne	3	5	2, 000, 000
Madison	445	40	114, 000, 000
Grant	325	22	80, 825, 000
Howard	160	28	80, 000, 000
Tipton	120	13	38, 000, 000
Hamilton	200	82	200, 000, 000
Hancock	200	9	15, 000, 000
Marion	70	26	40, 000, 000
Miami	20	13	24, 000, 000
Wabash	10	5	6, 000, 000
Henry	90	22	20, 000, 000
Rush	40	4	1, 500, 000
Shelby	20	8	3, 000, 000
Decatur	40	25	5, 000, 000
Franklin	2	4	500, 000
Dearborn	2	2	1, 500, 000
Dekalb	....	3	2, 000, 000
Total	2, 507	399	779, 525, 000

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 the Meade County district is failing, as it is in other sections of the country. For quite a while pumps have, at least at times, been used to force the gas to Louisville, and quite recently (1893) a Hastings fuel gas plant has been erected at Louisville to supplement the deficiency of the supply of natural gas. As this report is being prepared it is learned that a second plant with a capacity of 2,000,000 feet a day has been contracted for.

CALIFORNIA.

Though natural gas has been found in many parts of the State of California, it is only in the neighborhood of Stockton, San Joaquin county, and in the oil regions of southern California that it is produced in commercial quantities. In the southern part of the state it occurs in connection with the petroleum produced in that section and is of great value in furnishing fuel for pumping and operating the wells and for other purposes. By far the most important gas-producing district of California, however, is in the neighborhood of Stockton, San Joaquin county. In the vicinity of this city a large number of artesian wells have been bored; the first, the celebrated courthouse well in the years 1854 to 1858. This well yielded considerable gas, indeed many wells bored for water in this neighborhood produced gas to a greater or less extent.

There are no especial features in connection with the gas produced in California that need discussion. The gas and petroleum districts of this state are quite thoroughly treated in the reports of the state mineralogist of California, to which those interested are referred for further information.

OTHER STATES.

Though, as stated above, natural gas has been found in many, if not all, of the states of the Union, it is only in the five already named that it is found in sufficient quantities to be a commercial product of any importance.

The statement as to Pennsylvania natural gas can be carried over to New York, as the Pennsylvania oil and gas fields are continuations southwardly of the New York field, the same as the West Virginia and eastern Ohio fields are continuations somewhat still further southwardly of the Pennsylvania field.

In Missouri there have been quite extensive explorations for natural gas, but none of the wells have yielded considerable quantities. Gas springs are known to exist in a number of the counties, but the only gas that has been found in sufficient quantities to justify its use to any extent is in Kansas City, near one of the Kansas natural gas fields.

The wells in this neighborhood are some 475 to 500 feet deep, the rock being a reddish sandstone from 10 to 40 feet thick, containing occasionally a thick, black oil.

In Kansas gas has been found in two or three sections, chiefly in the neighborhood of Paoli, Fort Scott, Coffeyville, and Cherry Vale, in Montgomery county. The Paoli district has gradually decreased in production, as has also the Fort Scott, so that they play a role of little importance in the production of natural gas in Kansas, though Paoli still has some seven gas wells in operation, supplying 600 domestic fires. The Cherry Vale gas field is in Montgomery county. At the close of 1892 there were 11 wells in this district. The rock pressure was said to average 260 pounds, the wells to be from 600 to 700 feet deep, and to flow from 1,000,000 to 5,000,000 cubic feet of gas in twenty-four hours. The gas seems to be found in both sand and shale. The Coffeyville district is in the same county. At the close of 1892 there were four wells in operation in this district. The conditions here are similar to those existing in Cherry Vale.

Some gas, but not in sufficient quantities to require a discussion of its production here, has been found in Illinois, West Virginia, Texas, Arkansas, Utah, South Dakota, New Mexico, Tennessee, and Wisconsin. Those interested in learning of the production of these States are referred to the report on the Mineral Industries in the United States at the Eleventh Census, 1890.

ASPHALTUM.

By E. W. Parker.

Included under the head of asphaltum are all the species of hydrocarbons not belonging to the paraffins. In this chapter, therefore, are considered the hard asphaltum, the liquid asphaltum (or brea), and the bituminous rock of California; the gilsonite, wurtzelite, uintaite, etc., of Utah, the bituminous sandstones of Kentucky and the bituminous limestone (or "lithocarbon") of Texas. The total amount of all kinds reported in 1892 was 36,680 tons, valued at $292,375. This was distributed as follows: California, 6,250 tons of hard asphaltum, 1,300 tons of brea, or liquid asphaltum, and 24,000 tons of bituminous rock; Kentucky produced 2,680 tons of bituminous rock; and Utah contributed 1,700 tons of gilsonite and 750 tons of bituminous limestone. No reports have been received indicating that the "lithocarbon" property in Texas has been worked on a commercial scale. The production of asphaltum and bituminous rocks since 1882 is shown in the following table:

Production of asphaltum and bituminous rock since 1882.

Years.	Short tons.	Value.
1882	3,000	$10,500
1883	3,000	10,500
1884	3,000	10,500
1885	3,000	10,500
1886	3,500	14,000
1887	4,000	16,000
1888	50,450	187,500
1889	51,735	171,537
1890	40,841	190,416
1891	45,054	242,264
1892	36,680	292,375

Uses.—While the greater part of the asphaltum, particularly bituminous sandstone (or rock), and bituminous limestone, produced in and imported into the United States, is used for street-paving, its usefulness is by no means confined to that field. The finer grades, such as the hard asphaltum of California, the gilsonite and other pure qualities of Utah, "hard Cuban," Egyptian, and refined Trinidad, are consumed largely in the manufacture of varnishes, paints, insulators for electrical wires, roofing compounds, printing ink, lacquer, and japanning. It makes an unsurpassed covering for piling and wharf timbers, preserving them from rot and the destructive work of barnacles and sea water insects. It serves as a binding material for sea-walls, jetties, etc., better than cements, as it is not affected by salt water or climatic changes. Sewer-pipes made of wood and covered securely with asphaltum have proven practically as lasting as iron. Asphaltum is also used in the manufacture of waterproof cloth for mackintoshes, etc. In fact, new uses for the material are constantly being found, and the industry is one of growing importance. Among the concerns engaged in the mining of asphaltum in the United States, the following have contributed valuable information regarding the production of the mineral in 1892, and its uses in the arts:

Standard Asphalt Company, Bakersfield, California.
California Bituminous Block Manufacturing Company, San Francisco, California.
N. P. Perine Contracting and Paving Company, San Francisco, California.
California Petroleum and Asphalt Company, San Francisco, California.
San Luis Obispo Bituminous Rock Company, Los Angeles, California.
Los Angeles Oil Burning and Supply Company, Los Angeles, California.
Schillinger Brothers (mines in Kentucky), Toledo, Ohio.
Buffalo Paving Company (mines in Kentucky) Buffalo, New York.
Gilson Asphaltum Company (mines in Utah), Saint Louis, Missouri.
Wasatch Asphaltum Company, Salt Lake City, Utah.

The California asphalts.—The asphaltum deposits of California are found in the counties of Kern, Los Angeles, Monterey, San Bernardino San Luis Obispo, Ventura, and Santa Barbara. They yield about as many varieties as there are producing localities, from the liquid forms known as *maltha* or *brea*, to the solid or hard asphaltums, including bituminous rocks and sandstones. The reported product in 1892 is from Kern, San Luis Obispo, Santa Barbara, and Ventura counties. The Kern county product is of good quality and is used for paving, roofing, the lining of reservoirs, warehouse floors and other purposes. In regard to the product of the other counties the Survey is indebted for information to Mr. W. N. Cowles, President of the California Petroleum and Asphalt Company, and to Mr. Sutherland Hutton, of the Los Angeles Oil Burning and Supply Company. Mr. Cowles states that a large deposit of high-grade rock asphaltum is owned and operated by his company. He claims the mineral to average 60 per cent. in bitumen, the balance being fine impalpable silica, free from vegetable matter or clay. The refined product, he states, resembles No. 1 grade of refined Trinidad so closely that, placed side by side, it is almost impossible to distinguish them. Analysis shows the percentage of bitumen to be about the same in each, the main difference being in the character of the residue, which in Trinidad is principally clay and vegetable matter, while in the Alcatraz (Santa Barbara) asphaltum it is silica. It has not been determined how large the deposit is. The material lies beneath the surface and is easily and cheaply mined. The property was not well opened until 1892, and between 4,000 and 5,000 tons were shipped out during the year. The same company is also operating an extensive bituminous rock deposit near Carpenteria, in the same county. This rock is of superior quality, running as high as 30 per cent. in bitumen. A brief description of this deposit appears in Prof. S. F. Peckham's report on petroleum and its products at the Tenth Census. The deposit is formed by the seepage of maltha, or liquid asphalt, through the underlying stratum of oil shales into an immense bed of clean beach sand, covering a very large area; the average saturation is something over twenty per cent.; proceeding deeper into the deposit, this grows richer. Where the shale has been uncovered it is found that the seepage, or ooze, continues and that from this shale stratum liquid asphaltum is constantly flowing at the present time. Geologically, the deposit presents many interesting features, and commercially it is of great value. The company is just establishing a refinery on an extensive scale, and has determined processes for the separation of the sand and the maltha. The product is of very high grade, over 95 per cent. pure. The company is also making extensive shipments of the crude material, which is found admirably adapted for street pavements on the Pacific coast. This deposit is the only one so far known in which there is no clay.

Mr. Hutton, for the Los Angeles Oil Burning and Supply Company, states that this company has its material mined for it, and handles three grades, as follows:

1. Refined asphalt for paving, made from the crude asphaltum mined in Ventura, Santa Barbara, and San Luis Obispo counties. From the crude is extracted about 40 per cent. refined asphalt, 80 per cent. pure, leaving in the refuse about 25 per cent. of asphalt, by analysis, which as yet the company has found no method of extracting economically.

2. Refined asphalt for paints, varnishes, pipe-dipping, roofing, etc., the result of distillation of asphaltic oils produced in Los Angeles county. This is very pure and acts in every particular like "lithocarbon," reported as being produced in Texas.

3. Liquid asphalt, or maltha (used for tempering the harder grades). This comes from springs or wells and is heated in stills to drive off the water and to settle out any foreign matter. It is also obtained by distilling the asphaltic oils down to a specific gravity of 1.2 or heavier. [The liquid bitumens of California are divided by Mr. Peckham into three classes—(1) those that form asphaltum and do not contain paraffin—these constitute what have been termed maltha or brea; (2) those that do not form asphaltum and contain paraffin—these belong properly to the petroleums, and are not considered in this report; (3) those that form asphaltum and contain paraffin—it is to this class that the "asphaltic oils," mentioned by Mr. Hutton, doubtless belong].

Mr. Hutton states further that the crude asphaltum mined for them is not bituminous rock or "bituminized sand" used for paving, as they have found the asphalt could not be extracted therefrom at a profit. He also furnishes the formula used by his company in the preparation of street-paving. This is as follows: Sand, 80 per cent.; marble dust, 5 per cent.; asphalt cement, 15 per cent.

The asphalt cement is made with about 80 per cent. hard asphaltum, refined to 80 per cent. pure, and 20 per cent. of liquid asphaltum of 1.2 specific gravity. The asphalt is heated to 300 degrees Fahrenheit, the sand to 310 degrees.

Kentucky.—The entire product of Kentucky is bituminous rock, used exclusively for street-paving. The output in 1892 was 2,680 short tons, worth $10,525.

Utah.—Three companies were operating in Utah in 1892. Two companies were mining the "gum" asphaltum or gilsonite, the total product reported being 1,700 tons. The other company produced 1,000 tons of bituminous limestone, 750 tons of which were used for paving in Salt Lake City, the remainder going to various points and used in roofing, cellar floor paving, etc. It is claimed that this material is equal to the asphaltic limestone from Neufchatel. The mines from which this bituminous limestone is produced are in the northern part of Emery county, on the line of the Rio Grande Western railroad. The gilsonite mines are in the Uintah Indian reservation, one in Wasatch and the other in Uintah county. The product of these mines has to be hauled by wagon from 70 to 100 miles to Price, the nearest railroad station. It is from there distributed to all parts of the United States and used in the manufacture of high grades of varnish, insulating compounds, etc. The remarkable purity of the mineral makes it possible to stand the heavy cost of transportation. Two more companies, the American Asphalt Company, of Denver, and the Cosmos Mining, Land and Investment Company, of Washington, D. C., are preparing to develop other deposits in the Territory. The former has secured a valuable mineral lease from the Indians and the same has received approval of the Secretary of the Interior, who, however, has limited the area upon which the company may locate. The lease from the Indians permits the company to locate its claims on all lands south of the Strawberry creek as far east as its confluence with Duchesne river.

Trinidad Asphaltum.—The Trinidad asphalt lake and the street paving industry which this deposit has brought about has been particularly well described by Mr. Clifford Richardson, inspector of asphalt and cements for the District of Columbia, in his annual report for 1891 and 1892.

Imports.—The amount of asphaltum imported continues to be largely in excess of the domestic production. The island of Trinidad furnishes the greater portion of the supply. The remainder of the imports are made up of bituminous limestone from Sicily, Germany, Switzerland, and France, and a small amount of asphaltum from Cuba.

The table following gives the imports of crude asphaltum since 1867. In addition to the 120,255 short tons of crude imported in 1892, there was some of refined, the amount of which is not stated, but the value is given at $74,042:

Asphaltum imported into the United States from 1867 to 1892.

Years ended—	Quantity.	Value.	Years ended—	Quantity.	Value.
	Short tons.			*Short tons.*	
June 30, 1867	....	$6,268	June 30, 1880	11,830	$87,889
1868	185	5,632	1881	12,863	95,410
1869	203	10,559	1882	15,015	102,698
1870	488	13,072	1883	33,116	149,999
1871	1,301	14,760	1884	36,078	145,571
1872	1,474	35,533	Dec. 31, 1885	18,407	88,087
1873	2,314	38,298	1886	32,565	108,528
1874	1,183	17,710	1887	30,808	95,735
1875	1,171	26,006	1888	36,494	84,045
1876	807	23,818	1889	61,952	138,163
1877	4,532	36,550	1890	73,861	223,368
1878	5,476	35,932	1891	102,433	299,350
1879	8,084	39,635	1892	120,255	336,868

STONE.

By WILLIAM C. DAY.

The problem of locating stone quarries yielding a product suitable for building purposes of one kind or another is a matter determined largely by convenience with especial reference to transportation. This condition is due to the almost universal distribution of stone at least good enough to be used for foundation construction or rough work. When, however, fine quality is the prime consideration, convenience and the immediate presence of transportation facilities are very much subordinated, and the building of railroads or branches from already existing roads is not infrequently brought about by the creation of a demand for fine stone, known to occur in a comparatively out of the way place. This statement applies particularly to marble, slate, and the finer grades of granite and in less degree to other kinds of stone. Thus marble eminently desirable for purposes of interior decoration occurs abundantly in Tennessee. Some of the best of this stone is subject to a long haul by wagon over poor roads before it can reach a railroad, and yet the price which the stone has commanded for years is sufficient to justify this inconvenient and expensive means of transportation.

The kinds of stone least widely distributed in the United States are fine marble and slate, which occur only in spots here and there; granite occurs much more frequently, while sandstone and limestone, particularly the latter, are to be found over large areas.

When the subject of marble quarrying is discussed, the States which suggest themselves as important centers of production are Vermont, Tennessee, New York, and Georgia, named in the order of their commercial importance, bearing in mind, however, the special prominence of the first-named State.

When we speak of slate, Pennsylvania and Vermont are immediately thought of. Granite has long been associated with the New England States, particularly Massachusetts, Maine, Connecticut, New Hampshire, Vermont, and Rhode Island, and among the Southern States, Georgia. Some of the States named are prominent for the general volume of business annually done and others for the exceptionally fine quality of product and the high degree of perfection to which the manufacture of ornamental products has been brought. Thus the varieties of stone quarried at Barre, Vermont; Quincy, Massachusetts; and Westerly, Rhode Island, stand out prominently for their adaptability to ornamental work, and hence the widespread demand for these stones all over the United States.

Sandstone is quite intimately associated with Ohio, Pennsylvania, Connecticut, New York, Massachusetts, New Jersey, and within a comparatively recent period Colorado, which has made rapid strides in the development of an important sandstone industry.

When our thoughts are directed toward limestone the whole country suggests itself, with particular emphasis on Illinois, Indiana, Missouri, New York, and Ohio. The first two named States are far in advance of the others in the amount of limestone devoted to building.

The stone exhibit at the World's Columbian Exposition is a collection not only of stones whose reputation is already made and assured by years of competition, but also of samples, in many cases very fine, of products which are being introduced to the public for the first time and whose future will be determined in no small degree by the favor with which they are received by interested visitors.

Quite a number of these new products might long since have been found upon the market had it not been for the very serious difficulties to be overcome in transporting them from their natural resting place to suitable distributing points.

The following statement shows the total value of the different kinds of stone produced in the United States in 1892.

Production of stone in 1892, by kinds.

	Value.
Granite	$12,627,000
Sandstone	8,265,500
Limestone	18,392,000
Marble	3,705,000
Slate	4,117,125
Bluestone	1,600,000
Total	48,706,625

GRANITE.

The granite industry, particularly in the New England States, suffered severely from strikes, which began in May and continued until September, and in some cases October. All the producers report good demand and fair prices, and refer to the strikes as the only drawback to a good and prosperous year. At the close of 1891 all indications pointed to a year of heavy production in the granite-producing regions of New England. The Northern and Western States were very little affected by strikes, and with them production was fairly good.

Many small producers in various sections of the country have shut down work, in some cases temporarily but in many with apparently no intention of resuming operations. Of the larger plants the suspension of work was simply on account of the strikes, and as soon as these were adjusted operations were resumed.

The following table shows the value of production of granite by States:

Production of granite in 1892, by States.

States.	Value.	States.	Value.
Arkansas	$40,000	New York	$200,000
California	1,000,000	North Carolina	150,000
Colorado	100,000	Oregon	6,000
Connecticut	700,000	Pennsylvania	550,000
Delaware	250,000	Rhode Island	600,000
Georgia	700,000	South Carolina	60,000
Maine	2,300,000	South Dakota	50,000
Maryland	450,000	Texas	50,000
Massachusetts	2,200,000	Utah	15,000
Minnesota	360,000	Vermont	675,000
Missouri	325,000	Virginia	300,000
Montana	36,000	Wisconsin	400,000
New Hampshire	725,000		
New Jersey	400,000	Total	12,627,000

Arkansas.—The product of granite in this State in 1892 was valued at $40,000. It is at present used in comparatively rough condition, the local demand for the dressed stone being limited. The product of Pulaski county is a hornblende-biotite granite, while that from Garland county is elæolite syenite.

California.—The output of this State for 1892 is valued at $1,000,000. Business is very generally described by producers as poor in 1892. The basalt paving-block industry in Solano, Sonoma, and Alameda counties was far less active than in former years. The paving block and macadamizing business was better in northern California than in other parts of the State. In San Francisco the use of bituminous rock interfered somewhat with the use of basalt blocks.

The Folsom Water Power Company quarried quite a large amount, all of which was used in building the works of the company. A considerable quantity of stone is quarried at the State prison, at Folsom, but was all used in prison work. Among the labor organizations of the State there is a strong feeling against prison labor, and they have refused to work upon buildings using stone quarried by prisoners; consequently, there is but little demand for stone from the prison quarries.

In Placer county the following kinds of stone are quarried: biotite granite, hornblende-biotite granite, hornblende granite, and quartz-diorite; in Sacramento county, hornblende-biotite granite; basalt is quarried in Solano, Sonoma, and Alameda counties, and is very largely used for paving and roadmaking. Shasta county produces andesite, while andesitic tufa comes from Solano county. San Bernardino county produces quartz porphyry and Tehama county basaltic tufa.

Colorado.—The value of the granite product was $100,000. Operations were much less active than in former years. The production of lava building stone was fairly active and is reported as better than in 1891.

Connecticut.—In 1892 the granite output was valued at $700,000; this figure does not reach that for 1891, the only cause for less activity being the strikes among granite workers in the New England States and which lasted from May to September and in some cases still later. The outlook at the beginning of the year was favorable and but for labor troubles the output would probably have exceeded that of the preceding year.

Delaware.—The granite output of this State comes largely from quarries at Wilmington and was valued at $250,000. Very encouraging reports were received from the more important producers.

Georgia.—While the leading producers of this State report very good business in paving blocks and curbing, the total, $700,000, falls somewhat below that for 1891. Quite a number of the smaller producers abandoned the quarrying business during the year. The ease with which the stone is quarried at Stone Mountain and Lithonia will insure a large business in paving blocks for many years to come.

Maine.—Although strikes unquestionably injured business in Maine to some extent in 1892, the output was nevertheless in excess of that in 1891. The product was valued at $2,300,000. The Maine product is divided chiefly between ordinary building stock and paving blocks, so that producers are perhaps less dependent upon granite cutters than some of the other New England States. A number of producers were frightened from taking some of the contracts offered and their business suffered accordingly. In spite of the labor troubles, many producers regard the past year as an exceedingly good one.

Maryland.—Reports from producers in this State indicate a more encouraging condition in 1892 than in the previous year. The most important producing center is Port Deposit, at which place production was in advance of 1891. The output for the year was valued at $450,000.

Massachusetts.—The effects of the strike in Massachusetts were much more decidedly felt than in Maine. Although the demand for stone was very good, the total volume of business done was markedly less than in 1891. The quarrymen were unable to supply all of the demands made upon them. The output for the year was valued at $2,200,000.

Minnesota.—The output of granite in 1892 was valued at $360,000. This represents a slight increase on the preceding year. Much of the product was used in the construction of the new court-house and city hall in Minneapolis. Indications for increased output in 1893 were considered good at the beginning of the year.

Missouri.—The output of granite in this State did not come up to that of the previous year; it amounted to $325,000 in 1892. The most important operations in the State were those carried on at Graniteville, where, to secure material sufficient to fill orders, a blast of 10 tons of powder was fired, making the fifth heavy blast fired at these quarries. Prospects for the future are very good. All grades of stone are taken from these quarries and find a ready sale.

Montana.—The product of this State, valued at $36,000, came from quarries at Helena. More than half of the product was dressed stock for building purposes; somewhat less than half was used for bridge work.

New Hampshire.—The effects of the strike were felt in this State, but apparently not so keenly as in some other New England States, the value of the output was $725,000.

New Jersey.—The granite product held its own at $400,000 as the value for 1892.

New York.—The granite product in this State fell off about $25,000, making the total for 1892, $200,000. It is claimed that but for the strike business would have been 25 per cent. better.

North Carolina.—Some advance has been made in production in this State, the product being valued at $150,000. The great need has been sufficient capital to push the industry.

Oregon.—The value of the output is $6,000. Most of the product is sold in the rough and for paving.

Pennsylvania.—The value of the output was $550,000. Much of the product is used for rough building and road work, although a number of quarries yield a product suitable for fine building.

Rhode Island.—This State is prominent as producing more ornamental granite than any other. The effect of the strike was, however, quite severely felt, and the output amounted to but $600,000. Monumental work was very much interfered with by the labor troubles.

South Carolina.—The granite industry in this State appears to be steadily improving, although no great advances have been made at any one time. The product was valued at $60,000 in 1892.

South Dakota.—Although the producers actively engaged in quarrying report fairly good products, a number of quarrymen have abandoned the business, and the total product amounted to only $50,000.

Texas.—The outlook for the future in Texas is brighter than ever before, chiefly because of improvements in transportation facilities which have recently been made. Some ornamental work is now being done and the products are favorably received. The value of the output was $50,000.

Utah.—The value of the output was $15,000. This represents an increase over former years, but there are at present no decisive indications of any considerable growth in the near future.

Vermont.—The value of the output in Vermont declined from $700,000 in 1891 to $675,000 in 1892, but when the effects of the strike are considered it is surprising that the decline in volume of business was no greater.

The history of the industry at Barre is interesting on account of the rapid progress made in development. The strike at this point was quite severely felt, as a large amount of ornamental and polished work is ordinarily done.

Virginia.—Granite production in Virginia came up to the figure for

1891, *i. e.*, $300,000. A number of the large producers report an encouraging condition of the industry.

Wisconsin.—The granite industry in Wisconsin has been of rapid growth, but it appears to be thoroughly established, and a grade of very fine ornamental products is now produced in quite large quantity by four or five of the more important producers. The product was valued at $400,000.

MARBLE.

The marble industry as a whole has been prosperous during the year 1892, but nevertheless quite a number of small producers have abandoned their quarries as not sufficiently remunerative or because of lack of capital to operate them on a paying scale. The large producers all report good business.

The marble referred to as having been discovered in Alabama at Florence has not yet been developed, and it does not now appear as if anything further would be done. Nothing new has been accomplished with the marble discovered at Yellville, Arkansas.

The following table shows the amount produced:

Marble product in 1892, by States.

States.	Value.
California	$115,000
Georgia	280,000
Maryland	105,000
Massachusetts	100,000
Pennsylvania	50,000
New York	380,000
Tennessee	350,000
Vermont	2,275,000
Scattering	50,000
Total	3,705,000

The Inyo Marble Company, of Inyo county, California, has established itself in a way that indicates permanency. A much greater output was secured in 1892, and the producers appear to be well satisfied with the progress they have thus far made.

In Georgia an increase in product was realized, and the Southern Marble Company has made a decided advance.

In New York a number of new firms have started, and while some of them are still in the experimental stages, one of them, managed by Mr. John Webb, of Gouverneur, has already made a very satisfactory showing.

The output in Tennessee is satisfactory, and in a few cases a quite largely increased output was secured during the year. Lack of capital has at the same time caused quite a number of the smaller operators to close up their business.

The lack of railroad facilities interferes very much with the quarrying of the celebrated Hawkins county marble, putting the latter at a great disadvantage in competing with the cheaper product from Knox and Loudon counties.

The marble property owned by Mr. Philip Schwartz at Frisco, Utah, has not been worked during the past year.

The marble quarries of Vermont have been on the whole very prosperous, and in some cases exceptionally so, demand being fully up to the producing capacity.

The True Blue Marble Company mill was burned and the company lost about four months of the year while rebuilding. The company has now a new mill exceptionally well built and equipped, and the company is in a stronger position than ever. The product is largely in the form of cemetery and ornamental stocks.

SLATE.

The slate industry has been generally prosperous throughout the country during 1892. Almost all the producers report a good demand and in a great many cases a rise in price.

The following table shows the condition of the industry in 1892 by States:

Production of slate in the United States in 1892.

States.	Roofing slate.	Value.	Other purposes than roofing. (value).	Total value.
	Squares.			
California	3,500	$21,000	None	$21,000
Georgia	2,500	10,625	None	10,625
Maine	50,000	250,000	None	250,000
Maryland	24,000	114,000	$2,500	116,500
New Jersey	3,000	12,000	None	12,000
New York	20,000	160,000	50,000	210,000
Pennsylvania	550,000	1,925,000	408,000	2,333,000
Vermont	260,000	754,000	260,000	1,014,000
Virginia	40,000	150,000	None	150,000
Total	953,000	3,396,625	720,500	4,117,125

SANDSTONE.

The total value of the sandstone output of the United States in 1892 was $8,265,500. This is less than the figure for 1891.

The following table shows the distribution of the output by States:

Production of sandstone in 1892, by States.

States.	Value.	States.	Value.
Alabama	$32,000	Missouri	$125,000
Arizona	35,000	Montana	35,000
Arkansas	18,000	New Jersey	350,000
California	50,000	New Mexico	20,000
Colorado	550,000	New York	450,000
Connecticut	650,000	Ohio	3,300,000
Georgia	2,000	Oregon	35,000
Idaho	3,000	Pennsylvania	650,000
Illinois	7,500	South Dakota	20,000
Indiana	80,000	Texas	48,000
Iowa	25,000	Utah	40,000
Kansas	70,000	Washington	75,000
Kentucky	65,000	West Virginia	85,000
Maryland	5,000	Wisconsin	400,000
Massachusetts	400,000	Wyoming	15,000
Michigan	500,000		
Minnesota	175,000	Total	8,265,500

A notable increase is to be noted for Arizona, where operations have advanced from $1,000 in 1891 to $35,000 in 1892. The equipment for quarrying is quite complete, and a still larger output may be looked for in 1893 unless the general financial panic exerts a serious influence. The most important operations were those carried on by the Arizona Sandstone Company, whose quarries are at Flagstaff.

In California operations were by no means brisk, quite a number of producers doing nothing during the year.

Considerably less was done also in Colorado.

A notable increase is shown by the figures for Michigan, which ran from $275,000 in 1891 to $500,000 in 1892. A superior grade of stone is produced. The operations of the Cleveland Stone Company were very materially increased; most of the quarries of this company are at various points in Ohio, but they also quarry stone in Michigan.

LIMESTONE.

The limestone industry was in a prosperous condition throughout the year. The total output in 1892 including the value of lime made was $18,392,000, while the figure for 1891 was $15,792,000.

The Western Stone Company, operating quarries at Lemont, Lockport, and Joliet, have very decidedly increased their output during the year. The increase in the operations of this company is the most notable advance made by any one combination in 1892.

The lime industry in Maine has advanced from a total of $1,200,000 in 1891 to $1,600,000 for 1892.

The following table shows the value of the output of limestone by States in 1892:

Limestone production in the United States in 1892.

States.	Value.	States.	Value.
Alabama	$325,000	Nebraska	$180,000
Arkansas	18,000	New Jersey	180,000
California	400,000	New Mexico	5,000
Colorado	100,000	New York	1,200,000
Connecticut	95,000	Ohio	2,025,000
Idaho	5,000	Pennsylvania	1,900,000
Illinois	3,185,000	Rhode Island	30,000
Indiana	1,800,000	South Carolina	50,000
Iowa	705,000	Tennessee	20,000
Kansas	310,000	Texas	180,000
Kentucky	275,000	Utah	8,000
Maine	1,600,000	Vermont	200,000
Maryland	200,000	Virginia	185,000
Massachusetts	200,000	Washington	100,000
Michigan	95,000	West Virginia	85,000
Minnesota	600,000	Wisconsin	675,000
Missouri	1,400,000		
Montana	6,000	Total	18,392,000

CLAY MATERIALS OF THE UNITED STATES.

By Robert T. Hill.

There was steady progress in the mining, utilization, and application of the clay products of this country during the year 1892, which gives reasonable hope that we shall soon be able to equal foreign countries in the production of these most useful materials.

The year was marked by the opening of many new works for the production of brick, terra cotta, sewer pipes, and all the other colored clay products, and the continued development of new clay fields, while the potteries producing whiteware shared in this prosperity.

Not only has there been increased development of staple or essential clay material, but the artistic development has progressed with it, so that communities hitherto satisfied with any structural clay material that could be used in building, have paid great attention to improving the quality and artistic appearance of the product. Thus it is that the Atlantic States which, until a few years since, produced only red colored brick of conservative shape, have now many yards which make every variety of white and colored fire and building brick of any desired shape or pattern.

In anticipation of the opening of the Columbian Exposition the clay workers of the country were incited to improve and compete with each other in the manufacture of the highest products of the kiln. As a result of this incentive many magnificent specimens of the art were prepared for the Exposition, which will be more fully noted in the report for 1893.

It is difficult to separate the production of crude clays from the manufactured product owing to the fact that most of the works, except the higher class of potteries, are located at the clay banks and mine their own material. The manufacturers of china and porcelain ware, however, using an artificial mixture of several natural products, purchase their clay material from middlemen, who make a specialty of mining, buying, and mixing clays, selling to the potter a manufactured article. Owing to these peculiar conditions it is necessary to describe the clay industry largely by its product.

The users of clay as an accessory or makeweight are the chief purchasers of the raw material besides the potters. The so-called china clay is extensively used by paper-makers and is shiped in large quantities from the Carolinas for this purpose. These paper clays are not always adapted for china-making.

The great need of the clay industries in this country is a system of technical education concerning the occurrence, distribution, and utility of the clays that will supplement practical experience in the works. Although much money is expended in our mining and geological schools in teaching various technical branches, nowhere in the United States is a single course of study given upon clays and their products, notwithstanding their great value. Until intelligent men possess a full knowledge of the uses and distribution of clay materials we can hardly expect the vast resources of the country in this line to be explored. Not only is there this lack of an elementary knowledge concerning the classification and use of clays, but nowhere is instruction given in their manipulation. Brick and pottery making and all other lines of clay working require as much scientific skill as any industrial art, and offer as great reward to those who study them. Yet nowhere is that theoretical knowledge taught which will give a broad preparation for the business. As now conducted it requires a large duplication of costly experimentation for anyone to become established in any of the clay industries, and we are almost solely dependent upon European artisans for the mixing, firing, and decoration of our wares. American machines have done much to advance the peculiarly mechanical portion of these arts by improved appliances for the manipulation of clay, but our technical schools have entirely overlooked the importance of other branches of the subject.

There is also need of simply-written text-books upon the four distinct phases of the subject, which are as follows: (1) The natural occurrence, classification, and distribution of clays, also embracing their chemical composition; (2) the working of clays, including mixing, grinding, molding, and shaping; (3) the fusing or burning of clays, which should include manipulation and a thorough knowledge of the fusing properties of earths and silicates and a mechanical knowledge of the structure of kilns and machinery, and (4) their application, designing, and decoration. As has been remarked by a prominent pottery-maker, decoration and designing are not taught as such in this country so as to produce a sufficient variety of ornamentation, and these arts are not sufficiently differentiated in our art schools, where the education is mostly copying instead of creating and inventing ornamental forms. In the technical schools of the countries where clays are most appreciated, such as France and Japan, these subjects are thoroughly taught.

In the last report an introductory sketch was given of the occurrence and classification of clay materials in the United States. It is proposed to confine the present paper to the progress of the various clay industries during the year.

BURNED CLAY.

Burned clay is being largely used as a railroad ballast in clay producing regions. It has a peculiar elasticity absent in gravel and rock beds. The product becomes very solid and the dust is comparatively little. The expense of replacing ties is much less than in rock-filled tracks. The Chicago, Burlington and Quincy; Atchison, Topeka and Santa Fe, and Chicago, Rock Island and Pacific railroads have adopted this new ballast where it can be reasonably obtained. The Wabash is also using it quite extensively. It should prove of great value as a road-making material in clay regions, such as those portions of Arkansas, Texas, and Kansas, where rock material is not easily obtained. Much attention has been directed to this utilization of burned clays for the construction of roadways and railway ballast. Concerning this Mr. A. M. Smith has published the following interesting description in *Paving and Municipal Engineering* for April, 1893:

"I consider burned clay, when properly prepared, very good material for residence streets, providing all streets leading to it are improved. Mud carried from an unimproved street will soon pick the clay up and carry it off. It was first used in Kokomo, Indiana, at the intersection of two well-traveled streets, covering only about 40 feet square. The clay was of good quality, burned hard. In the center it stood all right, but near the foot crossings, where the streets leading to it were muddy part of the time, muddy wheels would pick up some of the material near the crossings and carry it off.

"Burned clay is made by first laying a long row of kindling wood on the ground, with enough slack coal added to make a good fire. This is then covered with good pulverized brick clay to a depth of a few inches on the sides, care being taken to leave a draft for the fire; it is then ready to light. The fire should be under good headway before adding more clay; then alternate layers of clay and slack coal are put on. After the top is covered it should be penetrated every few feet with a sharp-pointed crowbar, or the fires will smother out. This should be done as each layer is added. When it is of sufficient height, say about 5 or 6 feet (to insure good burning) it should be watched all the time to keep the holes open. After it is burned out it is ready for use.

"Burned clay, like all other material for street building, should have a good substructure. That being faulty, so will the superstructure be.

"Care should be taken to provide good drainage before material goes on by putting in a red tile on either side, about 30 inches deep. The subgrade should be rolled with a 15 or 18 ton roller before putting on the burned clay, which should be put on in 4-inch layers, each layer to be thoroughly rolled with the same roller used on the subgrade. Three such layers are sufficient to make a good roadway. Water will not stand on it, nor will it support vegetation. To a certain extent it is springy, almost noiseless, and very easy on a horse.

"I consider it, when well made, desirable for residence streets or parts, but not best for heavy traffic. It can be constructed for about $1.20 per square yard, exclusive of grading and curb."

BRICK.

BUILDING BRICK.

The remarkable activity and development of the brick industry in the United States has continued unabated. From every portion of the country reports come of the opening of new works and the improvement of older plants and products. In fact, the art of brickmaking in this country has awakened from a period of conventionality and entered into an era of originality. Where hitherto communities were content with any brick that would serve for ordinary construction purposes, now there is a healthy competition to improve the quality and artistic effect of the material, so that brickmaking has become an exceedingly intricate and diversified art, requiring a keen knowledge of the business. Improved machinery and increasing technical knowledge have resulted in producing an infinite variety of brick. Color, shape, surface, and texture have been especially experimented upon until the most ornate structures can be produced from American brick vying in architectural beauty and solidity with the most notable structures of the world. Great interest has been manifested in the making of many unique varieties, such as enamel brick, granite brick, and bricks of fancy or striking colors. The use of enamel brick for ornate purposes in building is rapidly increasing in this country. It is especially striking in floors and interiors generally.

In the North Atlantic States the advance in the improvement and variety of bricks manufactured continues, and now the region produces every known kind of ornamental building brick. The tendency toward the increased use of white brick has incited manufacturers to develop this material, and excellent clays have been found in several localities, a particularly promising bed having been opened near Washington, D. C.

The modern processes of brickmaking have been admirably described in an able article in *Cassier's Magazine* by Mr. C. H. Schumann, C. E., as follows:

"The earths most employed in brickmaking are the hydrated silicates of alumina and are found in beds or pockets of different depths, widely distributed, and in great quantities. These clays have been formed principally by the decomposition and precipitation of feldspathic rocks. The brick clays may be divided into (1) Plastic clays, composed principally of silica and alumina in varying proportions; (2) Loams or sandy clays, and (3) Marls, which are either sandy, clayey, or calcareous, according as silica in the form of sand, alumina, or carbonate of lime preponderates in the mixture. These clays almost always contain a small percentage of oxide of iron, carbonate of lime, soda, and carbonate of magnesia. Those containing a good proportion of oxide of iron form the red clays which, when made into bricks, become more or less red according to the degree of heat to which the bricks are subjected and to the amount of iron present, which, however, should not exceed 10 per cent. The red pressed brick of Philadelphia and other points obtain their deep color from these causes.

"When there is more than 10 per cent. of iron oxide present the clay burns to a blue and almost to a black color. A large percentage of iron with lime or an excess of silica present renders the clay fusible. Clays containing lime and very little iron burn white, and need less intense heat to make hard brick than any other clays, the lime acting as a flux. Clays containing too much carbonate of lime are unfit for bricks; the lime, often present in the form of chalk, marl, or lime pebbles, is converted in burning partly into quicklime, partly into a combination with the silica and alumina which may come into actual contact with it. The quicklime which will slake when the bricks become wet destroys them. Magnesia present in the clays generally produces bricks of a brown color.

"The presence of iron pyrites is objectionable, for the burning expels the sulphur, leaving oxide of iron or a basic sulphate, making the bricks porous and brittle. The purer clays contain one part alumina to two of silica, with a greatly varying percentage of water in the different clays. They all, however, mix freely with water in different proportions, and then become tenaceous and plastic. If molded and burned they shrink, warp, or crack. These rich or fat clays must therefore be mixed or tempered with sand, ashes, or cinders before they can be used for bricks. Again, some clays contain too much sand, when they become weak and brittle after being burned; such clays may be mixed with the richer clays to obtain a product of good bricks. All brickmaking clays should be free from pebbles, roots, vegetable remains, etc.

"It results, therefore, from the great difference in the nature and quality of clays found in various localities, that the methods pursued in brick-making must vary in different localities, the 'soft mud' method used on the banks of the Hudson river being somewhat different from the 'stiff mud' process elsewhere and wholly unlike the dry clay method employed in the West and South.

"One of the greatest common brick-making centers is the region along the Hudson river from Croton and Haverstraw northward on both sides of the stream. Here the clay is dug from banks close to the edge of the water, or is dredged from the river bed, and deposited and stored on the shore to be acted on by climatic influences until ready for use. It is well known that clays which have been exposed to the disintegrating action of frost and atmospheric changes for an extended period of time produce the best bricks.

"Connecticut and northern New Jersey are large producers of common brick. The clays found being similar to those of the Hudson river region, which often contain an undesirable quicksand.

"Bricks of a cherry red color and of the finest quality are made in

Pennsylvania, Maryland, and the States bordering thereon, the loamy clays being of a superior grade. The clays found in the vicinity of Chicago are limy, producing poor building bricks, while the plastic clays around Milwaukee, containing a small percentage of iron, make light cream-colored bricks. Canada furnishes many good clay localities. An infusorial, siliceous, and shelly clay is found in France and Germany, from which very light bricks are made, suitable for high-vaulted ceilings, or where lightness and safety against fire are essential. It is known that bricks made of this material are so light that they will float upon water.

"The process of making common brick from soft mud being most prevalent and adaptable in the Hudson river brick-making region, it is proposed to describe the various steps of this particular method, modifying the machinery and its application to the other processes.

"The entire operation may be classified under six divisions: (1) Preparing the clay, (2) tempering, (3) molding, (4) drying, (5) setting the bricks in the kiln, and (6) burning.

"The brick-making period opens in March and April and lasts until the hard winter weather sets in. The clay banks are found to be in suitable condition at the commencement of the season, the disintegrating influences of the previous winter having prepared the clay for proper working. It is dug or undermined in 'benches,' laborers being generally employed to pick or shovel the clay. This, as well as all brick-yard work, being exceedingly laborious, it is found advisable to set the men at work at break of day, working them until late in the morning, thus avoiding the great heat of the summer afternoons. A day's work usually consists of the amount or quantity of product turned out. The clay is loaded into small dump cars and hauled over a light railed track by horse or steam power to the tempering pit, into which the clay is dumped. This pit or ring consists of a circular hole in the ground, is from 20 to 33 feet in diameter and from 2 to 3 feet in depth, the wall or casing being formed of brick, and the bottom of thick wedge-shaped oak or pine plank boards. Such pits are capable of holding clay sufficient to make from 20,000 to 40,000 bricks.

"In the center of the pit is a vertical shaft which gears into a horizontal arm carrying the cutting or tempering wheel. This wheel is about 6 feet in diameter and has two narrow steel cutting tires bolted together. It travels by means of feed gearing, from the center of the pit to the casing, back and forth on the horizontal arm, which also carries it around in the pit, plowing and cutting through the tough lumpy clay mixture until this has been thoroughly tempered or reduced to a soft plastic mud. This operation consumes usually the entire day. Before this tempering can take place, the clay, which is of the rich, fatty order, must be seasoned. As stated before, sand, ashes, or cinders are usually employed for this purpose, preferably sand. After the clay has been dumped into the pit, it is watered and allowed to soak over night. The next morning the mass is mixed with clean, sharp sand—in the proportion of one to two of clay—and to this is added fine coal dust in the ratio of 3 pecks, more or less, to every 1,000-brick batch of clay. The practice of mixing this coal dust with the mud has often been condemned as weakening the bricks made therefrom, but the results attained do not bear this out.

"The hardest common bricks manufactured are those made on the banks of the Hudson by this coal-dust method. Presumably the coal dust, in the process of brick-burning, acts as a retainer of the heat, causing them to be thoroughly and uniformly baked. Possibly it is a substitute for the straw which was put in the bricks by the ancient brickmakers. It is claimed for the coal-dust method that it economizes in fuel and reduces the time of burning the bricks. When steam power is used for driving the tempering wheels several pits are placed in the same line of shafting and close together, the end of the horizontal shaft not extending much beyond the edge of the pit, which is not the case if horse power is employed, the shaft being then necessarily extended and the pits farther apart. To facilitate operations one pit can be tempered while the neighboring pit is being shoveled out and the mud molded into bricks, which latter operation is the third step in the process of brickmaking. The mud from the pit is generally wheeled in barrows to the brick mold or press, which stands at a lower elevation than the tempering pit, the top of the press, which receives the tempered clay, being level with the wheeling floor, to facilitate charging from the barrows to the press.

"Where the clay is of such a nature that it can be used directly for brick the tempering is done in a pug mill instead of in a circular pit, or, less desirably, in the tempering cylinder of the brick press, in which case the main or vertical shaft is provided with a number of steel knives which serve to mix the ingredients before being expelled by the wiper.

"When the molds, which are made usually of cherry or locust wood, and contain six bricks each, are thrust from under the press upon the table they are put on trucks and wheeled to the drying yard, where the bricks, six in a row, are laid upon the flat. This operation is called trucking off. The drying yard is a large space with a smooth and level floor made of clay. The brick press is always located at one end of this yard and housed under a rough, open shed. The drying yard may be open or covered. When covered the roof is made movable, to be opened in dry weather and closed against rain and storm. There is no protection for the bricks drying in an open yard, though a freer circulation of air and light is obviously obtained. Bricks exposed to the rain are called washed bricks and are not much esteemed.

"The bricks, when partly dry, are edged up, or set on edge, by means of an edger, and are then spatted or tapped with a flat board, called a spatter, to give them a clean edge. When sufficiently dry they are gathered by hand and placed on edge in long, narrow rows or hacks at the sides of the drying yard. This process is called hacking. The bricks remain in the hacks for several days, until thoroughly dry, when they are ready to be set in the kilns.

"Another mode of drying the bricks by hand is one known as the pallet system, in which the bricks are laid from the molds on long, narrow boards or pallets, each capable of holding conveniently a mold full of six bricks laid flat. These pallets are then placed in shelf-like tiers in covered frames, eleven shelves to a row and two rows, containing 132 bricks to a pocket. The pockets are arranged end to end in long lines, with aisles for passage between all the lines. It is claimed that the bricks thus hacked dry faster than by the other method. They are edged up by hand to dry properly. Drying ovens, or patent dryers have not been an economical investment for the manufacturers of common brick in the Hudson river region, inasmuch as coal and fuel are not plentiful or cheap, and the low market price obtained for this grade of brick does not warrant the outlay. Where space is limited, and other conditions are favorable for the maintenance of drying ovens, it is of decided advantage to operate them, as by their use work can be continued throughout all seasons of the year. In addition to the gases from combustion a large amount of air is admitted over the furnace into the flues. This air becomes heated and is then distributed over the bricks, after which it is carried off through the stack. Circulation of heated air may also be obtained by the use of steam pipes instead of furnaces, the oven then becoming known as a steam dryer. Drying ovens are impracticable for drying bricks made from very strong clays, or from those that will not dry without cracking in the sun. For loamy or sandy clays the dryers are acceptable.

"The next step in the process of brickmaking is that of setting them in the kiln. Kilns may be permanent or temporary. Both are covered with rough, movable roofs. In the first the kiln usually consists of two parallel high brick walls or arches, permanently constructed. The green bricks ready to be burned are set or placed between these walls. At the base of each wall, running through and at right angles to it, are the furnaces with their attendant grates and ash-pits. These are provided with iron doors, hinged to iron frames which are securely attached to the kiln. Permanent kilns, when properly constructed, yield better results than may be obtained from the temporary kilns. The setting of the bricks in both is essentially the same. In the construction of a temporary kiln the arch is generally fourteen courses high, the bricks being set on edge and about one-half inch apart. The lower eight courses are usually called the straight courses, on top of which are placed the overhangers or remaining six projecting courses. The pillar bricks are those between the straight courses, and the skintles are the bricks set diagonally in order to tie together the overhangers. The row first set on top of the arch is called the tie course, and the whole fourteen courses, the lower bench, and the next fourteen courses, which usually complete the height of the kiln, are called the upper bench. The kiln is usually forty-two high. The arch, lower, and upper benches having been set, all on edge, a brick called the raw platting is laid flat on the uppermost brick course of the setting; on top of this a burnt brick, or the burnt platting, is then laid reversed across it. The bricks having been set the face of the raw bricks is then covered or faced up with boards set on end.

"The opening through which the bricks are wheeled into the kiln and hauled out after burning is now closed or walled up with two thicknesses of brick, each being plastered over with soft clay. All other sides of the kiln are plastered over to hold the heat when the kiln is on fire. A kiln as described usually holds about 20,000 bricks, and several such may be set at one working.

"In burning the kilns coal or wood may be used, although in the employment of coal fuel the arches of the temporary kiln must be provided with ash pits and fire grates. Before placing the bricks in the kiln, logs or, where obtainable, discarded railroad ties, are placed at the bottom of the setting. These, on becoming ignited in the process of the initial firing, serve to dry out any moisture or dampness in the bottom of the kiln or in the bricks. The fires in the arches being started from each side to the center of the kiln, the burnt platting is stood upon end to facilitate the escape of the white, watery smoke which is emitted during the burning for several days. The fires are increased until about the fifth day, when the white water smoke changes into a bluish black. The kiln is now hot, and the fire is seen to come through the top. The bricks at this stage are ready to shrink or settle, the platting is put down and tightened, and the fires intensified. After the bricks have settled sufficiently, and the kiln has burned off, all doors and apertures are plastered over. The kiln then remains closed for about five days, allowing its contents to cool slowly, after which the bricks are ready for market.

"Burnt common bricks are divided into three classes, arch, red, and salmon or pale. All are found in the same burning, the salmon bricks, being largest in size and greatest in weight, are of poor quality, bringing the lowest marketable price. There are other plans for burning bricks, many of the annular kilns being very effective. Others operated by hot air, gas and air, superheated steam, etc., require unusual skill to work them. The second method of manufacturing bricks is the stiff-mud process. The essential differences between this method and the foregoing lie in the tempering and brick machines. The clay is hauled directly from the bank to the tempering mill, which prepares it for the brick machine. Clay that is very tough and full of stones is first passed through elevated rollers, which disintegrate it and remove the large stones. If necessary, it may be further pulverized and reduced by means of smaller rollers, suspended below the first set.

By means of an inclined bucket elevator the granulated clay is carried to the hopper of the brick machine. Where the nature of the clay admits it is fed directly from the bank to the hopper of the brick machine, where it falls into the tempering case. It is here tempered stiff by a limited quantity of water, and when necessary by the addition of loam or sand.

"The tempering case is conical in shape, and is fed at one side of the center of the top, so that the clay, in falling, meets the revolving tempering knives as they come up. These thoroughly cut and force the stiff clay forward into the screw case, which contains, on the end of the tempering shaft, a conical screw of hard iron. In revolving this forces the clay and delivers it into the forming die. The screw and die cases are heated by steam to facilitate the sliding of the clay. As the formed clay issues from the die it passes through a sand chamber, where it is evenly sanded, to prevent it from adhering or sticking. The formed clay, coming from the die in a long continuous bar, whose cross section is of the standard or required size, is cut into proper lengths by means of a cut-off, which may consist either of wires on a revolving frame or of a revolving spiral blade of steel, the distance between each spiral (or wire) being equal to the length of a brick. The speed of either cut-off is controlled by the movement of the clay bar itself, thus securing uniformity in the lengths of the bricks.

"In the dry-clay method of making bricks the clay from the bank is deposited under large sheds, where it is allowed to dry. When fed to the charge boxes in the press it contains little or no sand and very little moisture. An enormous pressure (something like 40 tons) is then exerted to press this dry clay into brick form. The molded product thus produced has a uniform, dense, and attractive appearance. Upon being burnt, however, it is found that the bricks have become open and weak and absorb water readily.

"Many bricks, notably pressed or front bricks, are molded by the hand process, in which the molder takes a lump of the tempered clay as it comes from the tempering pit (generally worked by horse power), throws a handful of sand over the lump of clay, works the mass into a peculiar shape or 'warp,' then dashes it down with great force into a cast-iron mold. Superfluous clay is struck off by the molder's 'plane.' This hand process of making common bricks is rarely seen, except in very small communities, where the slow demand for bricks can be supplied by such method. The best pressed or front bricks are made by a combination of the hand and the machine processes. The clay should be well tempered—this is effected best in a circular pit—it is then molded by hand and the bricks placed to dry in the usual manner. When properly dried the pressing machine is taken to the bricks, which are carefully put into the press mold one at a time. After the bricks are pressed they are laid flat or in squares, edgewise, five or six high. When sufficiently dry they are stored in sheds until required for burning. When set in the kilns they are placed usually eight courses high, and in such a manner that the fronts may be preserved. All bricks are set one over the other, on edge, only the bottom, one middle, and the top course being crossed. Great care is exercised in the setting and burning, the fires being lighter and more frequent than in the burning of common bricks.

"Ornamental bricks and shapes are usually made in the same manner as pressed bricks, the molds in the press conforming to the different styles and designs.

"Fire bricks are made from the most infusible clays, such as contain from 52 to 80 per cent of silica, with from 18 to 35 per cent of alumina, and the remainder water. Oxide of iron may be present, but the light color of the bricks shows that this is in very small quantities. Such clays are of common occurrence in the bituminous Coal Measures of Pennsylvania, Ohio, Illinois, and Missouri, where they are found in the underlying strata. They are also found associated with other clays of more recent formations, as at South Amboy, New Jersey, at Bennington, Vermont, and Mount Savage, Maryland. All these localities furnish the nonplastic fire clay, which is particularly adapted to the manufacture of fire brick, the plastic fire clay being used for the production of pottery, terra cotta, and an inferior grade of fire brick.

"Fire clay as found is indurated and not generally refractory, and must therefore be broken up or ground and mixed with some infusible material, such as pulverized quartz, finely ground old fire bricks, clean siliceous sand and gravel, powdered graphite, etc. The materials may be ground and mixed in a mill containing two roughly-surfaced rollers run at different speeds, or by a variety of pug mills. The grinding and tempering are done very effectively by these means, after which the mass is molded into bricks either in hand molds or by machinery, as described before. The bricks are dried, then set and burned, at a very high temperature, in kilns similar to common brickkilns, or, more commonly, in circular-domed, overdraft or annular kilns. It is for the lining of blast furnaces and stoves that fire bricks are extensively employed, and for this use they are prepared in a variety of sizes and shapes adapted to fit the curves in the lining of the stacks, the arches of the flues, etc. It is quite usual to find a fire brick factory in the vicinity of a stove foundry, although the fire clay is generally obtained from the great supply banks of South Amboy and elsewhere. A common rectangular fire brick is usually 9 inches in length, 4½ inches in breadth, and 2½ inches in depth, and weighs about 7 pounds. Building bricks vary in size in different localities, the dimensions running from 7½ to 9¼ inches long, 3½ to 4½ wide, and 2 to 2¼ inches thick, the variation being largely owing to the nature of the clay employed. Weak clays in tempering absorb water slightly and shrink but little in burning, while the strong clays absorb large quantities of water and shrink very perceptibly.

"English bricks are larger than the ordinary sizes made in this country, being about 9 inches long, 4½ wide, and 2¼ thick. Machine-made bricks shrink less in drying, but more in burning, than hand-made bricks. The average weight of a strong, well-burnt brick is about 5 pounds; it should be capable of withstanding a crushing pressure of about 7,000 pounds to the square inch.

"Bricks are enameled or glazed by means of a composition of porcelain or glass, which renders the surfaces or faces vitreous. This may be done either by applying a flux or a chemical solution to the surfaces. Pigments of metallic oxides are added to the composition, which give it any desired color or shade. The composition, with this pigment added, is usually reduced to a homogeneous mass by pulverization, then it is calcined, pulverized again, and made applicable by dissolving it in water to the consistency of cream. The faces of the bricks to be glazed are immersed in this solution or are coated with it by brushes, after which the brick is subjected to a temperature sufficient to fuse the enamel on the surface.

"A process of making bricks entirely of sand and some vitreous composition has come to light in St. Joseph, Michigan, which, if successful, bids well to revolutionize the entire brickmaking industry as now carried on. The method consists in mixing sand with a chemical composition which effects a combination of all the sandy particles into a homogeneous and congealed mass, which is then molded by enormous pressure into any shape or design. Any color desired may be given to the mass. No drying or burning is necessary, and it is claimed that the whole process can be operated on the most economical basis. The samples of brick produced appear hard, smooth, and dense and have clean and sharp edges and designs."

PAVING BRICK.

The utilization of brick for street paving has opened a new market for brick and created a distinct industry. Within the past few years thousands of miles of streets have been paved with this material throughout the West. Although this use of brick has passed the test of durability, it may still be said to be in the experimental stage, and there is much diversity of opinion and healthy discussion concerning the quality of the material and manipulation necessary for the production of perfect brick. The introduction of paving brick has also given great stimulus to the utilization of shales for brickmaking, and the vast beds of this material, which constitute such a large portion of our geological formations and hitherto considered worthless, are now proving of greatest value. According to the *Clay Worker*—

"It has grown to large proportions, requiring millions of dollars of capital. Chemical discoveries, supplemented by improvements in machiney and methods of burning, have made it possible to produce from some kinds of clay brick which rival granite in hardness, and yet the industry is in its infancy. The advance has been very rapid, and the industry has a great future. The brick made ten years ago withstood a pressure of from 500 to 4,000 pounds per square inch. Paving brick are now turned out which are capable of sustaining a pressure of 22,000 pounds per square inch. The chemical combination is of such a nature as to develop this enormous capacity for resistance."

The industry is rapidly spreading throughout the country, and there is hardly a state in the Union where excellent material does not exist.

The following notes are made of progress in this line:

New York.—It is but natural that the discovery of the utility of the Paleozoic shales for the making of paving brick should have attracted attention to the vast deposits of this material in New York State. According to the *Ithaca Journal* a sample of brick from the Campbell ovens at Newfield was recently tested in the mechanical laboratory of Sibley college with remarkable results. Ordinary brick, as found in the market, has a strength of from 3,000 to 5,000 pounds per square inch in resistance to crushing. The strongest brick known up to this time was a Canadian brick sent to Dr. Thurston for test years ago by Mr. Charles H. Haswell; and which bore nearly 10,000 pounds per inch. The Campbell brick sustained 250,000 pounds on one edge, or 16,000 pounds per square inch. At Alfred Center, New York, there are clay beds from which clay is obtained for making tile and terra cotta. A sample of hard-burned tile from that locality was tested at Columbia College School of Mines some time ago, which was officially reported to have borne a pressure of about 40,000 pounds per square inch. The samples here referred to were not specially hard burned, but were precisely as intended to be sent into the market for regular use.

Kentucky.—The subject of vitrified bricks for streets is exciting a great deal of attention in the West. Superior deposits of shale and marls in the Chester formation have been found in this State and the manufacture of brick has been entered into largely, especially in Cloverport, Breckinridge county, about 120 miles below Louisville, on the Ohio river.

West Virginia.—The fire and paving brick industry is carried on extensively in West Virginia in the counties of Taylor, Brooke, and Hancock, and according to Dr. I. C. White, Geologist of that State, they all come from the horizon of the Kittanning. The clay is the same in quality as that of East Liverpool, Ohio, Beaver, Rochester, New Brighton, and other localities, which are best adapted for paving brick, coke ovens, sewer pipes, and kindred products. Inasmuch as it fuses under a high heat, however, it can not be used as a first-class fire brick, but builds into all portions of structures where only a fair degree of heat is accumulated.

Rocky Mountain Region.—Excellent clays for making paving brick exist in the Cretaceous and Paleozoic formations of most of the States.

Texas.—Paving-brick works have been opened near Houston, and it was reported that that city would use them extensively.

TERRA COTTA.

The use of terra cotta is rapidly increasing in this country, both as an ornamental and economic material in structures. The term includes nearly all unglazed objects made from clay with the exception of brick and pottery. Its application is almost infinite from the cheapest drain tile used in agriculture, to extensive bas reliefs, cornices, columns, etc., used to give finish and ornament to the finest structures. It is only limited by the ingenuity or originality of the architect, and it will ultimately be largely used in every community.

Of recent years there has been a rapid increase in the use of this material in the interior walls of large buildings for fire-proofing and ventilation. The following note by Mr. A. W. Beidler, secretary of the Illinois Terra Cotta Company, is of interest in this connection:

"Terra cotta lumber is a material manufactured from clay mixed with sawdust, the sawdust being mixed with the clay while it is in a plastic state, after which it is run through machines that have dies attached thereto, and formed into blocks that fit between the floor beams in buildings. In burning the material the sawdust is totally destroyed, leaving the finished material porous or cellular. The material is also used for the covering of columns, girders, and all kinds of architectural iron work, and building partitions between offices. The reasons given for using this tile in preference to a tile made of pure clay are that it is less brittle and that it is a superior nonconductor of sound, and that it stands the action of heat and water very much better than tile made of pure clay, the porous nature of the material allowing it to contract and expand. The clay used by this company is the ordinary blue clay. The sawdust is secured from sawmills in Michigan, it being carried to the factory at Pullman by schooners."

The manufacture of all grades of tiling continued on a prosperous basis during the year. Under this heading there is a greater diversity of product than in any other branch of the clay worker's art, varying from the coarsest and cheapest material for drainage purposes to the beautiful and artistic tiles for interior ornamentation. In many of the large structures built during the year an increase was noticed in the use of roofing tile.

CHINA (POTTERY) CLAY.

The term china clay is indiscriminately used for many clays instead of being restricted to material for making white potter's ware. The name is also used for kaolin products employed as filling by the paper-makers. Of course it is not possible for us to change this nomenclature, but strictly speaking the term china clay should be reserved for the manufactured clay consisting of flint and kaolin used by potters.

The clay supply for the pottery industry of this country is drawn from the following sources: China clays (kaolin) (exclusive of the amount imported), New Castle county, Delaware; Chester and Delaware counties, Pennsylvania; Jackson county, North Carolina, and Lake county, Florida. This is the best American clay and enters into the manufacture of first-class American china ware. Ball clay, a commoner grade and used for common ware, is found extensively in New Jersey and Ohio. The Florida clay is the newest china clay, having been in the market only a little over a year (since September, 1892). It is very highly spoken of by potters who have tried it, but has yet to establish itself. It is very abundant in the natural state, but in refining yields a lower percentage than the other. New local fields are constantly developing as the old ones are exhausted in the Delaware and Pennsylvania territory.

The prospecting and development of new fields for clay material for the potter's use continued during the year, and some development was noted in the Carolina and Florida fields. The best potters express the opinion that the latter will be the source of abundant material for use in making the finest china clays. The country is still largely dependent upon foreign materials, however, not from the lack of the occurrence in America, but merely from the fact that our resources in this line have not been receiving proper study. It can be said that this country is fully able to supply all the materials used for making finer grades of potter's clay, but the European materials in most cases are cheaper and can be transported at less expense to the manufacturers.

The owners of the Palatkaha kaolin mines near Okahumka, Florida, have received word from the Trenton, New Jersey, potteries and also from France, that no clay like it in quality and flexibility has ever been found so far, and the amount of heat it will bear is perfectly wonderful. The company has a plant, costing $20,000. It has shipped 1,800 tons and have several hundred in the dryers ready. There is only one trouble—the freight rates to distributing points are high, and unless this serious trouble can be remedied, it will effect much damage.

POTTERY.

The manufacture of pottery has continued to increase during the year, and great improvement continues in quality. There is no industry so important to this country or which gives such great return to labor in the amount of wages in proportion to the small cost of raw material as this. It is also of the highest educational value, and its progress in America is a record of the growth of artistic knowledge in our country. It can now be said that whereas a decade ago we were dependent upon Europe for all crockery and were the recipients of the most common ware, from that country, under the stimulus arising from its manufacture in America, finer forms and quality have found introduction, and Europe, in order to obtain a market here, is forced to send its finest product. Furthermore, our potteries have ceased imitating foreign ware and have advanced in originality and independence, and American forms and designs are being copied in the kilns abroad. No works have done more to foster this art than such institutions as the Chesapeake Pottery, of Baltimore, Maryland, the Rookwood Pottery, of Cincinnati, Ohio, and the potteries of Trenton, New Jersey. Concerning the art in America the following description of American pottery wares and pottery work, by Mr. D. F. Haynes, is of interest (*a*). After speaking of the history of the industry in the United States, the work done at Trenton, New Jersey; Wheeling, West Virginia; and East Liverpool, Ohio, the writer describes the various kinds of pottery in use, as follows:

Descriptions.—The red earthenware, so familiar in our flower and bean pots, is made from the finer qualities of brick clay, and need only be mentioned in passing. Stoneware represented by our jugs, pots, and milk pans is made from a bluish clay and stands next higher in the ascending scale, having a homely beauty and value not always recognized. It is susceptible of receiving the most artistic touches, as shown by the work of the old English potter in his decoration of stoneware in cobalt blue, and by the fine drawing of sheep and donkeys executed with a dull point on the clay by Hannah Barlow at the Lambeth potteries. The glazing of stoneware by throwing common salt into the kiln when the firing is nearly finished is one of the most subtile and fascinating of the processes connected with the potter's craft.(*b*)

Akin to stoneware, because of being made from material prepared ready for the potter's hand by nature after her own formula, and next to it in value, come the grades known as yellow and Rockingham, made from a strong buff clay; the latter differing from the former chiefly in the rich brown color imparted to it by staining the glaze. Both are in demand for cooking purposes.

White wares suitable for household use are of four grades: (1) "C. C." ware, called C. C. because formerly cream-colored. This is a ware of considerable durability, and largely used on account of its cheapness. (2) White granite, which is a finer grade of ware, of a bluish tint, more largely used in this country than any other. It is strong and serviceable, and sold plain or decorated at prices within the reach of all. (3) A still finer ware, known by various names, but properly called "semi-porcelain," as the best brands of it are so nearly porcelain as to be translucent in pieces where the parts are very thin. In color it resembles French china. It is made of light weight, and well suited for dinner or toilet wares, being largely used for decorated sets, in which it is finished in great variety. (4) China or porcelain, either term may be used. This differs from the semi-porcelain described, chiefly in being made of the materials common to both, but so varied in proportion as to produce a vitreous translucent body of great durability. So near to the melting point must it be brought in firing that its pro-

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a The Home Magazine for August and September, 1892.

b The good results in this direction shown by a Milwaukee potter at the World's Columbian Exposition are also commendable.—Day.

duction involves great care at every stage and greatly increased expense. In fact, all successful potting may be said to depend upon practical experience guarded by constant watchfulness at all hours, every day in every year. The secrets are not many, but the hard work laid upon the superintendents is out of all proportion to the pecuniary recompense.

Materials.—The popular belief that earthenware and china are made of clay is true only in part. "Flint," which is white quartz rock, is abundant in this country, and is also used largely. "Feldspar," or feldspathic rock, is not so common as quartz, but easily secured of excellent quality. Both these materials are generally furnished to the potter in a finely powdered condition. Pottery glazes are varied to suit the wares upon which they are to be used; the ingredients, very carefully ground together, being such as to form, when fired, a coating of glass upon the ware of sufficient strength to protect the pieces from absorption of moisture and give luster and beauty to them.

The materials for the four grades of white ware mentioned are prepared for use by placing the proper quantity and quality of each to form the desired grade in a large tank fitted with revolving arms, where they are thoroughly combined and reduced with water to the consistency of thin cream. This slip is then forced by a steam pump into a press lined with canvas bags, the water in the slip being driven out through the canvas, leaving the mass the consistency of putty, soft and as plastic, and ready after kneading to be worked into form. The mass, although composed largely of flint and spar, still passes under the name of clay.

Making the ware.—The belief still prevails that pottery is made on that ancient instrument, the potter's wheel; but with all the sentiment attached to it, the wheel has been supplanted by a horizontal revolving disk driven by steam, known by the unpoetical name of "jigger." The "throwing" of ware, as in the olden times, is seldom resorted to in the production of white wares, nearly all the pieces being made upon or in plaster of Paris molds, which give the form required. To make a plate, saucer, or piece of similar shape, a thin bat of clay is thrown upon the mold by the workman, who places it upon the revolving jigger, pressing a tool upon it of proper form to shape the back, when it is carried away to dry, then taken from the mold, the edges finished, and it is ready for firing.

Hollow pieces, covered dishes, jugs and the like are made by the clay being pressed into the mold, which is divided into two parts so as to give access to the inside. The parts of the mold are then brought together, the seams covered with a roll of clay which is worked off smoothly and the mold set aside until, by the absorption of water from the piece by the plaster of the mold and the drying of the clay from the inside, the piece has so hardened and contracted as to be easily and safely removed; then the handle, which has been made in another mold, is fitted to the body and joined fast by a slip made from clay. The whole is smoothed off, finished, and, bearing the exact impress of the mold in which it was formed, it is placed in the "green room" to dry. Careful handiwork is required in all this manipulation, for, plastic as is the clay, it has rights that must be respected and it can not be forced too far. With all the care used many pieces are spoiled in the hands of the potter.

Firing.—Pottery kilns are solidly built of red brick lined with fire brick, and are about 16 feet in diameter inside and about 16 feet high inside to a crown or roof, above which the kiln rises, tapering in form to a sufficient height to give draft to the fires. Around the base are the fire chambers, eight or ten in number, above which are openings directly into the kiln, and from which lead flues under the floor of the kiln to the center. The kiln in which the ware receives its first fire is called the biscuit kiln. To protect the ware now prepared for firing, and which is ready to fall in pieces at a careless touch, boxes made of fire clay called "saggers" are used; these are made of all shapes to suit the ware, high, low, oval, and round, the sides being about an inch in thickness. One of these filled with ware is placed on the bottom of the kiln, with a roll of soft clay around the top; another sagger of same form, likewise filled, is placed on it, and the operation repeated until the tier or "bung" reaches the top of the kiln, other "bungs" are placed close to it, and this is kept up until the kiln is filled, then the door is bricked up and plastered over, the fires are lighted, and the work of burning begins. Gently, at first, the fires are fed, but after a time the interior of the kiln begins to glow. For two whole days and nights the firing goes steadily on until a blinding white heat fills the interior and a point equal to probably 3,000° Fahrenheit has been reached; this is maintained until the materials forming the ware have been thoroughly fused together and solidified, so that when withdrawn the pieces shall have the ring of metal. Now the fires are allowed to die, the cold air is carefully excluded, and three days given for cooling. When the kiln is opened and the drawing begins the broken pieces are cast aside and the good ones are carefully brushed and passed along to the dipping room. Here the "dipper," standing beside a tub filled with the glaze reduced to the thickness of cream, deftly catches a piece of the ware in his hand, gives it a whirl beneath the white liquid, a graceful shake as he withdraws it, and tosses it to a boy standing near, who places it on a board.

The kiln-man balances the board upon his head, and bears it away to the glost kiln for its second firing. This kiln and the saggers used are similar to those used for the biscuit firing, but still greater care is required in placing the ware, for if two pieces touch when the glaze melts in firing they will be cemented fast to each other. Hollow pieces can be placed upon the bottom of the saggers, which have been sprinkled with small bits of flint, the size of shot, to keep the wear from fastening to the sagger; but plates and flat pieces must be supported underneath by pins, with triangular points, made of clay, which are inserted in holes pierced in the sides of the sagger, and they are thus carried one above another while being fired. The firing of the glost kiln is accomplished in about twenty-four hours, and after cooling the kiln is opened and the wares are ready for the decorating department or to be placed in the bins of the glost wareroom.

Decorating.—In regard to the decoration of pottery Mr. Haynes says: "As this article deals with only the commercial product of our American potteries, it is not in place perhaps to refer to amateur decoration, so much of which is being done, but in fairness it can be said that a good deal of that class of work is praiseworthy. Much of it also emphasizes the fact, so generally conceded by our art instructors, that the American art student is unwilling, as a rule, to give sufficient time and study to the foundation work of drawing, and seldom takes up the study of design in earnest. Some of our art schools seem to leave their students to think that the sole end of art study is the painting of a picture, and neglect to provide thorough courses of training in design and decorative work, the benefits of which are so much needed by both amateur and commercial decorators of pottery.

"Hand-painting of the common motto-cup style is seldom employed by the potter at the present time, the copper-plate process being almost exclusively used. The design is engraved on a copper plate, mineral colors that will stand firing are mixed with a specially prepared oil, and a print is taken from the plate on a sheet of tissue paper; this is laid in proper position upon the piece of ware to be decorated and rubbed with a flannel until it adheres firmly. After a few hours the paper is removed and the perfect print remains on the ware. This is afterwards touched up with color by the women employed, their skill and knowledge having much to do with the character of the decoration produced, but no skill can compensate for the lack of a good design or make a poor drawing anything but commonplace. Tints covering the ware, or a good part of it, are sometimes used. They are applied by first covering the piece with a thin coat of oil, upon which the color in a fine powder is dusted; when the tint has been fired, a print can be applied on it and excellent effects secured. The application of gold either in the form that fires bright without burnishing or the preparation that requires after firing to be scoured or burnished, is made with a thin brush in same manner as color is applied.

"Simple as the processes used in decoration seemed to be, the field for the exercise of a refined taste in their application is boundless. The creation of good designs, the adaptation of decoration to form, the thousand combinations of color—all these deeply interest and draw forth the most earnest efforts of those who make a serious study of pottery decoration. The enamel kiln, in which the decoration is fired on the ware, is constructed with flues surrounding it, so that the fire can not come in direct contact with the ware, and therefore only fire-clay vats or shelves are required to place the ware upon in place of the sealed saggers used in the biscuit and glost kilns. From six to ten hours, firing is needed to give the decorations permanency, when the ware is removed from the kiln, examined, and wrapped for shipment."

The approach of the Chicago Exposition gave a healthy stimulus to the American potteries, and during the year each strived to put forth the best efforts of its art for the coming Exposition.

An American invention of the past few years marks a distinct advance in the decoration of pottery. This is a method of gilding invented by the Misses Healey, of Washington, District of Columbia. The process, of which they still retain the secret, produces a permanent and beautiful gold enamel and is cheaply applied. This process has received the highest encomiums, both in this country and abroad. It is also a matter of gratification to learn that some of the original designs of our American potteries have been copied by English makers. An increasing demand has also arisen for the Rookwood pottery, and some of its choicest pieces have been sold at good prices to the European art museums.

DEVELOPMENT AND DISCOVERY.

The importance of the study of the clay deposits of the country is gradually being appreciated by the State surveys and economic geologists. In addition to the descriptions of occurrences given in our last paper, the following occurrences are noted:

CLAY DEPOSITS OF KANSAS.

[By Chas. S. Prosser.]

The clay deposits of Kansas have not been examined carefully for any considerable part of the State, consequently their extent and value are as yet imperfectly known.

Clays suitable for the manufacture of common bricks are reported from 61 of the 106 counties. These clays are common in the eastern part of the State, and are surface deposits of the Quarternary, which are usually referred to the Loess or a modified form of it.

In the eastern part of Kansas are rocks belonging to the Carboniferous and Permian (?) systems, which are composed of alternating strata of limestones, shales, and sandstones, with some layers of coal. It has been discovered that some of the argillaceous shales produce an excellent quality of vitrified brick, and there is no doubt but that shales of this quality are of common occurrence in the eastern part of the State, so that the supply of raw material is practically unlimited. These deposits, however, contain characteristic Carboniferous fossils and are not properly *clays*, but shales, generally interstratified with limestones. These shales were first used for vitrified brick at Atchison in 1887, and since then plants for their manufacture have been established in several cities.

Near Topeka are good exposures of this shale, which makes a superior kind of vitrified brick for paving, which received an award at the Columbian Exposition, and a section of the quarry of the Capital City Vitrified Brick and Paving Company, 3 miles west of Topeka, gives a good idea of the general nature of these shales. In the lower part of the quarry are 17 feet of blue, very argillaceous shale, which hardens somewhat on exposure, and contains numerous small flakes of mica, some grains of quartz, iron, and carbonaceous material. Four feet from the base is a layer of calcareous concretions, also containing limonite and iron pyrites, which were collected largely about leaves of fossil ferns. The larger concretions are rejected from the shale before it is crushed for the brick. Above the blue shale 10 feet of yellowish shale, which is somewhat arenaceous, contains a considerable amount of mica and a greater quantity of iron than is found in the blue shale. Above the yellow shale are 2 feet of soil, while a little farther south, along the low hill, is an exposure showing that the shale is capped by a stratum of coal 14 inches thick, above which are 4 feet of olive shale, with a massive limestone stratum on top 2 feet or more in thickness, called the "cap rock."

In the preparation of the shale for the manufacture of brick alternate cars of the two kinds of shale are sent to the crusher, where the material is partly mixed; then it goes to the "pug mill," where it is thoroughly mixed and moistened and then passed to the "Boltz machine," where it is cut into bricks, which remain for forty-eight hours in dry kilns heated by steam, and then are burned from eight to ten days in kilns, the product being a vitrified brick of great strength. When only the blue shale is used the bricks are somewhat brittle and do not possess the toughness of those made of the mixed shales. It is to be noted that the brick is produced from simply the natural components of the shale and does not require the addition of any other material for vitrifaction.

During the present year pressed brick of fair quality have been made from these shales, and the only difficulty, which might be overcome by "seasoning," seems to be the excessive moisture in the shales when first taken from the quarry. The production of the Capitol City Company for the year 1893 is 550,000 pressed and 1,900,000 vitrified brick.

Six miles west of Topeka are Earnest's vitrified brick works, the shale for which is obtained from a stratum above that used at the Capitol City works and consequently overlying the coal stratum and limestone which were described as above the Capitol City shale. In the Earnest quarry are 26 feet of blue, argillaceous shale, which is covered by some yellowish decomposed shale. Mr. Earnest states that the blue shale has a thickness of 40 feet.

In Mission Township, 9 miles west of Topeka, higher than the stratum at the Earnest works, is another layer of shale suitable for vitrified brick, which, according to Mr. Ebey, has been drilled through, giving a thickness of 98 feet.

At Pittsburg, Crawford county, near the base of the Lower Coal Measures, a stratum of shale 12 feet thick is used for vitrified brick. Fire brick are also made at this place. The Pittsburg Vitrified Paving Brick Company reports for the present year that it has made 3,500,000 vitrified and 500,000 fire brick.

The other cities making vitrified brick in 1892 reported to Prof. Hay the following production: Atchison, 4,000,000; Leavenworth, 1,000,000, and Osage City, 200,000.

Pottery clay is reported from fifteen counties of the State, and at Fort Scott, in Bourbon county, and at Geneseo, in Rice county, brown earthenware is manufactured. A very good quality of pottery clay is found near Lyons, Rice county, and near Kanoplis, Ellsworth county, is a deposit of quite pure kaolin.

Prof. Hay states that drainage tile are made at Burlingame and Paola.

Near Kingman are brownish and gray Triassic shales which have been used for mineral paints, the brown paint being called "Cherokee" brown. Near Salina, Dickinson county, are reddish and grayish shales of the Cretaceous (Dakota), which in character resemble those near Kingman.

NEW YORK.

An excellent paper on the clays of New York State and their economic value has recently been published under the directions of the New York Academy of Science, December, 1892. According to the writer (Mr. Heinrich) deposits of clay suitable for the manufacture of brick, tile, etc., are found in nearly every county, and the introduction within the last few years of new forms of machinery and of improved methods give every indication of future success. Concerning the economic clays of this state he says:

"The economic value of the clays of New York is becoming of more importance each year. There are about three hundred and fifty yards which manufacture building brick alone, giving an annual production of about 1,300,000,000 brick. The income from this branch of the clay industry alone amounts to about $8,500,000 annually.

"In most cases the yards are situated so as to afford the greatest ease and facility of working. Along the Hudson river the clay is rarely hauled over 300 feet, and this on a down grade. The barges for transporting the brick can be brought to within a few feet of the kiln. All the Hudson river yards mold their brick by the soft-mud process; indeed, this is the one commonly used in most parts of the State.

"The Hudson river yards send their product chiefly to New York city. The yards in the north and west portion of the State are usually situated on some line of railroad, and their product is chiefly locally used. In many of these we find the artificial drying of the brick to be the favorite method. They use in most cases stationary kilns.

"The repressed brick made at Newfield are found to stand one of the highest pressures on record, viz, crushing at 240,000 pounds. The Syracuse paving brick will stand even more. These were tested on edge.

"In the western portion of the State many drain tile are made. Sewer pipe are manufactured at several localities, the native clay being mixed with a certain proportion of Jersey fire clay.

"Roofing tile, terra cotta, and paving brick are among the clay products of the State.

"Shale is another substance which has come into use within the last few years for the making of brick, in this State, the Hamilton, Chemung, and Salina ware being employed.

"The shale is pulverized first in a dry pan to a very fine powder and then ground with water, and in this state is plastic and can be molded into brick, etc. It very often gives better results than the clays.

"Future experiments will no doubt show the availability of shales of other formations than those now used for the manufacture of clay products. It is certain we have in this State an abundant supply of clay, and a still more abundant supply of shale."

NORTH CAROLINA.

Much has been said during the past year about the kaolin deposits of North Carolina, and several companies organized to work the same. The native product has all the appearance of superior quality. The total production of prepared kaolin in this State in 1892 is estimated at 3,900 tons, valued at $31,200 at the works. The principal industries were the mines at Sylva, Dilsboro, and Webster, in Jackson county.

GEORGIA.

Mr. J. W. Spencer, formerly State Geologist of Georgia, makes the following note concerning the clay deposits of Georgia in the *Manufacturers' Record* for March, 1893:

"The clays of the State are extremely variable. There are fire clays in all the great groups or formations described, and some of these are naturally white and form kaolin; others, again, are tinted. Some of the most extensive deposits of these clays occur along the northern belts of the Tertiary strata in the southern part of the State. The clays suitable for brick purposes are valuable, and capable of producing bricks equal in beauty to the Philadelphia pressed brick and others, through all the grades, to bricks of poor quality. Some of the clays, or mixtures of clays, are capable of making vitrified brick and roof tiling as well as underground tiles. White sands are abundant, especially on the northern border of the Tertiary rock."

IOWA.

The excellent First Annual Report of the new State Geological Survey of Iowa notes the occurrence of excellent shales in the Carboniferous formation of that State. They disintegrate rapidly under the influences of the weather, forming a very plastic clay, which is valuable for brick. The geographic extension of these shales is not known at present, nor is their stratigraphic position fully understood. In southeastern Iowa the clay shales at Burlington have been recently brought into prominence in the manufacture of paving brick. According to this report, throughout all the Coal Measures in Iowa occur unlimited quantities of shale of excellent quality for the manufacture of paving, press, fire, and other kindred brick. An excellent quality of potter's clay material for tiling, terra cotta, and, in fact, nearly all other kinds of clay products, are plentiful. Speaking of the clays in the vicinity of Sioux City, it is said that they are by no means of the highest grades, but there are clays enough to supply the whole world with all the products that can be made from such clays as do occur. Among the numerous articles that may be produced it will be sufficient to specify building brick, paving brick, fire brick, pressed brick, pottery, yellow ware, terra cotta, drain tile, sewer tile, and fancy or ornamental ware.

ILLINOIS.

The approaching opening of the Columbian Exposition inspired a large increase in the production of brick and other clay products in Illinois during 1892, and innumerable brickyards have been opened up within a short radius of Chicago. The manufacture of shale brick has continued active.

TEXAS.

Mr. N. F. Drake, in his report on the Colorado Coal Field of Texas (Austin, 1893, page 439) makes the following interesting report on the clays of the Carboniferous formation of that region:

"There are two classes of clays in this district—one, composing the regular strata of the beds, and the other Quaternary deposits, or accumulations of clays worn from the outcropping clay beds and deposited in valleys at the foot of escarpments, etc. These later deposits are more or less mixed with other materials, especially where other than clay strata are near by. Sand nearly always forms a large per cent. These are the deposits that are used in making brick, as they contain the desired proportions of sand and clay to make good brick. This class of deposit is abundant in the Coal Measures, and good brick-making material may be found in any of the divisions, but especially in the Strawn and Cisco divisions.

"The strata throughout the divisions afford clays with varying proportion of the elements, especially sand, lime, and iron. The lime, however, usually forms but a small per cent. Iron is usually contained in a high per cent., especially in the clays above the central part of the Cisco division.

"The following analyses represent the greater part of the clay of the Carboniferous below the middle part of the Cisco division:

"No. 1—Canyon division, Brownwood bed, 1½ miles northeast of Milburn.

"No. 2—Cisco division, Waldrip bed, clay above the coal seam at the Silver Moon mine.

Analyses of Texas clays. (a)

	No. 1.	No. 2.
Water	1.70	1.70
Loss on ignition (water and carbonic acid)	7.00	7.07
Silica	57.60	55.57
Ferric oxide	6.14	7.35
Alumina	19.34	22.04
Lime	1.22	.35
Magnesia	2.01	1.35
Potash	2.02	1.04
Soda	2.73	3.46
Total	99.86	100.02

a Analyses by L. E. Dickson.

"The high percentage of the fluxing elements of iron, lime, magnesia, potash, and soda in these clays shows they are not fire clays, nor clays that can be used for the finer grades of manufacture; but as they represent the general character of the clay beds, and not particular deposits, better clays may be expected to be found as soon as the deposits can be more closely examined."

Mr. Kennedy notes the occurrence of fair brick clays in Grimes, Brazos, and Robertson counties. In his report on these counties, Geological Survey of Texas, Austin, June, 1893, he says:

"In several portions of Grimes county deposits of clay exist in greater or less quantities and in qualities ranging from the ordinary brick earths to a grade suitable for the manufacture of the ordinary or even finer grades of earthenware.

"Brick clays or earth occur at different portions of the country, but no steady brickmaking industry is carried on. Near Navasota a yellowish brown earth has been used for brickmaking purposes at intermittent times for years, and the bricks used in Navasota for building and paving purposes were made in this yard. These bricks are very hard and of a brown color, more or less spotted with blue iron stains. A good grade of yellowish gray earth for brickmaking occurs in great quantities in the neighborhood of Anderson. By care in selecting the materials two grades of bricks can be obtained in this neighborhood, distinguishable chiefly by their color, as both, when properly made, are hard and of good texture. In color they range from a creamy white to a yellow in the first grade and a brick red in the second grade. The new court-house at Anderson is built of these bricks, and presents a very pleasing effect.

"An extensive deposit of a good clay occurs in the neighborhood of Piedmont Springs. The high percentage of the alkalies, iron, lime, and magnesia contained in this clay places it in the anomalous position of midway between the grade of a good pottery clay and a 'slip' clay. It might probably, with care, be utilized for certain grades of earthenware. In composition the Piedmont clay closely resembles the 'Albany' slip, so much used among the pottery manufacturers for glazing purposes, and by careful preparation, with the addition of a small quantity of lime, might be utilized for glazing in the same manner as the kaolite slip clay of Ohio. Throughout the northern portion of the county deposits of clays suitable for the manufacture of coarse earthenware occur in many places.

"Throughout the greater portion of Robertson county good brick clays or earths are plentiful, but with the exception of one yard at Calvert and two at Hearne no permanent brickmaking is carried on, and even the yard at Calvert has been idle for sometime. In only one of the yards at Hearne is work carried on continuously and systematically. This yard, that of Mr. Robb, employs about 20 men during the busy season, and during 1892 the total output was 1,250,000, at a value of $12,500. The bricks are handmade and dried under cover. In burning, bituminous coal is chiefly used. The smaller Elliott yard turned out 500,000.

"In the northeastern portion of the county deposits of clay suitable for the manufacture of the finer grades of earthenware exist. Clays closely approximating the Kosse fire clays also exist in this region. These clays were examined by Prof. Streeruwitz a number of years ago, and considered a fine grade of fire clay."

It has been announced that a vitrified brick plant was established at Garrison, where the brick for paving will be manufactured. This will be an important industry for Texas, and Austin will have the distinction of first introducing Texas-made vitrified brick in its streets.

In addition to the unique conditions of Texas relative to the occurrence of materials for making pottery clay, mentioned in the last volume of Mineral Resources, it is highly probable that the Paleozoic shales of the State contain abundant material for paving brick.

THE ROCKY MOUNTAIN REGION.

The year 1892 witnessed a great increase in the development of the brick and fire clays of the Rocky mountain region. It is estimated that the Denver yards produced about 85,000,000 brick, employing 800 workmen. Considerable progress was made in this city in the increase in the manufacture of burned brick. The demand for out-of-city pressed brick has almost entirely ceased. At Pueblo, Socorro, and other places the brickmaking trade continued fair.

WASHINGTON.

The principal clay product of this State, as near as can be learned, is estimated at about 30,000,000 manufactured in the vicinity of Puget sound last year.

NATURAL AND ARTIFICIAL CEMENTS.

By Spencer B. Newberry.

HYDRAULIC CEMENT.

The manufacture of cement from natural rock during 1892 reached greater magnitude than in the previous year, the production in 1892 being about 450,000 barrels in excess of that in 1891. The increase was greatest in the Louisville region, in Indiana and Ohio, while some of the less important centers of production show a slight decline. The only new works established during the year are, so far as known, the Milroy Cement Works, at Milroy, Pennsylvania. The depressed condition of prices which prevailed during 1891 has continued without relief throughout the past year; indeed, it is difficult to understand how the manufacture can be carried on without actual loss at the present price of cement, which in some sections does not exceed 25 cents per barrel, in bulk, at the works, or but little more than the average price of common lime. The cost of manufacture of cement, however, greatly exceeds that of lime, on account of the expensive operation of grinding to which the cement is subjected after burning.

The following table gives the amount and value of hydraulic cement produced in various regions during 1891 and 1892:

Product of hydraulic cement in 1891 and 1892.

States.	1891.			1892.		
	Number of works.	Barrels.	Value.	Number of works.	Barrels.	Value.
Georgia	1	40,000	$40,000	1	50,393	$41,294
Illinois	2	409,877	276,931	2	472,876	236,438
Indiana and Kentucky	12	1,513,009	983,456	13	2,100,000	1,365,000
Kansas and Missouri	2	135,000	94,000	2	110,000	77,000
Maryland and West Virginia	5	233,900	210,955	5	252,092	220,991
Minnesota	1	101,875	76,406	1	100,000	75,000
New Mexico	1	33,750	33,750	1	10,000	10,000
New York—						
Onondaga county	8	300,941	197,344	8	240,580	152,550
Ulster county	17	2,815,010	2,252,008	17	2,833,107	2,408,141
Schoharie county	1	27,055	21,644	1	32,000	27,840
Erie county	4	788,300	575,283	4	675,000	486,250
Ohio	2	70,000	68,000	2	56,863	53,863
Pennsylvania	6	695,000	536,600	6	664,594	502,511
Texas	1	40,000	40,000	1	40,000	40,000
Utah	1	5,000	10,000	1	5,000	7,500
Virginia	1	20,000	18,000	1	10,000	10,000
Wisconsin	2	539,262	269,631	2	558,676	284,772
Total	67	7,767,979	5,704,008	68	8,211,181	5,999,150

GENERAL NOTES ON HYDRAULIC CEMENT.

Louisville, Kentucky.—The Western Cement Association, which controls nine factories, has now made arrangements by which it acts as selling agent for all the works, thirteen in number, in the Louisville region.

Kansas.—The Fort Scott Cement Company, which built new works at Fort Scott about three years ago, discontinued business at the close of the year 1892. The older works at Fort Scott, belonging to the Kansas City and Fort Scott Cement Company, are still in successful operation.

Ohio.—The cement works at Defiance, Ohio, where cement was formerly made from the "black slate" are being rebuilt, and will soon be in operation.

Virginia.—Owing to serious freshets, by which the cement mills at Balcony Falls have several times been damaged, the office and grinding department of the James River Cement Company were removed to Lynchburg in 1890. During the past year the location of the works was again changed to Holcombe's Rock, where operations were begun during the summer of 1892.

Wisconsin.—In addition to the works already established at Milwaukee, a new company has been organized for the erection of works on the shore of Lake Michigan, near the city of Milwaukee.

PORTLAND CEMENT.

The manufacture of Portland cement, from artificial mixtures of carbonate of lime and clay, is steadily increasing in the country, and there is no reason to doubt that within a very few years all of the artificial cement used in the country will be produced at home.

The product for 1892 was 547,440 barrels, an increase of about 100,000 barrels over 1891. This quantity is, however, only about one-fifth as great as that imported from Europe during the same year.

Several new factories are in process of construction, and there seems to be a widespread awakening to the fact that this country possesses abundant supplies of excellent cement material, and that there are no difficulties in the process which can not be surmounted here as well as abroad. From a pecuniary point of view the industry can not be said to have been, as yet, distinctly profitable in this country. The various operations of mixing, drying, grinding, and bolting which the process involves entail a large amount of labor, and the high price of intelligent labor in this country has, up to the present time, more or less completely counterbalanced the cost of importation. Several factories established during the past few years have subsequently been abandoned, and a number of the works now in successful operation were run for a long time at a loss.

The effect of the high price of labor is shown in the repeated efforts which are being made in this country to develop new processes requiring less hand labor or to replace the latter, as far as possible, by machinery. The preparation of the raw material and mixing of the ingredients, and also the operation of burning, are the parts of the process which in Europe demand the greatest expenditure of labor. In England, and to a large extent in Germany, the wet process of mixing is employed. In this the raw materials are thoroughly agitated with water and washed through fine screens, and are thus freed from all coarse particles. The thin slurry is then allowed to settle for weeks in large tanks or basins, and the supernatant water drawn off. This gives a very perfect mixture, but is quite out of the question in this country, owing to the labor required and the cost of drying out the very wet slurry obtained. The dry process, also largely used in Germany, in which the materials are separately dried and ground and mixed together in the form of dry powders, has been introduced in this country, especially in localities where dry crude materials are available, as in southeastern Pennsylvania. It has been found, however, extremely difficult to mix dry powders together on a large scale so as to produce a uniform material. Subsequent grinding of the mixtures promotes uniformity and homogeneity, but adds greatly to the expense. Further, the mixture must usually be molded into bricks for burning, and for this another moistening and drying are necessary. In this country the available materials are chiefly shell-marl and clay, both usually in a very wet condition. The semi-wet process is almost everywhere followed. This consists in charging the materials, in a wet state, into large iron pans, provided with heavy rolls or edge-runners. In these the plastic materials are thoroughly blended; the mixture as it issues from the pans is molded directly into bricks, dried, and burned. In one or two cases the brick-making is omitted, and the wet mixture spread out to dry on floors heated by steam pipes, and cut up into blocks with spades, as is commonly the practice in England.

This semi-wet process is certainly by far the most economical. Its only drawback is, however, the almost invariable presence of a certain proportion of coarse particles (shells, etc.) in the materials. These are but little crushed in the pans, and are a source of free lime in the resulting cement, giving rise to a tendency to crack after setting. Attempts have been made to grind the plastic material after mixing in buhrstones. The operation is, however, exceedingly slow, and has not been successfully used. If the amount of coarse material present is slight, exposure of the cement to the air for a week or more after grinding has the effect of slacking the free lime present, and renders the cement sound. A certain period of seasoning is in fact always necessary, in order to overcome the ill effects of free lime, due to incorrect proportions or imperfect mixture.

The burning is also an operation requiring a large amount of hand labor, and many attempts have been made to simplify and cheapen this stage of the process. The old form of intermittent kilns is still most largely used in Europe, the cement mixture, in the form of bricks, being charged with coke into shaft kilns, which are allowed to burn out and cool down before they are drawn. To charge, burn, cool, and empty a kiln requires a week, and from 60 to 100 barrels of cement are obtained at each burning. The labor of charging the kilns, breaking out the agglomerated clinker, and picking out the underburned portions by hand is very great. Continuous kilns, of the Dietzsch type, for example, effect a saving of labor, and permit the use of slack coal instead of coke. These have been introduced at two factories in Ohio, and are certainly immensely more advantageous than the old common kilns. It is stated that in Germany more than 2,000,000 barrels of cement (about one-fifth of the total product) are burned annually in Dietzsch kilns. The Shöfer kiln is somewhat similar in principle, and is also coming rapidly into use in Germany.

The use of furnaces of the rotary type, consisting of an inclined revolving cylinder heated by gas or oil, through which the material passes in a constant stream, is making great progress in this country, though reported to have failed in England when tried several years ago. While acting as consulting chemist at works near Syracuse, New York, during the past year, the writer had the opportunity of fully testing the capabilities of the rotary process, and can speak highly of its efficiency and economy.

The rotary process for burning cement certainly possesses the advantage of economy in first cost and in hand labor. As to the quality of the resulting cement, it appears that greater care is necessary in securing a perfect mixture of the ingredients, since the combination of the silica, lime, and alumina must take place in the half hour, at most, during which a given portion of the charge is passing through the hot part of the furnace. In the common or continuous vertical kilns the materials are kept for several hours at a white heat, and combination appears gradually to take place, even with very imperfect mixing. With properly prepared materials, however, it is certainly possible by the rotary process to produce faultless cement, showing by the tests for constant volume that the ingredients are perfectly combined, and that no free lime is present.

One important advantage in the rotary process is its applicability to materials containing a high percentage of sulphate of lime. Such materials in the common kilns often produce cement containing much sulphides. This cement turns blue on immersion in water and is deficient in strength. This is due to the reducing action of the fuel in the kilns, and is especially liable to occur when the draft is poor. Owing to the ease with which the flame in the rotary furnace can be controlled, it is possible to maintain a purely oxidizing flame, by which the formation of sulphides is prevented, and the sulphates present are largely decomposed. On analysis of a cement prepared in the rotary furnace from a mixture containing nearly 4 per cent. calcium sulphate, the writer found only 1½ per cent.; the remainder having been decomposed during the burning.

The rotary process has been introduced at several points in this country, and appears to have been almost uniformly successful. The works at Coplay, Pennsylvania, where the process has been in operation for several years, have lately been considerably enlarged. The factory at Warners, New York, using the same process, was in continuous operation during the past year. New works to use the rotary furnace have been established at Phillipsburg, New Jersey, Montezuma, New York, and Sandusky, Ohio.

The great advantage of the process seems to be that it obviates the necessity of molding the mixtures into bricks and drying on pallets, an operation requiring much hand labor, and allows the materials to be dried in cylindrical dryers by the waste heat of the burning furnaces.

During 1892, 104,000 barrels of cement were produced in the rotary furnace, an amount equal to nearly one-fifth of the total product.

The following table gives the production of Portland cement in the United States during 1891 and 1892:

Product of Portland cement in 1891 and 1892.

States.	1891.			1892.		
	Number of works.	Barrels.	Value.	Number of works.	Barrels.	Value.
California	1	5,000	$15,000			
Colorado	1	12,500	40,000	1	10,000	$30,000
Dakota	1	31,813	71,579	1	34,000	68,000
Indiana	1	15,000	36,000	1	12,000	30,000
New Jersey				1	20,000	40,000
New York	5	87,000	190,250	4	124,000	279,000
Ohio	2	35,000	82,000	2	46,600	108,500
Pennsylvania	6	268,500	532,850	6	300,840	597,100
Total	17	454,813	967,429	16	547,440	1,153,600

GENERAL NOTES ON PORTLAND CEMENT.

California.—The projected works at Santa Cruz, referred to in the report for 1891, have not yet been erected, though efforts are still being made to obtain the necessary capital. The material which it is proposed to use is a soft "coralline" limestone of extraordinary purity, and practical tests have shown conclusively that excellent cement can be made from it.

The Jamul Cement Works at San Diego discontinued operations at the close of 1891, owing to the fall in price of foreign cement in the San Francisco market.

Canada.—Portland cement works have lately been established at Owen Sound, on Georgian bay, and also at Napanee, on Lake Ontario. At the former rotary furnaces are used for burning the cement.

Illinois.—Works are being erected at Deer Park Glen, near Utica.

New York.—At Tomkins Cove, Rockland county, where the manufacture of cement was carried on experimentally during 1891 and 1892, works are now being erected and will soon be in operation. The material used is a white shell-marl.

The new factory of Millen & Sons, at Wayland, began operations in October 1892. (*a*) Samples of the product tested by the writer were found to possess remarkable hardening properties, and showed a tensile strength, especially at one day, greatly in excess of most imported cements. The capacity of the mills is 300 barrels per day.

The works of the Warners Company, at Warners, were in continuous operation during the whole of the year 1892, and the difficulties formerly encountered in the use of the rotary furnace appear to have been completely surmounted. (*b*)

At Montezuma a factory has lately been erected, and cement was made there during the year from the marl which underlies, at varying depth, the whole of the great Montezuma marshes, which cover many thousand acres of territory. At these works (c) the process of manufacture has been most surprisingly simplified. The wet marl and clay are mixed in a peculiar pug-mill, and the soft slurry is run directly into the upper end of an immense rotary furnace, 70 feet long and 6 feet in diameter. In this furnace the charge is dried, calcined, and burned to clinker, issuing in the form of irregular fragments of the size of coarse gravel. As yet the industry can hardly be said to have passed the experimental stage, but there can be little doubt of the cheapness of the operation, all handling being avoided. Probably the chief difficulty, if any is encountered, will be that of obtaining a sufficiently intimate mixture of the ingredients without some process of grinding between the operations of drying and burning.

A company has been organized to manufacture Portland cement from the large deposits of marl which occur on the west shore of Onondaga lake, on the outskirts of the city of Syracuse.

Ohio.—Near the close of 1892, an extensive plant for the manufacture of Portland cement was begun at Martin's point, five miles west of Sandusky, on the shore of Sandusky bay. The large marsh between Martin's point and the town of Venice is underlain by a bed of very pure white marl, several hundred acres in extent. The point itself is formed of a bluff of yellow Erie clay, which at that locality is perfectly

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a Destroyed by fire early in July, 1893.

b Destroyed by fire in February, 1893; now being rebuilt.

c Destroyed by fire in June, 1893.

free from sand or bowlders. The following analyses give the composition of an average sample of the marl and clay:

Analyses of marl and clay from Martin's point, Ohio.

Marl.	Per cent.	Clay.	Per cent.
Carbonate of lime	92.6	Silica	64.7
Sulphate of lime	2.8	Alumina	11.9
Carbonate of magnesia	0.5	Iron oxide	9.9
Insoluble	0.2	Lime	0.9
Organic matter, moisture, and alkalies (by difference)	3.9	Magnesia	0.7
Total	100	Moisture, combined water, organic matter, and CO_2	11.9
		Total	100

Pennsylvania.—The production of Portland cement shows a great increase over 1891. This region still produces more than one-half the total amount made in the United States, in spite of the considerable increase in other sections. The Atlas Company appears to have been completely successful in the use of the rotary furnace, and contemplate the building of an extensive plant at Northampton, Pennsylvania.

With the works of this region should properly be included the factory erected during the year at Phillipsburgh, New Jersey, opposite Easton, Pennsylvania. The building of these works was begun in November, 1891, and completed in July, 1892. The rotary process is employed at these works also, and has been found fully successful.

IMPORTS AND EXPORTS OF CEMENT.

The importation of cement during 1892 showed a slight decrease from that of 1891. This is perhaps due in part to over-importation during the former year, and also to the increased production of cement in this country. The imports during the past three years were as follows:

Imports of Portland cement for three years.

Years.	Barrels.	Value.
1890	2,584,125	$3,175,159
1891	2,807,820	4,021,998
1892	2,686,921	3,855,572

The exports of cement during 1891 amounted to 83,607 barrels; in 1892, 79,179 barrels.

From the figures already quoted the total consumption of cement in the United States in 1891 and 1892 may be calculated as follows:

Consumption of cement in 1891 and 1892.

	1891.	1892.
	Barrels.	*Barrels.*
Production hydraulic cement	7,767,979	8,211,181
Production Portland cement	454,813	547,440
Imports of cement	2,807,820	2,686,921
Total	11,030,612	11,445,542
Deducting exports	83,607	79,179
Total consumption	10,947,005	11,366,363
Increase consumption in 1892		419,358

NOTES ON THE CHEMISTRY OF CEMENT.

Cement possessing hydraulic properties is always obtained when a mixture of carbonate of lime and clay, in proper proportions, is strongly heated. Although this operation appears very simple, yet the chemical reactions which take place in the burning and hardening of cement, and the chemical nature of the cement itself, are still more or less obscure. Le Chatelier has shown, perhaps conclusively, that the essential constituent of Portland cement, burned at high temperature, is a compound of silica and lime, probably of the formula $3CaO.SiO_2$. The alumina and oxide of iron of the clay appear, therefore, to play an unimportant part in the hardening of cement. Nevertheless, Le Chatelier failed to obtain the trisilicate on heating lime and silica together, a mixture of lower silicates (bisilicate) and free lime being always obtained. It is evident, therefore, that in order to produce complete combination of the silica and lime at the temperature of the cement-kiln, some other substance, such as alumina or iron oxide, must be present to act as a flux. By fusion with the oxyhydrogen blowpipe, however, the writer has lately succeeded in bringing pure silica and lime into combination in the proportion required by Le Chatelier's formula, obtaining a product which showed all the qualities of good cement. It appears, therefore, that the possibility of making cement from silica and lime alone is only a question of temperature. As to the part played by the alumina and iron oxide of the clay, it is interesting to recall that Dr. Schott long ago found that the alumina in cement mixtures can be completely replaced by oxide of iron, or the oxide of iron by alumina, without injury to the resulting product. He thus obtained cements containing only silica, lime, and alumina; and equally good cements containing only silica, lime, and iron oxide, showing that alumina and oxide of iron act in a precisely similar manner.

The exact way in which the alumina acts in promoting the combination of silica and lime is, however, still more or less uncertain. Le Chatelier considers that in the burning of cement the silica and alumina first combine with a small amount of lime, forming a fusible glass, and that this gradually takes up more lime, becoming more and more basic and at the same time less fusible, until finally the all-important trisilicate, which is the essential constituent of cement, is produced. Le Chatelier has, however, shown that alumina and lime form exceedingly fusible aluminates, especially when the lime is present in large proportion. In view of this fact it seems to the writer much more probable that a fusible aluminate is first produced, and that this is then gradually decomposed by the silica with the formation of the trisilicate, the alumina finally remaining in combination with a comparatively small proportion of lime. Substantially the same view has already been advanced by Michaelis. Experiments now in progress under the writer's direction are expected to throw light on this interesting question.

In the case of hydraulic cement, made from natural rock, the conditions are very different. The cement rock used in this country usually contains a high proportion, often 30 per cent., of magnesium carbonate. Late experiments by Erdmenger and others seem to prove that magnesia is an inert material in cement mixtures, and that this constituent does not combine with silica and alumina after the manner of lime. The injurious effect of magnesia in Portland cement is ascribed to the very slow hydration and expansion of the free magnesia contained in the cement, causing cracking of the mass weeks or months after immersion in water. Magnesium carbonate calcined at low heat combines readily with water; that which has been heated to the temperature of the Portland cement kiln becomes hydrated only after the lapse of long periods of time. The harmlessness of magnesia in common hydraulic cement is doubtless due to the readiness and completeness with which it becomes hydrated on mixing the cement with water.

It is well known that in making Portland cement the proportions of basic and acid constituents (lime and clay) must be almost absolutely constant, the best results being obtained with from 2.8 to 3 parts of lime to 1 part of silica. In natural-rock cement, if the magnesia be disregarded, the clay will generally be found to be very greatly in excess, the proportion of lime to silica not usually exceeding 1½ or 2 to 1. At the low temperature at which the natural-rock cement must of necessity be burned, it is probable that the chief reaction which takes place is the combination of the alumina with the lime, and that most of the silica remains uncombined. The quick setting properties of hydraulic cement accord closely with the behavior of calcium aluminate, and indicate that the latter is the active constituent in cement made from natural rock. The progressive hardening of this cement under water, and the great strength which it often ultimately attains may be explained by the gradual action of the amorphous silica present on the aluminate, an action similar to that known to take place between the silica of pozzuolana, slag, etc., and slaked lime.

ABRASIVE MATERIALS.

By E. W. PARKER.

BUHRSTONES.

The value of buhrstones made from stone of domestic production in 1892 was $23,417, an increase of $6,830 over that of 1891, when the total value was $16,587. The producing States were New York, Pennsylvania, Virginia, and Vermont, the last named appearing for the first time as a producer of this article. Until 1892 the production of buhrstones has steadily declined, the output in 1891 being the smallest ever recorded, and although the production increased somewhat in 1892 it is not probable that it will continue to do so. The introduction of the roller process in flouring mills has practically shut out buhrstones, and the only demand at present is for grinding paints, cements, etc. The decline in the use of American stone has been accompanied by a similar falling off in the use of imported stones. As was the case in domestic production, the imports in 1891 were the lowest in several years; in fact, with one exception, the smallest on record. The general tendency of importations has been on the decrease since 1880, when the total value was $125,072, and since 1884 they have reached $40,000 in one year only—1889. They decreased both in 1890 and 1891, but show, like the domestic production, an increase in 1892.

The following table shows the value of buhrstones produced in the United States since 1883:

Value of buhrstones produced in the United States since 1883.

Years.	Value.	Years.	Value.
1883	$150,000	1888	$81,000
1884	150,000	1889	35,155
1885	100,000	1890	23,720
1886	140,000	1891	16,587
1887	100,000	1892	23,417

Value of buhrstones and millstones imported into the United States from 1868 to 1892.

Years ended—	Rough.	Made into millstones.	Total.	Years ended—	Rough.	Made into millstones.	Total.
June 30, 1868..	$74, 224	....	$74, 224	June 30, 1881..	$100, 417	$3, 495	$103, 912
1869..	57, 942	$2, 419	60, 361	1882..	103, 287	747	104, 034
1870..	58, 601	2, 297	60, 898	1883..	73, 413	272	73, 685
1871..	35, 406	3, 698	39, 104	1884..	45, 837	263	46, 100
1872..	69, 062	5, 967	75, 029	1885..	35, 022	455	35, 477
1873..	60, 463	8, 115	68, 578	Dec. 31, 1886..	29, 273	662	29, 935
1874..	36, 540	43, 170	79, 710	1887..	23, 816	191	24, 007
1875..	48, 068	66, 991	115, 059	1888..	36, 523	705	37, 228
1876..	37, 759	46, 328	84, 087	1889..	40, 432	452	40, 884
1877..	60, 857	23, 068	83, 925	1890..	32, 892	1, 103	33, 995
1878..	87, 679	1, 928	89, 607	1891..	23, 997	42	24, 039
1879..	101, 484	5, 088	106, 572	1892..	33, 657	529	34, 186
1880..	120, 441	4, 631	125, 072				

GRINDSTONES.

The production of grindstones shows a decrease of over $200,000, the output in 1892 being valued at $272,244 against $476,113 in 1891. The product is all, practically, from Michigan and Ohio, though a small output is reported from California and South Dakota. The annual production since 1880 has been as follows:

Value of grindstones produced in the United States, 1880 to 1892, inclusive.

Years.	Value.	Years.	Value.
1880	$500, 000	1887	$224, 400
1881	500, 000	1888	281, 800
1882	700, 000	1889	439, 587
1883	600, 000	1890	450, 000
1884	570, 000	1891	476, 113
1885	500, 000	1892	272, 244
1886	250, 000		

Grindstones imported and entered for consumption in the United States, 1868 to 1892, 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

a Since 1884 classed as finished or unfinished.

OILSTONES AND WHETSTONES.

There was very little change in the production of this class of abrasives in 1892 compared with 1891. The total value of the oilstones, whetstones, and scythestones produced in 1892 was $148,730. This includes, in addition to the production of the Pike Manufacturing Company at Pike Station, New Hampshire, the output, valued at $7,680, of a company in Ohio whose product is reported this year for the first time. The Pike Company estimates the value of its output in 1892 at $141,050. The bulk of the rough stone consists of two grades of novaculite known as Arkansas and Washita stone from Hot Springs, Arkansas, and Orange or Hindostan, stone from Orange county, Indiana, shipped to Pike Station, New Hampshire, or New York city (both factories being run by the one concern) for manufacture. The remainder of the product is made up of Labrador stone from Truxton, New York, chocolate stone from Lisbon, New Hampshire, Indian Pond and Lamoille scythestone, quarried at Haverhill and Piermont, Grafton county, New Hampshire, and in Orleans county, Vermont, and sandstone from Indiana, made into kitchen and shoemakers' rubstones. The quarries at Truxton, New York, were not worked in 1892, but there were 500 pounds of Labrador stone made and sold from material previously quarried.

The Pike Manufacturing Company reports its output in 1892 as follows:

Production of whetstones, etc., by the Pike Manufacturing Company.

	Output.	Value.
Washita stone .... pounds..	400,000	$60,000
Arkansas stone .... do....	20,000	12,000
Labrador stone .... do....	500	50
Hindostan stone .... do....	300,000	15,000
Sandstone .... do....	100,000	2,000
Chocolate stone .... do....	20,000	2,000
Scythestones .... gross..	16,000	50,000
Total	....	141,050

Of the above sales the following is furnished as an estimate of the quantity exported and imported. It should also be stated that the foregoing, as well as the following, figures are not taken from the books, but are sufficiently correct to serve all practical purposes.

The exports were about:

Estimated exports of whetstones in 1892.

	Value.
Scythestones, 8,000 gross	$20,000
Washita stone, 150,000 pounds	20,000
Arkansas stone, 9,000 pounds	12,250
Hindostan stone, 75,000 pounds	2,250
Total	54,500

Estimated imports of whetstones in 1892.

	Value.
Turkey stone, 1,000 pounds	$200
Scotch stones (all kinds), 8,000 pounds	800
Razor hones, 1,000 dozen	2,000
English scythestones, 50 gross	300
Norway Ragg scythestones	None
German emery scythestones, 50,000	1,000
Total	4,300

The following table shows the total value of all kinds of hones and whetstones imported since 1880:

Imports of hones and whetstones for the years 1880 to 1892.

Years ended June 30—	Value.	Years ended December 31—	Value.
1880	$14,185	1887	$24,093
1881	16,631	1888	30,676
1882	27,882	1889	27,400
1883	30,178	1890	37,454
1884	26,513	1891	35,344
1885	21,434	1892	33,420
1886	21,141		

EMERY AND CORUNDUM.

Corundum and emery are distinguished from each other in that the former is oxide of aluminum alone, while the latter is an intimate mixture of oxide of aluminum with oxide of iron. Corundum is by far the more valuable mineral, being harder and of greater durability. Both minerals are used chiefly for the manufacture of abrasive wheels, the production of which is controlled by a few firms.

The product in 1892 consisted of 321 tons of corundum and 1,450 tons of emery, the total value of which was $181,300 more than double the value of the output in 1891.

The product is from Rabun county, Georgia; Macon and Jackson counties, North Carolina; Westchester county, New York; Chester county, Pennsylvania, and Hampden county, Massachusetts.

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	1887	600	108,000
1882	500	80,000	1888	589	91,620
1883	550	100,000	1889	2,245	105,567
1884	600	108,000	1890	1,970	89,395
1885	600	108,000	1891	2,247	90,230
1886	645	116,190	1892	1,771	181,300

Emery imported into the United States from 1867 to 1892, inclusive.

Years ended—	Grains.		Ore or rock.		Pulverized or ground.		Other manufactures.	Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
	Pounds.		*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	a144,380	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

a To June 30, only; since classed with grains.

INFUSORIAL EARTH.

The product consisted of 972 short tons of crude, 3,000 tons of refined, and 38,750 pounds manufactured into various cleansing preparations. The combined value was $43,655. The actual mining varies considerably in different years, some manufacturers producing enough crude earth in one year to last three or four years. In 1891 the production was light, the total value of the output in that year being $21,988. The supply in 1892 was obtained from Connecticut, Maryland, Nevada, New Hampshire, and New Jersey. The California properties were not worked.

The following table shows the annual production of infusorial earth since 1880:

Production of infusorial earth from 1880 to 1892.

Years.	Short tons.	Value.	Years.	Short tons.	Value.
1880	1,833	$45,660	1887	3,000	$15,000
1881	1,000	10,000	1888	1,500	7,500
1882	1,000	8,000	1889	3,466	23,372
1883	1,000	5,000	1890	2,532	50,240
1884	1,000	5,000	1891	....	21,988
1885	1,000	5,000	1892	....	43,655
1886	1,200	6,000			

TRIPOLI.

Through a very interesting and comprehensive exhibit at the World's Columbian Exposition, attention has been called to a valuable deposit of this material which occurs in Newton county, Missouri, and which has not received notice in previous volumes of "Mineral Resources."

The property was discovered about 1870, and partially opened in 1872, but the full value of the material was not then known, and it was not worked until 1887, when a steam plant was erected and new and improved machinery of special design was introduced for reducing the rock to a fine powder for mechanical purposes. Also for sawing, turning, and shaping the mineral in disks, cylinders, tubes, etc., for water filters. Even then the production was rather limited, and it was not until March, 1892, when the American Tripoli Company, of Carthage, Missouri, with a capital stock of $100,000, was incorporated, that work was actively pushed.

The mine is situated about 1 mile from the Saint Louis and San Francisco railroad at Seneca in Newton county, Missouri. The property consists of 283 acres. The deposit of tripoli is overlaid with about 4 feet of loose earth, and in thickness ranges from 10 to 20 feet, and is known to underlie from 80 to 100 acres. It is said to be the largest known deposit of its kind in the world.

The mineral is very compact, but sufficiently porous to make an excellent water filter. It is free from iron and coarse sand or grit, and ground for polishing purposes makes an exceedingly fine powder. The grain is sharp and cutting and yet fine enough not to scratch metal surfaces in polishing. The ground material is also used to a considerable extent in the manufacture of soaps.

Dr. Henry Froehling, of Richmond, Virginia, has made a partial examination, chemically and physically, of the mineral, but has not yet definitely ascertained what it is. He is convinced that it is not properly infusorial earth, and thinks it is probably a species of decomposed quartz.

The output from the mine in 1892 was nearly 2,000,000 pounds, or 1,000 short tons, of powdered material, and between 15,000 and 20,000 finished pieces of filter goods, the total value of which is estimated at about $30,000.

RECENT INVENTIONS.

Carborundum.—This material is the invention of Mr. E. G. Acheson, of Monongahela City, Pennsylvania. It is a chemical combination of carbon and silicon, or, in other words, a carbide of silicon. It is the result of a series of experiments conducted by Mr. Acheson in the hope of securing a substitute for the diamond as an abrasive. It is essentially a manufactured product and as such does not properly belong in an article devoted to the discussion of natural abrasives, but on account of its future bearing on the industry and the interest developed in the invention by the exhibit of the material at the World's Columbian Exposition a brief notice may not be out of place. It is produced by passing an electric current through an intimate mixture of crushed coke and sand, the current being sufficiently high and kept up long enough to fuse the mass and effect the combination.

The product is a porous cinder-like mass of iridescent crystals, the principal color being about sapphire blue. The mass is first cleansed by washing with water and is then treated with acids to remove soluble impurities. After this it is dried and crushed. The crushing breaks apart the individual crystals which are then assorted into various sizes by a system of floating. This "floating" is accomplished by a series of tanks through which the water holding the carborundum in suspension flows in a continuous stream.

The first use to which the product was put was as a polishing material in lapidary work, but its field of usefulness has been recently enlarged by the manufacture of hones, wheels, and other forms in which abrasives are used. The crystals are mixed with clay or other suitable cementing material and molded into the desired shapes, the percentage of bonding material varying according to the work to be done. The articles manufactured from carborundum were exhibited in the Mining Building at the Columbian Exposition and their merits demonstrated by practical tests. In addition to the ordinary abrasive wheels and hones, small discs and points for dental work are made from carborundum and have been received with great favor.

Carborundum has also been made into buttons, and used (as yet experimentally) for electric lighting. Its future use in this way is at present a matter of uncertainty and conjecture, but enough has been done to show the advisability of further investigation. The experiments in this line have been conducted by Mr. Nikola Testa, and the results were exhibited by him before the Institution of Electrical Engineers in London, February 1892. In fact, the invention or discovery of carborundum has opened a field of investigation, the development of which will be watched with a great deal of interest.

Crushed steel.—Another recent invention in the line of abrasives, to which attention has been called by an interesting exhibit at the Columbian Exposition, is "crushed steel" manufactured by the Pittsburg Crushed Steel Company, limited, of Pittsburg, Pennsylvania. This product is obtained from crucible steel, highly carbonized and made crystalline in structure by manipulation in furnaces and chemical bath treatment. It is then reduced to small crystals by crushing under heavy machinery, after which it is assorted into sizes by a system of sieves. The larger sizes, which vary from about the size of a No. 2 bird shot to 1-40 of an inch, are classed as crushed steel proper, and used for sawing stone, particularly those varieties possessing hard and gritty qualities, such as granite, sandstone, marble etc. Grains which pass through sieves ranging from 40 to 150 meshes to the inch are classed as "steel emery," and used upon rubbing beds and for polishing purposes. The finest product is, by an oxidizing process, manufactured into putty powder and rouge for polishing marbles, granites, agate, and glass.

The crystals of crushed steel and steel emery present sharp cutting edges, having about the same angles as quartz when crushed. They are exceedingly hard and are more effective under the saw blades and on the rubbing bed than sand. The effectiveness of crushed steel and steel emery is due to the fact that the crystals do not wear away and become smooth. A grain of crushed steel under the microscope presents a series of crystals, and if sufficient force be applied they are detached, but maintain their crystalline form and abrasive qualities. For this reason the material can be used a great number of times, and in order to effect the greatest economy in its use, the manufacturers of crushed steel have also invented automatic attachments for saw gangs and rubbing beds by which the steel once used is saved and returned. The efficacy of these products—crushed steel, steel emery, and the putty powder and rouge—has been attested by stone workers and manufacturers of lenses.

PRECIOUS STONES.

By George F. Kunz.

This paper is founded on and is a résumé of the nine papers on the precious stones of the United States written since 1882 for the annual reports of the Division of Mining Statistics and Technology of the U. S. Geological Survey, on a report for the Eleventh United States Census, and the following is a condensation of these, together with additional information obtained from studying the collections in the United States and from personal examination of many of the localities where gems are found, and some notes on the gems and precious stones shown at the World's Columbian Exposition. The reader should also consult "Gems and Precious Stones of North America."(*a*)

Systematic mining for gems.—Although nearly all the known varieties of precious stones are found in the United States, there has been very little systematic exploration for them until very recently, as the indications seldom justified the investment of much capital in such search. Whereas mining for precious stones was only carried on in two States in 1889, the following gems were mined in 1893: Tourmaline in Maine, emeralds in North Carolina, turquois in New Mexico, sapphires in Montana, and opal in Washington state, Idaho, and Oregon. Otherwise the gems are found accidentally in connection with other substances that are being mined. They are often gathered on the surface, as is the case with garnet and olivine in Arizona and New Mexico; or in sluicing for gold, as with the sapphires from Montana; or in connection with mica mining, as the beryl from Connecticut and North Carolina; or from the beds of streams and decomposing rocks, as the moss agate from Wyoming; or on the beaches, as the agate, chlorastrolite, and thomsonite from the shores of Lake Superior.

Nearly all of the gems found in these various ways are sent to the large cities in small parcels or are sold in the neighborhood to tourists, or sent to other places to be disposed of as having been found where they are sold.

DIAMONDS.

The occurrence of diamonds in the United States is chiefly confined to two regions, geographically quite remote. The first is a belt of country lying along the eastern base of the southern Alleghenies, from Virginia to Georgia, while the other extends along the western base of the Sierra Nevada and Cascade ranges in northern California and

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a New York: 1892. 8vo, 363 pp., 24 pl. Scientific Pub. Co.

southern Oregon. More recently (1891) they have been found in Wisconsin. In all three regions alike, the diamonds are found in loose deposits of gravel and earth, associated with garnets, zircons, iron sands, monazite, anatase, and particularly with gold, in the search for which they have usually been discovered. These loose deposits are merely the débris of the crystalline rocks of the adjacent mountains, and therefore present a general similarity, although the ages of the rocks themselves are widely different. The rocks of the Blue Ridge and eastern Alleghenies are of ancient Archean and Cambrian ages, while in the western belt the Sierra Nevada rocks were not elevated and metamorphosed until the middle or later Mesozoic. From this general resemblance of conditions the details of discovery in the two regions are very similar, and in both occasional diamond crystals are found, accidentally picked up on the surface, or more frequently encountered in the search for gold, sometimes in placer mining and sometimes in the flumes and sluices of hydraulic workings.

There have been various reports of the finding of diamonds in other parts of the country, but little or no positive evidence. A supposed diamond field in central Kentucky has been the subject of much study and discussion on account of the resemblance of the rock to that of the diamond-bearing region of South Africa; but upon closer examination important differences are recognized, and the diamonds are yet to be discovered. The formations in the eastern portions of the United States where diamonds have really been found are entirely different from those of South Africa, and are more like those of the diamond fields of Brazil and of parts of India. The diamonds found in the United States are evidently from much older rocks than those of South Africa, and if they have ever occurred in rock similar to that in Kimberly there is nothing to indicate it now, since the rocks in American diamond-bearing localities are mainly granitic.

North Carolina, so rich and varied in mineral resources, has long been known to yield some gold; and a few diamonds have been found in the same region, either loose in the soil or taken from the washings of auriferous gravel. The portion of the State is that known as the Piedmont region, a belt of country lying, as its name indicates, at the foot of the mountains, along the eastern base of the Blue Ridge. The rocks here are metamorphic and crystalline, with some Cambrian beds a little farther west.

Quite a number of small diamonds have been obtained since 1860 from the various points in this region, and they probably occur sparingly distributed throughout the auriferous belt of the Carolinas and northern Georgia. In the rude and hurried methods of gold-washing employed, they may often have been overlooked in the past, and now lie buried in the piles of sand that stretch for miles along the water courses.

On passing into Georgia the same metamorphic belt, with its localities for gold, itacolumite, and to some extent diamonds, extends across the State to the Alabama line. In several of the counties lying along this belt diamonds are said to have been found; and it is quite possible that, as in North Carolina, they may occur occasionally in the entire line of country adjacent to the crystalline rocks.

Many notices have from time to time appeared, both in local newspapers and in scientific journals, of the occurrence of diamonds in California. They seem in all cases to have been imbedded in the auriferous gravels and thence washed out in the search for gold. These gold-bearing gravels are of two classes: first, loose material in the valleys and bars of modern streams, and, second, great accumulations, now covered with masses of lava and compact tufa, which occupy the valleys of more ancient streams, trenching the sides of the Sierra Nevada and running down into the valley of California, which lies between the Sierras on the east and the Coast Range on the west. Between these lava streams, which run out as spurs from the Sierras and from the divides between the modern streams, the latter have formed their own gravel deposits, partly from the wear of the old accumulations and partly from that of the mountain sides, as at first. The surface diggings and placers of the early prospective days of California were of course in these modern gravels and bars. The older gravels, equally rich, are worked either by the hydraulic process, or when compacted into what are called "cement beds," by stamp mills. It is in these deposits that the diamonds have been found, picked from the sluices and flumes. In the case of the cement beds, only fragments are obtained, as the diamond crystals have been crushed under the stamps. There is much in the mode of their occurrence that recalls at first sight the diamond mines of Brazil and South Africa. In Brazil the matrix is also a gravel, and is frequently cemented into a conglomerate "cascalho" by oxide of iron. The first recognition of diamonds in the State goes back to the early gold-seeking days of 1850, when Mr. Lyman, a clergyman from New England, was shown a crystal about the size of a small pea, with convex faces, and of a straw-colored tint. He saw it for a moment only, yet its general aspect was enough to identify it as a true diamond, and the interesting fact was published.(*a*)

The first diamond from the Cherokee district, Butte county, was obtained in 1853. This has since proved one of the principal localities in the State. In 1854 Melville Attwood called attention, in a newspaper article, to the similarity of the California deposits to the diamantiferous gravel and conglomerate of Brazil, with which he had become familiar by a residence there. He advised that search be made and care exercised, lest diamonds should pass unheeded in the gold washings. Since then diamonds have been reported from a number of points, and at present, according to Mr. Henry S. Hanks, formerly state mineralogist,

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a Am. Jour. Sci., II, Vol. 8, p. 294, Sept., 1849.

five counties, Amador, Butte, El Dorado, Nevada, and Trinity are known to have yielded them. Other localities and larger numbers are yet, in his judgment, to be discovered.

A few small diamonds have been found in the placer diggings of Idaho, of about the same quality, and occurring under the same conditions as those in California. Some excitement has occasionally arisen about these Idaho diamonds. In 1864 to 1866 local and mining papers made many references to reported or anticipated discoveries; but nothing of any importance was found. In the winter of 1892–1893 the matter has again attracted some attention, only small quartz crystals and no diamonds were found, the name Diamond Basin having given color to the reported findings. Diamond Basin lies on the Snake river in Owhyhee county, Idaho. The excitement, intense for a time, subsided before the winter was over.

A few years ago reports were started of the finding of diamonds in central Kentucky. Prof. Edward Orton, the State Geologist of Ohio, visited the district and observed certain resemblances to the diamond-bearing region of South Africa. He found dykes of eruptive rock (peridotite) breaking through fissures in shale, and spreading to some extent over the adjacent country. Garnets and other associated minerals derived from the decomposition of the peridotite were found, suggesting the possibility of a diamond yield from the similarity of the conditions to those of Africa. And the diamonds found at Dlaschkowitz, Bohemia, the writer attributes to similar conditions of occurrence.(*a*)

Similar investigations and results were reported by Prof. A. R. Crandall.(*b*)

It had been previously suggested by Messrs. E. J. Dunn, E. Cohen, H. Huddleston, and Rupert Jones, that the South African diamonds were formed in a sort of volcanic mud (Mr. Huddleston), by a process rather hydrothermal than igneous, resulting from the action of steam in contact with magnesian mud, under pressure upon carbonaceous shales.

In the chemical laboratory of the U. S. Geological Survey, Prof. J. Edward Whitfield found 37.52 per cent. of carbon in the shale from near the Kimberly mine, while in the blackest shale adjoining the peridotite of Kentucky he found only 0.68 per cent. of carbon. The peridotite at the time of its intrusion must have been forced up through a number of coal beds and at a greater depth it penetrated the Devonian black shale, which is considerably richer in carbon than the shale now exposed at the surface.

A small diamond field has lately been found in Pierce County, Wisconsin. Here gold occurs in the gravel and sand along Plum Creek and its smaller tributaries; and some sluicing has been done by private parties. During 1887 and 1888 several small diamonds were found in the

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a Trans. Am. Inst. Min. Engineers, 1892, p. 241.

b Note on the peridotite of Elliott county, Kentucky. Am. Jour. Sci., III Vol. 32, p. 121, Aug., 1886.

auriferous sands a little below the level of the stream; the largest is a rounded hexoctahedron of about three-fourths of a carat and could be cut into a brilliant of about three-sixteenths of a carat. The others are quite small.

SAPPHIRE.

Corundum is found in the United States chiefly in the crystalline rock along the Appalachian mountains from Chester, Massachusetts, to northern Georgia, Colorado, and Montana. At Chester, where the deposits have long been worked, the mineral exists mainly as emery; no gems have ever been found. In the metamorphic rocks of the Highlands of New York and northern New Jersey corundum is somewhat abundant. At Vernon, New Jersey, from 1850 on, crystals of sapphire and ruby corundum have been found, but always opaque; so that among many specimens obtained, some of which have been cut, scarcely any has furnished a transparent gem. It is of interest to note that near Mandalay, in Burmah, rubies occur similarly associated with limestone; hence they are generally found detached and separated from their original matrix.

Mr. C. W. Jenks, in 1870, commenced mining at Corundum Hill, Franklin, North Carolina, and obtained about one hundred gems; but although found here in their original matrix, they were so infrequent that it was found unprofitable to mine for them alone. Several sapphires, true blue and violet blue, weighing over one carat each, were discovered, as well as several fine rubies. The work was discontinued for some years owing to the financial crisis of 1873, but has lately been resumed by the Hampden Emery Company, which now own the mines. It is not easy to learn what success they have had, but certainly few or no gems have appeared in the market of late from that locality. Some very interesting specimens from here are shown in the North Carolina exhibit of the World's Columbian Exposition, Mines and Mining building, and a very remarkable 90-pound mass of red and blue banded sapphire from the lands of the Sapphire Valley Company, near Franklin, North Carolina, in the Tiffany gem collection in the northwest gallery of the Mines and Mining building.

The largest crystal of corundum ever found, five times larger than any other known crystal, is one early discovered by Mr. Jenks and described by Prof. C. U. Shepard. It is now in the cabinet of Amherst College, but it was injured by the disastrous fire of 1882, which destroyed many fine specimens of the Shepard collection. In variety of color the North Carolina corundum excels. It was found gray, green, rose, ruby-red, emerald-green, sapphire-blue, dark-blue, violet, brown, yellow, and of all intervening shades, and colorless. Many specimens have been cut and mounted, especially of the blue and red shades, and make good gems, though not of the choicest quality. Several fair rubies of 1 carat each have been found; a blue sapphire, 1 carat in weight, is in the United States National Museum at Washington, and a series of fine red and blue crystals have been deposited there by Dr. S. F.

Lucas, and a series from a recent find in the Tiffany exhibit, northwest gallery, Mines and Mining building, World's Columbian Exposition.

In Montana, sapphires are found at what are known as Eldorado Bar, Emerald Bar, French Bar, Ruby Bar, and for some 6 miles along the Missouri River; also in Missoula county, 70 miles distant. Stubb's Ferry, 12 miles east of Helena, is about the central point of the Missouri river district. Although these bars had been sluiced for gold, no systematic attempt had been made before 1891 to work them for gems. Occasionally sapphires were sent to the large cities, but owing to the cost of cutting them, and the small demand for any other than the true ruby-red or sapphire-blue stones, they received but little recognition.

The greater part of the region above described passed in 1891 into the hands of an English company bearing the name of the Ruby and Sapphire Mining Company, which has since obtained a large number of stones, some of which have been cut and exhibited in London. They embrace a great variety of the lighter shades—red, yellow, blue, and green. The latter color is quite pronounced and rather a blue green than an emerald green. Nearly all the stones, when finely cut, have a certain metallic luster strikingly beautiful and peculiar to the sapphires from this locality. No true red rubies or true blue sapphires have been found. A fine series of these gems was shown by Mr. Spratt in the Montana exhibit of the Mines and Mining building, World's Columbian Exposition, and mounted in jewelry by an American jeweler in the Manufacturers' building.

At all these bars along the upper Missouri the sapphires occur chiefly in a layer of auriferous glacial gravel, a few inches thick, which lies immediately in a slaty bed rock. Associated in the same layer were topaz in small crystals, garnets of a rich, ruby-red color, often mistaken for and called rubies, cyanite in broken crystals, cassiterite (stream tin), and other commoner minerals. The original source of the sapphires found at these bars is indicated in an eruptive dike, found cutting the slaty rock at Ruby Bar, on which rests the glacial gravel. In this eruptive rock there were found crystals of sapphire, pyrope, garnet, and sanidine feldspar. There seems no doubt that all the sapphire along these bars of the Missouri is derived from the breaking down, by glacial action, of a rock similar to this. The outcrop at Ruby Bar can not, however, account for the deposit of sapphires at Eldorado Bar, 6 miles to the north; and it will be necessary to await further discoveries before attempting to determine the exact source of these gems.

Mr. H. Miers finds the rock at Ruby Bar to be a vesicular mica-augite-andesite, containing an abundance of brown mica and porphyritic crystals of augite. The ground mass consists chiefly of feldspar microlites with a considerable amount of glassy, interstitial matter and much magnetite. Many of the cavities are occupied by a brown glass which appears yellow in thin sections and displays a speculitic structure originating in the sides of the cavities.

It is of course difficult to say whether or not the sapphires could have been caught up by the augite-andesite from schists or other rocks cut through in coming up, as may be seen in the case of the occurrences in the Eifel Laacher See at Unkel, and in Auvergne (Espailly), France.

During 1892 excavating and mining have been actively pushed on the property of the Ruby and Sapphire Mining Company, under the superintendence of the well-known mining engineer, Mr. E. G. Wood, who, it is said, lays considerable stress on the placer gold that he hopes to find in connection with the sapphires. During 1892 none or few gems from this property have been placed on the American market, although they have been publicly shown in England, and several minor gems have been cut and their product placed on the New York market. Up to this time it is impossible to state whether the gem market of the world will accept these "fancy-colored" stones in quantity when the demand in the past has only been for the standard ruby and sapphire. A number of minor deposits have been found and considerable interest has been shown in the property adjoining that of the larger company. Various lots of gems have been sent to New York, but the sale for the year, including those sold by the Helena (Montana) jewelers, does not exceed perhaps $5,000, the sales generally being to tourists who are passing through or visiting Montana.

In October, 1892, the Montana Gold and Gem Mining Company was incorporated by some of the best known men in Helena. The property owned by the new company, comprising about 2,000 acres, is situated partly on Emerald Bar, about 15 miles from Helena, and partly at the mouth of Prickly Pear creek, covering 2 miles on both sides of the creek. The company proposes to mine for gold as well as for gems.

During the past year sapphires have also been found in Missoula county, 30 miles west of Phillipsburg, on the west fork of Rock creek, and 70 miles from the Missouri River locality. The sapphires obtained here are of yellow, blue, green, and other colors, associated with garnets, pyropes, etc., occurring in a gravel bed which is 4 feet in depth down to the bed rock, and is overlaid by 3 feet of loam. The sapphires are all found in this bed, and appear to be exceedingly plentiful, from ten to twenty being found in every pan of the gravel. The colors are steely blue, green, yellow, and a few pink or reddish stones.

SPINEL.

Spinel fine enough to be cut into gems has but rarely been found in the United States. A few specimens of a smoky blue or velvety green, and of a dark-tinted claret color, weighing about 2 carats each, have been found near Hamburgh, Sussex county, New Jersey. Some half dozen from San Luis Obispo, California, of very good quality and of nearly 2 carats each, were brought to the notice of the writer by Mr. James W. Beath, of Philadelphia, Pennsylvania. A locality believed to lie between Monroe and Southfield, in Orange county, New York, was known to only two collectors, both now deceased. They secretly worked the place on moonlight nights from 1862 to 1866, and extracted the monster crystals of black spinel peculiar to Orange county. From the sale of these specimens they realized over $6,000, although many fine crystals were ruined in blasting and breaking out. Since the death of these workers the location has been lost.

TURQUOISE.

This mineral is found near Los Cerrillos, Santa Fé county, and in the Burro Mountains, Grant county, New Mexico; in the Turquois mountains, Cochise county, and in Mineral Park, Mohave county, Arizona; near Columbus, Nevada; in Saguache county, Colorado, and Taylor's Ranch, Fresno county, California. The first-named locality is part of a group of conical mountains situated about 22 miles southeast of Santa Fé, New Mexico, and north of the Placer or Gold mountains, from which they are separated by the valley of the Galisteo river. They are composed of yellow and gray quartzite sandstones with porphyritic dykes.

During the past two years turquoise has been actively mined for by two companies, the American Turquoise Company and the Azure Turquoise Company; a few minor attempts by others have been made. The first of the two above-named companies, engaged in mining 6 miles from Los Cerrillos, New Mexico, reopening some of the mines originally worked by the Indians, and have found turquoise equal in color to the finest Persian material. Its stability in retaining color is equally great, not changing within a short time, as does the Egyptian turquoise, which was so extensively placed on the market about the time when the Persian mines were ceasing to yield. In 1891 the writer had started on a trip to Persia, intending to visit the famous mines of turquoise, when the first specimens from this district were sent to him at Berlin with a fixed price on each gem. Word also reached him of the scarcity of the true turquoise in Persia, and he subsequently had opportunity at Nijni Novgorod, of seeing nearly all the yield of the year. He returned to the United States, giving up the projected trip, and purchasing only the finest gems, as nearly all the material shown, although held at high prices, was not up to the standard of the American turquoise. Stones have been found at these new localities weighing up to 60 carats each, one of which was sold for about $4,000; and it is now possible for the first time in the past half century to match a perfect turquoise necklace.

The Azure turquoise mines are in Grant county, New Mexico. The material is of rather a robin's-egg blue; that is, with a faint greenish tinge. This may be due either to a partial change or metamorphism which has taken place while the turquoise was in the rock, or it may be a local peculiarity. The stones are not the sky-blue of the more northern locality, but it is claimed by the owners of the mine that they are not subject to change of color. Turquoise has always been known as an unstable gem. Even the finest Persian stones are liable to change occasionally with scarcely any warning, the alteration probably being due to the turquoise coming in contact with acid exhalations from the skin or with fatty acids or alkalies in soap, although wearers of turquoise are especially warned to remove the rings while washing their hands. Recent observations also indicate that turquoise is liable to injury from perfumes. The sale of turquoise during the year 1891 from these two localities has probably exceeded $100,000, and, for 1892, $175,000, and a greater amount for 1893 is expected, as quantities of this gem from an American market have been sold abroad for the first time. This gem has given the most substantial evidence of gem mining in the United States.

TOPAZ.

The gem topaz has been found in Huntington and Middletown, Connecticut; Stoneham, Maine; North Chatham, New Hampshire; Deseret, Utah; at Nathrop, Chalk mountain, Crystal Park, Florissant, and Devil's Head mountain, Colorado, and at Ruby mountain, Nevada, and crystals have recently been seen by the author from Palestine, Texas. The first discovery of topaz in the United States was at Trumbull, Connecticut, where it was found in a vein associated with chlorophane. Probably the most brilliant and beautiful crystals of North American topaz are those from Thomas mountain, Deseret, Utah, an isolated and arid elevation about 6 miles long. These crystals are larger than those from Nathrop, California, always white, evidently have been decolorized by heat or exposure to sunlight, and equally as brilliant as those from San Luis Potosi, Mexico, which they closely resemble, and exist in quantity great enough to suggest their use as an abrasive.

Many fine large topaz crystals have been found at Crystal Park, near Pike's Peak, El Paso county, Colorado. The crystals from this locality, remarkable for their color and clearness, have been fully described by Messrs. Whitman Cross and William F. Hillebrand under the title of "Minerals from the neighborhood of Pike's Peak, Colorado." (*a*)

At Devil's Head mountain, in the Colorado range, some 30 miles north of Pike's Peak, the topaz is found in isolated and usually loose crystals surrounded by distorted smoky quartz. The principal color is cherry, although wine-yellow, milky-blue, and colorless crystals were found. (*b*)

Since the discovery of these Colorado localities it is estimated fully $6,000 worth of topaz have been sold as crystals and gems, notably a crystal weighing 18½ ounces (587 grams), found at Cheyenne, Colorado, during 1886, and two sherry-colored gems weighing 125 and 193 carats. During 1882 crystals from Herndon Hall, in the vicinity of Stoneham, Maine, were determined by the writer to be topaz, and further search resulted in the finding of a quantity of crystals.

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a Am. Jour. Sci., III, Vol. 24, p. 282.

b Contributions to the Mineralogy of the Rocky Mountains, p. 70 et seq.; Bulletin No. 20 of the United States Geological Survey, Washington, 1885.

During 1888 nearly 100 crystals, associated with phenacite, were found on Bald mountain, New Hampshire, which is only a few miles from the Stoneham locality. They were colorless, light green or sherry colored on the outer sides, and colorless in the center. The largest one measured 1½ inches in height and the same in thickness. In habit these crystals closely resemble those from Cheyenne mountain, Colorado, and some of them are equal in quality, though not in size, to any found in Colorado.

TOURMALINE.

Tourmalines of gem value were first discovered by Elijah J. Hamlin, at Mount Mica, Paris, Maine, in 1826. He, with several members of his family, among them the person of Dr. A. C. Hamlin, have worked the original locality at Mount Mica, Paris, Oxford county, Maine, finding from time to time remarkable specimens of tourmaline, some single stones of which have been sold for $1,000 apiece. The gem has been found in various shades of green, grass green, olive green, pink, red, blue, yellow, and white. For the past ten years this locality has been worked by the Mount Mica Gem Company.

Enough gems have been found in this locality to realize over $50,000. The finest collection of crystals from this locality is the combined collection of the discoverer and Dr. A. C. Hamlin, and presented by James A. Garland, Esq., of New York city, to the Mineralogical Cabinet of Harvard University. The famous Hamlin tourmaline necklace was exhibited in the Tiffany Pavilion at the 1893 World's Fair.

Some of the fine gems in this locality were in the possession of the late Dr. Charles I. Sheppard, and a fine series of crystals from the Tenny collection are in the Peabody Museum, Yale University.

Tourmalines were discovered at Mount Apatite, Auburn, Maine, in 1893. Several thousand crystals have been found, their value aggregating about $5,000. The work was carried on in a desultory manner, and all the tourmalines from this locality being retained in their original crystalline condition. Tourmaline of gem value have also been found at Hebron and other localities in Oxford county, Maine.

In July, 1893, on the summit of one of the San Jacinto mountains in Riverside county, California, tourmaline was discovered in float crystals, generally green or black. Some good green, rose, red, white, and blue were found. The green crystals, on being broken open, were found to contain red and white centers. One crystal 9 inches and another 6 inches long were found and a number of gems were obtained. Work is now being done on the vein.

BERYL (EMERALD, AQUAMARINE).

The emerald variety of beryl is found in Alexander county, North Carolina. Emeralds and beryls suggesting them have been found at five different points, with quartz, rutile (the latter some of the finest ever found), dolomite, muscovite, garnet, apatite, pyrite, etc., all in fine crystals. One of these localities, Stony Point, is about 35 miles southeast of the Blue Ridge and 16 miles northeast of Statesville, North Carolina. The country has a rolling surface, and lies about 1,000 feet above the sea. The soil, which is not rich, is generally a red, gravelly clay, resulting from the decomposition of the gneissoid rock, and hence under these circumstances it is easy to find the sources of minerals discovered on the surface. The unaltered rock was found at Stony Point at a depth of 26 feet and is unusually hard, especially the walls of the gem-bearing pockets. The Emerald and Hiddenite Mining Company was organized in 1881 to work the property at Stony Point, and has done so irregularly for periods varying from one week to eight months of each year. The entire output (including specimens of other minerals and other gems) since the organization of the company in 1881 to the present time amounts to about $15,000. Some crystals have been found here measuring 8 inches in length and weighing 10 ounces, but no gem obtained has been sold for over $100. At Stoneham, Maine, many transparent crystals of beryl have been found, and at least $3,000 worth of gems have been sold from this locality; one gem weighed 133¾ carats. At Mount Antero, Colorado, at an altitude of 14,000 feet, many beautiful crystals of beryl were found resembling in color and habit the crystals from Mourne mountain, Ireland; one crystal measured 4 inches in length, many of these afforded small gems, and fully $5,000 worth were cut into gems.

A dark-green beryl, weighing 25.4 ounces, part of which would furnish gems of some size, was found in January, 1888, near Russell Gap road, Alexander county, North Carolina, and fine gems from this crystal were shown in the North Carolina exhibit and in the gem collection in the northwest gallery of the Mines and Mining building, World's Columbian Exposition. Deep golden brown and golden yellow crystals have been discovered in Mitchell county. Yellow and green beryl gems have been found in Alabama, near Coosa, Rockford county. The largest known beryl crystals have been obtained at Alger's Hill, near Grafton, New Hampshire, weighing 2,900 pounds and measuring 4 by 2 by 2½ feet. They were valueless as gems. White and pale gems have been found at Grafton and South Ackworth, New Hampshire, Mount Mica and Hebron, Maine. Very fine golden yellow beryls have been found at the Avondale quarries, Delaware county, Pennsylvania; one weighed $35\frac{1}{16}$ carats and another 20 carats. Six fine yellow beryls were found at Manhattanville, New York city. At a mica mine between Litchfield and New Milford, Connecticut, many beryls, deep yellow, light yellow, yellow green, light green, and white have been found during the past seven years, which were cut into gems and extensively sold, the former under the name of golden beryl. About $17,000 worth of beryls from this locality were sold within four years by the owner of the mine, S. L. Wilson.

PHENACITE.

Phenacite was first identified in the United States in 1888 in the Pike's Peak range, El Paso county, Colorado, in fine crystals. Since then it has also been found on Mount Antero, where the crystals occur at an altitude of about 14,000 feet in a region of almost perpetual snow, accessible for only a short period in the summer. Some crystals of phenacite were described by the author as occurring on Bald mountain, North Chatham, New Hampshire, near the State line between Maine and New Hampshire, and also in the neighborhood of Stoneham, Maine. From all the localities gems have been cut from the transparent crystals.

GARNET.

The pyrope (precious) garnets are found in the United States, in New Mexico, Arizona, southern Colorado, and Utah, where they are often miscalled rubies. In New Mexico they occur, it is believed, only on the Navajo reservation, where the Indians collect them largely from ant hills and scorpion holes, and are also said to pound them out of rocks. They are associated with olivine and chrome pyroxene. In north-eastern Arizona they occur in loose sand, and have probably been brought by the action of water from a point 50 miles to the north, where they occur, as the writer believes, in a peridotite rock. In western Arizona (on the same parallel with Fort Defiance), on both sides of the Colorado river, garnets are similarly associated with grains of peridot, a chrome pyroxene and a hyaline chalcedony. Here also they are found on the ant hills and near the excavations made by scorpions, and are collected by soldiers and Indians, and sold to the Indian traders who send them to the large cities in lots of an ounce and upwards. They vary from an eighth to a quarter of an inch in diameter and a few measure one-half inch across. They have never been found in place by any geologist, and it has been suggested that they are derived from some lower cretaceous sandstone, but it is very evident, from the associated minerals, that they have weathered out of a peridotite rock under an identical mode of occurrence as the pyrope garnets in Bohemia, Elliot county, Kentucky, and Kimberly, South Africa.

Although the garnets found in washing and mining for diamonds in south Africa (the so-called "Cape Rubies") are larger than those of Arizona and New Mexico, and perhaps equal to them in color by daylight, the latter are much superior by artificial light. Only the clear blood-red hue is then visible, while in the "cape rubies" the dark color remains unchanged. They are much used as gems, the annual sales amounting to about $5,000 worth of cut stones. A few remarkably fine ones have brought from $50 to over $100 each, though others equally good have been sold for much less. Fine stones of 1 carat bring from $1 to $3 each, and exceptional ones even $5. They seldom exceed 3 carats. Pyrope garnet of good color that has furnished gems has been found in the sands of some of the gold washings of North

Carolina. The peridotite rock of Elliott county, Kentucky, contains quantities of deep ruby-red grains of pyrope, locally regarded as rubies, having a specific gravity of 3.673 and varying from one-tenth to one-quarter inch in diameter. They are sometimes as fine in color as the Bohemian garnets, which they closely resemble. The lower cost of cutting stones abroad and the smaller size of the Kentucky garnets somewhat precludes the possibility of making them profitable to search for, although it might be possible to encourage the cutting by farmers in their leisure time, on the house industry system of the "Jura," Bohemia, and other European gem-cutting centers.

Large crystals of almandite garnet, some weighing 20 pounds, not fine enough for gems, but which might be cut into dishes or cups, measuring from 3 to 6 inches across, have been found near Morgantown and Warlick's Mills, in Burke county, North Carolina, and in Rabun county, Georgia. Many of them are transparent in part, varying in color from the purple almandine to pyrope red. Tons of these have been crushed to make "emery," and the sandpaper called garnet paper. The peculiar play of color observed in the North Carolina garnets is often due to inclusions. In those of Rabun county, Georgia, sometimes nearly one-quarter of the entire specimen is taken up by fluid cavities and acicular crystals of rutile. Quantities of fine purple almandine garnets are found in the gravel of the placer mines near Lewiston, Idaho, and near Helena, Montana, in rolled and pitted grains, from one-sixteenth to 1 inch across, and would cut into good gems or jewels for watches. Hoffman mentions good small crystals from Black canyon, Colorado river, Nevada. Fine small almandines are also found in the trachyte of White Pine county, Nevada. Tons of almandite garnet, generally opaque, are found in the gold washings near Helena, Montana, suggesting use as an abrasive, as is the garnet found and mined in large quantities in Lewis county, New York.

The Alaska garnets, so well known for their remarkably perfect crystals, which contrast beautifully with their dark gray matrix, occur in quantities near the mouth of the Stikeen river, in the vicinity of Fort Wrangel, Alaska. They are found in a bed of mica schist, and when quarried out are carried about a mile to the river, and thence by boat to Fort Wrangel. Over $1,000 worth are annually sold as specimens.

Spessartite (manganese alumina garnet) is the most interesting garnet yet found in this country, and never found as a gem anywhere else. It was found in Amelia county, Virginia, a few years ago in the working of the Allen mica mines. A cut stone weighing 96 carats is in the Tiffany-Morgan collection in the American Museum of Natural History, New York. Fine examples are shown in the Mines and Mining building and in the Manufactures building, and a remarkable one in the Smithsonian Institution collection, U. S. Government building, of the World's Columbian Exposition. Fully $5,000 worth of this gem were found, and as the mica mines have since been closed as unprofitable, this gem will undoubtedly become very rare.

Essonite, cinnamon garnet, cinnamon stone, or the hyacinth of the jeweler, has been found of good quality in Oxford county, Maine. Very fine essonites, red and yellow, were formerly found at Phippsburg, Maine, and at Warren, New Hampshire. Beautiful essonite crystals one-fourth of an inch in diameter, entirely transparent and quite flat, have been found between plates of mica at Avondale quarry, Pennsylvania, and near Bakersville, North Carolina. Some of these would cut into fine gems over a carat in weight.

Hiddenite, lithia emerald, spodumene, etc.—In 1881 Mr. J. A. D. Stephenson called the attention of Mr. William E. Hidden to a transparent spodumene and to the locality in which it was found. Mr. Hidden, supposing the mineral to be diopside, sent the specimens for examination to Dr. J. Lawrence Smith, who on investigation found it not to be diopside, but a transparent variety of spodumene, and named it after Mr. Hidden, who sent him the crystals. The crystals were first found loose in the soil with emeralds, but systematic mining revealed them in attached veins of the walls of the rock. The spodumene is generally more or less altered, hence its pitted or eaten-out appearance; but when found in the rock the crystals are quite perfect and unchanged. The crystals are always transparent, and range from colorless (rare) through light yellow and yellowish green into deep yellow emerald green. Sometimes an entire crystal has a uniform color, but generally one end is yellow and the other green. Its hardness is 6.5 on the prism faces. At first considerable difficulty was found in cutting it, owing to its remarkably perfect prismatic cleavage, which is very lustrous. Gems have, however, been cut up to 2½ carats in weight. Its specific gravity varies from 3.18 to 3.194.

The yellow color exhibited by the mineral in even the darkest green gems will prevent its competing with the true emerald. The Siberian demantoids or Uralian emeralds, as the green garnets are variously termed (erroneously olivine), resemble the hiddenite somewhat, but are generally darker, and in addition to their brilliancy have a play of fire or color that has made them highly popular, especially in the very small sizes, the small green garnets selling for a greater price than emeralds of the same size. When lithia emeralds were first introduced they had a considerable sale because of their novelty as a strictly American stone and from the newspaper notoriety which they gained through the controversy as to the true discoverer. Hence for a time the demand exceeded the supply, which, from the desultory working of the mine, was limited. Thus a 2½ carat stone was sold for $500, and a number of stones brought from $40 to over $100 a carat. The total sale of all the gems found from the beginning of operations in August, 1880, to the close of 1892 amounted to about $8,000.

Peridot (olivine chrysolite) is found in the form of small olive-green pitted grains in the sands of Arizona and New Mexico and at Ison's mills, Elliott county, Kentucky. In the two former localities they are called Job's tears (on account of their pitted appearance). These afford smaller gems than those from the Levant. As the demand seems to be for large peridots of the richer olive-green color, which is not possessed by those from the United States, $5,000 would be an outside valuation for the American peridots cut into gems since 1880.

Olivine in meteorites.—There have been found in several instances in the United States—Eagle Station, Carroll county, Kentucky, and Kiowa county, Kansas—meteorites of the type known as pallasites, containing olivine in crystals or masses disseminated through the iron. Some of these olivine grains have been fine enough to furnish good peridot gems. The meteorite found in Kiowa county, Kansas, is a true pallasites with very sharply defined crystals of bright yellow olivine, which break out and leave their casts in the iron; the one from Carroll county, Kentucky, consists largely of olivine with the iron traversing it in irregular meshes and fillings. In the Turner and Liberty mounds in the Little Miami valley, Ohio, some pieces have been found both natural and hammered into articles of use or ornament of a similar pallasite iron, but apparently not identical with either of these other falls, and in the meteorite found in Glorietta mountain, Santa Fe county, New Mexico, olivine grains were found, and from all four of these meteorites the olivine has been cut into what might truly be called a celestial gem.

Quartz (*rock crystal*) has been found near Long Shoal creek, on a spur of Phœnix mountain, in Chestnut Hill township, North Carolina, also at two places 600 feet apart (about 1 mile from the former crystals), one weighing 285 pounds, that was 29 inches long, 18 inches wide, and 13 inches thick, showing one pyramidal termination entirely perfect and the other partly so; also another specimen that weighed 188 pounds, as well as many pieces weighing from 10 to 50 pounds each. A crystal ball over 5 inches in diameter, and a number of art objects made from the rock crystals found, were exhibited at the World's Columbian Exposition; these were all of American work. A rock crystal ball from the summit of Mount Antero, Colorado, was shown in the Mines and Mining building of the World's Columbian Exposition. It measured a trifle less than 6 inches in diameter. It is not perfect, but quite equal to the crystal balls of the eighteenth century.

At Lake George, in Herkimer county, and throughout the adjacent regions in New York, the calciferous sand rock contains single crystals and at times large cavities are found filled with doubly terminated crystals often remarkably perfect and brilliant. These are collected in numbers, and both natural and cut specimens are mounted in jewelry and sold to tourists under the name of "Lake George diamonds." A remarkably choice collection of fine quartz crystals was shown by Mr. A.

B. Crim, of Middleville, New York, in the west gallery of the Mines and Mining building, World's Columbian Exposition.

At Crystal mountain, Arkansas, and in the region around Hot Springs for about 40 miles, large veins of quartz are frequently met with in a red sandstone, the exact geological horizon of which has not yet been accurately defined. They are mined by the farmers, who bring them to Hot Springs in wagons and sell them to local dealers and tourists. At least $10,000 worth are annually sold to be taken away as mementoes. Great quantities of imitation (paste) diamonds are sold to the unwary as cut rock crystals, and quantities of foreign crystals as Arkansas quartz of local cutting.

Many localities in Colorado, notably Mount Antero, yield fine specimens of quartz. All along the Atlantic coast, at Narragansett Pier, Long Branch, Atlantic City, Cape May, Old Point Comfort, and other places, transparent pebbles are found in the sand and are much sought after by visitors, who often have them cut as souvenirs. At many such places the local lapidaries have been known to substitute for pebbles found on the beach foreign-cut quartz, cairngorm, topaz, crocidolite, moonstone from Ceylon, and even glass, obtaining twice the value of the foreign gem for the price of the supposed lapidary work. Many thousands of dollars' worth of such stones are sold annually. At all of these resorts large quantities of the quartz pebbles are cut into gems and seals, and all manner of ornaments are sold as having coming from the vicinity. Sometimes even the stones found by the visitors and intrusted to lapidaries for cutting are exchanged for cut stones brought from Bohemia, Oldenburg and the Jura. Cutting is done abroad on so large a scale and by labor so poorly paid that the cut stones can be delivered in this country at one-tenth of the price of cutting here, as the rock crystal itself has but little value. In the West there are many dealers who sell so-called "Rocky Mountain Gems," the entire stock frequently not containing a genuine stone, all being glass imitations. The same is true of all the blue moonstones and various stones sold in great quantity at the World's Columbian Exposition.

Amethyst is found on Deer hill, at Stow, Maine, where there is a vein of amethystine quartz which has been traced fully one-quarter of a mile and has furnished thousands of crystals during the last twenty years. A few have been of some gem value. Among some found in 1885 was a remarkable mass that yielded a gem weighing 25 carats of the deep purple color of the Siberian amethyst. Fine amethysts have been obtained at Mount Crawford, Surry, Waterville, and Westmoreland, New Hampshire. At Burrillville and at Bristol, on Mount Hope bay, Rhode Island, fine amethysts were found and used as ornaments over sixty years ago. Crystals of fine quality, though not affording gem material, one weighing seven pounds, have been found in Upper Providence township, Delaware county, Pennsylvania. Fine crystals and gems have been found in western North Carolina, and in Rabun county, Georgia. The mode of occurrence of the above gem is identical with those in the Taljan and other mines in the government of Perm, Ural mountains, Asiatic Russia, which mines have furnished the finest known gems for a century and a half where single stones have sold for $500 each.

Perhaps the most unique gem in the U. S. National Museum at Washington is an amethyst found at Webster, North Carolina, and deposited by Dr. H. S. Lucas. It was originally of a turtle-shaped form, which has unfortunately been lost by chipping; and it is said when found to have borne marks of the handiwork of primitive man. It now measures $3\frac{2}{5}$ inches in length, $2\frac{3}{5}$ inches in width, $1\frac{1}{2}$ inches in thickness and weighs $4\frac{3}{4}$ ounces Some very fair amethysts have been found on the Lake Superior shore and in trap rock at Keweenaw point and elsewhere in the upper peninsula of Michigan.

Smoky quartz, also known as smoky topaz, cairngorm, and citrine, is abundant at and near Pike's Peak, Colorado; also to some extent on the summit of Mount Antero, Colorado; Three-Mile Gulch, near Helena, Montana; Magnet Cove, Arkansas; Burke and Alexander counties, North Carolina, Oxford county, Maine, etc. At Pike's Peak it occurs in pockets in a coarse pegmatitic granite, often associated with beautiful crystals of amazon stone and flesh-colored and other feldspars. The largest Pike's Peak crystal found is over 4 feet in length. A beautiful faceted stone measuring 84 millimeters ($3\frac{1}{3}$ inches) was shown by Messrs. Tiffany & Co. at the World's Columbian Exposition, found in 1891 on Mount Antero, Colorado. The Pike's Peak material is sent abroad in large quantities to be cut, and the larger part is returned to be sold in tourists' jewelry, principally at Denver and Colorado Springs, Colorado; Hot Springs, Arkansas, and in other Western cities and summer resorts. The sum realized from the cut material amounts to about $7,500 annually, and that from the crystals sold to $2,500 more. Most of the cut articles of smoky quartz sold at the tourists' resorts are either from foreign localities or are American material cut abroad. Smoky quartz pebbles are occasionally found along the Atlantic coast at Long Branch, Cape May, etc., and cut as souvenirs.

Rose quartz occurs in large masses at Albany and Paris, Maine, Southbury, Connecticut, and at many other places in the United States; but as yet it has not been used in the arts or as a gem. At Stow, Albany, Paris, and other localities in Maine the quartz veins shade from white-transparent and opalescent—resembling hyaline quartz often without any imperfections—through faintly tinted pink and salmon into a rich rose color, thus forming a beautiful series of tints for gems or for ornamental work. Specimens of this rose quartz, when cut into double cabochons or spherical objects, distinctly show the asteria effect, similar to the star sapphire. Possibly as fine transparent, opalescent, rose quartz as has ever been found was obtained at Round mountain, Albany, Maine, in pieces measuring 4 by 5 inches in size, free from all flaws and of a fine rose red, with a beautiful milky opalescence. A sphere $2\frac{1}{2}$ inches in diameter and various art objects cut from this material are shown at the World's Columbian Exposition.

Gold quartz.—When clear, compact, white quartz contains veins, streaks, or spots of fine gold, it is worked into jewelry and souvenirs on a considerable scale in San Francisco. The mines in California, Oregon, Idaho, and Montana have furnished very fine specimens, especially when the quartz is clear and the gold penetrates in compact stringers. The gold found in California quartz is worth about $16.50 an ounce, but jewelers willingly give $20 to $30 for each ounce of gold contained in material that they can thus use. The price of specimens is governed by their beauty, varying from $3 to $40 per ounce of quartz. The specific gravity of the mineral is first taken, after which the gold value of the quartz is ascertained by Price's table. The amount of this material sold in the rough for jewelers' purposes is variously estimated at from $40,000 to $50,000 a year, $1,000 to $2,000 worth being often purchased at one time. One lapidary at Oakland, California, where most of the cutting of this material is done, bought nearly $10,000 worth within a year; and a large jewelry firm in San Francisco, during the same time, purchased nearly $15,000 worth. A clever imitation of this was patented some years ago by a San Francisco lapidary, who put grains of gold from common gold quartz in a magma of molten white glass the color of a milky quartz.

Novaculite (whetstone or honestone) is a fine grained, compact, sandstone-like substance, found in large pieces at Hot Springs, Arkansas, and employed to a limited extent for cutting into figures such as birds for jewelry. It is extensively used for whetstones, which have a worldwide reputation as Washita whetstones. Its compactness and the purity of its white color make it a very pretty ornamental stone and it should be used for this purpose more than it has been.

Sagenite.—Rutilated quartz of unexcelled beauty (rutile in quartz, Flèche d'amour, or Venus' hairstone), the rutile usually brown, red, golden, and black, has been found in many places in Randolph, Catawba, Burke, Iredell, and Alexander counties, North Carolina. Fine pieces of quartz, 4 inches square, containing acicular rutile of a rich red color, have been found near Amelia Court House, Virginia. Cut specimens command prices ranging from 25 cents to $5 each, and at one time about $500 worth was sold annually. The specimens found here are quite equal to the variety found in Japan, and are even better adapted for use in jewelry than the remarkable transparent masses over a foot across, procured from Madagascar, in which the crystals of hornblende are too large. Quartz crystals with inclusions of goethite have been found in the Tarry-All mountains 40 miles west of Colorado Springs, and cut into beautiful ornaments resembling quartz penetrated by acicular rutile.

The most magnificent specimen known was found in bowlders from the vicinity of Hanover, New Hampshire, during the years 1830 to 1850.

Thetis' hairstone, of Dr. Charles T. Jackson, is found near Sneatch Pond, Cumberland Hill, Rhode Island, is occasionally met with in fair pieces and is used to a very limited extent in jewelry. It is transparent quartz so completely filled with acicular crystals of green actinolite as to make it quite opaque. Probably $100 worth was at one time sold annually to be cut into seals and charms.

Dumortierite in quartz.—This is a rare species, a nearly pure silicate of alumina, very near staurolite in composition, but without the iron; it exists in small amounts at Harlem, New York, and has of late been found in some quantity at Clip, Yuma county, Arizona. Here it occurs as a dense fibrous inclusion in quartz, to which its deep blue color imparts the appearance of lapis-lazuli in masses one foot square. As the quartz and the dumortierite are about equal in hardness, the mass polishes well and yields a fine dark blue ornamental stone. A locality was discovered in Riverside county, California, in July, 1893.

Agate.—Agate is not produced in sufficient quantity in the United States to admit of exportation. The annual production and sale here does not exceed $2,000. Nearly all the agate jewelry sold in this country, as elsewhere throughout the world, comes from Oberstein and Idar on the river Nahe in the Duchy of Oldenburg, where the manufacture of such articles has flourished for over three centuries.

Agate pebbles, in quantity small and of great beauty, are at Agate Bay, Lake Superior. These are sold to the tourists at all the Lake Superior cities.

Agate in bowlders from a few inches to a foot across, of rich red brown and mottled tints, is found in the vicinity of Austin Bluffs, near Colorado Springs and Colorado City, Colorado. In Colorado, chalcedony is found 8 miles south of Cheyenne mountain, at the Los Pinos Agency, at Chalk Hills on the bluffs near Wagon Wheel Gap, and along the upper Rio Grande valley, in Middle South Park, Buffalo Park, Fair Play, Frying Pan, along Trout creek and Gunnison river, and frequently in drift accumulations. In Pinal county, Arizona, large quantities of amygdules of beautifully banded agate are found, often coated with opal. They vary from 1 to 8 inches in diameter, and when broken are generally light bluish gray or light gray in color. They would be extremely beautiful if cut and polished. Seven miles south of Cisco, Utah, there are extensive beds of flesh red, pink, and salmon-colored agate, which received considerable press notice under the name of "blood-agate," and a company has been formed to work it.

The beautiful little agates found on Pescadero beach in California are sold in large quantities and in different forms, polished and unpolished, loose or in vials of water. Occasionally some of these are found inclosing a pebble moving in liquid, like the hydrolites from Uruguay and the chalcedony from Tampa bay, Florida. These pebbles, which may well be called sealed flasks, vary from one-tenth to one-fourth of an inch and rarely are one inch in diameter. They are also found on the Oregon coast near Yaquina bay and Astoria, where they average an inch or more in diameter. They are of quite frequent occurrence in pebbles little larger than a pea at Pescadero beach near San Francisco. Another locality is Canyon Springs in southern California, as reported by Mr. Orcutt. He also reports beautiful chalcedonies and agates in the drift of the Colorado desert and the neighboring mesas. Fine examples of chalcedony replacing coral and sponges are also found at Tampa bay, Florida, a few holding more than half a gill of water each. The chalcedony coatings on the blue and green chrysocolla occuring in the cavities of the Copper Queen mine, Arizona, are very beautiful if cut with their inclosures and form some of the prettiest and most interesting gem-stones ever found. Fully $10,000 worth of this material has been sold in its natural state for cabinet specimens.

Chrysoprase is found in a vein of serpentine in the nickel mines at Nickel Mount near the town of Riddles, Douglas county, Oregon. It occurs there in veins over an inch thick in the nickel ore, and a few fine rich green stones several inches square have been obtained. Some were shown in the southwest gallery of the Mining building in the World's Columbian Exposition. Some fine stones were also found near Visalia, Tulare county, California, by Mr. M. Braverman.

Jasper Bloodstone or heliotrope in beautiful specimens with very fine red marking is found in Chatham county, Georgia. Heliotrope was formerly obtained in the veins in slate at Blooming Grove, Orange county, New York. Good specimens have been found near the Willamette river, Oregon, near the South Park, Colorado, and below the Uncompahgre near Grand river.

Silicified wood, also known as wood agate and wood opal, is found in great abundance in Colorado, California, Arizona, New Mexico, and other western States and Territories. The agatized wood found at Chalcedony Park and elsewhere in Arizona is one of the most beautiful high-class ornamental stones known. Magnificent collections of polished specimens, some nearly 3 feet in diameter, are shown in the Arizona and South Dakota exhibit and in the Manufactures Building of the World's Columbian Exposition.

On a visit to the locality for the Eleventh Census the writer found that Chalcedony Park, near Holbrook, Arizona, the nearest of the so-called forests in the formation on the Atlantic and Pacific railroad, is about a mile square and is inclosed by table lands from 50 to 100 feet high, composed of several beds of variously colored sandstone, red, white, black, etc. Nearly all the agatized trunks are found lying on the plain below, but they were never in place there. They have been weathered out in the decomposition of the upper layer of sandstone and have rolled down upon the plain. None of those remaining in the upper layer are found in the erect position, nor were any roots visible, and, since none of the trees retain any of the orginal bark, it seems probable that all this deposit was once the bed of an inland sea or lake. Another deposit, 3 miles from Los Cerrillos, New Mexico, very closely resembles that of Chalcedony Park, in Arizona. Two sections from this locality, weighing about a ton each, are in the Historical Society's collection at Santa Fé, New-Mexico.

Prof. A. A. Julien, in a communication to the New York Microscopical Society, in January, 1892, announced the discovery of the well-preserved mycelium of a fungus, secreting iron oxide in the jasperized wood from Arizona. To which he attributes the coloration of the agate as detailed in the last report of this series.

Agatized wood in large quantities, consisting of trees from 12 to 35 feet in length and from 18 inches to 2 feet in diameter, has been found near Calistoga, in Napa county, California. True examples of agatized and opalized wood and bluish chalcedony associated with quartz are found in the vicinity of Gallatin, Montana, great quantities of which were collected by Dr. Albert C. Peale and Prof. George P. Merrill, and later by Prof. Frank H. Knowlton, of the United States Geological Survey, for the United States National Museum.

OPAL.

Opal was not observed as a precious stone in the United States until 1889. Since then it has been found in gems equal to the Hungarian in Washington State, Idaho, and Oregon.

In August of 1890 a fine opal was detected in digging a well near Whelan, 20 miles southwest of Colfax, in Washington State. This was in latitude 47 degrees north and longitude 117 degrees west, about midway between the Cœur D'Alene and the Nez Perce Indian reservations, near Moscow, Idaho, almost on the line between Idaho and Washington. It occurred more or less plentifully, and the last 4 feet of the rock contained cavities filled with precious opal. This opal occurs in a basalt, in which most if not all of the feldspar and pyroxene as well as the green mass appears to be altered. Buildings have been erected and the locality named Gem City. The total yield of these mines, during the summer and fall of 1891, amounted to over $5,000; the opal is fine, in many respects equal to the best material from the Hungarian or Australian mines. A gem weighing 3½ carats from this district was held at the extravagant figure of $500, partly perhaps on account of its American origin, and a rough mass of 2 ounces at $1,200. If the material is as abundant as supposed, and is properly worked, it is likely to be one of the most promising of our precious stones from a financial point of view, notwithstanding the abundance of fine stones now being found in Queensland and more recently at Wilcannia, New South Wales.

Some remarkable fine fire opals have been found 30 miles from Hepner, Morrow county, Oregon. At this place, immediately overlying a bed of hardened or baked clay or silicified slate, there is a deposit of eruptive ashes about 4 feet in thickness. This, in turn, is overlaid by red lava and other lavas to the top of the mountain. In this bed of ashes are found large nodules or spherical masses from 1 to 40 per cubic yard. These vary in size from one to several feet. On breaking them open, they are found to obtain some kind of opal, of which one in twenty is a fire opal or a noble opal. It is estimated that some $20,000 worth of specimens have been obtained here during 1892; many of these were stolen at the Spokane fair so that the estimate may be exaggerated.

Quite a number of opals of good quality have been found in the Owyhee mountains at Opaline, 20 miles from Silver City, Owyhee county, Idaho, and about 30 miles from Boisé City. In the northwestern part of that county there are extensive lava beds in which are layers of tufa; in this tufa and in the overlying stratum some very fine opals, weighing from 3 to 20 carats, have been found; they are generally associated with hydrophane and some have been sold for from $5 to $40 a carat. Opals have also been discovered in Latah county, Idaho, where they are mined by two companies, and near Moscow in the same State. A fine collection was shown in the Idaho exhibit, Mines and Mining building, World's Columbian Exposition.

A white opaque variety of hydrophane in rounded lumps from 5 to 25 millimeters (one-fifth to 1 inch) in diameter, with a white, chalky, or glazed coating, somewhat resembling the cacholong from Washington county, Georgia, has been found in Colorado. It is remarkable for its power of absorbing liquid. When water is allowed to drop slowly on it it first becomes very white and chalky and then, by degrees, perfectly transparent. This property is so striking that the finder has proposed for it the name "magic stone," and has suggested its use in rings, lockets, charms, etc., to conceal photographs, or other objects which the wearer wishes to reveal only at his pleasure.

MOONSTONE.

Moonstone, albite variety, has been found in fine large masses at the Allen mica mines, Amelia county, Virginia, and in Delaware county, Pennsylvania. Very few moonstones that are transparent have been found in the United States. During 1892 transparent moonstones in very beautiful small crystals (too small to be of value) were found in some quantity by Clement Hightower on the headwaters of the San Francisco river, a tributary of the Gila, 18 miles east of the Arizona line, New Mexico. No moonstones are found on our coast; those so reported are of Ceylonese origin and passed off as of American origin.

SUNSTONE.

Beautiful varieties of orthoclase sunstone are found near Crown Point and Chappaqua, New York. It also occurs at Amelia Court-House, Amelia county, Virginia. A very interesting variety of sunstone was found by Mr. J. A. D. Stephenson at a quarry in Statesville, North Carolina; the reflections are as fine as in that found at Twedde strand, Norway, but the spots of color are very small. Several hundred dollars worth from this locality have been sold as gems.

Labrador spar is found in large quantities in Lewis and Essex counties, New York, and as bowlders in the drift all the way down to Long Island and New Jersey. In Lewis county the bowlders are so plentiful in one of the streams that it has been named Opalescent river. Large quantities of this labradorite rock are quarried at Keesville, Essex county, New York, for monumental and building work. It is polished there for similar purposes at a cost of about $1 a square foot, and finds a ready sale under the name of Au Sable granite. It somewhat resembles the labradorite from Kief, Russia.

Amazonstone (microcline) is found at Pike's Peak, Colorado, in cavities, in a coarse pegmatite granite with smoky quartz crystals, often of huge size, and with flesh-colored and white feldspars. When associated with smoky quartz it makes a most pleasing and effective combination. Many thousand amazonstone crystals of the most beautiful green color have been obtained, measuring from one-half an inch to over 12 inches in length, and of different shades of green, from the lightest and most delicate to a deep apple green. The crystals are often in groups, the bases of which are covered with white albite. The groups in the New York State Museum at Albany, in the collections of Mr. Clarence S. Bement in Philadelphia, and of Mr. Frederick A. Canfield in Dover, New Jersey, are among the finest known. It is frequently cut into gems or ornamental stones, and large quantities are sold annually to tourists.

Several localities in North Carolina also furnish this mineral. Rockport, Massachusetts, formerly afforded richly colored pieces and some fine green crystals have been found at Paris, Maine; also at Mount Desert, Maine, material that would cut into fair gems is occasionally met with. Several light-green crystals over 6 inches long, and one over 10, were found in the Allen mica mines, Amelia Court-House, Virginia. From the Pike's Peak locality over $10,000 worth have been sold as specimens at prices as high as $200 for a single specimen. Over $1,000 worth from this place is annually cut into tourists' jewelry, In Middletown, Delaware county, Pennsylvania, many shades of green feldspar passing into cassinite and delawarite are found in the soil in loose bowlders up to 20 inches in diameter.

Obsidian in nodules is found in the lower members of the trachytic dike. There is a dike of light gray and clear obsidian with concentric structure near the Colorado Central lode, north of Saguache creek, near Georgetown, Colorado. Obsidian in fine pieces is very abundant 10 miles southeast of Silver Peak, Nevada, and at Obsidian Cliff, in the Yellowstone Park, Wyoming. This locality is described by Mr. Joseph P. Iddings, (*a*) who says: "The cliff presents the partial sections of a floor of obsidian, the dense glass constituting the lower portion, which is from 75 to 100 feet thick. One of its remarkable features is a primitive column forming its southern extremity, which rises 50 or 60 feet and is only 2 to 4 feet in diameter.

Chondrodite that could be cut into gems has been found at the Tilly Foster mine at Brewster's, New York. During 1891 and 1892 some fine transparent garnet-colored crystals were found measuring one-half by one-fourth inch and a few over 4 inches across, some of which would furnish fine gems.

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a Seventh Annual Report of the United States Geological Survey, p. 254 *et seq.*

JADE.

As regards origin, some early writers have attributed the Alaskan nephrite native implements to a Siberian source. Native reports pointed to a source known as the Jade mountains north of the Kowak river, about 150 miles above its mouth, and after several attempts the spot was visited in 1882 by Lieut. G. M. Stoney, U. S. Navy. He collected specimens of jade in situ and a number of samples were examined. A magnificent series of archæological objects of Alaskan jade is in the United States National Museum. Lieut. Stoney found that the implements and jade in situ are identical, thus disposing of the theory that their presence in Alaska is to be accounted for upon the basis of trade with Siberia. That theory is also negatived by the discovery announced by Prof. George M. Dawson, of small nephrite bowlders on the upper part of the Lewis river, not far from the eastern boundary of Alaska. But these nephrites are also strikingly like those from many other localities. The most remarkable specimen of jade (nephrite) or pectolite found on this continent is the bowlder (weight 47¼ pounds) from southern Oregon, now in the James Terry collection of the American Museum of Natural History, New York, which museum during 1892 acquired the George F. Kunz collection of 449 specimens of jade and allied minerals, which with the Terry, the "Squier and Davis," the Lieut. Emmons, the Bement, and the objects formerly owned by the Museum, makes this the finest collection of archæological jade known. No American jade has as yet been utilized in the arts. The compact pectolite found in Alaska and in Tehama county, California, is tough, and resembles some white Chinese jade and would make the best known substitute for it. The so-called jade from near Candelaria, Nevada, of which there was quite a mine, proved to be a green agalmatolite, a soft mineral of no little value as an ornamental stone but useful in the arts as a powder.

Rhodonite, so extensively found and cut in Russia, has been little utilized in this country. It has been found in an extensive bed at Blue Hill bay, Maine, and on Osgood's farm near Cummington, Massachusetts, in very fine large masses and in the neighboring towns, in Warwick, Massachusetts, in Irasburg and Coventry, Vermont, near Winchester and Hinsdale, New Hampshire, and at Cumberland Hill, Rhode Island.

ZEOLITIC GEMS.

Among the Zeolitic gems may be mentioned Zonochlorite, referred to prehnite by Hawes. This gem was found at Neepigon bay, Lake Superior, by Dr. A. E. Foote, in 1877, and is generally of a dark-green color, its name being suggested by the bandings which are characteristic of it. A few thousand dollars would represent the commercial value of all the stones found.

Chlorastrolite is found on the beach at Isle Royal in more or less profusions, where they are weathered out from the Amygdaloid rock in which they are found. They vary in size from that of a pea to a few exceptional stones measuring nearly 2 inches in length, generally selling from 25 cents to $5 each by the jewelers of the Lake Superior region; $25 to $100 have been paid for a few of the remarkable stones. For the past twenty years from $1,000 to $5,000 worth of these stones have been annually sold to be cut into gems or to be taken away as souvenirs.

Thomsonite, generally flesh-colored and beautifully marked with white bands and with green layers (lintonite), is found in great profusion at Grand Marais, Minnesota. This stone is also weathered from Amygdaloid rock, and is generally in grains varying in size from the pea to more than an inch across. Ten dollars is an exceptional price for even the finer specimens; they can generally be bought for from a few cents to several dollars each. In the past ten years from $500 to $1,500 worth have been sold annually.

Fossil coral, generally (Favosites) compact with a grayish-cream color, is found in beautiful masses at Iowa City, Iowa, and in pebbles at the beach at Petosky, Michigan. At the latter place it is known as Petosky marble. The local jewelers in both places cut and polish this material into paper weights, charms, etc., and $1,000 to $2,000 worth are sold annually.

Rutile is found in beautiful, brilliant crystals in Alexander county, North Carolina. In this district the crystals are generally compact enough to admit of the cutting into brilliant stones, with a luster that hey are almost indistinguishable from the cut black diamond.

Pyrite is more or less sold for ornamental purposes in two districts in the United States. First at Wilkesbarre and other parts of the Pluma coal district, where the thin crusts of brilliant crystals are cut nto oval, square, and other forms for scarf pins and other ornaments. In this form several thousand dollars worth are sold annually. In Colorado single crystals or small groups of brilliant crystals in their natural position and to the value of several thousand dollars worth are sold annually. It is not cut into faceted forms as is the same mineral in France, which is known there as marcasite.

TITANITE (SPHENE).

A very remarkable discovery of titanite has been made at the celebrated Tilly Foster iron mine, at Brewster's, Putnam county, New York, where Mr. E. Schernikow obtained several hundred magnificent crystals from 1 to 2 inches in length. Nearly all have highly polished faces, and some are beautifully twinned. They are of fine yellow shades, many of them transparent, and a number are large enough to cut into gems of from 1 to 15 carats each. These were found in the summer of 1891, and are among the finest titanites that have been observed in any recent locality, equaling some of the best crystals from Tavetsch or other celebrated places of occurrence abroad. Over $1,000 worth were sold as gems. Some of the finest crystals are shown in the southwest gallery of the Mines and Mining building at the World's Columbian Exposition by Mr. George L. English, and a fine cut gem of ten carats is in the collection of the United States National Museum. Some fine gems have been obtained at Bridgewater station, Delaware county, Pennsylvania, and small crystals at Magnet Cove, Arkansas.

PRODUCTION.

The following table shows the value of the precious stones produced in the United States from 1885 to 1892, inclusive:

Estimated production of precious stones in the United States from 1885 to 1892.

Species.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Value.	Value.	Value.	Value.	Value.	Value.	Value.	Value.
Diamond		$60						
Sapphire gems	$500	750	$500	$500	$6,725	$6,725	$10,000	$20,000
Chrysoberyl								
Topaz	1,250	1,000	2,000	600	400		100	1,000
Beryl	750	5,500	3,500	800				1,000
Phenacite				650	200			
Emerald	3,200	3,200		100	450		*a*1,000	
Hiddenite	2,500	4,500						
Tourmaline	600	5,500	500		2,250	2,250	3,000	3,000
Smoky quartz	7,000	7,000	4,500	4,000	4,232	2,225	5,000	5,000
Quartz	11,500	11,500	11,500	11,150	14,000	14,000	10,000	10,000
Silicified wood	6,500	1,500	36,000	16,000				1,000
Garnet	2,700	3,250	3,500	3,500	2,308	2,308	3,000	5,000
Anthracite	2,500	2,500	2,000	1,500				3,000
Pyrite	2,000	2,000	2,500	2,500	2,000	2,000	1,500	1,500
Amazonstone	2,750	2,250	1,700	1,700	500	500		1,000
Catlinite (pipestone)	10,000	10,000	5,000	5,000	5,000	5,000	5,000	5,000
Arrow points	2,500	2,500	1,500	1,500				1,000
Trilobites	1,000	1,000	500	500				
Sagenitic rutile	250	1,750						
Hornblende in quartz	300	200	100					
Thomsonite	750	400	750	500	400	400	200	500
Diopside	100		50					500
Agate	2,000	2,000	4,000	4,000				2,000
Chlorastrolite		1,009	800	800	500	400	500	500
Turquoise	3,500	3,000	2,500	3,000	23,675	28,675	150,000	175,000
Moss agate	2,500	2,000	950	950				1,500
Amethyst	2,100	2,100	2,100	2,500	98			200
Jasper				100				
Sunstone	350	300	150					
Fossil coral		1,000	2,000	3,000	700	700	1,000	1,000
Rutile	750	750						
Aquamarine					747		1,000	(*a*)
Rose quartz					600	200		200
Gold quartz	140,000	40,000	75,000	75,000	9,000	9,000	6,000	15,000
Rutilated quartz					30			
Dumortierite in quartz					250	250		
Quartz coated with chalcedony					4,000	2,000		500
Chrysoprase					200	200		100
Agatized and jasperized wood					53,175	6,000	2,000	10,000
Banded and moss jasper					630			
Fluorite					500	500		
Azurite and malachite					2,037			
Zircon (*b*)					16,000			
Gadolinite, furgusonite, etc. (*b*)					1,500			
Monazite (*b*)					1,000			
Spodumene (*b*)					200			
Wooden ornaments decorated with minerals (*c*)					15,500	15,500	15,000	15,000
Opal							5,000	10,000
Peridot							1,000	1,000
Miscellaneous minerals (*d*)					20,000	20,000	15,000	20,000
Total	209,850	118,850	163,600	139,850	188,807	118,833	235,300	299,000

a See Beryl.
b Including lithia emerald.
c Used to extract the rarer elements for chemical purposes.
d Such as clocks, horseshoes, boxes, etc.

PHOSPHATE ROCK.

The statistics of production of phosphate rock in the United States in 1892 are as follows:

Product of phosphate rock in 1891 and 1892.

States.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*	
Florida:				
Hard rock	} 57,982		a155,908	$859,276
Soft rock			6,710	32,418
Land pebble			21,905	111,271
River pebble	54,500		b102,820	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

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.

SOUTH CAROLINA.

The figures given represent the sales and not that part of the product which went over to be marketed in 1893. This stock increased markedly over the stock carried over from 1891. The average price received by the miners for land rock decreased from $6.33 per long ton in 1891 to $5.07 in 1892, and for river rock from $5.88 in 1891 to $4.26 in 1892. These are for dry rock, free on board, at the point of production.

Phosphate rock (washed product) mined by the land and river mining companies of South Carolina.

Years ending May 31—	Land companies.	River companies.	Total.
	Long tons.	*Long tons.*	*Long tons.*
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
1885 (June 1 to Dec. 31)	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

A more detailed statement below shows the disposition made of the product. The local consumption has increased quite remarkably.

Detailed statement of total foreign and coastwise shipments and local consumption since July 1, 1874.

Periods.	Shipments and consumption.	Beaufort.	Charleston.	Total.	Total for each year.
		Long tons.	*Long tons.*	*Long tons.*	
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	30,600	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	468,998
	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	

FLORIDA.

The sales aggregated 155,908 long tons of hard-rock or plate phosphate, 102,820 tons of river pebble, 21,905 tons of land pebble, and 6,710 tons of soft-rock phosphates. These sales include besides the actual amount mined, the difference in stocks at the beginning and close of the year. The stocks decreased very markedly, for it was found impossible otherwise to deliver the contracts made in advance of legitimate mine development. The great decline in prices for phosphate rock from Florida and all other sources has already been very thoroughly published by the technical press, especially in the excellent reviews of the market in the Manufacturers' Record. Briefly, the great anxiety of the producers to secure contracts as a basis for developments led them to offer much more phosphate on the English market than could possibly be furnished. The English price dropped consequently from 12*d.* per unit in the ton at the ports of Europe to 7½*d*—the equivalent of from $13 to $8 per ton, free on board, at the shipping ports in the United States. The miners in the Somme department of France withdrew from the foreign trade and the Canadian apatite mines shut down, actually driven out by offers of phosphate rock which did not yet exist above ground. The actual cargoes exported were also badly marketed. They were offered by several brokers, and thus tended to multiply the visible supply. A poor harvest added its feature to the situation, and the result was a thorough disorganization of the trade. It is therefore only surprising that the average prices for the whole year were as good as they were, *i. e.*, hard rock, $5.51 per long ton; soft rock, $4.83; land pebble, $5.08, and river pebble, $4.04.

A further disturbing feature which still hampers the production is the fact that the foreign business is subjected to narrow limits in the analytic stipulation, so that if a cargo, which may or may not be well represented in the sampling, falls a trifle short of the mark it is rejected and must seek a new market with the discredit of having been rejected as of inferior quality. The lesson which it is thus intended to teach the producer, of greater care in making the quality of the cargo, is impractical, considering the narrow limits involved and the fact that a slight variation in the percentage of phosphoric acid has no harmful effect beyond the inconsiderable difference in yield of superphosphate.

Fertilizers imported and entered for consumption in the United States, 1868 to 1892, inclusive.

Calendar years ending December 31, from 1886 to 1892; previous years end June 30.	Guano.		Crude phosphates and other substances used for fertilizing purposes.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Long tons.		*Long tons.*		
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	....	165, 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
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

SULPHUR.

By E. W. Parker.

The only producing locality in 1892 was at the old Dickert and Myers property in Utah, now operated by the Utah Sulphur Company. The total product during the year was 2,688 short tons, worth $80,640, against 1,200 short tons, valued at $39,600, in 1891. The property having passed into the hands of a new company, increased facilities for mining, refining, and shipping the sulphur have been added; but the consumption of Utah sulphur must necessarily be limited to points at a distance from the Atlantic seaboard, owing to the high wages paid for mining, etc., and the cost of transportation, which shut it out of markets easily reached by Sicilian sulphur.

The following table shows the production of sulphur in the United States since 1880. During 1888, 1889, and 1890 the Dickert and Myers mines were in litigation and nonproductive. The product in 1889 was from the Barnes sulphur mine, near Frisco, Utah, and the Wise mine, at Winnemucca, Nevada. The output in that year was 1,150 short tons of sulphur ore, yielding 450 tons of refined sulphur.

Sulphur product of the United States since 1880.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	600	$21,000	1887	3,000	$100,000
1881	600	21,000	1888		
1882	600	21,000	1889	450	7,850
1883	1,000	27,000	1890		
1884	500	12,000	1891	1,200	39,600
1885	715	17,875	1892	2,688	80,640
1886	2,500	75,000			

Prices.—The firmer tone in the market which prevailed during 1891 was not continued in 1892, but on the other hand prices were demoralized throughout the year. In January the highest price quoted was $33 for best unmixed seconds and $32 for best unmixed thirds. These fell off steadily until April, when as low as $23 and $22 respectively were quoted. A slight recovery took place in the later summer months, but declined again at the end of the year. The following table shows the highest and lowest prices quoted during each month in 1892:

Highest and lowest prices for sulphur in each month during 1892.

[Price per ton.]

	January.		February.		March.		April.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
Best unmixed seconds	$33	$28.50	$29	$26	$25	$24	$25	$23
Best unmixed thirds	32	27.50	28	25	24	23	24	22

Highest and lowest prices for sulphur in each month during 1892—Continued.

	May.		June		July.		August.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
Best unmixed seconds ...	$24	$23	$24	$23	$25	$24	$25	$24
Best unmixed thirds.....	23	22	23	22	24	23	24	23

	September.		October.		November.		December.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
Best unmixed seconds ...	$24.50	$24	$24	$23	$25	$24	$26	$23
Best unmixed thirds.....	23.50	23	23	22	24	23	25	22

Average prices of sulphur, best unmixed seconds, from 1881 to 1892.

Years.	Price per ton.	Years.	Price per ton.
1881	$31.00	1888:	
1882	27.50	January	$24.75
1883	27.00	May	20.67
1884	23.50	June	27.00
1885	22.40	December	26.00
1886	20.50	1889	23.00
		1890	30.00
1887:		1891	33.00
January	20.50	1892:	
July	18.67	January	31.00
December	24.90	December	24.50

Imports.—The following tables show the total amount of sulphur imported into the United States from 1867 to 1892, and the countries from which received and customs districts through which imported since 1876:

Sulphur imported and entered for consumption in the United States, 1867 to 1892, inclusive.

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...	24,544.10	$620,373	110.05	$5,509	250.55	$10,915	....	$636,797
1868..	18,150.55	446,547	16 48	948	64.75	2,721	....	450,216
1869...	23,589.69	678,642	96.59	4,576	645.04	27,149	....	710,367
1870...	27,379.60	819,408	76.34	3,927	157.24	6,528	$1,269	831,132
1871...	36,131.46	1,212,448	65.54	3,514	92.26	4,328	754	1.221,044
1872...	25,379.55	764,798	35.97	1,822	56.94	2,492	....	769,112
1873...	45,533.27	1,301,000	55.29	2,924	35.97	1,497	....	1.305,421
1874...	40.989.55	1,260,491	51.08	2,694	56.68	2,403	....	1,265,588
1875...	39,683.10	1,259,472	17.83	891	....	....	....	1,260,363
1876...	46,434.72	1,475,250	41.07	2,114	43.87	1,927	....	1,479,291
1877...	42,962.69	1,242,888	116.34	5,873	1,170.80	36,962	....	1,285,723
1878...	48,102.46	1,179,769	158.71	7,628	149.51	5,935	....	1,193,332
1879...	70,370.28	1,575,533	137.60	6,509	68.94	2,392	....	1,584,434
1880...	87,837.25	2,024,121	123.70	5,516	158.36	5,262	....	2,034,899
1881...	105,096.54	2,713,485	97.66	4.226	70.96	2,555	....	2,720,266
1882...	97,504.15	2,627,402	158.91	6,926	58.58	2,196	....	2,636,524
1883...	94,539.75	2,288,946	79.13	3,262	115.33	4,487	....	2,296,695
1884...	105,112.19	2,242,697	178.00	7,869	126.00	4,765	....	2,255,331
1885...	96,839.44	1,941,943	120.56	5,351	114.08	4,060	....	1,951,354
1886 ..	117,538.35	2,237,989	212.61	8,739	116.05	3,877	....	2,250,605
1887...	96,881.55	1,688,360	278.56	9,980	83.54	2,383	....	1,700,723
Dec. 31, 1888...	98,252.15	1,581,583	127.67	4,202	27.02	734	....	1,586,519
1889...	135,933.00	2,068,208	15.34	1,954	10.00	299	....	2,070,461
1890...	162.674.00	2,762,953	12.06	1,718	103.00	3,060	....	2,767,731
1891...	116,971.00	2,675,192	206.00	6,782	10.00	1,997	133,250	2,817,221
1892...	100,938.00	2,189,481	158.00	5,439	26.00	4,106	587,981	2,787,007

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 1892.

Countries whence exported and customs districts through which imported.	1876.		1877.		1878.		1879.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES.	*Short tons.*		*Short tons.*		*Short tons.*		*Short 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

Countries whence exported and customs districts through which imported.	1880.		1881.		1882.		1883.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES.	*Short tons.*		*Short tons.*		*Short tons.*		*Short 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	428	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	35,036	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

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 1892—Continued.

Countries whence exported and customs districts through which imported.	1884 *a*.		1885.		1886.		1887.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES.	*Short tons.*		*Short tons.*		*Short tons*		*Short 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

Countries whence exported and customs districts through which imported.	1888.		1889.		1890.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES.	*Short tons.*		*Short tons.*		*Short tons.*	
Belgium	83	$1,993	180	$4,086	182	$3,995
Danish West Indies	....	....	....	....	550	9,076
England	310	7,200	305	8,337	4,898	101,100
Scotland	....	....	....	....	20	487
Italy	92,528	1,499,720	123,260	1,935,368	115,240	1,800,585
Japan	6,332	72,729	6,446	77,853	21,031	221,316
Total	99,253	1,581,582	130,191	2,025,644	141,921	2,136,559
DISTRICTS.						
Baltimore, Md	11,989	$182,769	15,791	$234,693	21,198	$322,918
Beaufort, S. C	500	9,000	600	9,213	....	....
Boston and Charlestown, Mass	3,760	62,298	6,446	104,257	7,410	135,044
Charleston, S. C	12,005	199,048	23,377	364,859	15,752	255,106
New Orleans, La	200	3,845	....	....	200	3,397
New York, N. Y	50,486	816,286	60,922	959,872	66,359	983,754
Philadelphia, Pa	10,519	173,699	13,288	202,357	13,919	210,576
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
Savannah, Ga	....	....	2,345	44,244	5,560	86,826
Wilmington, N. C	1,532	25,893	1,753	28,443	2,040	32,800
All other customs districts	600	9,000	560	11,200	20	487
Total	99,253	1,581,582	130,191	2,025,644	141,921	2,136,559

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 1892—Continued.

Countries whence exported and customs districts through which imported.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
COUNTRIES.	*Short tons.*		*Short tons.*	
Belgium	267	$6,576	....	....
England	5,613	127,976	6,522	$162,616
France	....	....	1	23
Quebec, Ontario, etc	....	....	1	49
Italy	101,660	2,140,516	90,668	2,147,942
Japan	12,763	168,073	12,227	213,776
Other countries	501	8,372	....	....
Total	120,804	2,451,513	109,419	2,524,406
DISTRICTS.				
Baltimore, Md	9,339	247,324	9,981	263,293
Beaufort, S. C	1,300	26,951	....	....
Boston and Charlestown, Mass	6,381	136,402	9,086	221,033
Charleston, S. C	28,281	557,384	14.651	364,593
Mobile, Ala	750	14,863	....	....
New Orleans, La	1,300	30,474	2,118	47,165
New York, N. Y	44,027	910,075	52,647	1,191,169
Pensacola, Fla	1,399	23,206	....	....
Philadelphia, Pa	10,842	216,763	9,380	211,570
Portland, Me	....	....	2.000	42,460
San Francisco, Cal	8.819	115.637	7,256	127,797
Savannah, Ga	5,245	99,717	....	....
Willamette, Oregon	288	11,852	398	6,866
Wilmington, N. C	2,832	60,843	1,900	48,388
All other customs districts	1	22	2	72
Total	120,804	2,451,513	109,419	2,524,406

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 Cicily since 1883.

Countries.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
United States	96,629	94,929	99,378	98,590	89,419	128,265	109,008	106,656	97,520	84,850
France	63,602	65,098	58,264	54,280	56,222	52,083	67,340	71,790	56,168	73,176
Italy	66,810	56,292	49,415	48,658	48,997	47,664	43,523	40,231	42,212	38,701
United Kingdom	41,788	40,760	33,402	30,236	30,007	35,634	39,203	26,213	23,408	24,853
Greece	10,494	7,033	13,664	19,697	18,370	5,809	10,158	18,103	11,414	14,371
Portugal	15,298	11,018	17,760	30,943	16,587	15,851	16,799	16,695	11,439	13,490
Russia	10,413	12,831	13,420	10,570	13,441	22,043	17,678	17,158	11,930	14,178
Germany	7,232	6,622	6,103	8,689	9,700	12,402	15,401	15,703	10,629	13,699
Austria	4,915	6,037	5,965	5,800	6,702	8,942	8,984	8,746	10,575	....
Turkey	3,043	1,285	3,077	4,598	6,238	1,457	2,231	4,231	3,000	(*a*)
Spain	5,242	3,920	2,243	5,890	5,873	3,433	6,586	5,679	3,845	7,132
Belgium	7,660	6.793	9,516	6.580	5,318	6,951	7,752	7,279	5,089	....
Holland	1.256	696	1,237	2,999	1,747	2,793	2,424	....	....	....
Sweden	1,010	744	328	1,916	1,169	3,004	3,899	3,314	2,252	....
South America	....	....	....	....	710	95	23	....	....	....
Australia	....	....	....	....	600	885	....	....	....	1,200
Denmark	....	....	810	....	202	464	443	400	300	....
Other countries	....	....	....	....	....	....	....	2,565	3,542	24,286
Total	335,392	314,058	314,582	329,446	311,302	347,775	351,451	344,763	293,323	309,936

a Included in exports to Greece.

The ports in the United States to which such shipments were made, together with the 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.	1889.	1890.	1891.	1892.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
New York	41, 238	46, 460	50, 814	49, 952	45, 979	60, 706	55, 939	37, 390	49, 023	49, 090
Charleston	5, 425	7, 706	12, 416	10, 556	14, 324	22, 496	12, 399	27, 563	21, 646	4, 510
Phliadelphia	23, 123	19, 234	12, 153	15, 662	11, 764	11, 793	14, 334	11, 094	6, 856	10, 400
Baltimore	16, 175	13, 986	16, 435	15, 680	10, 306	17, 330	15, 316	16, 700	11, 365	12, 355
Boston	5, 864	4, 723	4, 200	3, 800	3, 300	6, 300	4, 950	2, 500	1, 950	3, 325
Wilmington, N. C	....	....	....	....	1, 020	2, 355	2, 040	1, 309	2, 600	....
Savannah	....	....	....	....	....	3, 545	3, 240	5, 920	1, 550	1, 170
Pensacola	....	....	....	....	....	....	....	1, 390	....	....
Port Royal	600	610	680	660	1, 000	600	....	600	700	....
Providence	650	1, 140	1, 370	1, 180	630	1, 250	590	650	....	....
Sundries	670	....	....	....	600	480	....	....	....	....
San Francisco	1, 884	500	....	....	296	....	....	....	....	....
New Orleans	350	100	250	....	200	250	200	800	1, 200	2, 000
Woods Holl	650	470	1, 060	1, 100	....	1, 160	....	....	....	....
Mobile	....	....	....	....	....	....	....	740	....	....
Delaware Breakwater	....	....	....	....	....	....	....	....	630	....
Portland	....	....	....	....	....	....	....	....	....	2, 000
Total	96, 629	94, 929	99, 378	98, 590	89, 419	128, 265	169, 008	166, 656	97, 520	84, 850

Quality of Sicilian sulphur received at the different ports of the United States since 1886.

Ports.	1886.		1887.		1888.		1889.		1890.		1891.		1892.	
	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.	Best unmixed seconds.	Best thirds.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*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	29, 358	19, 665	34, 390	14, 700
Charleston	7, 506	3, 050	8, 875	5, 449	15, 485	7, 011	6, 325	6, 074	20, 873	6, 690	17, 196	4, 450	4, 010	500
Philadelphia	4, 660	11, 002	2, 127	9, 637	3, 050	8, 743	2, 000	12, 334	1, 000	10, 094	450	6, 406	3, 600	6, 800
Baltimore	7, 325	8, 355	4, 463	5, 843	11, 380	5, 950	7, 656	7, 660	5, 930	10, 770	4, 510	6, 855	900	11, 455
Boston	600	3, 200	260	3, 100	700	5, 600	750	4, 200	200	2, 300	1, 300	650	1, 825	1, 500
Savannah	......	......	......	......	2, 130	1, 415	2, 790	1, 450	2, 750	3, 170	850	700	600	570
Wilmington, N.C.	......	......	1, 020	......	2, 355	......	2, 040	......	1, 309	......	1, 900	700	......	......
Other ports	1, 180	1, 760	106	2, 620	1, 500	2, 240	200	590	1, 540	2, 640	1, 200	1, 330	4, 000	......
Total	57, 623	40, 967	46, 710	42, 709	72, 173	56, 092	53, 744	55, 264	54. 403	52, 253	56, 764	40, 756	49, 325	35, 525

Pyrites.—The production of pyrites increased slightly in 1892 as compared with 1891, being 122,963 short tons, against 119,320. Sympathizing with the decline in the price of sulphur during the year the value of the pyrites marketed also declined, being $305,191, against $338,880 in 1891. The new developments in Louisa county, Virginia, of which mention was made in the preceding report, had not reached the stage of producing pyrites for market, but one new producing locality was added. This property is near Quantico, Virginia, and about 1,400 tons were shipped from there to Baltimore acid makers in 1892. The following table shows the annual production of pyrites since 1882.

Production of pyrites in the United States from 1882 to 1892.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1882	13,440	$72,000	1888	60,851	$167,658
1883	28,000	137,500	1889	104,950	202,119
1884	39,200	175,000	1890	111,836	273,745
1885	54,880	220,500	1891	119,320	338,880
1886	61,600	220,000	1892	122,963	305,191
1887	58,240	210,000			

Imports of pyrites containing not more than 3½ per cent of copper. (a)

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Long tons.			*Long tons.*	
1884	16,710	$50,632	1887	16,578	$49,661
1885	6,078	18,577	1891	100,648	392,141
1886	1,605	9,771	1892	152,359	587,980

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 E. W. Parker.

The amount of salt produced in the United States in 1892 was unprecedentedly large, reaching a total of 11,698,890 barrels, against 9,987,945 barrels in 1891. But although the yield was the largest yet obtained, the business was not by any means satisfactory to producers. Sharp competition for trade during the past two years has cut the prices to such low figures that profits have almost disappeared, and a number of the smaller concerns have been compelled to close their works. This struggle for trade while it has worked some injury has also resulted beneficially in the improvement of the quality of the refined salt produced for table and dairy use. The refinement of salt has been made the subject of conscientious and intelligent study. New and improved methods have been introduced, the producers guarding each discovery made with jealous secrecy, and the results have been exceedingly gratifying. No more conclusive evidence of the improvement in the quality of the domestic salt is necessary than a study of the table of imports, which show a steady decrease in value since 1885. The total value of the salt imported into the United States in 1885 was over a million and a half dollars, and in 1892, $774,806, a decline of nearly 50 per cent. This decrease has been almost entirely in refined salt, which in 1885 was valued at $1,030,029, decreasing almost steadily until 1892, when the total imports were valued at $488,108, a difference of $541,921 or 52½ per cent.

An analysis of the production in 1892 by States shows that the most noteworthy increases in production have been in Kansas, 624,564 barrels; in New York 632,529 barrels, and in Utah, 323,471 barrels. Gains are also shown in the outputs of California, Illinois, and Louisiana. Michigan suffered the heaviest loss, the product decreasing from 3,966,784 barrels in 1891 to 3,829,478 barrels in 1892, a decline of 137,306 barrels. The salt production of Michigan depends very largely upon the lumber trade, many of the lumber mills using their exhaust steam to evaporate the brine and some using the otherwise wasted sawdust as a fuel for the "direct heat" process. Owing to the low prices for salt prevailing in 1892, these concerns only ran their salt works while the sawmills were running. Several independent salt works which are operated in good seasons were closed down entirely during 1892. Nevada's output decreased from 60,799 barrels in 1891 to 22,929 barrels in 1892, the loss being due to the closing of silver smelting works, which consumed a large portion of the product. The product in Virginia decreased over 10,000 barrels, and the one establishment which contributed the entire product of the State was torn down during the latter part of the year to give place to a plant for the manufacture of soda ash, so that unless some new source is reported in 1893, Virginia will cease to appear in the list of salt producers. The production of Ohio, Pennsylvania, Texas, and West Virginia was not reported separately in 1891, so that no comparison with the year under review can be made.

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 following table 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 during years 1883 to 1892.

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

a Estimated.

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	7,0 8,653	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

a Estimated. *b* Included in "other States."

CALIFORNIA.

The amount of salt produced in California in 1892 was 235,703 barrels, valued at $104,788, against 200,949 barrels, worth $90,303, in 1891.

The entire product is obtained from sea water by solar evaporation. 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 required for each operation depending, of course, upon the weather.

The output during 1892 was the largest ever obtained, as will be seen in the following table:

Salt product of California since 1883.

Years.	Barrels.	Value.	Years.	Barrels.	Value.
1883	214, 286	$150, 000	1888	220, 000	$92, 400
1884	178, 571	120, 000	1889	150, 000	63. 000
1885	221, 428	160, 000	1890	62, 363	57, 085
1886	214, 285	159, 000	1891	200, 949	90, 303
1887	200, 000	140, 000	1892	235, 703	104, 788

ILLINOIS.

This State produced 60,000 barrels of salt, worth $48,000, in 1892, against 39,670 barrels, valued at $34,909 in 1891. The statistics of salt production in Illinois prior to 1891 have not been obtained.

KANSAS.

Salt production in Kansas during 1892 shows a phenomenal increase (about 75 per cent.) over that of 1891, the output in 1892 being 1,480,100 barrels against 855,536 the preceding year. The following table shows the annual product of the State since 1888, when the first statistics of production were obtained.

Salt product of Kansas since 1888.

Years.	Barrels.	Value.
1888	155, 000	$189, 000
1889	450, 000	202, 500
1890	822, 666	397, 199
1891	855, 536	304, 775
1892	1, 480, 100	773, 989

LOUISIANA.

The production of salt at the Petite Anse mine in 1892 was 200,000 barrels, or 28,000 tons, valued at $100,000, against 173,714 barrels, or 24,320 tons, in 1891, valued at $102,375. The following table shows the annual production, in tons, at the Petite Anse mine since 1882.

Production of the Petite Anse salt mine from 1882 to 1892.

Years.	Short tons.	Years.	Short tons.
1882	25, 550	1888	55, 214
1883	37, 130	1889	45, 588
1884	31, 355	1890	39, 079
1885	41, 898	1891	24, 320
1886	41, 957	1892	28, 000
1887	47, 750		

MICHIGAN.

The salt product of Michigan in 1892 was 3,829,478 barrels, valued at $2,046,963, as compared with 3,927,671 barrels, worth $2,037,289, in 1891. The causes for the decreased production in Michigan have already been referred to. In the following table, showing the production of salt in the State since 1869, the figures to 1891, inclusive, are from the inspectors' reports; those for 1892 are from direct returns from producers to the United States Geological Survey.

Grades of salt produced in Michigan, as reported by the inspectors, from 1869 to 1892, 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	746,702	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
1899	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	....	....	....	....	....	3,829,478

NEVADA.

Owing to the shutting down of silver smelting works, which consumed the greater part of Nevada's salt product, the returns for 1892 show a decreased output. The amount was only 22,929 barrels against 60,799 barrels in 1891. Previous to 1891 no separate statistics of salt production in Nevada have been obtained.

NEW YORK.

The salt product of New York is obtained from the Onondaga reservation and the Warsaw district. The former is owned by the State and the brine is sold to the manufacturers. The wells of the Warsaw district are operated independently. The total product of the State in 1892 amounted to 3,472,073 barrels, valued at $1,662,816, against 2,839,544 barrels, valued at $1,340,036. Both districts share in the increased production, the Onondaga reservation increasing from 3,948,914 bushels, or 789,783 barrels, in 1891, to 4,405,674 bushels, or 881,135 barrels, in 1892, and the Warsaw district from 10,248,505 bushels, or 2,049,701 barrels, to 12,954,705 bushels, or 2,590,941 barrels. The following table shows the product of the two districts, in bushels, since 1883:

Product of salt in New York for the years 1883 to 1892.

Districts.	1883.	1884.	1885.	1886.	1887.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Onondaga reservation	7,497,431	6,942,270	6,934,299	6,101,757	5,695,797
Warsaw district	600,000	2,000,000	4,589,635	6,056,060	6,072,000
Total	8,097,431	8,942,270	11,523,934	12,157,817	11,767,797
Districts.	**1888.**	**1889.**	**1890.**	**1891.**	**1892.**
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Onondaga reservation	5,657,367	5,365,039	4,928,122	3,948,914	4,405,674
Warsaw district	5,935,000	6,000,000	7,732,060	10,248,505	12,954,705
Total	11,592,367	11,365,039	12,660,182	14,197,419	17,360,379

The Onondaga salt springs reservation.—The annual report of Mr. P. J. Brummelkamp, State superintendent of the Onondaga salt springs for 1892, gives the total amount of salt inspected during the year as 4,405,674 bushels of 56 pounds each. Of this amount 1,282,885 bushels was produced in the fine salt works by artificial heat, and 3,122,789 bushels of coarse salt by solar evaporation. The production of the several districts into which the reservation is divided has been as follows:

Product of Onondaga reservation in New York, by districts, in 1892, according to inspectors' returns.

Districts.	Fine.	Solar.	Solar ground.	Ground dairy.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*
Syracuse, No. 1	574,704	933,000	331,253	....
Salina, No. 2	340,375	123,009	....	....
Liverpool, No. 3	180,600	787,591	....	....
Geddes, No. 4	187,206	947,936	....	....
Total	1,282,885	2,791,536	331,253	....

Production of the Onondaga district, 1797 to 1892.

[Bushels of 56 pounds.]

Years.	Solar.	Fine.	Total.	Years.	Solar.	Fine.	Total.
	Bushels.	*Bushels.*	*Bushels.*		*Bushels.*	*Bushels.*	*Bushels.*
1797		25,474	25,474	1845	353,455	3,408,903	3,762,358
1798		59,928	59,928	1846	331,705	3,507,146	3,838,851
1799		42,704	42,704	1847	262,879	3,688,476	3,951,355
1800		50,000	50,000	1848	342,497	4,394,629	4,737,126
1801		62,000	62,000	1849	377,735	4,705,834	5,083,569
1802		75,000	75,000	1850	374,732	3,894,187	4,268,919
1803		90,000	90,000	1851	378,967	4,235,150	4,614,117
1804		100,000	100,000	1852	633,595	4,288,938	4,922,533
1805		154,071	154,071	1853	577,947	4,826,577	5,404,524
1906		122,577	122,577	1854	734,474	5,068,873	5,803,347
1807		175,448	175,448	1855	498,124	5,584,761	6,082,885
1808		319,618	319,618	1856	709,391	5,257,419	5,966,810
1809		128,282	128,282	1857	481,280	3,830,846	4,312,126
1810		450,000	450,000	1858	1,514,554	5,518,665	7,033,219
1811		200,000	200,000	1859	1,345,022	5,549,250	6,894,272
1812		221,011	221,011	1860	1,462,565	4,130,682	5,593,247
1813		226,000	226,000	1861	1,884,697	5,315,694	7,200,391
1814		295,000	295,000	1862	1,983,022	7,070,852	9,053,874
1815		322,058	322,058	1863	1,437,656	6,504,727	7,942,383
1816		348,665	348,665	1864	1,971,122	5,407,712	7,378,834
1817		408,665	408,665	1865	1,886,760	4,499,170	6,385,930
1818		406,540	406,540	1866	1,978,183	5,180,320	7,158,503
1819		548,374	548,374	1867	2,271,892	5,323,673	7,595,565
1820		458,329	458,329	1868	2,027,490	6,639,126	8,666,616
1821		526,049	526,049	1869	1,857,942	6,804,295	8,662,237
1822		481,562	481,562	1870	2,487,691	6,260,422	8,748,113
1823		726,988	726,988	1871	2,464,464	5,910,492	8,374,956
1824		816,634	816,634	1872	1,882,604	6,048,321	7,930,925
1825		757,203	757,203	1873	1,691,359	5,768,998	7,460,357
1826		811,023	811,023	1874	1,667,368	4,361,932	6,029,300
1827		983,410	983,410	1875	2,655,955	4,522,491	7,179,446
1828		1,160,888	1,160,888	1876	2,308,679	3,083,998	5,392,677
1829		1,129,280	1,129,280	1877	2,525,335	3,902,648	6,427,983
1830		1,435,446	1,435,446	1878	2,788,754	4,387,443	7,176,197
1831		1,514,037	1,514,037	1879	2,957,744	5,364,418	8,322,162
1832		1,652,985	1,652,985	1880	2,516,485	5,482,265	7,998,750
1833		1,838,646	1,838,646	1881	3,011,461	4,905,775	7,917,236
1834		1,943,252	1,943,252	1882	3,032,447	5,307,733	8,340,180
1835		1,209,867	1,209,867	1883	2,444,374	5,053,057	7,497,431
1836		1,912,858	1,912,858	1884	2,353,860	4,588,410	6,942,270
1837		2,167,287	2,167,287	1885	2,439,332	4,494,967	6,934,299
1838		2,575,033	2,575,033	1886	2,772,348	3,329,409	6,101,757
1839		2,864,718	2,864,718	1887	3,118,974	2,576,823	5,695,797
1840		2,622,305	2,622,305	1888	3,115,314	2,542,053	5,657,367
1841	220,247	3,120,520	3,340,767	1889	2,916,922	2,448,117	5,365,039
1842	163,021	3,128,882	2,291,903	1890	2,726,471	2,201,651	4,928,122
1843	318,105	2,809,395	3,127,500	1891	2,113,727	1,735,186	3,948,914
1844	332,418	3,671,134	4,003,552	1892	3,122,789	1,282,885	4,405,674

UTAH.

The salt production of Utah in 1892 was 1,292,471 barrels, valued at $340,442, an increase over 1891 of over 300,000 barrels in quantity, and of about $75,000 in value. The product in 1891 was more than 125 per cent. over that of 1890, which in turn exceeded that of 1889 by about 113 per cent. The product of the Territory since 1883 has been as follows:

Production of salt in Utah, 1883 to 1892.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Barrels.			*Barrels.*	
1883	107,143	$100,000	1888	151,785	$32,000
1884	114,285	80,000	1889	200,000	60,000
1885	107,140	75,000	1890	427,500	126,100
1886	164,285	100,000	1891	969,000	265,350
1887	325,000	102,375	1892	1,292,471	340,442

OTHER STATES.

The combined product of Ohio, Pennsylvania, Texas, and West Virginia in 1892 was 942,783 barrels. In 1891 these States were included in the estimated product of "other States," which was quoted at 430,761 barrels. The returns for 1892 are sufficiently complete to give the product of each State, which is to be found in the tables of production by States. The estimate of the output in 1891 was probably less than the actual output. Virginia's product decreased from 70,442 barrels in 1891 to 60,000 barrels in 1892, and will probably be omitted from the list of salt producers in the future, as the property has changed hands, the works torn down, and in its stead a plant for the manufacture of soda ash has been erected.

IMPORTS AND EXPORTS.

Salt imported and entered for consumption in the United States, 1867 to 1892, inclusive.

[Calendar years ending December 31 from 1886 to 1892; previous years end June 30.]

Years.	In bags, barrels, and other packages.		In bulk.		For the purpose of curing fish.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
1867	254, 470, 862	$696, 570	229, 304, 323	$336, 302	....	....	$1, 032, 872
1868	308, 446, 080	915. 546	219, 975, 096	365, 458	....	....	1, 281, 004
1869	297. 382, 750	895. 272	256, 765, 240	351, 168	....	....	1, 246, 440
1870	288, 479, 187	797, 194	349, 776, 433	507, 874	68, 597, 023	$87, 048	1, 392, 116
1871	283, 993, 799	800, 454	274, 730, 573	355, 318	64, 671, 139	66, 008	1, 221, 780
1872	258, 232, 807	788, 893	257, 637, 230	312, 569	57, 830, 929	60, 155	1, 161, 617
1873	239. 494, 117	1, 254, 818	388, 012, 132	525, 585	86, 756, 628	86, 193	1, 866, 596
1874	358, 375, 496	1, 452, 161	427, 294, 209	649, 838	105, 613, 913	126, 896	2, 228, 895
1875	318, 673, 091	1, 200, 541	401, 270, 315	549, 111	110, 294, 440	119, 607	1, 869, 259
1876	331, 266, 140	1, 153, 480	379, 478, 218	462, 106	118, 760, 638	126, 276	1, 741, 862
1877	359, 005, 742	1, 059, 941	444, 044, 370	532, 831	132, 433, 972	140, 787	1, 733, 559
1878	352, 109, 963	1, 062, 995	414, 813, 516	483, 909	100, 794, 611	96, 898	1, 643, 802
1879	375, 286, 472	1, 150, 018	434, 760, 132	532, 706	94, 060, 114	95, 841	1, 778, 565
1880	400, 970, 531	1, 180, 082	449, 743, 872	548, 425	109, 024, 446	119, 667	1, 848, 174
1881	412, 442, 291	1, 242, 543	529, 361, 041	658, 068	133, 395, 065	144, 347	2, 044, 958
1882	329, 969, 300	1, 086, 932	399, 100, 228	474, 200	134, 777, 569	147, 058	1, 708, 190
1883	312. 911, 360	1, 035, 946	412, 938, 686	451, 001	142, 065, 557	154, 671	1, 641, 618
1884	340, 759, 010	1, 093, 628	441, 613, 517	433, 827	126, 605, 276	122, 463	1, 649. 918
1885	351, 276, 969	1, 030, 029	412, 322, 341	386, 858	140, 067, 018	121, 429	1, 538, 316
1886	319, 232, 750	966, 993	366, 621, 223	371, 000	103, 360, 362	94, 721	1, 432, 714
1887	275. 774, 571	850, 069	343, 216, 331	328, 201	105, 577, 947	107, 089	1, 285, 359
1888	238, 921, 421	620, 425	272, 650, 231	246, 022	113, 459, 083	111, 120	977, 577
1889	180, 906, 293	627, 134	234, 499, 635	249, 232	97, 960, 624	100, 123	976, 489
1890	172, 611, 041	575, 260	243, 756, 044	252, 848	98, 279, 719	96, 648	924, 756
1891	150, 033, 182	492, 144	220, 309, 985	224, 569	103, 990, 324	89, 196	805, 909
1892	150, 799, 014	488, 108	201, 366, 103	196, 371	105, 192, 086	90, 327	774, 806

Salt of domestic production exported from the United States from 1790 to 1892, inclusive.

Fiscal years ending September 30 until 1842, and June 30 since.	Quantity.	Value.	Calendar years ending December 31 from 1886 to 1892; previous years end June 30.	Quantity.	Value.
	Bushels.			*Bushels.*	
1790	31, 935	$8, 236	1861	537, 401	$144, 046
1791	4, 208	1, 052	1862	397, 506	228, 109
1830	47, 488	22, 978	1863	584, 901	277, 838
1831	45, 847	26, 848	1864	635, 519	296, 088
1832	45, 072	27, 914	1865	589, 537	358, 109
1833	25, 069	18, 211	1866	670, 644	300, 980
1834	89, 064	54, 007	1867	605, 825	304, 030
1835	126, 230	46. 483	1868	624. 970	289, 936
1836	49, 917	31, 943	1869	442, 947	190, 076
1837	99, 133	58, 472	1870	298, 142	119, 582
1838	114, 155	67, 707	1871	120. 156	47, 115
1839	264, 337	64, 272	1872	42, 603	19, 978
1840	92, 145	42. 246	1873	73, 323	43, 777
1841	215, 084	62, 765	1874	31, 657	14, 701
1842	110, 400	39, 064	1875	47, 094	16, 273
1843 (nine months)	40, 678	10, 262	1876	51, 014	18, 378
1844	157, 529	47, 755	1877	65, 771	20, 133
1845	131, 500	45, 151	1878	72, 427	24, 968
1846	117, 627	30, 520	1879	43, 710	13, 612
1847	202, 244	42, 333	1880	22, 179	6, 613
1848	219, 145	73, 274	1881	45, 455	14, 752
1849	312, 063	82, 972	1882	42, 085	18, 265
1850	319, 175	75, 103	1883	54, 147	17, 321
1851	344, 061	61, 424	1884	70, 014	26, 007
1852	1, 467, 676	89, 316	1885	*a*4, 101, 587	26, 488
1853	515, 857	119, 729	1886	4, 828, 863	29, 580
1854	548, 185	159. 026	1887	4, 685, 080	27, 177
1855	536, 073	156, 879	1888	5, 359, 237	32, 986
1856	698, 458	311, 495	1889	5, 378, 450	31, 405
1857	576, 151	190, 699	1890	4, 927, 022	30, 079
1858	533, 100	162. 650	1891	4, 448, 846	23, 771
1859	717, 257	212, 710	1892	5, 208, 935	28, 399
1860	475, 445	129, 717			

a Pounds from 1885.

GYPSUM.

The total amount of gypsum produced in the United States in 1892 was 256,259 short tons, valued at $695,492, against 208,126 short tons in 1891, valued at $628,051. The value of the product has been determined in its first marketable condition. Some producers market their product crude, some grind for use as land plaster, and some calcine their output into plaster of Paris. In arriving at the value of the last the value of the calcined plaster is taken. In a number of cases producers sell in all three conditions. The following table shows the production in 1892 by States. In order not to disclose confidential statements furnished by producers the product of Colorado, Iowa, Ohio, Texas, and Utah has been consolidated, their being only one operator in each of those States. No product was reported from South Dakota and Wyoming, and the mines in California were not worked, the manufacturers of plaster of Paris obtaining their supplies of crude gypsum from Mexico.

Product of gypsum in the United States in 1892, by States.

States.	Sold crude.		Ground into land plaster.		Calcined into plaster of Paris.			Total product.	
	Quantity.	Value.	Quantity.	Value.	Before calcining.	After calcining.	Value of calcined plaster.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	*Short tons.*		*Short tons.*	
Kansas	420	$840	....	....	45, 596	31, 961	$194, 357	46, 016	$195, 197
Michigan	47, 500	71, 250	14, 458	22. 026	77, 599	53, 105	213, 251	139, 557	306, 527
New York	7, 887	5, 661	24, 407	55. 039	100	75	400	32, 394	61, 100
Virginia	400	800	5, 028	20, 357	1, 563	1, 250	7, 050	6, 991	28, 207
Other States (*a*)	1, 873	2, 246	3, 775	8, 825	25, 653	19, 750	93, 390	31, 301	104, 461
Total	58, 080	80, 797	47, 668	106, 247	150, 511	106, 141	508, 448	256, 259	695, 492

a Includes Colorado, Iowa, Ohio, Texas, and Utah. In each of these States the output is reported from only one company.

It will be observed that the product of crude gypsum sold in Michigan was unusually large. This was due to the mill of one company having been destroyed by fire. The product was probably calcined by the purchasers and the value enhanced accordingly. The increased value, however, does not appear in this report. For the purposes of comparison the following table showing the statistics of production in 1891 is given:

Product of gypsum in the United States in 1891, by States.

States.	Total amount sold crude.	Value of crude.	Ground into land plaster.	Value of land plaster.	Calcined. Weight before calcining.	Calcined. Weight after calcining.	Value of calcined plaster.	Total product.	Total value.
	Short tons.		*Short tons.*		*Short tons.*	*Short tons.*		*Short tons.*	
California, Ohio, Utah, and Wyoming	....	....	988	$3, 336	16, 127	14, 085	$90, 810	17, 115	$94, 146
Iowa	....	....	4, 822	4, 845	26, 563	21, 049	53, 250	31, 385	58. 095
Kansas	640	1, 280	70	210	39, 497	28, 468	159, 832	40, 217	161, 322
Michigan	11. 000	22. 000	15, 100	28. 550	53, 600	44, 860	173, 175	79. 700	223. 725
New York	6, 730	5, 058	23, 405	53, 513	....	....	....	30, 135	58, 571
South Dakota	....	....	1, 560	4, 680	2, 055	1, 544	4, 938	3, 615	9, 618
Virginia	204	352	5, 755	22, 222	....	....	....	5, 959	22, 574
Total	18, 574	28, 690	51, 700	117, 356	136, 727	110, 006	482, 005	208, 126	628, 051

Comparing the total results with those for the preceding three years, we find that both the amount and value of the product are in excess of those of 1890 and 1891, but considerably less than in 1889, a year of exceptional activity in the industry. The total product, with its distribution and value for the last four years, was as follows:

Comparative statistics of gypsum production for four years.

States.	1889. Product.	1889. Value.	1890. Product.	1890. Value.	1891. Product.	1891. Value.	1892. Product.	1892. Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Colorado	7, 700	$28, 940	4, 580	$22, 050	....	....	....	....
Iowa	21, 789	55. 250	20, 900	47, 350	31, 385	$58, 095	....	....
Kansas	17, 332	94, 235	20, 250	72, 457	40, 217	161, 322	41, 016	$195, 197
Michigan	131, 767	373, 740	74, 877	192, 099	79, 700	223, 725	139, 557	306, 527
New York	52, 608	79, 476	32, 903	73, 093	30, 135	58, 571	32, 394	61, 100
South Dakota	320	2, 650	2, 900	7, 750	3, 615	9, 618	....	....
Virginia	6, 838	20, 336	6, 350	20, 782	5. 959	22, 574	6, 991	28. 207
Other States	29, 420	109. 491	20, 235	138, 942	17, 115	94, 146	31, 301	104, 461
Total	267, 769	764, 118	182, 995	574, 523	208, 126	628, 051	256, 259	695, 492

California.—The gypsum properties in Santa Barbara county, California were not worked in 1892, the owners of the mines, whose calcining works are in San Francisco, finding it to their advantage to procure their supplies of crude gypsum from Mexico.

Colorado.—One mill was destroyed by fire early in 1892, and one other, owing to slack demand, was closed part of the year. Trade was reported very dull and the probabilities are that the burned mill will not be rebuilt.

Iowa.—The product reported is from one mine only, and considerably less than the output of the State in 1891. Ninety per cent. of the output was calcined, the remainder being sold for land plaster.

Kansas.—Reports have been received from five operators, the total product being 46,016 short tons, valued at $195,197, against 39,092 short tons in 1891, valued at $157,322, an increase of 6,924 short tons in quantity and of $37,875 in value. All of the producers report an improved condition of trade compared with 1891 both in demand and prices. While the product of Kansas is classed as gypsum, all of the output is not really true gypsum. A portion of the product is in reality a decomposed gypsum, or, as styled by the producers, "gypsum clay." Its use, however, in the manufacture of wall plasters, etc., gives it place in the statistics of gypsum production.

Michigan.—Michigan produced 139,557 short tons of gypsum in 1892, against 79,700 tons in 1891. The total value given for the product in 1892 was $306,527, but in this statement are included 47,500 tons of the mineral which was sold in crude condition, the calcining mill at the place of production, Alabaster, being destroyed by fire in 1891. The total value of the product of the State in 1891 was $223,725. Michigan producers report larger business but closer prices. The construction of the exhibition buildings in Jackson Park, Chicago, undoubtedly increased the demand for Michigan plaster.

New York.—The output in 1892 was 32,394 short tons, worth $61,100, against 30,135 short tons valued, at $58,571, in 1891. The product is used almost exclusively as a fertilizer, the consumption depending very much on the weather. More plaster is used in dry seasons than in wet ones. Of the product in 1892 100 tons were calcined, producing 75 tons of plaster of Paris, worth $400.

Ohio.—The product is of excellent quality and the greater portion is calcined into plaster of Paris. That which is off color (and which represents about 8 per cent. of the total) is ground into land plaster and sold for $2 per ton. The purer mineral is valued at $3 per ton crude and $5 per ton after calcining. The demand is improving. The output is entirely from Ottawa county. Additional facilities have been added to the grinding and calcining property by the addition of new machinery, so as to double the capacity of the works. The actual increase in output in 1892 over 1891 was between 40 and 50 per cent.

Virginia.—The output in 1892 was 6,991 short tons, valued at $28,207. This was over 1,000 tons greater than the product in 1891, and the largest yet obtained in the State, the nearest approach to it being in 1889, when the product was 6,838 tons. The greater portion of the product is used for fertilizing purposes, though in 1892 1,563 tons were calcined, yielding 1,250 tons of plaster of Paris, worth $7,050.

Other States.—No product is reported from either South Dakota or Wyoming in 1892. Utah's product decreased about 12 per cent. Texas became a producer for the first time in 1892. The producing mines are at Quanah, in Hardeman county. The material is said not to be really gypsum, but a mixture of clay and gypsum, similar to the gypsum clay of Kansas.

Imports.—The following table exhibits the total gypsum, ground or calcined and crude, imported into the United States since in 1867.

Gypsum imported into the United States from 1867 to 1892.

Years ended—	Total.	Ground or calcined.		Unground.		Value of manufactured plaster of Paris.
		Quantity.	Value.	Quantity.	Value.	
		Long tons.		*Long tons.*		
June 30, 1867	$125,182	....	$29,895	97,951	$95,386	....
1868	114,350	....	33,988	87,694	80,362	....
1869	186,512	....	52,238	137,039	133,430	$844
1870	148,720	....	46,872	107,237	100,416	1,432
1871	154,013	....	64,465	100,400	88,256	1,292
1872	168,873	....	66,418	95,339	99,902	2,553
1873	165,459	....	35,628	118,926	122,495	7,336
1874	170,901	....	36,410	123,717	130,172	4,319
1875	171,096	....	52,155	93,772	115,664	3,277
1876	179,070	....	47,588	139,713	127,084	4,398
1877	162,917	....	49,445	97,656	105,629	7,843
1878	140,587	....	33,496	89,239	100,102	6,989
1879	125,542	....	18,339	96,963	99,027	8,176
1880	150,409	....	17,074	120,327	120,642	12,693
1881	171,724	....	24,915	128,607	128,107	18,702
1882	200,922	5,737	53,478	128,382	127,067	20,377
1883	218,969	4,291	44,118	157,851	152,982	(a) 21,869
1884	210,904	4,996	42,904	166,310	168,000	....
1885	173,752	6,418	54,208	117,161	119,544	....
1886	153,338	5,911	37,642	122,270	115,696	....
1887	195,890	4,814	37,736	146,708	162,154	....
Dec. 31, 1888	190,787	3,340	20,764	156,697	170,023	....
1889	220,140	5,466	40,291	170,965	179,849	....
1890	229,859	7,568	55,250	171,289	174,609	....
1891	226,319	9,560	97,316	110,257	129,003	....
1892	308,011	6,882	75,608	181,104	232,403	....

(*a*) Not specified since 1883.

FLUORSPAR.

The only source of supply for fluorspar in commercial quantity is Rosiclaire, Illinois. The product in 1892 was 12,250 short tons, valued at $89,000, against 10,044 short tons, worth $78,330, in 1891. Operators report the demand for fluorspar (particularly for fluxing purposes, as its properties in this regard become better understood) to be increasing annually and the trade steadily improving. In addition to its use for metallurgical purposes, it is consumed in the manufacture of glass and of hydrofluoric acid. When intended for glass or acid making the fluorspar is crushed and put through a buhr mill at the mines before selling. For other purposes it is sold in lumps as mined. The reader is referred to "Mineral Resources of the United States, 1889 and 1890," for a more extended discussion of the use of flourspar for metallurgical purposes.

The following table shows the yearly production of fluorspar since 1882:

Production of fluorspar in the United States from 1882 to 1892.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1882	4,000	$20,000	1888	6,000	$30,000
1883	4,000	20,000	1889	9,500	45,835
1884	4.000	20,000	1890	8,250	55,328
1885	5.000	22,500	1891	10,044	78,330
1886	5,000	22,000	1892	12,250	89,000
1887	5,000	20,000			

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. A discovery of a deposit of cryolite was reported in Colorado several years ago, but no later intelligence has been received corroborating the report. The imports of cryolite for a series of years is shown in the following table:

Imports of cryolite from 1871 to 1892.

Years ended—	Amount.	Value.	Years ended—	Amount.	Value.
	Long tons.			*Long tons.*	
June 30, 1871	....	$71,058	June 30, 1882	3,758	$51,589
1872	....	75,195	1883	6,508	97,400
1873	....	84,226	1884	7,390	106,029
1874	....	28,118	Dec. 31, 1885	8,275	110,750
1875	....	70,472	1886	8,230	110,152
1876	....	103,530	1887	10,328	138,068
1877	....	126,692	1888	7,388	98,830
1878	....	105,884	1889	8,603	115,158
1879	....	66,042	1890	7,129	95,405
1880	....	91,366	1891	8,298	76,350
1881	....	103,529	1892	7,241	96,932

GRAPHITE.

The production in 1892 was 1,398,363 pounds of refined graphite, valued at $87,902, against 1,559,674 pounds, worth $10,000, in 1891. Of the product in 1892, 1,298,363 pounds were from Ticonderoga, N. Y. The other 100,000 pounds was mined in Berks County, Pa.

Uses.—The higher grades of graphite are used in the manufacture of lead pencils and lubricants. The poorer qualities are used for crucibles, stove polish, foundry facing, and in the manufacture of paint for metallic surfaces.

Sources of supply.—The graphite produced in the United States is by no means commensurate with the demand, and manufacturers are obliged to secure supplies elsewhere. The island of Ceylon furnishes the bulk of the world's supply of the mineral, and graphite mining is one of the most important industries of the island. Only the most primitive methods are employed in mining, but, nevertheless, the industry is a very profitable one. Germany also produces a considerable amount of graphite, the output of the empire in 1890 being 4,355 metric tons.

The production in the United States since 1880 has been as follows:

Production of graphite since 1880.

Years.	Quantity.	Value.
	Pounds.	
1880		$49,800
1881	400,000	30,000
1882	425,000	34.000
1883	575,000	46,000
1884		
1885	327,883	26,231
1886	415,525	33,242
1887	416,000	34,000
1888	400,000	33,000
1889		72,662
1890		77,500
1891	1,559,674	110,000
1892	1.398.363	87,902

Imports.—The amount of graphite imported and entered for consumption, including withdrawals from warehouses, in 1892, was 11,677 short tons, or (as usually weighed) 233,540 hundredweight, valued at $667,775. In amount this did not equal the imports in 1890, when 255,955 hundredweight was imported, but the value exceeded by more than $70,000 the imports of any previous year. The following table shows the annual imports since 1867:

Graphite imported into the United States from 1867 to 1892.

Years ended—	Unmanufactured.		Manufactured.	Total.
	Quantity.	Value.		
	Cwt.			
June 30, 1867	27,113	$54,131	....	$54,131
1868	68,620	149,083	....	149,083
1869	74,846	351,004	....	351,004
1870	80,795	269,291	$833	270,124
1871	51,628	136,200	3,754	139,954
1872	96,381	329,030	....	329,030
1873	157,539	548,613	....	548,613
1874	111,992	382,591	....	382,591
1875	46,492	122,050	....	122,050
1876	50,589	150,709	17,605	168,314
1877	75,361	204,630	18,091	222,721
1878	60,244	154,757	16,909	171,666
1879	65,662	164,013	24,637	188,650
1880	109,908	278,022	22,941	300,963
1881	150,927	381,966	31,674	413,640
1882	150,421	363,835	25,536	389,371
1883	154,893	361,949	21,721	383,670
1884	144,086	286,393	1,863	288,256
1885	110,462	207,228	....	207,228
1886	83,368	164,111	....	164,111
1887	168,841	331,621	....	331,621
Dec. 31, 1888	184,013	353,990	....	353,990
1889	177,381	378,057	....	378,057
1890	255,955	594,746	....	594,746
1891	212,360	555,080	....	555,080
1892	233,540	667,775	....	667,775

ASBESTOS.

By E. W. Parker.

Two different minerals are usually classed under this head, asbestos proper and chrysotile. In appearance they are very similar, both being of a fibrous nature and both are remarkable for their resistance to heat. Chrysotile is by far the more valuable mineral, its fibers being tough and flexible and capable of being woven into fabrics. Asbestos possesses longer fibers, but they lack strength and flexibility and are not suitable for the manufacture of woven goods. It is, however, valuable for covering for boilers, steam and hot-air pipes, for packing in fireproof safes, and is used largely in the manufacture of cements and paints. Chrysotile is not produced in the United States, this country obtaining its supply from the Thetford and Black Lake mines of Canada. Asbestos occurs in a number of places throughout the United States, but the commercial product has been, until 1892, limited to California. In 1891, 66 tons, valued at $3,960, were mined in that State and used in the manufacture of fireproof paint. The output from this source in 1892 was only 30 tons, but the decrease there was more than compensated for by the production of 64 tons in Oregon and 10 tons in Wyoming, making the total product for the year 104 tons, which was worth $6,416. It is claimed by the promoters of a plan to develop the Wyoming mines that the mineral possesses the qualities of chrysotile and that, like chrysotile, it occurs in distinct veins in a country rock of serpentine.

The production of asbestos in the United States since 1880 has been as follows:

Annual product of asbestos since 1880.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	150	$4,312	1887	150	$4,500
1881	200	7,000	1888	100	3,000
1882	1,200	36,000	1889	30	1,800
1883	1,000	30,000	1890	71	4,560
1884	1,000	30,000	1891	66	3,960
1885	300	9,000	1892	104	6,416
1886	200	6,000			

Imports.—There was a decrease in the value of the asbestos (chrysotile) imported into the United States in 1892, as compared with 1891, of nearly $90,000. The imports in 1891 were valued at $358,461, more than $100,000 over those of 1890. The falling off in 1892 indicates that the imports in 1891 were much larger than the demand warranted. The Canadian Statistical Year Book for 1892 shows also that there was a decided falling off in the production of asbestos, or chrysotile, during 1892, the output being 6,042 tons, against 9,000 tons in 1891. The following table shows the imports of asbestos since 1869:

Asbestos imported from 1869 to 1892.

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

THE ASBESTOS INDUSTRY IN CANADA.

As nearly all the asbestos consumed in the United States is now obtained from Canada, the following abstract of a paper read by Mr. L. A. Klein before the General Mining Association of Quebec will be of interest:

"To prepare the abestos for market two operations are necessary, viz., the mining proper and cobbing or separation of the abestos from the adhering serpentine. At most of the mines the drilling is done by steam or compressed air, 45 feet of hole per day of ten hours in the former case and 50 to 55 feet in the latter being considered a fair day's work, at an average cost of 7 to 8 cents per foot of hole drilled. At present there are in use 7 compressors, with a total capacity of 44 drills, and there are 44 steam drills. The average cost of drilling amounts to 3½ cents per ton of rock broken. Dualin, which contains 33 per cent. nitroglycerine and costs 20 cents per pound, is the explosive used; it is fired by electricity. The expense for explosives is about 3 cents per ton of rock. The broken rock is roughly sorted in the pit, the waste rock being sent to the dump by wheelbarrows, or in the larger mines by derricks, and the crude asbestos to the cobbing-sheds. The cost of this averages 25 cents per ton of rock.

"The second and most important part of the work is the dressing or cobbing of the abestos and then grading it. This grading is generally done by hand by boys. Some of the mines have, however, partially or entirely adopted machinery for this purpose, in order to avoid the loss of asbestos contained in the so-called cobbing stone, *i. e.*, large pieces of rock with a vein of asbestos in it, which did not separate by the blast and which can only be separated by heavy sledge hammers, or by crushing. The first to try to solve this problem was the Scottish-Canadian Asbestos Company. Their plant consisted of a Blake crusher, traveling picking tables, Cornish rolls, revolving screens, elevators, chokers, and blowers.

"The mines of this company were closed during 1888, and it was not until the winter of 1890-'91 that the American Asbestos Company started to experiment in this direction, the main object being to do away with what is known as grade No. 2. At this plant the crude asbestos is conveyed by an inclined railway and automatically dumped in front of a Blake crusher, the jaws of which are set at 1½ inches. The crushed ore drops on an inclined sieve in shaking motion, which separates all the loose fiber and the dust from the larger pieces of rock and asbestos veins, the former going directly to the cleaning or grading machines, the latter dropping on a revolving picking table, where the barren rock is removed by hand to one side of the table, the asbestos veins being left on the other. At the end of the table is a receiving chute which is divided into two compartments, and into which rock and asbestos are discharged respectively. The rock drops from the chute directly into a larry and is wheeled to the dumps, while the asbestos is conveyed either to the kilns, necessary in winter time or rainy weather, or to the fine crushers for further treatment. These latter are of unique construction, of which the object is to allow particles of a certain size and loosened fiber to go through without being further crushed, as thereby the asbestos fiber is likely to be injured. This so reduced stuff is brought to the cleaning and grading machines, consisting mainly of a set of inclined sieves in rapid shaking motion in connection with blowers, fans, etc., while the remaining unbroken stone and unloosened fiber goes back to a set of still finer crushers to undergo the process again. The plant at King Brothers' mines in Thetford, which was principally erected for the extracting of asbestos out of large pieces of rock on the old dumps, which some years ago did not warrant the expenses for block-holing and further handling, consists of a Blake crusher, from which the stuff is conveyed on a set of Cornish rolls, with the intention of having all stone reduced to powder, from there to a revolving screen, of which the object was to screen out all the dust and leave the clean fiber. This object, however, has not been fully realized, owing to the failure of the rolls to break up the rock entirely, and an additional blowing and screening plant has been put in, which produces now a very clean product of one grade.

"The Anglo-Canadian Company also runs a crusher and a set of sieves, and another company has recently put in a couple of crushers to overwork the old dumps. None of the processes at their present state, however, may as yet be considered complete, the main difficulties being two: (1) That if asbestos is crushed with a considerable amount of stone, until the latter is reduced to powder, the long and most valuable asbestos is partially destroyed; (2) if the stone is not entirely reduced before grading it is nearly impossible to free the fiber from the stone, and a large amount of waste is the result.

"The cost of cobbing, according to Mr. Klein, varies considerably, according to the quality of material. While some asbestos will break from the stone very easy, other requires considerable labor; then larger veins will sooner be gathered than small ones. He places it, including the breaking of the cobbing stones, at $7 per ton at the leading mines.

"The asbestos, after being graded, which is, however, in the entire discretion of every particular mine, is put in bags of 100 pounds each. Cost of bags is from 5 to 6 cents each; cost of bagging, 20 to 25 cents per ton. The cost for transport to cars and loading varies from 10 to 60 cents a ton, according to distance from railroad.

"In estimating the cost per ton of asbestos, Mr. Klein says: 'On this subject the opinions of the asbestos quarrymen are very different, and while some claim to mine only 50 or 60 tons of rock to the ton of asbestos, others go as high as 150. I am of the opinion that as a rule the quantity of rock mined to the ton of asbestos is greatly underestimated. Basing on the capacity and actual work of our machinery appliances the known quantity of larry loads removed from a mine during a year and the known average weight of each load, in relation to the totals of asbestos produced, I hold that one ton of asbestos to 100 tons of rock is a fair average. If we accept this, the cost of production of asbestos may be set down as follows: Drilling, 3½ cents; blasting, 3 cents; labor for removing rock and gathering asbestos in the pits, 25 cents, making a total of 31½ cents to the ton of rock, or $31.50 to the ton of asbestos; $7 for cobbing; $1.50 for bags and bagging; 50 cents for loading; $5.50 for supplies, which includes fuel, tools, iron, steel, timber, other materials, and repairs; $6 for general business expenses, such as management, insurance, offices, marketing, and others; $3.55, 10 per cent. wear and tear, calculated on a total of $355,000 in plant, making a total of $55.55 to produce one ton of asbestos. If we calculate now that we have to pay interest on a total invested capital of about $2,250,000, for which at least 10 per cent. must be expected, we have in our sales to average a price of at least $80 per ton of asbestos.'

"The output of asbestos in 1880 was but 380 tons, valued at $24,700. Since then the industry has steadily increased, with the only exception of 1888, and reached in 1890 9,860 tons, with a value of $1,260,240. During the period between 1880 and 1890 the increase has been nearly 2,600 per cent. in tonnage and 5,100 per cent. in value. Since 1880 the prices have been as follows: 1880, $65; 1881, $65; 1882, $65; 1883, $72; 1884, $65; 1885, $58; 1886, $59.75; 1887, $49; 1888, $60; 1889, $69.75;

1890, $127; 1891, $111; 1892, $64.30. During this time the imports of asbestos by the United States have increased from $9,786 in 1880 to $269,642 in 1892."

The Statistical Year Book gives the following statement showing the amount and value of shipments from the mines since 1879:

Annual product of asbestos in Canada since 1879.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Tons.			*Tons.*	
1879	300	$19,500	1887	4,619	$226,976
1880	380	24,700	1888	4,404	255,007
1881	540	35,100	1889	6,113	426,554
1882	810	52,650	1890	9,860	1,260,240
1883	955	68,750	1891	9,000	1,000,000
1884	1,141	75,079	1892	6,042	388,462
1885	2,440	142,441			
1886	3,458	206,251	Total	50,062	4,181,728

The exports of asbestos from Canada amounted in 1891 to 7,022 tons, valued at $513,909, and in 1892 to 7,316 tons, valued at $514,412, some of the exports in the latter year being from material won the year before, the production in 1892 being 1,274 less than the exports.

SOAPSTONE.

In the report for 1891 mention was made of increased facilities for quarrying and manufacturing this mineral to accommodate the increased demand. These resulted in a largely increased product, the output (exclusive of the fibrous variety treated of in a separate paragraph) being 23,208 short tons, against 16,514 short tons in 1891, a gain of 6,794 short tons, or over 40 per cent. The increase in the value of the product was still more remarkable, advancing from $243,981 in 1891 to $423,449, an increase of $179,468, or over 70 per cent. The seemingly disproportionate increase in value was due to the fact that a number of producers, heretofore engaged in quarrying the mineral and selling it either rough or sawed into slabs convenient for shipping, have added manufacturing plants to their establishments, and now sell the manufactured products, increasing their revenue accordingly. In fact, of the entire product in 1892, only 1,560 short tons were reported as being sold rough, and brought an average of $7 per ton. The manufactured product from the same quarry was sold at an average of $14 per ton, or exactly double. 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	1887	12,000	$225,000
1881	7,000	75,000	1888	15,000	250,000
1882	6,000	90,000	1889	12,715	231,708
1883	8,000	150,000	1890	13,670	252,309
1884	10,000	200,000	1891	16,514	243,981
1885	10,000	200,000	1892	23,208	423,449
1886	12,000	225,000			

Uses of soapstone.—Considering the number of ways in which soapstone now finds a useful place in the liberal arts, the only cause for surprise appears to be in the tardy development of the industry. Some of its advantages were early recognized by the North American Indians. Its resistance to heat and the ease with which it could be worked into desirable shapes even with the crude instruments at their command made the manufacture of cooking utensils of soapstone one of their few industrial occupations. They also made tobacco pipes and many fancifully shaped articles used in religious ceremonies, etc. The uses to which soapstone is applied to-day are very numerous. With modern machinery it is easily wrought into fire brick for lining cooking stoves, heaters, and smelting furnaces. For making tubs for the laundry or bath and particularly for sinks in chemical laboratories it is largely used. It does not absorb grease or acids, is unaffected by extremes of boiling or freezing mixtures, and any dirt or impurities adhering to it are readily removed. Hearthstones, mantels, slate pencils, and stone griddles are made from it, the peculiar quality of the last being that no grease need be applied to them. Ground soapstone is used as a base for pigments and cosmetics, for dressing skins and leather, for lubricating, and as an adulterant or makeweight in the manufacture of soap, paper, and rubber. As a paint it is peculiarly adapted for covering sandstone and limestone structures from climatic influences.

Occurrence.—Soapstone occurs in nearly every State along the Atlantic slope, though not always in deposits that can be profitably worked. Also along the coast of California and in Texas, Arizona, and South Dakota. The producing States in 1892 were Vermont, New Hampshire, Massachusetts, New York (fibrous), New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, and Georgia.

Fibrous talc.—Gouverneur, St. Lawrence county, New York, continues to furnish the entire product of the fibrous variety of soapstone. This mineral is used almost exclusively as a filler in the manufacture of medium grades of paper, a small amount being used in making dynamite. The production in 1892 decreased about 11,000 tons as compared 1891, though owing to better prices the value declined very slightly in proportion. The product in 1892 was 41,925 short tons, valued at $472,485, against 53,054 short tons, worth $493,068 in 1891.

Annual production of fibrous talc since 1880.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	4,210	$54,730	1887	*a*15,000	$160,000
1881	*a*7,000	60,000	1888	*a*20,000	210,000
1882	*a*6,000	75,000	1889	23,746	244,170
1883	*a*6,000	75,000	1890	41,354	389,196
1884	*a*10,000	110,000	1891	53,054	493,068
1885	*a*10,000	110,000	1892	41,925	472,485
1886	*a*12,000	125,000			

a Estimated.

Talc imported into the United States from 1880 to 1892, inclusive.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1880	....	$22,807	1887	(*a*)	$49,250
1881	....	7,331	1888	24,165	22,446
1882	....	25,641	1889	19,229	30,993
1883	....	14,607	1890	1,044	1,560
1884	....	41,165	1891	81	1,121
1885	....	24,356	1892	531	5,546
1886	....	24,514			

(*a*) Quantity not reported previous to 1888.

MINERAL PAINTS.

Under this head are included ochers, umbers, siennas, metallic paint, Venetian and Indian reds, mineral black, soapstone and slate ground for pigment, and the output of white lead corroders; namely, white lead, red lead, litharge and orange mineral. Some graphite is also used for paint, but the production is included in the statistics of graphite. It should also be noted that in the table of mineral products on page 7 the production of white lead, etc., is not included among mineral paints, the lead so consumed being included in the lead product, and a separate statement is given of the slate ground for pigment. The following table exhibits the production of all mineral paints in the United States in 1892:

Product of the mineral paints in the United States in 1892.

Kinds.	Quantity.	Value.	Kinds.	Quantity.	Value.
	Short tons.			*Short tons.*	
Ocher	13,390	$176,624	Slate	3,787	$23,523
Umber	475	7,100	White lead	74,485	8,733,620
Sienna	500	9,350	Red lead	6,122	757,787
Metallic paint	30,211	452,966	Litharge	5,764	611,726
Venetian and Indian reds	4,900	106,800	Orange mineral	395	60,170
Mineral black	200	2,500			
Soapstone	1,050	10,400	Total	141,279	10,952,566

Ocher.—Previous to 1892 no separate statistics of the production of umber and sienna were obtained, they being included in the production of ocher. The returns for 1892 are, however, more complete, and the production of each has been shown to be: Ocher, 13,390 short tons, valued at $176,624; umber, 475 short tons, valued at $7,100; sienna, 500 short tons, valued at $9,350; a total of 14,365 short tons, valued at $193,074.

Ocher was produced in Alabama, Georgia, Maryland, Massachusetts, Missouri, New Jersey, Pennsylvania, Vermont, and Virginia. Pennsylvania produced the only umber reported, and all the sienna was from that State and New Jersey. The following table shows the production in 1892 by States:

Product of ocher, umber, and sienna, in 1892, by States.

States.	Ocher.		Umber.		Sienna.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Alabama	375	$4,050					375	$4,050
Georgia	1,748	26,800					1,748	26,800
Maryland	1,000	10,000					1,000	10,000
Massachusetts	46	418					46	418
Missouri	1,922	28,220					1,922	28,220
New Jersey	75	600			100	$3,000	175	3,600
Pennsylvania	6,180	77,305	475	$7,100	400	6,350	7,055	90,755
Vermont	544	5,731					544	5,731
Virginia	1,500	23,500					1,500	23,500
Total	13,390	176,624	475	7,100	500	9,350	14,365	193,074

For the purposes of comparison the production for the preceding three years is shown in the following table. Prior to 1889, when the statistics were compiled for the eleventh census, the product for each State was not published.

Production of ocher, umber, and sienna in 1889, 1890, and 1891, 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	7,000	84,000
Total	15,158	177,472	17,555	237,523	18,294	233,823

(*a*) Includes all of Maryland, and estimated products of some firms in other States not reporting.

Annual production of ocher since 1884.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1884	7,000	$84,000	1889	15,158	$177,472
1885	3,950	43,575	1890	17,555	237,523
1886	6,300	91,850	1891	18,294	233,823
1887	8,000	75,000	1892	14,365	193,074
1888	10,000	120,000			

Imports.—The following tables show the amount and value of ochers, etc., from 1867 to 1892.

Ocher, etc., imported from 1867 to 1883.

Fiscal years ending 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 1892.

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

Imports of umber from 1867 to 1892.

Years ended—	Quantity.	Value.	Years ended—	Quantity.	Value.
	Pounds.			*Pounds.*	
June 30, 1867	2,147,342	$15,946	June 30, 1880	1,877,645	$17,271
1868	345,173	2,750	1881	1,475,835	11,126
1869	570,771	6,159	1882	1,923,648	20,494
1870	708,825	6,313	1883	785,794	8,419
1871	470,392	7,064	1884	2,946,675	20,654
1872	1,409,822	18,203	1885	1,198,060	8,504
1873	845,601	8,414	Dec. 31, 1886	1,262,930	9,187
1874	729,864	6,200	1887	2,385,281	16,536
1875	513,811	5,596	1888	1,423,800	14,684
1876	681,199	7,527	1889	1,555,070	20,887
1877	1,101,422	10,213	1890	1,556,823	19,329
1878	1,038,880	8,302	1891	633,291	6,498
1879	986,105	6,959	1892	1,028,038	6,256

Metallic paint.—The falling off in the production of ocher in 1892 as compared with 1891 was more than made up in the output of metallic paint, which shows a total in 1892 of 30,211 short tons, valued at

$452,966, against 25,142 tons in the preceding year, valued at $334,455. The combined product of ocher and metallic paint in 1891 was 43,436 short tons, worth $568,278, and in 1892, 44,576 short tons, worth $644,340, an increase of 1,140 short tons and $77,962. The following table shows the production of metallic paint for the last four years by States:

Production of metallic paint in 1889, 1890, 1891, and 1892, by States.

States.	1889.		1890.		1891.		1892.	
	Product.	Value.	Product.	Value.	Product.	Value.	Product.	Value.
	Short tons.		*Short tons.*		*Short tons.*		*Short tons.*	
Alabama	3,000	$30,000	....	....	....	....	....	....
California	....	....	40	$480	22	$880	25	$750
Colorado	90	2,500	1,300	22,100	....	....	....	....
Delaware	....	....	....	....	73	1,097	50	900
Kentucky	....	....	....	....	....	....	150	1,875
Maryland	....	....	....	....	....	....	500	5,000
Missouri	....	....	....	....	....	....	135	1,350
New Jersey	....	....	10	130	867	13,178	5,000	100,000
New York	3,658	63,698	5,224	72,952	7,352	99,487	5,200	76,500
Ohio	540	11,123	637	16,341	800	14,500	879	17,090
Pennsylvania	8,849	128,036	8,955	145,243	9,175	134,138	10,289	176,785
Tennessee	3,507	24,237	5,386	46,088	4,000	30,000	5,000	32,000
Virginia	....	....	....	....	110	1,800	135	1,890
Vermont	....	....	500	6,000	400	5,000	400	5,000
Wisconsin	1,832	26,700	2,125	31,035	2,343	34,375	2,448	33,826
Total	21,026	286,294	24,177	340,369	25,142	334,455	30,211	452,966

Venetian and Indian reds.—The product in 1892 was 4,900 short tons, valued at $106,800, against 4,191 short tons, valued at $90,000, in 1891, and 4,000 tons, worth $84,100, in 1890. Prior to 1890 no statistics of production were obtained.

Soapstone.—Against a product of 25 tons in 1891, worth $200, an output of 1,050 short tons is reported in 1892, valued at $10,400. The use of soapstone as a pigment in this country began in 1891.

Mineral black.—This pigment is reported for the first time in 1892, the product being 200 short tons, valued at $2,500. All of it came from Pennsylvania.

Slate as a pigment.—For the three years preceding 1892 the amount of this product has been estimated at 2,000 tons annually, the values for each year being placed at $20,000 or $10 per ton. The amount actually returned by producers in 1892 was 3,787 short tons, worth $23,523.

White lead.—The product of white lead in 1892 was 148,969,464 pounds, or 74,485 short tons, valued at $8,733,620, against 156,036,131 pounds, or 78,018 short tons, in 1891, valued at $10,454,029 in 1891, a decrease of 3,533 short tons in quantity and $1,720,409 in value. The following table exhibits the tendency of production since 1884:

Product of white lead in the United S'ates since 1884.

Years.	Quantity.	Value.
	Short tons.	
1884	65,000	$6,500,000
1885	60,000	6,300,000
1886	60,000	7,200,000
1887	70,000	7,560,000
1888	84,000	10,080,000
1889	80,000	9,600,000
1890	77,636	9,382,967
1891	78,018	10,454,029
1892	74,485	8,733,620

The prices of white lead are always affected by the condition of the pig lead market. In 1890 and 1891 the average yearly prices per pound for pig lead in New York were 4.33½ and 4.32½ cents respectively against 3.80½ cents in 1889. As a result the price of white lead in oil advanced from 6 cents per pound, in 1889, to 6.25 cents in 1890, and 6.37 cents in 1891. The pig lead market, in 1892, was weak throughout the year. The highest average monthly price reached was 4.22 cents per pound, in April, and the lowest, 3.74 cents, in December. The average price for the year was 4.05 cents per pound. The price of white lead in oil, at New York, accordingly declined to 5.67 cents, reaching the lowest figure in the history of the trade. This average, it must be rembered, is not the average price for the total product of the United States, which was about 5.88 cents.

The following table is of interest, showing the average yearly prices of pig lead and white lead in oil, 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.

Years.	Pig lead in New York, per 100 pounds.	White lead in oil in New York, per 100 pounds.	Difference, per 100 pounds.
1874	$6.00	$11.25	$5.25
1875	5.95	10.50	4.55
1876	6.05	10.00	3.95
1877	5.43	9.00	3.57
1878	3.58	7.25	3.67
1879	4.18	7.00	2.82
1880	5.05	7.60	2.55
1881	4.80	7.25	2.45
1882	4.90	7.00	2.10
1883	4.32	6.88	2.56
1884	3.73	5.90	2.17
1885	3.95	6.00	2.05
1886	4.63	6.25	1.62
1887	4.47	5.75	1.28
1888	4.41	5.75	1.34
1889	3.80	6.00	2.20
1890	4.33	6.25	1.92
1891	4.33	6.37	2.05
1892	4.05	5.67	1.62

Red lead, litharge, and orange mineral.—The amount of red lead produced in the United States in 1892 was 12,244,967 pounds, or 6,122 short tons, valued at $757,787, against 9,214,286 pounds, or 4,607 short tons, valued at $591,730, showing an increase of 3,030,681 pounds, or 1,515 tons, in quantity, and of $166,157 in value. The output of litharge increased 10,716 pounds and amounted to 11,528,015 pounds, worth $611,726. The product of orange mineral in 1892 was 790,596 pounds, valued at $60,170, against 660,000 pounds, valued at $43,300 in 1891.

The following table shows the imports of white lead, red lead, and litharge since 1867:

Red lead, white lead, and litharge imported from 1867 to 1892.

Years ended—	Red lead.		White lead.		Litharge.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	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, 766	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, 440
1875	1, 048, 713	73, 131	4, 354, 131	295, 642	15, 767	950
1876	749, 918	54. 884	2, 546, 766	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

The imports of orange mineral in 1892 were 1,409,601 pounds, worth $64,133.

BARYTES.

The production of barytes continues to increase, the output in 1892 being 32,108 short tons, valued (crude) at $130,025, against 31,069 short tons in 1891, valued at $118,363, and 21,911 short tons, worth $86,505 in 1888. The manufacturers of barytes in Saint Louis pay usually about $5 per ton for the crude mineral, buying sometimes direct from the miners, but more frequently from country merchants who act as middlemen between the producers and the manufacturers. The barytes is usually mined in off seasons by farmers, taken to the stores and exchanged for supplies or cash, the dealer shipping to Saint Louis as the trade demands. The value of the crude barytes in this report is that actually received by the producers in cash or "trade" as near as could be ascertained.

Barytes, or heavy spar (barium sulphate), is a grayish white mineral having a specific gravity of 4.5. Its chief use is as an adulterant in the manufacture of paint, being usually mixed with white lead. Owing to its high specific gravity the weight of the mixture is not appreciably different from that of pure white lead. A description of the method of manufacturing or "floating" barytes is given in "Mineral Resources" for 1885.

The product for 1892 was entirely from Missouri and Virginia, no output from North Carolina or Illinois being reported.

Production of crude barytes from 1882 to 1892.

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Short tons.			*Short tons.*	
1882	22,400	$80,000	1888	22,400	$110,000
1883	30,240	108,000	1889	21,460	106,313
1884	28,000	100,000	1890	21,911	86,505
1885	16,800	75,000	1891	31,069	118,363
1886	11,200	50,000	1892	32,108	130,025
1887	16,800	75,000			

Imports of barium sulphate from 1867 to 1892.

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, 604	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, 205
1888	3, 821, 842	17, 135	6, 504, 975	9, 037
1889	3, 601, 506	22, 458	13, 571, 206	7, 660
1890	1, 563	16, 453	4, 815	13, 133
1891	*a*2, 149	22, 041	*a*2, 900	8, 816
1892	1, 389	15, 419	2, 789	7, 418

a Tons since 1891.

MINERAL WATERS.

By A. C. Peale.

Although the list of commercial mineral springs for the year 1892 shows a slight reduction in the number of springs as compared with 1891, a much larger proportion than usual report.

The reduction amounts to 5 springs; 283 springs make up the list; of these 242 report, leaving only 41 delinquent. This has been exceeded only by the report for 1889, when 258 springs reported. The production, however, has greatly increased.

The total product for 1892, including the estimate for the delinquent springs, which is taken at one-half the figures last reported, is 21,876,604 gallons at a valuation of $4,905,970. This is 3,483,872 gallons and $1,909,711 more than the figures given for 1891. If we compare only the figures actually reported the increase was 5,153,702 gallons and $1,917,287.

The North Atlantic States lose four springs from the list of 1891, but gain one, Vishnu Spring of Massachusetts, which is new to the list, leaving 71 springs instead of 74 as in 1891; of these, 65 report instead of 62, as in the previous year. There is also a gain of 1,128,970 gallons and the increased value of the product is $341,670.

In the South Atlantic States three springs have been taken from the list and four new ones added, leaving the total of 57, which is one less than in 1891. The new springs are the Carroll Springs of Maryland and the Steep Hill Springs, the Harris Anti-dyspeptic and Tonic Spring, and the Virginia Waukesha Lithia Springs of Virginia. Forty-seven springs report, and the delinquent list for the section is 10 instead of 15, as in 1891. The increase in the production is 266,508 gallons, with a total increase in the value of the production of $39,750.

Four springs are taken from the list for the North Central States, leaving the list at 83 instead of 87 as in 1891. However, a larger proprotion of those on the list report for 1892, and there is an increase in production of 3,555,884 gallons, with an increased value of $1,352,650.

While one spring is taken from the list for the South Central States, Louisiana appears in the list for the first time, adding one spring, the Abita Spring; and one spring, Stafford Mineral Spring, is added to the list for Mississippi, which leaves the list 38 instead of 37 as in 1891. The increase in production for 1892 is 64,529 gallons and $3,312.

The list of springs for the Western States and Territories remains at 34, as in 1891. There is, however, an increased production of 137,813 gallons and of $179,905 in the value of the product.

Production of mineral waters for 1892, by States and Territories.

States and Territories.	Springs reporting.	Product.	Value.
		Gallons.	
Alabama	4	22,085	$17,517
Arkansas	4	36,885	9,907
California	11	336,875	162,019
Colorado	6	553,968	200,904
Connecticut	5	28,000	16,326
Georgia	3	114,000	30,450
Illinois	8	173,360	24,917
Indiana	7	115,500	7,400
Iowa	4	101,000	11,140
Kansas	8	2,135,448	204,448
Kentucky	3	37,000	3,700
Maine	9	645,172	106,524
Maryland	5	84,300	15,890
Massachusetts	10	962,882	119,486
Michigan	8	1,996,900	300,267
Mississippi	4	66,800	30,780
Missouri	8	430,000	44,675
New Hampshire	2	1,060,000	503,000
New Mexico	3	40,800	7,360
New York	22	2,528,868	828,516
North Carolina	7	183,683	46,296
Ohio	8	1,101,400	267,100
Pennsylvania	10	1,324,100	323,164
Rhode Island	2	195,000	8,000
Tennessee	4	121,374	20,895
Texas	12	405,400	24,535
Vermont	4	102,500	26,600
Virginia	25	605,532	246,029
Washington	2	140,000	134,000
West Virginia	6	35,430	10,528
Wisconsin	20	4,858,232	952,293
Other States (a)	8	895,610	120,478
Total	242	21,138,104	4,825,144

a Idaho, Louisiana, Minnesota, Montana, Nebraska, New Jersey, South Carolina, and South Dakota are included here, as only one spring in each State reports.

Production of natural mineral waters from 1883 to 1892.

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	4,106,464	471,575
South Atlantic	47	646,239	198,632
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

Alabama.—Although Alabama loses one spring from the list of the previous year, all now on the list report sales for 1892, with a slightly increased product. The springs reporting are:

Bailey Springs, Bailey Springs, Lauderdale county.

Healing Springs, Healing Springs, Washington county.

Matchless Mineral Water, Greenville, Butler county.

Bladen Springs, Bladen Springs, Choctaw county.

Arkansas.—Only one of the Arkansas springs is delinquent for 1892. The four springs reporting are:

Arkansas Lithia Springs, Hope, Hempstead county.

Dovepark Springs, Dovepark, Hot Spring county.

Fairchild's Potash Sulphur Spring, Hot Springs, Garland county.

Eureka Springs, Eureka Springs, Carroll county.

California.—The list of springs for California remains the same as in the previous year, but only eleven of the fourteen springs report. They are as follows:

Azule Seltzer Spring, San Jose, Santa Clara county.

Bartlett Springs, Bartlett Springs, Lake county.

Castalian Mineral Water, Inyo county.

Coronado Natural Mineral Water, Coronado, San Diego county.

El Toro Springs, Nevato, Marin county.

Geyser Soda Springs, Litton Springs, Sonoma county.

Napa Soda Springs, Napa Soda Springs, Napa county.

Ojai Hot Springs, Matilija, Ventura county.

Pacific Congress Spring, Saratoga, Santa Clara county.

Tolenas Springs, Fairfield, Solano county.

Tuscan Spring, Red Bluff, Tehama county.

Colorado.—Three of the Colorado springs have not sent in any reports. The six reporting for 1892 are:

Boulder Springs, Boulder Springs, Boulder county.

Clark Magnetic Mineral Spring, Pueblo, Pueblo county.

Canon City Vichy and Iron Duke Spring, Cañon City, Fremont county.

Idaho Springs, Idaho Springs, Clear Creek county.

Manitou, Navajo, and Shoshone Springs, Manitou, El Paso county.

Ute and Little Chief Iron Springs, Manitou, El Paso county.

Connecticut.—All of the springs credited to Connecticut have reported. They are:

Aspinock Springs, Putnam Heights, Windham county.

Highland Rock Spring, Manchester, Hartford county.

Highland Tonica Spring, Highland Park, Hartford county.

Oxford Chalybeate Spring, Oxford, New Haven county.

Stafford Mineral Springs, Stafford Springs, Tolland county.

Florida.—No reports have been received from either of Florida's two commercially used springs.

Georgia.—One spring is taken from the list for Georgia. The remaining three report. They are:

Bowden Lithia Springs, Lithia Springs, Douglas county.

Hughes Springs, Rome, Floyd county.

Ponce de Leon Springs, Atlanta, Fulton county.

Idaho.—The State of Idaho is still represented on our list by only one spring, viz.:

Idanha Springs, Soda Springs, Bingham county.

Illinois.—One spring is dropped from the list for Illinois. The remaining eight springs report. They are:

Black Hawk Springs, Rock Island, Rock Island county.
Cumberland Mineral Spring, Greenup, Cumberland county.
Glen Flora Spring, Waukegan, Lake county.
Kirkwood Springs, Kirkwood, Warren county.
Peoria Magnetic Artesian Spring, Peoria, Peoria county.
Perry Springs, Perry Springs, Pike county.
Red Avon Springs, Avon, Martin county.
Sanicula Springs, Ottawa, La Salle county.

Indiana.—The State of Indiana loses two springs from the list of previous years. Of the remaining eight the following seven report:

French Lick Springs, French Lick, Orange county.
Indiana Mineral Springs, Indiana Mineral Springs, Warren county.
Kickapoo Magnetic Springs, Kickapoo, Warren county.
King's Mineral Spring, Muddy Fork, Clark county.
Lodi Artesian Well, Silverwood, Fountain county.
Magnetic Mineral Spring, Terre Haute, Vigo county.
West Baden Springs, West Baden, Orange county.

Iowa.—Four of the five springs credited to Iowa report. They are as follows:

Black Hawk Springs, Eldon, Davis county.
Colfax Mineral Water, Colfax, Jasper county.
Lake View Medical Springs, Lake View, Sac county.
Ottumwa Mineral Springs, Ottumwa, Wapello county.

Kansas.—All of the springs on the list for Kansas report. They are:

Blazing's Artesian Mineral Spring, Manhattan, Riley county.
Geuda Mineral Spring, Geuda Springs, Cowley county.
Great Spirit Spring, Cawker City, Mitchell county.
Iola Mineral Well, Iola, Allen county.
Jewell County Lithium Spring, Montrose, Jewell county.
Providence Mineral Wells, Providence, Butler county.
Topeka Mineral Wells, Topeka, Shawnee county.
Wichita Mineral Springs, Wichita, Sedgwick county.

Kentucky.—Only three of the five springs on the list for Kentucky report. These springs are:

Bedford Springs, Bedford, Trimble county.
Blue Lick Springs, Blue Lick Springs, Nicholas county.
St. Patrick's Well, Louisville, Jefferson county.

Louisiana.—For the first time this State appears on the list. The only spring the water of which, so far as known, is used commercially is:

Abita Springs, St. Tammany parish.

Maine.—The nine springs of Maine all report sales for 1892. They are:

Barker Mill Spring, Auburn, Androscoggin county.
Cold Bowling Spring, Steep Falls, York county.
Crystal Springs, Auburn, Androscoggin county.
Hartford Cold Spring, Oxford county.
Keystone Spring, East Poland, Androscoggin county.
Poland Spring, South Poland, Androscoggin county.
Seal Rock Springs, Saco, York county.
Underwood Springs, Falmouth Foreside, Cumberland county.
Wilson Springs, Wilson Springs, Cumberland county.

Maryland.—The list for Maryland remains the same in number for 1892 as in 1891, although one spring has been taken from the list and one new to the list added. All of the springs report. They are:

Carroll Spring, Forest Glen, Montgomery county.
Chattolanee Mineral Springs, Baltimore county.
Flintstone Mineral Spring, Flintstone, Allegany county.
Strontia Mineral Spring, Brooklandville, Baltimore county.
Takoma Park Springs, Takoma Park, Montgomery county.

Massachusetts.—One new spring is added to the list for Massachusetts, making ten in all, and all report. They are:

Allandale Mineral Springs, West Roxbury, Suffolk county.
Belmont Hill Spring, Everett, Middlesex county.
Belmont Natural Spring, Belmont, Middlesex county.
Commonwealth Mineral Spring, Waltham, Middlesex county.
Echo Grove Spring, Lynn, Essex county.
Everett Crystal Spring, Everett, Middlesex county.
Sheep Rock Springs, Lowell, Middlesex county.
Simpson Spring, South Easton, Bristol county.
Undine Spring, Brighton District, Suffolk county.
Vishnu Spring, Stoneham, Middlesex county.

Michigan.—The list for Michigan remains unchanged. Of the nine springs, the following eight report for 1892.

Americanus Well, Lansing, Ingham county.
Bethlehem Magnetic Mineral Spring, Spring Lake, Ottawa county.
Eastman Springs, Benton Harbor, Berrien county.
Mount Clemens Original Mineral Spring, Mount Clemens, Macombe county.
Moorman Well, Ypsilanti, Wastenaw county.
Salutaris Spring, Saint Clair Springs, Saint Clair county.
Sprudel Water, Mount Clemens, Macomb county.
Zauber Wasser, Hudson, Lenawee county.

Minnesota.—The Inglewood Springs of Minneapolis, Hennepin county, is still the only spring on the list for Minnesota.

Mississippi.—One spring is added to the list for Mississippi, making a total of four, all of which report for 1892. These are:

Brown's Wells, Brown's Wells, Copiah county.

Castalian Springs, Durant, Holmes county.

Godbold Mineral Well, Summit, Pike county.

Stafford Mineral Springs, near Vossburg, Jasper county.

Missouri.—Eight of the ten springs credited to Missouri have made reports. They are:

B. B. Spring, Bowling Green, Pike county.

Blue Lick Springs, Blue Lick, Saline county.

Eldorado Springs, Cedar county.

Lebanon Springs, Lebanon, Laclede county.

Paris Springs, Paris Springs, Lawrence county.

Randolph Springs, Randolph Springs, Randolph county.

Reiger Springs, Lineville, Mercer county.

Sweet Springs, Sweet Springs, Saline county.

Montana.—The only spring on the list for Montana is:

Pipestone Springs, Pipestone Springs, Jefferson county.

Nebraska.—The Victoria Mineral Spring is still the only representative on our list for the State of Nebraska; it is located at New Helena, Custer county.

New Hampshire.—There is no change in the list for New Hampshire, but only two of the three springs make reports. They are:

Londonderry Lithia Spring, Londonderry, Rockingham county.

Ponemah Spring, Amherst Station, Hillsboro county.

New Jersey.—The one representative on the list for New Jersey is still the—

Kalium Springs, Collingswood, Camden county.

New Mexico.—Three of New Mexico's four springs report for 1892. They are:

Aztec Springs, Sante Fé, Sante Fé county.

Coyote Soda Springs, Coyote Canyon, Bernalillo county.

Ojo Caliente Springs, Ojo Caliente, Taos county.

New York.—Three springs have been taken from the list of 1891, leaving the total for 1892 at twenty-six; of these, twenty-two report. They are as follows:

Artesian Lithia Springs, Ballston Spa, Saratoga county.

Avon Springs, Avon, Livingston county.

Cayuga Water, Cayuga, Cayuga county.

Deep Rock Spring, Oswego, Oswego county.

Massena Spring, Massena, St. Lawrence county.

Miller's Geneva Mineral Spring, Geneva, Ontario county.

Oneida Springs, Utica, Oneida county.

Verona Springs, Verona Springs, Oneida county.

White Sulphur Springs, Sharon Springs, Schoharie county.

White Sulphur Springs, Richfield Springs, Otsego county.

Victor Springs, Darien, Genesee county.

Saratoga Springs, Saratoga county:
- Champion Spring.
- Excelsior Springs.
- Empire Spring.
- Hathorn Spring.
- Imperial Spring.
- Royal or New Putnam Spring.
- Saratoga Vichy Spring.
- Star Spring.
- Saratoga Carlsbad Spring.
- Saratoga Kissingen Spring.
- High Rock Spring.

North Carolina.—One spring is taken from the list of North Carolina, leaving the total ten; of these, seven report as follows:

Barium Springs, Barium, Iredell county.

Black Mountain Iron and Alum Spring, Black Mountain, Buncombe county.

Park's Alkaline Spring, Danville, Caswell county.

Panacea Springs, Warren county.

Seven Springs, Seven Springs, Wayne county.

Shaw's Healing Springs, Littleton, Halifax county.

Thompson's Bromine Arsenic Springs, Crumplers, Ashe county.

Ohio.—The State of Ohio loses one spring from the list of the previous year, and of the nine springs remaining the following send reports for 1892:

Adams County Mineral Spring, Mineral Springs, Adams county.

Crystal Mineral Spring, Mineral Springs, Adams county.

Devonian Mineral Spring, Lorain, Lorain county.

Electro-Magnetic Spring, Fountain Park, Champaign county.

Rex Mineral Water, New Richmond, Clermont county.

Ripley Bromo-Lithia Spring, Ripley, Brown county.

Sulphur Lick Springs, Anderson, Ross county.

Oregon.—No reports have been received from the two springs on the list for Oregon.

Pennsylvania.—Ten of the eleven springs credited to Pennsylvania have reported for 1892. They are:

Black Barren Mineral Spring, Pleasant Grove, Lancaster county.

Bedford Springs, Bedford, Bedford county.

Cresson Springs, Cresson, Cambria county.

Corry Artesian Mineral Spring, Corry, Erie county.

Eureka Springs, Saegertown Crawford county.

Barker Magnetic Mineral Spring, Gardeau, McKean county.

Pavilion Springs, Wernersville, Berks county.

Pulaski Natural Mineral Spring, Pulaski, Lawrence county.

Rosscommon Springs, Rosscommon, Monroe county.

Susquehanna Springs, Rush, Susquehanna county.

Rhode Island.—As usual both springs for Rhode Island report. They are:

Holley Mineral Springs, Woonsocket, Providence county.

Ochee Mineral and Medical Springs, Johnston, Providence county.

South Carolina.—Only one of South Carolina's three springs reports for 1892, as follows:

Garrett Springs, Spartanburg, Spartanburg county.

South Dakota.—South Dakota still holds a place on the list with one spring, viz.:

Dakota Hot Springs of Hot Springs, Fall River county.

Tennessee.—The list for Tennessee remains the same as for 1891, but of the six springs only four report for 1892. They are:

Idaho Springs, St. Bethlehem, Montgomery county.

Park and Hurricane springs, Tullahoma, Franklin county.

Red Boiling Springs, Red Boiling Springs, Macon county.

Tate Spring, Tate Spring, Grainger county.

Texas.—Twelve springs report for Texas, leaving only one delinquent. The springs reporting for 1892 are:

Capp's Well, Longview, Gregg county.

Dalby Springs, Dalby Springs, Bowie county.

Elkhart Mineral Wells, Elkhart, Anderson county.

Hynson's Iron Mountain Spring, Marshall, Harrison county.

Montvale Springs, Marshall, Harrison county.

Mineral Wells, Mineral Wells, Palo Pinto county.

Overall Mineral Well, Franklin, Robertson county.

Page's Well, Georgetown, Williamson county.

Slack's Well, Walder Depot, Fayette county.

Texas Sour Springs, Luling, Caldwell county.

Tioga Mineral Wells, Grayson county.

Wooten Wells, Wooten Wells, Robertson county.

Vermont.—The State of Vermont still has four springs on the list and all report for 1892. They are:

Alburg Springs, Alburg Springs, Grand Isle county.

Brunswick White Sulphur Springs, Brunswick, Essex county.

Clarendon Springs, Clarendon Springs, Rutland county.

Missisquoi Mineral Springs, Sheldon, Franklin county.

Virginia.—Three springs new to the list are added for Virginia, making a total of twenty-six. Of these twenty-five report. The name of the Virginia Arsenic Bromine and Lithia Spring is changed to Crockett Arsenic-Lithia Spring. The following are those that report for 1892:

Blue Ridge Springs, Botetourt county.

Buffalo Lithia Springs, Buffalo Lithia Springs, Mechlenburg county.

Chase City Chlorine Spring, Chase City, Mechlenburg county.

Cove Lithia Springs, near Wytheville, Wythe county.

Crockett Arsenic-Lithia Spring, Christiansburg, Montgomery county.

Elk Lithia Springs, Elkton, Rockingham county.
Farmville Lithia Spring, Farmville, Cumberland county.
Harris Antidyspeptic and Tonic Spring, Burkeville, Nottoway county.
Healing Springs, Healing Springs, Bath county.
Hunter's Pulaski Spring, Sassin, Pulaski county.
Jordon White Sulphur Spring, Stephenson, Frederick county.
Massanetta Springs, Harrisburg, Rockingham county.
Otterburn Lithia Spring, Amelia Court House, Amelia county.
Osceola Springs, Harrisburg, Rockingham county.
Powhatan Mineral Spring, Powhatan, Powhatan county.
Rawley Springs, Rawley Springs, Rockingham county.
Roanoke Red Sulphur Spring, Catawba, Roanoke county.
Rockbridge Alum Springs, Goshen, Rockbridge county.
Rockingham Springs, McGaheysville, Rockingham county.
Seven Springs, Abingdon, Washington county.
Steep Hill Springs, North Staunton, Augusta county.
Shenandoah Alum Springs, Mount Jackson, Shenandoah county.
Stribling Springs, Stribling Springs, Augusta county.
Wallawhatoola Alum Springs, Millboro Springs, Bath county.
Wolf Trap Lithia Springs, Wolf Trap Station, Halifax county.

Washington.—Two of Washington's three springs report. They are:
Cascades Springs, Cascades, Skamania county.
Medical Lake, Medical Lake, Spokane county.

West Virginia.—The six springs of West Virginia are all represented in the figures for 1892. They are:
Capon Springs, Capon Springs, Hampshire county.
Irondale Springs, Independence, Preston county.
Red Sulphur Springs, Monroe county.
Salt Sulphur Springs, Salt Sulphur Springs, Monroe county.
Triplet Springs, Grant District, Pleasants county.
White Sulphur Springs, White Sulphur Springs, Greenbrier county.

Wisconsin.—Twenty springs of Wisconsin's 23 report for 1892. They are:
Allouez Magnetic Spring, Green Bay, Brown county.
Ashland Springs, Ashland, Ashland county.
Bethania Mineral Springs, Osceola, Polk county.
Darlington Mineral Water, Darlington, Lafayette county.
Fort Crawford Springs, Prairie du Chien, Crawford county.
Lebens Wasser, Green Bay, Brown county.
Nee-Ska-Ra Spring, Wauwatosa, Waukesha county.
Palmyra Spring, Palmyra Spring, Jefferson county.
Salvator Springs, Green Bay, Brown county.
Sheboygan Spring, Sheboygan, Sheboygan county.
Silver Sand Spring, Milwaukee, Milwaukee county.
Vita Mineral Spring, Beaver Dam, Dodge county.

Waukesha Springs, Waukesha county:
- Almanaris Spring.
- Arcadian Spring.
- Bethesda Mineral Spring.
- Horeb Spring.
- Henk Mineral Spring.
- Mineral Rock Spring.
- Waukesha Hygeia Mineral Spring.
- White Rock Mineral Spring.

Summary of reports of mineral springs for 1892, by States and Territories.

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	9	0	9	Ohio	8	1	9
New Hamsphire	2	1	3	Indiana	7	1	8
Vermont	4	0	4	Illinois	8	0	8
Massachusetts	10	0	10	Michigan	8	1	9
Rhode Island	2	0	2	Wisconsin	20	3	23
Connecticut	5	0	5	Minnesota	1	0	1
New York	22	4	26	Iowa	4	1	5
New Jersey	1	0	1	Missouri	8	2	10
Pennsylvania	10	1	11	North Dakota	0	0	0
				South Dakota	1	0	1
SOUTH ATLANTIC STATES.				Nebraska	1	0	1
				Kansas	8	0	8
Delaware	0	0	0				
Maryland	5	0	5	WESTERN STATES AND TERRITORIES.			
District of Columbia	0	0	0				
Virginia	25	3	28				
West Virginia	6	0	6	Alaska	0	0	0
North Carolina	7	3	10	Wyoming	0	0	0
South Carolina	1	2	3	Montana	1	0	1
Georgia	3	0	3	Colorado	6	3	9
Florida	0	2	2	New Mexico	3	1	4
				Arizona	0	0	0
SOUTH CENTRAL STATES.				Utah	0	0	0
				Nevada	0	0	0
Kentucky	3	2	5	Idaho	1	0	1
Tennessee	4	2	6	Washington	2	1	3
Alabama	4	0	4	Oregon	0	2	2
Mississippi	4	0	4	California	11	3	14
Louisiana	1	0	1				
Texas	12	1	13	Total	242	41	383
Indian Territory	0	0	0				
Arkansas	4	1	5				
Oklahoma	0	0	0				

IMPORTS AND EXPORTS.

Imports.—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 imimported. 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 ending 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	2,329	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 1892.

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

Exports of natural mineral waters, of domestic production, from the United States.

Fiscal year ending June 30—	Value.	Fiscal year ending June 30—	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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