

STONE.

BY WILLIAM C. DAY.

VALUE OF DIFFERENT KINDS OF STONE PRODUCED IN 1894 AND 1895.

The report on stone for 1894 treated in some detail of the nature, composition, and properties of the different kinds of commercially important stone; also of uses to which they are put, the modes of occurrence in nature, methods of quarrying, dressing, and finishing for their various uses, etc. The present report is limited mainly to the discussion of statistical features. Persons interested in a more complete treatment of the general subject of stone are referred to the report for 1894 as being the most comprehensive one of the series which the writer has prepared for Mineral Resources of the United States.

The following table shows the value of the different kinds of stone produced in the United States in the years 1894 and 1895:

Value of different kinds of stone produced in the United States during the years 1894 and 1895.

Kind.	1894.	1895.
Granite	\$10,029,156	\$8,894,328
Marble	3,199,585	2,825,719
Slate	2,790,324	2,698,700
Sandstone	3,945,847	4,211,314
Limestone	16,190,118	15,308,755
Bluestone	a 900,000	a 750,000
Total	37,055,030	34,688,816

a Estimated.

An inspection of this table shows a decrease for all kinds of stone except sandstone, which, having fallen off more than any other kind in 1894, gained a little in 1895. There is, of course, only one fundamental cause for this general decline, and that is the financial depression, which exercised the same kind of effect in 1895 as in the two years previous.

VALUE OF STONE PRODUCT IN 1895, BY STATES.

The following table shows the values of the various kinds of stone produced in 1895, by States:

Value of the various kinds of stone produced in 1895, by States.

State.	Granite.	Sandstone.	Slate.	Marble.	Limestone.	Total
Alabama		\$31,930			\$222,424	\$254,354
Arizona		20,000			24,159	44,159
Arkansas		13,228			47,376	60,604
California	\$348,806	11,933	\$10,500	\$22,000	322,211	715,450
Colorado	35,000	63,237			116,355	214,592
Connecticut	779,361	397,853			154,333	1,331,547
Delaware	73,138					73,138
Florida					10,550	10,550
Georgia	508,481		10,675	689,229	12,000	1,220,385
Idaho	14,560	6,900		2,250	7,829	31,539
Illinois		6,558			1,687,662	1,694,220
Indiana		60,000			1,658,976	1,718,976
Iowa		5,575		13,750	449,501	468,826
Kansas		93,394			316,688	410,082
Kentucky		25,000			154,130	179,130
Maine	1,400,000		140,154		700,000	2,240,154
Maryland	276,020	16,836	60,357	145,000	200,000	698,213
Massachusetts	1,918,894	339,487		2,000	75,000	2,335,381
Michigan		159,075			424,589	583,664
Minnesota	148,596	74,700			218,733	442,029
Missouri	128,987	100,000			897,318	1,126,305
Montana		31,069			95,121	126,190
Nebraska					7,376	7,376
Nevada	3,200					3,200
New Hampshire	480,000					480,000
New Jersey	151,343	111,823	700		150,000	413,866
New Mexico		2,700			3,375	6,075
New York	68,474	415,644	91,875	207,828	1,043,182	1,827,003
North Carolina	75,000	3,500				78,500
Ohio		1,449,659			1,568,713	3,018,372
Oregon	1,728				970	2,698
Pennsylvania	300,000	500,000	1,647,751	59,787	3,055,913	5,563,451
Rhode Island	968,473					968,473
South Carolina	22,083					22,083
South Dakota	33,279	26,100			4,000	63,379
Tennessee				362,277	156,898	519,175
Texas		97,336			62,526	159,862
Utah		5,000			22,503	27,503
Vermont	1,007,718		625,331	1,321,598	300,000	3,254,647

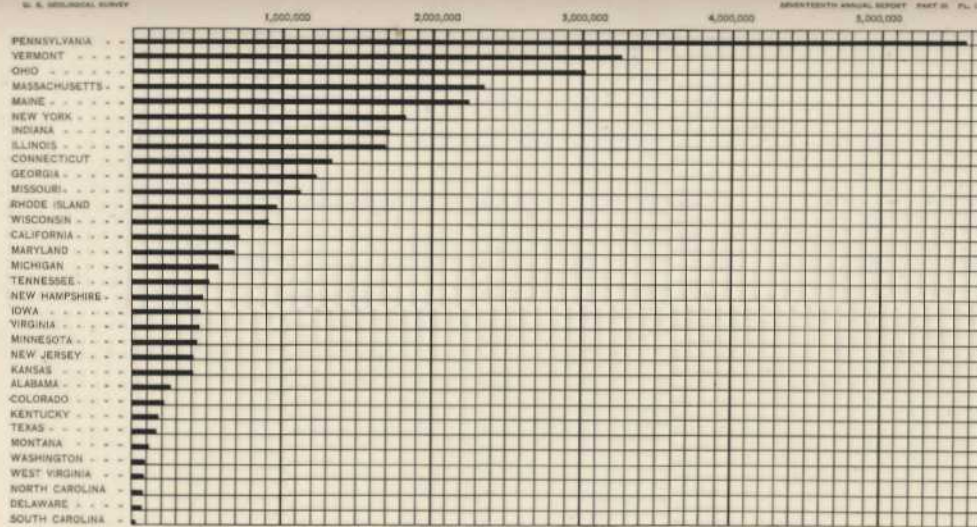


DIAGRAM SHOWING THE VALUE OF THE DIFFERENT KINDS OF STONE PRODUCED IN THE VARIOUS STATES DURING THE YEAR 1895.
(In millions of dollars.)

Value of the various kinds of stone produced in 1895, by States—Continued.

State.	Granite.	Sandstone.	Slate.	Marble.	Limestone.	Total.
Virginia	\$70,426	.....	\$111,357	.....	\$268,892	\$450,675
Washington .....	.....	\$14,777	.....	.....	75,910	90,687
West Virginia .....	.....	40,000	.....	.....	42,892	82,892
Wisconsin	80,761	78,000	.....	.....	750,000	908,761
Wyoming .....	.....	10,000	.....	.....	650	10,650
Total	8,894,328	4,211,314	2,698,700	2,825,719	15,308,755	33,938,816

GRANITE.

The following table shows the value of the granite output in 1895, by States:

Value of granite product in 1895, by States.

State.	Value.	State.	Value.
California	\$348,806	New Jersey	\$151,343
Colorado	35,000	New York	68,474
Connecticut	779,361	North Carolina ...	75,000
Delaware	73,138	Oregon	1,728
Georgia	508,481	Pennsylvania	300,000
Idaho	14,560	Rhode Island	968,473
Maine	1,400,000	South Carolina ...	22,083
Maryland	276,020	South Dakota ...	33,279
Massachusetts	1,918,894	Vermont	1,007,718
Minnesota	148,596	Virginia	70,426
Missouri	128,987	Wisconsin	80,761
Nevada	3,200	Total	8,894,328
New Hampshire ..	480,000		

Value of granite paving blocks made in 1895, by States.

State.	Value.	State.	Value.
California	\$34,079	New York	\$16,443
Connecticut	46,830	North Carolina ...	1,320
Delaware	16,556	Pennsylvania	69,503
Georgia	232,041	Rhode Island	49,255
Maine	636,063	South Carolina ...	12,505
Maryland	2,633	South Dakota ...	20,800
Massachusetts ...	496,544	Vermont	30,702
Minnesota	4,800	Virginia	8,028
Missouri	22,014	Wisconsin	17,000
New Hampshire ..	16,823	Total	1,773,328
New Jersey	39,389		

The foregoing table shows a total of \$1,773,328 as the value of paving blocks produced in 1895. In 1894 the total was \$2,254,587. In the latter year there was undoubtedly an overproduction because of the falling off in demand for building and ornamental granite. This overproduction in 1894 naturally caused a diminished output in 1895, and also caused a lowering in price. Another cause which operates against the production of granite blocks is the increasing tendency in large cities to use paving bricks and asphaltum on streets whose traffic will allow other material than granite. It is not unlikely that the increasing use of the bicycle in large cities is an influence favoring the substitution of smoother forms of pavement than that afforded by granite blocks. A large amount of asphalt pavement and also paving bricks have been laid in Philadelphia during the past two years, and a serious falling off in the granite-block industry of Pennsylvania has been the result in this case at least.

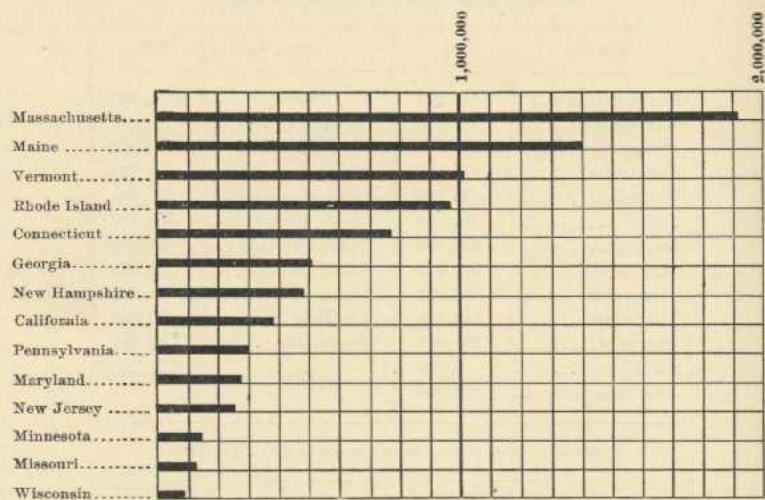


FIG. 2.—Value of granite produced in the various States during the year 1895 (in millions of dollars).

VALUE OF GRANITE PRODUCT, BY STATES, FROM 1890 TO 1895.

The following table gives the value of the granite output, by States, for the years 1890 to 1895:

State.	1890.	1891.	1892.	1893.	1894.	1895.
Arkansas.....	(a)	805,000	\$40,000	.....	\$28,100	.....
California.....	\$1,329,018	1,300,000	1,000,000	8531,322	367,000	\$948,806
Colorado.....	314,673	309,000	100,000	77,182	49,302	85,000
Connecticut.....	1,061,202	1,167,000	700,000	652,459	504,390	779,361
Delaware.....	211,194	210,000	250,000	215,964	173,805	73,138
Georgia.....	752,481	790,000	700,000	476,387	511,804	508,481
Idaho.....	.....	.....	.....	.....	.....	11,560
Maine.....	2,225,838	2,200,000	2,300,000	1,274,954	1,551,036	1,400,000
Maryland.....	447,489	450,000	450,000	260,855	308,966	276,020
Massachusetts.....	2,503,503	2,600,000	2,200,000	1,631,204	1,994,830	1,918,894
Minnesota.....	356,782	.....	300,000	270,296	153,936	148,596
Missouri.....	500,642	400,000	325,000	388,803	98,757	128,087
Montana.....	(a)	51,000	36,000	1,000	5,800	.....
Nevada.....	(a)	.....	.....	3,000	1,500	3,200
New Hampshire.....	727,531	750,000	725,000	442,424	734,702	480,000
New Jersey.....	425,672	400,000	400,000	373,147	310,965	151,343
New York.....	222,773	225,000	200,000	181,449	140,618	68,474
North Carolina.....	146,627	.....	150,000	122,707	108,993	75,000
Oregon.....	44,150	5,000	6,000	11,255	4,993	1,738
Pennsylvania.....	623,252	575,000	550,000	206,493	600,000	300,000
Rhode Island.....	931,216	750,000	600,000	509,799	1,211,439	968,473
South Carolina.....	47,614	50,000	60,000	95,443	45,899	22,083
South Dakota.....	304,673	100,000	50,000	27,828	8,806	33,279
Texas.....	22,550	75,000	50,000	39,991	.....	.....
Utah.....	8,700	.....	15,000	500	.....	.....
Vermont.....	581,870	700,000	675,000	778,450	850,956	1,007,718
Virginia.....	332,548	300,000	300,000	103,703	123,361	70,426
Washington.....	(a)	.....	.....	.....	.....	.....
Wisconsin.....	296,095	400,000	400,000	133,220	160,098	80,761
Total.....	14,464,095	13,867,000	12,642,000	8,808,934	10,029,156	8,894,328

a Granite valued at \$76,000 was produced in Arkansas, Montana, Nevada, and Washington together, and this amount is included in the total.

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GRANITE INDUSTRY IN THE VARIOUS STATES.

California.—In 1894 the granite output was valued at \$307,000; in 1895, at \$348,806. The gain of \$40,000 is quite noteworthy, in view of the fact that in some other industries the year did not come up to 1894 in prosperity. Some of the producers speak encouragingly of the prospects for 1896. The paving-block industry is at present suffering from the increasing use of the bituminous rocks mined in the State; furthermore, overproduction of blocks in 1893 and 1894 told decidedly on the output of 1895, and, as a further consequence of carrying old stock, prices were reduced. Collections are still slow, and frequently three or four months' time had to be given in order to make sales.

Colorado.—The output of granite fell off somewhat in 1895, owing to the shutting down of a number of quarries, leaving but few active producers. These, however, speak somewhat encouragingly of the prospects for 1896.

Connecticut.—Production in Connecticut, as shown by the increase from \$504,390 to \$779,361, has been quite active during the past year. The product for 1895 is the largest since 1891, when it amounted to \$1,167,000. Prospects for 1896 are very good.

Delaware.—Quite a falling off in output is the result of operations in 1896. General depression is given as the cause.

Georgia.—This State has managed to hold its own in the production of granite as well as marble. The figures for 1894 and 1895 are, respectively, \$511,804 and \$508,481. About one-half the output was in the form of paving blocks, for which there has been a pretty fair demand, although prices have had to come down somewhat to suit the hard times. The disposition of granite in its natural occurrence in Stone Mountain is such as to render quarrying easy and much cheaper than in many other places.

Maine.—The granite output in Maine declined from \$1,551,036 in 1894 to \$1,400,000 in 1895. Quite a large number of small quarries ceased operations altogether for the time, but they will probably resume when general business improves. Operators who have continued through the past three years without interruption have complained of poor business and constantly lowering prices, particularly in the case of paving blocks. The increasing use of asphaltum pavement and of various kinds of paving bricks is beginning to be felt by producers of Belgian blocks, which, on being thrown out in large cities, have declined in price sufficiently to allow of their use in some towns that have heretofore been content with macadam or similar cheap paving material. Some of the producers of the finer kinds of granite are complaining of competition with Scotch granite, which, they say, is more profitable to dealers than the American.

Maryland.—The value of the output in 1894 was \$308,966 and in 1895 \$276,020, thus showing a decrease. The industry generally was dull.

A few large orders were filled by some of the leading producers, but these constituted almost the entire business for the year.

Massachusetts.—This State still stands at the head of the list of those producing granite. The reason for this preeminence is mainly that stone of all grades is to be found in the State, from the finest ornamental stock to such material as is adapted only to road metal or paving blocks. The quarrymen can thus adapt themselves to changing demands, as well as to periods of financial depression better than those of other regions in which the stone is restricted to fewer uses. The product in 1894 was valued at \$1,994,830, in 1895 at \$1,918,894; so that while there has been some decrease, it is not proportionately large. The general complaint of lower prices for paving blocks is very similar to that so liberally made in Maine. As is also the case in Maine, a large number of small quarries have ceased operations entirely for the present, although when business improves they will probably revive.

Minnesota.—Production in Minnesota is about the same for 1895 as for 1894, although the amount is only one-half what was quarried in 1892. All of the operators complain of the dullness of trade, although some are hopeful as to possibilities in 1896. A number of quarries ceased operations entirely.

Missouri.—The output of granite in Missouri is somewhat in advance of 1894, but the figures are decidedly below those of previous years, particularly 1890, when the product was valued at \$500,000. In a number of Western States, including Missouri, crushed granite formed an important part of the output. The use of crushed granite in road making seems to be increasing in a very satisfactory manner, a result due to a general disposition to improve roads, aided by the cheapness of stone owing to hard times.

New Hampshire.—A very decided falling off in output marks the granite industry of New Hampshire in 1895. Without exception producers report very poor business and many ceased work entirely. Although many operators express themselves as disheartened, a few predict much improvement for 1896. Complaints of foreign competition are made by a number of producers.

New Jersey.—Very little was accomplished in New Jersey during the past year. The stone is mostly trap rock and is largely used for road making at present, much of the stone being crushed.

New York.—Low prices prevailed throughout the year in New York. Much of the product was crushed stone for road work. Prospects for 1896 are more encouraging.

North Carolina.—Poor demands and low prices characterized the industry for 1895. Much of the product was for paving and curbing. Judging from the abundance of easily quarried granite of good quality in the State, ordinary prosperity in general business will undoubtedly result in making the granite industry quite an important one in North Carolina in the course of a few years.

Pennsylvania.—Many quarries closed during the year. Those that continued in operation report very poor business. Some claims have been made that the extensive use of brick and asphaltum for paving material in Philadelphia has seriously reduced the paving-block output.

Rhode Island.—The special item of interest which attaches to the consideration of granite in Rhode Island is the fact that this State leads in the production of monumental and ornamental stock. The quarries of Westerly are the most important. The output of 1894, valued at \$1,211,439, was the largest in the history of the State. The product of 1895 was valued at \$968,473, and while this is less than the product of 1894 it is greater than that of any year previous to 1894. Prospects for 1896 are regarded as good.

South Carolina.—Dull business is reported. More than half the output was in the form of paving blocks, prices for which were low.

Vermont.—Hard times and low prices have not been able to prevent a larger output in Vermont. The value of the product in 1894 was \$893,956, in 1895, \$1,007,718, thus exceeding \$1,000,000. With the exception of a slight decline in 1892 the value of the output in Vermont has steadily increased, so that the figure for 1895 is the highest ever reached in the history of the State. It is interesting to note that Vermont is the only granite-producing State which has regularly increased in output, so that for last year the figures reached a maximum.

Virginia.—Business on the whole was very dull in Virginia during 1895. The outlook for 1896 is somewhat better.

Wisconsin.—The same conditions of depression that existed in 1894 are again referred to by producers in Wisconsin to account for a very poor condition of business in 1895. The value of the output in the latter year is about one-half that of 1894.

MARBLE.

VALUE OF MARBLE PRODUCT BY STATES.

The following table shows the value of the marble produced in the United States during the year 1895, by States:

Value of marble product for the year 1895, by States.

State.	Value.	State.	Value.
California	\$22,000	New York	\$207,828
Georgia	689,229	Pennsylvania	59,787
Idaho	2,250	Tennessee	362,277
Iowa	13,750	Vermont	1,321,598
Maryland	145,000	Total	2,825,719
Massachusetts	2,000		

The value of the output in 1894 was \$3,199,585. A falling off of \$373,866 is thus evident. Improvement in the industry was noticeable toward the latter part of the year, and many of the producers speak quite hopefully of still more decided improvement in 1896. A number of operators who were entirely inactive in 1895 contemplate a resumption of business in 1896. The chief cause of the decline in 1895 was, naturally, business depression, causing greater economy in the use of ornamental material of every kind. Another reason is one which is independent of hard times—namely, the increasing use of granite for cemetery purposes and for polished interior work in public buildings. Owing to the invention of new machinery for turning, polishing, and carving granite, and the use of improved abrasive material, this stone is coming more and more into general use and thus into competition to a certain extent with the softer and more easily finished marble. Prices for marble products have declined somewhat in a number of localities during the past two years.

The adoption of a number of the leading marbles of the United States in the new Congressional Library Building in Washington furnishes a fine opportunity for the comparative study of these materials as well as of a number of varieties of Italian marble. Probably no other building in the world shows so well the beauties and fine effects obtainable in marble, whether in polished slabs or carved or otherwise finished, as does this magnificent structure.

The following table shows the value, by States, of the marble produced during the years 1890 to 1895, inclusive:

Value of marble, by States, from 1890 to 1895.

State.	1890.	1891.	1892.
California	\$87,030	\$100,000	\$115,000
Georgia	196,250	275,000	280,000
Idaho			
Iowa			
Maryland	139,816	100,000	105,000
Massachusetts			100,000
New York	354,197	390,000	380,000
Pennsylvania		45,000	50,000
Tennessee	419,467	400,000	350,000
Vermont	2,169,560	2,200,000	2,275,000
Scattering	121,850	100,000	50,000
Total	3,488,170	3,610,000	3,705,000

Value of marble, by States, from 1890 to 1895—Continued.

State.	1893.	1894.	1895.
California	\$10,000	\$13,420	\$22,000
Georgia	261,666	724,385	689,229
Idaho	4,500	3,000	2,250
Iowa			13,750
Maryland	130,000	175,000	145,000
Massachusetts			2,000
New York	206,926	501,585	207,828
Pennsylvania	27,000	50,000	59,787
Tennessee	150,000	231,796	362,277
Vermont	1,621,000	1,500,399	1,321,598
Scattering			
Total.....	2,411,092	3,199,585	2,825,719

THE MARBLE INDUSTRY IN THE VARIOUS STATES.

California.—Marble quarrying in California was very much restricted during 1895, and producers, without exception, have expressed themselves in the most unqualified manner to the effect that there was scarcely any inducement to continue quarrying during the year. Operators are awaiting such revival in business as will justify them in renewing their efforts. Under ordinarily good conditions of trade the State is equal to a production of marble valued at \$100,000 per annum, but, as is evident from the table of production, the figure for 1895 is far below this limit.

Idaho.—A small amount of marble was produced in Cassia County during 1895. Larger amounts would doubtless be quarried if business were in a normal condition. Quarries are at present being opened near Albion, Cassia County, and an output may be looked for from these in 1896.

Georgia.—The activity of marble quarrying in Georgia during the past two years is almost phenomenal, when the depressing conditions of trade generally are considered. The product for 1895 was valued at \$689,229, which falls but little below the corresponding figure for 1894.

A most commendable spirit of business enterprise has been shown in the development of these quarries since the year 1884. The stone is now well and favorably known throughout the country for interior decoration as well as for outside construction and cemetery work.

Improvement in demands was noticed toward the latter part of the year, and for building, both exterior and interior, the outlook for 1896 is good, much better, in fact, than for ornamental and cemetery products.

Iowa.—Marble production in Iowa is of recent date, but, as the material appears to withstand exposure very well, there is no reason why

it should not develop into a permanent industry. The stone is not what would be called highly crystalline, and some of it is not, in the strict sense of the term, true marble; it is really a coralline limestone in various stages of metamorphism, some of it being crystalline. In the form of mantels and other kinds of interior decoration it gives very pleasing effects, some of the coral markings being very delicate and beautiful. As is evident from the table of production, but little has as yet been accomplished in the way of actual output.

Maryland.—The Maryland marble quarries, like those in a number of other States, have produced less stone in 1895 than in the preceding year, but, with the improvement in general trade, activity in quarrying will doubtless increase. The Maryland marble is so thoroughly well known for its desirable qualities that, while production fluctuates a little according to changes in commercial activity, it is as little affected by financial depression as any similar stone in the country.

Massachusetts.—Marble from quarries at Lee, in this State, has long been quarried, but at present but little is being produced.

New York.—In 1894 the value of the marble output was much higher than usual. This was due to greatly increased activity at Tuckahoe. The figure for 1895, namely, \$207,828, is somewhat below the customary output, but the restricted production is entirely due to the depression in business, which caused a number of quarries to suspend operations for the year. Some of them resumed production early in 1896, and the quarrymen regard indications for 1896 as much better than for two years past.

Pennsylvania.—Quarries in Montgomery and Chester counties produce an annual output of about \$65,000 value. The Montgomery County stone has been known to the trade for a long time, and for building purposes it has a well-established reputation. The Chester County stone is of comparatively recent discovery, but it is rapidly making a reputation for its adaptability to building purposes, for which most of it is used.

Tennessee.—During the past year quite a significant advance has been made in the marble industry of this State. In spite of financial depression the value of the output has increased from \$231,796 in 1894 to \$362,277 in 1895. The chief use to which Tennessee marble has been put in the past is interior decoration, although at the period when marble-topped furniture was fashionable large quantities were devoted to this use. At present the stone is strongly advocated by the producers as an outside building material; judging from its appearance in a number of buildings in which it has been used it will probably make a reputation in this line. Improvements in quarrying methods are being made, and it will be a matter of surprise if the industry does not show a remarkable advance within the next few years.

Vermont.—About one half of the marble output of this country comes from Vermont. In 1892 the value of the output was \$2,275,000,

probably the highest figure which the industry has ever reached in any one year. Since that time there has been a decline, caused entirely by the general dullness of business. The output for 1895 is valued at \$1,321,598. Indications for 1896 are for better business than for several years past. A few firms who have almost entirely suspended operations during 1895 expect to resume in 1896.

SLATE.

VALUE OF SLATE PRODUCT, BY STATES.

The following table shows the output of roofing and milled slate in 1895:

Value of slate product in 1895, by States.

State.	Roofing slate.		Other purposes (value).	Total value.
	Squares.	Value.		
California.....	1,500	\$10,500	.....	\$10,500
Georgia.....	2,500	10,675	.....	10,675
Maine.....	23,774	118,791	\$21,363	140,154
Maryland.....	13,188	59,157	1,200	60,357
New Jersey.....	200	700	.....	700
New York.....	13,624	90,150	1,725	91,875
Pennsylvania.....	426,687	1,437,697	210,054	1,647,751
Vermont.....	221,359	531,482	93,849	625,331
Virginia.....	27,095	92,357	19,000	111,357
Total.....	729,927	2,351,509	347,191	2,698,700

The table shows a total output of 729,927 squares of roofing slate, valued at \$2,351,509. The corresponding totals for 1894 were 738,222 squares, and \$2,301,138. It is evident that, although the number of squares produced is somewhat less in 1895, the value is greater, showing an increase in the value per square, namely, from \$3.11 in 1894, to \$3.23 in 1895.

This gain in value per square is not what would be expected as the result of reading statements made by many of the producers, who claimed that prices had fallen since 1894. Taken as a whole, the slate industry is in better condition than it was a year ago. The following table shows the average annual price per square of roofing slate since 1890:

Average annual price per square of roofing slate for the entire country.

1890.....	\$3.34	1893.....	\$3.55
1891.....	3.49	1894.....	3.11
1892.....	3.58	1895.....	3.23

The following table shows the value of the production of slate, by States, during the years 1890 to 1895, inclusive:

Value of slate, by States, from 1890 to 1895.

State.	1890.			
	Roofing slate.	Value.	Other purposes than roofing, value.	Total value
	<i>Squares.</i>			
Arkansas.....				
California.....	3, 104	\$18, 089		\$18, 089
Georgia.....	3, 050	14, 850	\$480	15, ' 30
Maine.....	41, 000	201, 500	18, 000	219, 500
Maryland.....	23, 099	105, 745	4, 263	110, 008
New Jersey.....	2, 700	9, 675	1, 250	10, 925
New York.....	16, 767	81, 726	44, 877	126, 603
Pennsylvania.....	476, 038	1, 641, 003	370, 723	2, 011, 726
Utah.....				
Vermont.....	236, 350	596, 997	245, 016	842, 013
Virginia.....	30, 457	113, 079		113, 079
Other States <i>a</i>	3, 060	15, 240		15, 240
Total.....	835, 625	2, 797, 904	684, 609	3, 482, 513

State.	1891.			
	Roofing slate.	Value.	Other purposes than roofing, value.	Total value.
	<i>Squares.</i>			
Arkansas.....	120	\$480		\$480
California.....	4, 000	24, 000		24, 000
Georgia.....	3, 000	13, 500		13, 500
Maine.....	50, 000	250, 000		250, 000
Maryland.....	25, 166	123, 425	\$2, 000	125, 425
New Jersey.....	2, 500	10, 000		10, 000
New York.....	17, 000	136, 000	40, 000	176, 000
Pennsylvania.....	507, 824	1, 741, 836	401, 069	2, 142, 905
Utah.....				
Vermont.....	247, 643	698, 350	257, 267	955, 617
Virginia.....	36, 059	127, 819		127, 819
Other States <i>a</i>				
Total.....	893, 312	3, 125, 410	700, 336	3, 825, 746

a Includes Arkansas, Michigan, and Utah.

Value of slate, by States, from 1890 to 1895—Continued.

State.	1892.			
	Roofing slate.	Value.	Other purposes than roofing, value.	Total value.
	<i>Squares.</i>			
Arkansas				
California	3,500	\$21,000		\$21,000
Georgia	2,500	10,625		10,625
Maine	50,000	250,000		250,000
Maryland	24,000	114,000	\$2,500	116,500
New Jersey	3,000	12,000		12,000
New York	20,000	160,000	50,000	210,000
Pennsylvania	550,000	1,925,000	408,000	2,333,000
Utah				
Vermont	260,000	754,000	260,000	1,014,000
Virginia	40,000	150,000		150,000
Total	953,000	3,396,625	720,500	4,117,125

State.	1893.			
	Roofing slate.	Value.	Other purposes than roofing, value.	Total value.
	<i>Squares.</i>			
Arkansas				
California				
Georgia	2,500	\$11,250		\$11,250
Maine	18,184	124,200	\$15,000	139,200
Maryland	7,422	37,884		37,884
New Jersey	900	3,653		3,653
New York	69,640	204,776	206	204,982
Pennsylvania	364,051	1,314,451	157,824	1,472,275
Utah	75	450	400	850
Vermont	132,061	407,538	128,194	535,732
Virginia	27,106	104,847	12,500	117,347
Total	621,939	2,209,049	314,124	2,523,173

Value of Slate, by States, from 1890 to 1895—Continued.

State.	1894.			
	Roofing slate.	Value.	Other purposes than roofing value.	Total value.
	<i>Squares.</i>			
Arkansas.....				
California.....	900	\$5,850		\$5,850
Georgia.....	5,000	22,500		22,500
Maine.....	24,690	123,937	\$22,901	146,838
Maryland.....	39,460	150,568	2,500	153,068
New Jersey.....	375	1,050		1,050
New York.....	7,955	42,092	2,450	44,542
Pennsylvania.....	411,550	1,380,430	239,728	1,620,158
Utah.....				
Vermont.....	214,337	455,860	202,307	658,167
Virginia.....	33,955	118,851	19,300	138,151
Total.....	738,222	2,301,138	489,186	2,790,324
State.	1895.			
	Roofing slate.	Value.	Other purposes than roofing value.	Total value.
	<i>Squares.</i>			
California.....	1,500	\$10,500		\$10,500
Georgia.....	2,500	10,675		10,675
Maine.....	23,774	118,791	\$21,363	140,154
Maryland.....	13,188	59,157	1,200	60,357
New Jersey.....	200	700		700
New York.....	13,624	90,150	1,725	91,875
Pennsylvania.....	426,687	1,437,697	210,054	1,647,751
Vermont.....	221,359	531,482	93,849	625,331
Virginia.....	27,095	92,357	19,000	111,357
Total.....	729,927	2,351,509	347,191	2,698,700

THE SLATE INDUSTRY IN THE VARIOUS STATES.

California.—While the production of slate in California has never yet reached large proportions, the product has always commanded a good price. The demand for slate as a roofing material is curtailed by the cheapness and excellence of redwood shingles produced in the State. There is no reason at present to expect that the production of roofing slate will increase markedly within the next few years. The output comes entirely from Eldorado County.

Georgia.—The output of slate in Georgia has been about the same for the past five years, with the exception of 1894, when it reached a total of 5,000 squares. In 1895 the total was 2,500 squares, but indications for steady improvement are better now than they have been, as the producers are better prepared than formerly to fill orders promptly. There seems to be no reason why the production of slate in the South should not prosper, for the material is good and should supply the whole Southern trade, both for roofing purposes and manufactured articles or milled stock. The entire output comes from Polk County.

Maine.—Quarries in Piscataquis County yielded an output valued at \$140,154. Of this value, \$118,791 represents the value of 23,774 squares of roofing slate, while the remainder is the value of milled stock. The roofing slate commands a price well above the average for the country.

Maryland.—Productive quarries are all in Harford County, near the Pennsylvania State line, and form a part of what is known as the Peach Bottom region. The product has always been favorably regarded for roofing purposes, and the price per square is higher than the average for Pennsylvania slate.

New Jersey.—The slate produced in this State comes from Sussex County, and the quarries form a continuation of the Pennsylvania slate belt. Production on the New Jersey side of the line has never been very considerable.

New York.—The output of 13,624 squares of roofing slate, valued at \$90,150, comes from Washington County, near the Vermont line. Most of the product is of a bright cherry-red color, and as it is the only slate in the country of this color it commands a high price. Used with black slate, it forms a very pleasing combination in the roof.

Pennsylvania.—The value of the slate output in Pennsylvania amounts each year to more than half of the total value for the whole country.

The productive counties are Berks, Carbon, Lehigh, Northampton, and York. There is very little difference between the years 1894 and 1895 in total output, but it is interesting to note that the average value per square has increased from \$3.35 in 1894 to \$3.39 in 1895. This difference is not great, to be sure, but it is sufficient to indicate an improvement, which will probably continue in 1896, as the general prosperity of the country increases in its recovery from the depression of the past few years.

Vermont.—This State is second only to Pennsylvania in the production of slate. The product comes from Rutland County and differs from Pennsylvania slate in color, the latter being entirely black, or nearly so, while Vermont slate is of various shades of green and purple.

Vermont slate is easily and cheaply quarried, and the industry can be successfully prosecuted at lower prices per square than in any other State. There has been but little change (a slight increase) over 1894, but as is true in Pennsylvania also, indications for improvement in 1896 are good. The average price per square in 1894 was \$2.12, while in 1895 it was \$2.40.

Virginia.—The output comes from Buckingham County. Although there was a slight decrease in output in 1895, it is hardly sufficient to be significant. The production of milled stock is of recent date, but seems to be firmly established as a permanent addition to the industry in the State.

SANDSTONE.

VALUE OF SANDSTONE PRODUCT BY STATES.

The year 1895 shows a slight improvement in the general condition of the industry.

The following table reveals a total of \$4,211,314 as the value of the output in 1895; this means a gain of \$265,467 over 1894:

Value of sandstone production in 1895, by States.

State.	Value.	State.	Value.
Alabama	\$31,930	Montana	\$31,069
Arizona	20,000	New Jersey	111,823
Arkansas	13,228	New Mexico	2,700
California	11,933	New York	415,644
Colorado	63,237	North Carolina ..	3,500
Connecticut	397,853	Ohio	1,449,659
Idaho	6,900	Pennsylvania	500,000
Illinois	6,558	South Dakota	26,100
Indiana	60,000	Texas	97,336
Iowa	5,575	Utah	5,000
Kansas	93,394	Washington	14,777
Kentucky	25,000	West Virginia	40,000
Maryland	16,836	Wisconsin	78,000
Massachusetts	339,487	Wyoming	10,000
Michigan	159,075		
Minnesota	74,700	Total	4,211,314
Missouri	100,000		

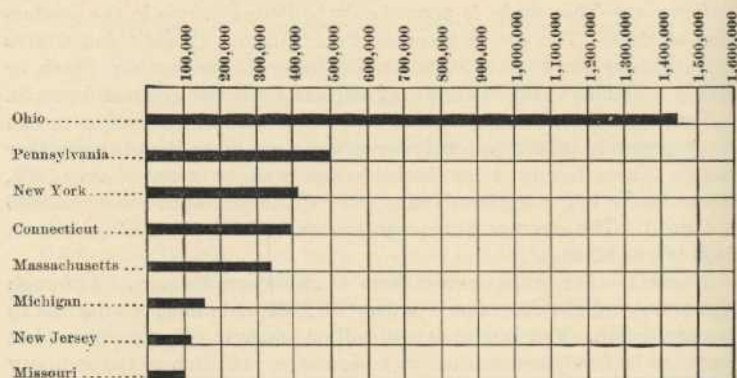


FIG. 3.—Value of sandstone produced in the various States during the year 1895.

The following table shows the output of sandstone, by years, from 1890 to 1895:

Value of sandstone, by States, from 1890 to 1895.

State.	1890.	1891.	1892.
Alabama	\$43,965	\$30,000	\$32,000
Arizona	9,146	1,000	35,000
Arkansas	25,074	20,000	18,000
California	175,598	100,000	50,000
Colorado	1,224,098	750,000	550,000
Connecticut	920,061	750,000	650,000
Florida	(a)		
Georgia	(a)		2,000
Idaho	2,490		3,000
Illinois	17,896	10,000	7,500
Indiana	43,983	90,000	80,000
Iowa	80,251	50,000	25,000
Kansas	149,289	80,000	70,000
Kentucky	117,940	80,000	65,000
Maryland	10,605	10,000	5,000
Massachusetts	649,097	400,000	400,000
Michigan	246,570	275,000	500,000
Minnesota	131,979	290,000	175,000
Missouri	155,557	100,000	125,000
Montana	31,648	35,000	35,000
Nevada	(a)		
New Hampshire	3,750		
New Jersey	597,309	400,000	350,000
New Mexico	186,804	50,000	20,000

a Sandstone valued at \$26,199 was produced by Rhode Island, Nevada, Vermont, Florida, and Georgia together, and this sum is included in the total.

Value of sandstone, by States, from 1890 to 1895—Continued.

State.	1890.	1891.	1892.
New York	\$702,419	\$500,000	\$450,000
North Carolina	12,000	15,000	.....
Ohio	3,046,656	3,200,000	3,300,000
Oregon	8,424	.....	35,000
Pennsylvania	1,609,159	750,000	650,000
Rhode Island	(a)	.....	.....
South Dakota	93,570	25,000	20,000
Tennessee	2,722	.....	.....
Texas	14,651	6,000	48,000
Utah	48,306	36,000	40,000
Vermont	(a)	.....	.....
Virginia	11,500	40,000	.....
Washington	75,936	75,000	75,000
West Virginia	140,687	90,000	85,000
Wisconsin	183,958	417,000	400,000
Wyoming	16,760	25,000	15,000
Total	10,816,057	8,700,000	8,315,500
State.	1893.	1894.	1895.
Alabama	\$5,400	\$18,100	\$31,930
Arizona	46,400	.....	20,000
Arkansas	3,292	2,365	13,228
California	26,314	10,087	11,933
Colorado	126,077	69,105	63,237
Connecticut	570,346	322,934	397,853
Florida .....	.....	.....	.....
Georgia .....	.....	11,300	.....
Idaho	2,005	10,529	6,900
Illinois	16,856	10,732	6,558
Indiana	20,000	22,120	60,000
Iowa	18,347	11,639	5,575
Kansas	24,761	30,265	93,394
Kentucky	18,000	27,868	25,000
Maryland	360	3,450	16,836
Massachusetts	228,348	160,231	339,487
Michigan	75,547	34,066	159,075
Minnesota	80,296	8,415	74,700
Missouri	75,701	131,687	100,000

^a Sandstone valued at \$26,199 was produced by Rhode Island, Nevada, Vermont, Florida, and Georgia together, and this sum is included in the total.

Value of sandstone, by States, from 1890 to 1895—Continued.

State.	1891.	1894.	1895.
Montana	\$42,300	\$16,500	\$31,069
Nevada			
New Hampshire			
New Jersey	267,514	217,941	111,823
New Mexico	4,922	300	2,700
New York	415,318	450,992	415,644
North Carolina			3,500
Ohio	2,201,932	1,777,034	1,449,659
Oregon			
Pennsylvania	622,552	349,787	500,000
Rhode Island			
South Dakota	36,165	9,000	26,100
Tennessee			
Texas	77,675	62,350	97,336
Utah	136,462	15,428	5,000
Vermont			
Virginia	3,830	2,258	
Washington	15,000	6,611	14,777
West Virginia	46,135	63,865	40,000
Wisconsin	92,193	94,888	78,000
Wyoming	100	4,000	10,000
Total	5,295,151	3,955,847	4,211,314

THE SANDSTONE INDUSTRY IN THE VARIOUS STATES.

Alabama.—Reports indicate a much more satisfactory condition than that which prevailed in 1894, although, of course, the industry is still struggling under adverse financial conditions. Prospects for 1896 are regarded as good.

Arizona.—Quarries near Flagstaff were in operation during the year, producing an output valued at \$20,000. This speaks well for the development of what may be before long an industry of some magnitude.

Arkansas.—Operations of sandstone quarrying have never reached a considerable magnitude in Arkansas, but proportionately much more was done in 1895 than in 1894.

California.—Reports of operations in sandstone quarrying in California are rather discouraging, and an output valued at \$11,933 is much smaller than was produced in this State a few years since. Building operations were very much curtailed in the past year.

Colorado.—When the large sandstone outputs of 1890 and 1891 are considered, it is evident that at present the possibilities in this indus-

try are far from being realized. It is encouraging to note, however, that better conditions for 1896 are unhesitatingly predicted by a number of the producers.

Connecticut.—The important and long-known sandstone quarries of Portland and Cromwell, Conn., yield most of the State's output of sandstone. Quite a marked improvement is to be noted for the year 1895, but the industry, as in most States, is far behind what it was in 1890 and 1891. Some of the producers appear to be much encouraged at the outlook for 1896.

*Indiana.*¹—Quite a decided improvement in sandstone production is evident for the year 1895. Most of the operators report an encouraging outlook for 1896.

Kansas.—A decided increase in output characterizes this State in 1895. The output of 1894 was valued at \$30,265; the product of 1895 reaches the valuation of \$93,394. This is due to the increased output of a small number of producers. Prospects for 1896 are good.

Massachusetts.—The year in Massachusetts has been the most productive of sandstone since 1892. The gains are due to the considerably increased output of a few important producers. Small operators complain of the hard times, and quite a number have stopped work until business generally shall improve.

Michigan.—The total value of the sandstone output in 1895 (\$159,075) means a heavy gain over 1894. Of this total, \$35,107 is the value of grindstones and whetstones. In the production of these articles Michigan is annually increasing in importance, and the cessation of hard times will probably be marked by quite decided gains in this direction. Next to Ohio, Michigan is the most important State in grindstone and whetstone production.

Minnesota.—The sandstone output in Minnesota was quite restricted in 1894, but by the operations of a few new firms the output of 1895 very largely exceeds that of the preceding year. The outlook for 1896 is encouraging.

Missouri.—The output of 1894 was valued at \$131,687. Owing to the fact that a number of quarrymen ceased operations during 1895, the total output was reduced to a value of \$100,000 in 1895. Complaints of business depression have been made by nearly all of the producers.

Montana.—The output of Montana increased from \$16,500 in 1894 to \$31,069 in 1895. The latter figure includes the value of stone used for lining converters and furnaces operating in the State. This stone was not on the market, but was quarried by the consumers.

New Jersey.—The sandstone interests of New Jersey have been in the past, notably in the years 1890, 1891, and 1892, of very considerable magnitude, but the business depression of the past few years has been

¹Attention is called to a valuable article by Prof. T. C. Hopkins on the sandstones of western Indiana on pages 780-787 of this report.

very seriously felt. There seems to be no other reason for the falling off in production, as the stone has an established reputation as a valuable building material. Many of the quarries have ceased operations in the past two or three years. The output of 1895 was valued at \$111,823.

New York.—The sandstones of New York have been so long and so favorably known that the financial depression of the past few years has done as little harm in this State as in any other in the country. The output of 1894 was valued at \$450,992, and while the value for 1895 (\$415,644) is somewhat less, the difference is not great. The general opinion seems to be that 1896 will show a decided gain.

Ohio.—This State is far in the lead in producing sandstone. The output of 1890 was valued at \$3,046,656, in 1892 at \$3,300,000; since the last-named year the output has been declining, owing, apparently, only to the trying financial conditions which have marked this period. The output of 1895 is valued at \$1,449,659. Most of the grindstone output of this country comes from Ohio. The value of the grindstones and whetstones produced is included in the above figure.

Pennsylvania.—The output of Pennsylvania was valued at \$500,000 in 1895. This means quite a gain over 1894. The product is the result of the operations of a large number of comparatively small producers. Business was much better after August.

South Dakota.—Owing to the commencement of quarrying operations by a few new firms, the output of this State increased from \$9,000 in 1894 to \$26,000 in 1895. The sandstone of South Dakota is well worth the attention it has received, and there seems at present to be no doubt but that 1896 will show a considerably increased output, if financial conditions will permit.

Texas.—Owing to increased operations of a few important concerns, the output of sandstone in Texas increased from a valuation of \$62,350 in 1894 to \$97,336 in 1895. This is the highest figure yet reached for sandstone in the State.

West Virginia.—Production in West Virginia was not up to the average during 1895. There is plenty of good bridge and building stone in the State, but poor demand and low prices have restricted quarrying operations during the past two years.

Wisconsin.—Production fell from \$94,888 in 1894 to \$78,000 in 1895. The prospects for 1896 are much better.

THE SANDSTONES OF WESTERN INDIANA.

By T. C. HOPKINS.

Beds of sandstone of commercial importance occur in both the Upper and Lower Carboniferous strata of western Indiana. In the different deposits the stone varies in texture from very fine-grained to coarse-grained, and even to coarse conglomerate; in color from light-gray,

almost white, through various shades of buff, yellow, yellow-brown, red-brown, and red; in thickness from a few inches to more than 100 feet, sometimes regularly stratified in layers from a few inches to several feet in thickness, sometimes in one massive bed. These sandstones occur at more or less widely separated intervals over all the western and southwestern part of the State of Indiana, including nearly one-third of the State.

THE MANSFIELD SANDSTONE.

The most important bed of sandstone in the State from both a commercial and scientific standpoint is the one designated in a recent geological report as the "Mansfield" sandstone, which is supposed to correspond stratigraphically to the Millstone grit of the adjoining States. It lies at the base of the Coal Measures unconformably upon the Lower Carboniferous limestone, or, in the absence of the limestone, on sandstone or shale of Lower Carboniferous age. The unconformity is shown both by the erosion channels and the basal conglomerate, composed of fragments of chert and limestone from the underlying rocks. It is overlain by shale, sandstone, or coal of the Productive Coal Measures, or by glacial drift. It varies in thickness from a few feet to more than 100 feet, and consists largely of a bed of coarse sandstone, but is associated in many places with lenticular and irregular masses of conglomerate varying in thickness from a fraction of an inch to 10 feet or more, and in some places with beds of variable thickness of shale, coal, and fire clay.

The Mansfield sandstone outcrops at intervals over a belt of territory varying in width from a few hundred yards to 10 miles or more, and extending from north of the middle of the State border on the west in a direction east of south to and beyond the Ohio River, a distance of more than 175 miles in Indiana. Over the northern half of this area is a mantle of glacial drift varying in thickness from a few inches to 200 feet or more, and over the southern part of the area is a heavy covering of soil. The sandstone exposures are mainly confined to the water courses, and in some instances are continuous for a mile or more, but more commonly occur in small patches a few yards in extent, between which the stone is concealed by the drift or soil covering.

In many places the occurrence of this stone could be traced on a good topographic map by its bold outcrops, forming perpendicular and overhanging cliffs. These cliffs are caused by (1) the good weathering properties of the sandstone, and (2) the occurrence of a bed of very pyritiferous shale immediately underlying the sandstone, which shale not only disintegrates very rapidly compared with the sandstone, but the acid from the pyrite cuts away the underlying limestone rapidly. The erosive action being greater along the water courses, the small tributaries have cut notches back into the bluffs bordering the larger streams, thus giving the bluff a very winding course. These notches,

coves, or gorges extend back a variable distance from the main stream, depending upon the size and age of the tributary. In many places the upper limit of the Mansfield sandstone is a crescent-shaped cliff, with the stream in the middle of the crescent forming a waterfall.

Color.—The many different colors of the sandstone may be conveniently grouped into two general classes: (1) The brownstones; (2) the gray and buff stone, with variegated stone in each class. The coloring matter is mostly iron oxide in various amounts and various degrees of hydration. Part of the blue and dark color may be due to carbonaceous material and iron pyrites. A sandstone may be colored, because the grains composing it are colored, or the cementing substance may be colored; in the latter case the coloring matter may simply form a film over the grain and another colorless or less brightly colored cementing substance may be present and form the bulk of the cement, or the whole mass of the cement may be colored and form the matrix in which the colorless grains are embedded. The last condition prevails in the brownstones or red sandstones of Indiana; the mass of the rock is made up of white or colorless quartz grains embedded in a matrix consisting almost wholly of iron oxide, but containing small quantities of clay and occasional mica flakes.

The red or brown stone deposits contain many different shades of color, due in part to the unequal distribution of the iron oxide, and in part to the different proportions of the hydrous and anhydrous oxides. The prevailing color is a purplish brown, closely resembling that of the average brownstones of Connecticut and Pennsylvania. In general it is of a brighter color than that of the Eastern stone, the lighter shade being due largely to an appreciable amount of light-colored nearly white siliceous grains, supposed to be chert. Interspersed with this red-brown color are patches of lighter yellow-brown and darker walnut-brown. In some localities the stone has a uniform red color, in no sense a brown. In such cases the iron is almost entirely anhydrous, and forms a much smaller percentage of the rock, so that the lighter color of the grains modifies the deeper shade of the iron. This color is a very desirable one, as is shown on the outcrops and in the old buildings. The yellow, buff, and gray sandstones have a lower percentage of iron oxide than the red, and the iron is in the hydrous form. They are more common than the brownstones.

Structure.—In most places the Mansfield sandstone occurs in a massive bed varying from a few feet to more than 100 feet in thickness. In some places the massive seamless stone is accompanied by a few feet of thinly stratified stone, in others by a coarse conglomerate, and in many places by shale and fire clay. In many places it is characterized by false bedding.

Texture.—The stone varies in texture from fine-grained sandstone to very coarse conglomerate. About nine-tenths of the bed is a comparatively uniform medium to coarse-grained sandstone. The remaining

one-tenth consists of shale, shaly sandstone, fire clay, coal, and conglomerate. The conglomerate pebbles vary from those no larger than wheat grains to those several inches in diameter. In general, the larger pebbles are composed of chert, and generally, but not always, lie at the base of the sandstone. The hard crystalline quartz pebbles are sometimes closely aggregated in patches and sometimes scattered through the sandstone. The brownstones contain much iron oxide, which in some places has ferruginized the pebbles, often disintegrating them after forming a crust of iron oxide. These are known as iron blisters or iron kidneys, and injure a great deal of otherwise good stone. The iron oxide sometimes segregates along joint planes or in regular masses in the body of the rock. There are certain areas, however, which are almost entirely free from the segregated iron and which will furnish building stone of a superior quality.

The Mansfield stone is in most places soft and friable when first quarried, but hardens on exposure to the air and sunlight. In many places the stone is so soft when first quarried that the citizens are afraid to use it, fearing that it might crush under the buildings. However, no instance of such crushing is recorded.

Chemical composition.—The accompanying table of analyses shows the stone to consist almost entirely of insoluble material and iron oxide. The insoluble material consists almost entirely of quartz grains as shown by microscopic analysis. There are small quantities of mica flakes in places. The iron oxide is most abundant in the brownstones. The microscope shows the presence of small quantities of other minerals in minute grains, such as apatite, rutile, kaolin, feldspar, pyrite, etc

Chemical analyses of Mansfield sandstone.

No.	Locality.	Colors of stones.	Color of insoluble residue.	Insoluble in hydrochloric acid.	Alumina (Al ₂ O ₃)	Iron oxide (Fe ₂ O ₃)	Lime (CaO).	Carbonic acid (CO ₂).	Total.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1	Mansfield	Brown.	White..	92.16	.....	6.29	0.05	.004	98.50
2	Portland Mills ....do ..	do ..	do ..	.....	2.58	19.39	.....	.25	.....
3	Judson.....do ..	do ..	do ..	93.21	.51	4.91	.12	.095	98.85
4	Hillsboro.....do ..	do ..	do ..	91.65	.56	6.60	.12	.095	99.03
5	Fountain.....do ..	do ..	do ..	91.66	.60	6.44	.05	.04	98.79
6	Bloomfield ....do ..	do ..	do ..	85.29	.19	11.82	.06	.05	97.41
7	St. Anthony.....do ..	do ..	do ..	88.41	.63	8.40	.13	.10	97.67
8	Green Hill....Red ....do ..	do ..	do ..	98.73	.28	.36	.03	.024	99.42
9	Williamsport. Buff....do ..	do ..	do ..	98.57	.05	.65	.02	.016	99.31
10	Fern.....do ..	do ..	do ..	.....	.30	1.03	.....	.....	.....
11	Cromwell, Conn. ....do ..	Brown.	do ..	70.84	13.15	2.48	3.09	9.73	99.29

Durability.—The Mansfield sandstone, despite its rather coarse grain and friable nature, is an exceedingly durable stone, as is indicated by its topographic features and its appearance in the old buildings and bridges where it has been used. Sufficient laboratory tests have not been made to prove anything in regard to the stone. One or two samples from one locality show a crushing strength about equal to the average sandstone, a porosity above the average, and that the stone does not stand the fire very well. However, the field examination is sufficient to show that the stone, even though porous and friable, is exceedingly durable. The exposures are in most places bold, perpendicular, or overhanging cliffs, with compact, indurated surface, the boulders having hard surfaces and generally sharp angles, with little or no disintegrated material scattered around them. In many places the stone retains glacial striae well preserved. In a number of structures where the stone has been exposed fifty years or more, it shows no sign of disintegration and is harder and apparently in a better state of preservation than that in the quarry from which it came. The stone should be quarried early in the season and not exposed to freezing weather until thoroughly dry.

Adaptability to masonry.—Its massive structure, coarse grain, durability, and ease of working render this stone suitable for heavy masonry of all kinds, and unsuitable for work where a smooth finish or delicate carving of anykind is required; hence its fitness for building bridges, foundations, retaining walls, etc.

Occurrence of the stone.—The position of the sandstone area has already been mentioned as extending in a broad strip in a direction east of south through the west-central part of the State. In this area, however, the character of the stone and the extent of the outcrops are by no means uniform. Through the northern half of the area the stone is covered by a bed of glacial drift, varying from zero to 100 feet or more in thickness; and in the southern half there is a heavy bed of disintegrated material. The exposures of the stone are for the most part in the bluffs bordering the water courses, sometimes forming bold cliffs along each side of the stream for several miles, but generally forming only isolated exposures of variable extent, separated by drift or soil covered slopes.

The brownstone has been quarried at Mansfield, Parke County; Hillsboro, Fountain County; near Green Hill, Warren County; Judson and Portland Mills, Parke County, and St. Anthony, Dubois County. The quarries at the last three localities are in operation at the present time, the others being temporarily suspended. Good stone in suitable position for quarrying, but not yet developed, occurs near Bloomfield, Greene County, and on Rocky Fork and on Sugar Mill Creek in Parke County. Smaller outcrops of less importance occur elsewhere in the area.

Buff and gray colored stone is more common and widely scattered than the brownstone. It has been quarried at Williamsport and Attica, and at many places in the vicinity of these towns in Warren and Fountain counties; at Rob Roy, Stone Bluff, Hillsboro, Wallace, and elsewhere in Fountain County; at Guion, Judson, and several different localities along Raccoon and Sugar creeks in Parke County, and at numerous small quarries throughout the area further south.

THE PORTLAND STONE.

Interspersed among the coal beds at a horizon above that of the Mansfield stone are several beds of sandstone which are commercially important at certain localities, but whose areal extent has not been traced out and which are probably more local in their occurrence than the Mansfield stone. One of the most important of these is the so-called Portland stone at Worthy, 4 miles above Hillsdale, on the west side of the Wabash River, in Vermillion County. The quarry is located on the Chicago and Eastern Illinois Railroad, between Terre Haute and Chicago, and the principal markets for the stone are these two cities and intervening points.

The quarry has been opened but a few years and has an extensive trade. It is well equipped with modern machinery, such as channelers, steam drills, and sawmill, and has its own locomotive for shifting cars. The stone is used for buildings, bridges, and similar purposes. As side wall fronts or trimmings, it has been used in two hundred or more buildings in Chicago. The court-house and church at Charleston, Ill., have been built of this stone.

The stone occurs in a massive bed, which in the quarry shows a working face of 51 feet without exposing the bottom of the stone. A core from the diamond drill is said to have been taken out to the depth of 69 feet without reaching the bottom of the stone. However, the present quarry face extends to the bottom of the ravine, and deeper quarrying would require pumping, especially in wet weather. As there is no permanent stream in the ravine, if the stone should prove to be of good quality to a considerable depth, it might prove to be cheaper to pump the water in wet weather than to remove the overlying waste material from a new surface, since the present quarry face has a thickness of 25 feet or more of shale, fire-clay coal, and boulder clay overlying the quarry stone.

The Portland stone is finer grained and more complex in its composition than the Mansfield stone. It is made up of angular quartz grains associated with feldspar and mica grains in a cement of clay, silica, decaying feldspar, iron oxide, and carbonates of lime and iron. The mica is muscovite in small ragged flakes intimately twisted among the quartz grains, thus serving as a bond of strength.

Chemical analysis of the Portland sandstone.

	Per cent.
Silica	91.18
Calcium carbonate	0.86
Magnesia	1.41
Ferric oxide.....	1.12
Alumina	2.14
Water and loss.....	3.29
Total	100.00

The crushing strength of the Portland stone, as given by Professor Kramer, of Cincinnati, is 6,825 pounds per square inch.

THE CANNELTON STONE.

Some of the oldest and largest sandstone quarries in Indiana are those near Cannelton, Perry County. Sandstone is exposed in the Ohio River bluffs in many places in Perry County and has been quarried at and below Cannelton, but the most valuable stone, and that which has been quarried most extensively, occurs on the bluff 2 to 4 miles above (east of) Cannelton, at and below Rock Island, in secs. 12, 13, and 14, T. 7 S., R. 3 W. The Mansfield sandstone and conglomerate occur at the base of the bluff at Rock Island, but is not quarried except in small quantities for riprap. The dimension stone is all taken from beds overlying the Mansfield stone and in most places separated from it by a bed of black shale. It is finer grained than the average Mansfield sandstone, the average diameter of the grains being 0.14 millimeters, the largest being 0.2 millimeters. The chemical analysis shows a higher percentage of insoluble residue than the average sandstone, but the residue is not all quartz, as in much of the Mansfield sandstone, but mica. Both muscovite and biotite occur. The quartz contains zircon, apatite, and rutile crystals.

Analysis of Cannelton sandstone.

	Per cent.
Residue, insoluble in hydrochloric acid.....	96.18
Ferric oxide (Fe_2O_3)	1.56
Alumina (Al_2O_3).....	.54
Lime (CaO).....	.15
Total	98.43

The color varies from a lemon-yellow to a light or dark gray. In general, however, the color is comparatively uniform at any one quarry opening, but varies from place to place.

The color is in no place an attractive one for fine buildings, owing to the rusty yellow tint of the iron oxide which always occurs. It is better adapted to heavy masonry, where beauty is subordinated to ease of working and durability.

The stone occurs in a massive bed which only rarely shows open bedding planes, but nearly always has an easy cleavage parallel to the bedding, so that it can be readily split into any thickness desired. This greatly facilitates the working of the stone, which is all done by hand. In many of the openings there is not sufficient quarry floor to use a channeler to advantage. The stone occurs on the face of a steep bluff, and is overlain by black shale, which is in turn overlain by other sandstone. The stone is quarried back in the bluff until the thickness of the overlying shale becomes too great to remove and to permit any profit on the stone, which in some places is not far.

The large cotton mill and the Catholic church at Cannelton are constructed of stone from these quarries. There are in Cannelton a dozen or more smaller buildings, storerooms, and dwelling houses which are built of it; also many foundations, retaining walls, etc. It was used in the locks on the canal at Louisville, Ky., and for a similar purpose on the Green River, Kentucky. It has been used in a number of places along the river for riprap, retaining walls, wharves, etc., even as far down as Memphis.

The quarrying of sandstone at this locality will no doubt prove to be an important industry, as the stone occurs in a heavy deposit, is easily worked, and well adapted to heavy masonry.

Sandstone has been quarried in small quantities at Brazil, West Baden, Paoli, Rockport, Coxville, Covington, The Glen, and elsewhere.

LIMESTONE.

PRODUCT IN 1895.

The following table shows the value of the limestone output for 1895:

Value of limestone production in 1895, with the uses to which the stone was applied.

State.	Lime.	Building and road making.	Flux.	Total.
Alabama	\$170,764	\$26,319	\$25,341	\$222,424
Arizona	15,380	6,574	2,205	24,159
Arkansas	39,282	8,094	.....	47,376
California	244,580	77,631	.....	322,211
Colorado	8,646	24,363	83,346	116,355

Value of limestone production in 1895, etc.—Continued.

State.	Lime.	Building and road making.	Flux.	Total.
Connecticut.....	\$125,000	\$29,333	.....	\$154,333
Florida.....	8,500	2,050	.....	10,550
Georgia.....	12,000	.....	.....	12,000
Idaho.....	7,216	613	.....	7,829
Illinois.....	164,785	1,482,425	\$40,452	1,687,662
Indiana.....	167,451	1,395,286	96,239	1,658,976
Iowa.....	114,205	324,136	11,160	449,501
Kansas.....	9,870	306,818	.....	316,688
Kentucky.....	37,108	113,418	3,604	154,130
Maine.....	600,000	100,000	.....	700,000
Maryland.....	150,000	50,000	.....	200,000
Massachusetts.....	55,000	20,000	.....	75,000
Michigan.....	70,589	350,000	4,000	424,589
Minnesota.....	29,895	188,838	.....	218,733
Missouri.....	210,376	659,787	27,155	897,318
Montana.....	20,121	.....	75,000	95,121
Nebraska.....	.....	7,376	.....	7,376
New Jersey.....	100,000	25,000	25,000	150,000
New Mexico.....	1,500	1,875	.....	3,375
New York.....	610,206	406,991	25,985	1,043,182
Ohio.....	613,575	668,124	287,014	1,568,713
Oregon.....	.....	970	.....	970
Pennsylvania.....	1,720,000	796,424	539,489	3,055,913
South Dakota.....	.....	4,000	.....	4,000
Tennessee.....	84,297	69,330	3,271	156,898
Texas.....	30,700	14,194	17,632	62,526
Utah.....	11,348	.....	11,155	22,503
Vermont.....	270,000	30,000	.....	300,000
Virginia.....	186,506	4,866	77,520	268,892
Washington.....	73,350	.....	2,560	75,910
West Virginia.....	25,922	5,413	11,557	42,892
Wisconsin.....	600,000	150,000	.....	750,000
Wyoming.....	650	.....	.....	650
Total.....	6,588,822	7,350,248	1,369,685	15,308,755

An inspection of this table shows a total value of \$15,308,755 for the entire limestone industry for 1895. The total for 1894 was \$16,190,118. There has then been a decrease of \$881,363. The value of the lime output for 1894 was \$8,610,607 and for 1895 \$6,588,822. The falling off in this item is nearly sufficient to account for the total decrease, but this has been offset by an increase of more than half a million in the

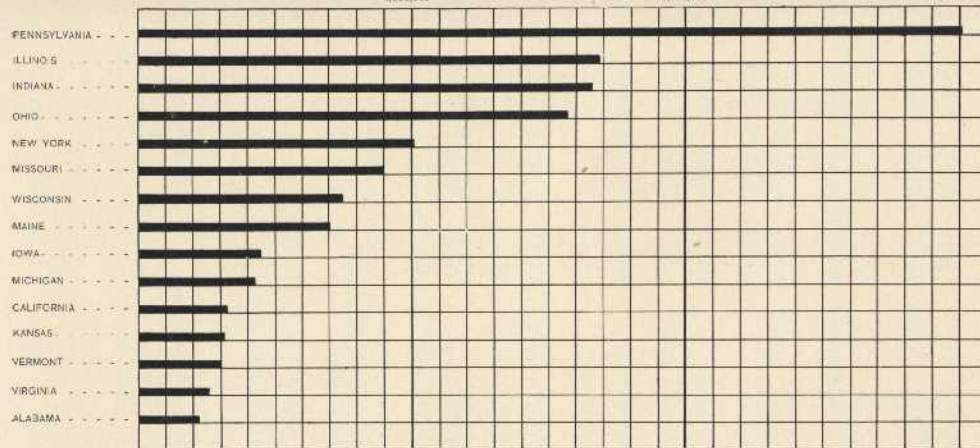


DIAGRAM SHOWING THE VALUE OF LIMESTONE PRODUCED IN THE UNITED STATES DURING THE YEAR 1895.
(In millions of dollars.)

limestone used for fluxing in 1895. Large quantities of limestone for flux were used in the smelting operations of Alabama, Colorado, Montana, Ohio, and Pennsylvania, while neighboring States also supplied stone in increased quantity for this purpose.

The value of lime made is slightly less than the value of stone used for building and roadmaking, while in 1894 it was greater than these two items. Roadmaking is annually making larger demands upon the limestone quarries.

PRODUCT BY STATES FROM 1890 TO 1895.

The following table shows the value of limestone, by States, since 1890:

Value of limestone, by States, from 1890 to 1895.

State.	1890.	1891.	1892.
Alabama	\$324,814	\$300,000	\$325,000
Arizona	(a)	-----	-----
Arkansas	18,360	20,000	18,000
California	516,780	400,000	400,000
Colorado	138,091	90,000	100,000
Connecticut	131,697	100,000	95,000
Florida	(a)	-----	-----
Georgia	(a)	-----	-----
Idaho	28,545	-----	5,000
Illinois	2,190,607	2,030,000	3,185,000
Indiana	1,889,336	2,100,000	1,800,000
Iowa	530,863	400,000	705,000
Kansas	478,822	300,000	310,000
Kentucky	303,314	250,000	275,000
Maine	1,523,499	1,200,000	1,600,000
Maryland	164,860	150,000	200,000
Massachusetts	119,978	100,000	200,000
Michigan	85,952	75,000	95,000
Minnesota	613,247	600,000	600,000
Missouri	1,859,960	1,400,000	1,400,000
Montana	24,964	-----	6,000
Nebraska	207,019	175,000	180,000
New Jersey	129,662	100,000	180,000
New Mexico	3,862	2,000	5,000
New York	1,708,830	1,200,000	1,200,000
Ohio	1,514,934	1,250,000	2,025,000
Oregon	(a)	-----	-----
Pennsylvania	2,655,477	2,100,000	1,900,000

^a Limestone, valued at \$77,935, was produced in Oregon, Georgia, Florida, Arizona, South Dakota, and Wyoming. The value is included in the total.

MINERAL RESOURCES.

Value of limestone, by States, from 1890 to 1895—Continued.

State.	1890.	1891.	1892.
Rhode Island.....	\$27,625	\$25,000	\$30,000
South Carolina.....	14,520	50,000	50,000
South Dakota.....	(a)	-----	-----
Tennessee.....	73,028	70,000	20,000
Texas.....	217,835	175,000	180,000
Utah.....	27,568	-----	8,000
Vermont.....	195,066	175,000	200,000
Virginia.....	159,023	170,000	185,000
Washington.....	231,287	25,000	100,000
West Virginia.....	93,856	85,000	85,000
Wisconsin.....	813,963	675,000	675,000
Wyoming.....	(a)	-----	-----
Total.....	19,095,179	15,792,000	18,342,000

State.	1893.	1894.	1895.
Alabama.....	\$205,000	\$210,269	\$222,424
Arizona.....	15,000	19,810	24,159
Arkansas.....	7,611	38,228	47,376
California.....	288,626	288,900	322,211
Colorado.....	60,000	132,170	116,355
Connecticut.....	155,000	204,414	154,333
Florida.....	35,000	30,639	10,550
Georgia.....	34,500	32,000	12,000
Idaho.....	1,000	5,315	7,829
Illinois.....	2,305,000	2,555,952	1,687,662
Indiana.....	1,474,695	1,203,108	1,658,976
Iowa.....	547,000	616,630	449,501
Kansas.....	175,173	241,039	316,688
Kentucky.....	203,000	113,934	154,130
Maine.....	1,175,000	810,089	700,000
Maryland.....	-----	350,000	200,000
Massachusetts.....	156,528	195,982	75,000
Michigan.....	53,282	336,287	424,589
Minnesota.....	208,088	291,263	218,733
Missouri.....	861,563	578,802	897,318
Montana.....	4,100	92,970	95,121
Nebraska.....	158,927	8,228	7,376
New Jersey.....	149,416	193,523	150,000
New Mexico.....	-----	4,910	3,375

^a Limestone, valued at \$77,935, was produced in Oregon, Georgia, Florida, Arizona, South Dakota, and Wyoming. The value is included in the total.

Value of limestone, by States, from 1890 to 1895—Continued.

State.	1893.	1894.	1895.
New York.....	\$1,103,529	\$1,378,851	\$1,043,182
Ohio.....	1,848,063	1,733,477	1,568,713
Oregon.....	15,100	.....	970
Pennsylvania.....	1,552,336	2,625,562	3,055,913
Rhode Island.....	24,800	20,433	.....
South Carolina.....	22,070	25,100	.....
South Dakota.....	100	3,663	4,000
Tennessee.....	126,089	188,664	156,898
Texas.....	28,100	41,526	62,526
Utah.....	17,446	23,696	22,503
Vermont.....	151,067	408,810	300,000
Virginia.....	82,685	284,547	268,892
Washington.....	139,862	59,148	75,910
West Virginia.....	19,184	43,773	42,892
Wisconsin.....	543,283	798,406	756,000
Wyoming.....	.....	.....	650
Total.....	13,927,223	16,190,118	15,308,755

THE LIMESTONE INDUSTRY IN THE VARIOUS STATES.

Alabama.—Considering the general condition of trade, the limestone output of the State in 1895 is higher than might be reasonably expected. The output of 1894 amounted in value to \$210,269, while that of 1895 reaches the figure \$222,424. Of this figure \$170,764 represents the value of lime made. In its production of good lime for building and other purposes the State is steadily acquiring a high standing in the South.

Arizona.—It is only within the last few years that limestone production has amounted to anything more than a very small figure. Since 1893, however, there has been a regular annual increase. In 1895 the product was valued at \$24,159. More than one-half of this figure is the value of lime made.

Arkansas.—The output of this State in limestone is greater than ever before. The value of the product in 1895 was \$24,159; most of this represents the value of lime made.

California.—The value of the product in 1895 was \$322,215; this figure includes the value of lime made, namely, \$244,580. The remainder was used mainly for rough building and roadmaking. Dull trade is complained of, and a number of the smaller operators ceased quarrying for the year.

Colorado.—Most of the output of limestone in Colorado is used for

fluxing and smelting gold and silver ores. The total value of the output was \$116,355, of which \$83,346 worth was for limestone used as flux. The output is a little behind that of 1894.

Connecticut.—In the burning of limestone to produce lime, Connecticut has done considerable in past years, particularly in 1894, when the value of the lime produced amounted to \$204,414. All of the limestone output, with the exception of a very small portion, is burned into lime. In 1895 business seems to have been restricted to actual necessities, and the output is valued at \$154,333. The vicinity of Canaan is the most important locality for lime burning.

Illinois.—Next to Pennsylvania, Illinois is the most important in value of output. The extensive quarries at Joliet and Lemont are by far the most productive. The stone is used mostly for building and street work, and it has an enviable reputation for these purposes. A large quantity is annually used in Chicago. The value of the output in 1895 fell quite considerably below that of 1894. The figures for 1894 and 1895 were respectively \$2,555,952 and \$1,687,662. The only reason apparent for the decline is the usual one—financial depression, which operated to lower the prices and to restrict output. Some of the larger operators report that the outlook for 1896 is much better.

Incidental to the digging of the great Chicago drainage canal, enormous quantities of limestone have been blasted out by violent explosives, so that while the stone is too much shattered to be of value for building, it is nevertheless applicable to roadmaking, and it will all probably be used in time for this purpose. At present the stone removed in excavating the canal is piled in enormous heaps along the edges of the canal.

Indiana.—Much interest attaches to the limestone output of Indiana on account of the beauty of the Silurian stone for use in the finest buildings. The Bedford Silurian stone has a national reputation as an ornamental building stone, and it is also prized for its adaptability to ornamental carving and monumental work. In spite of hard times, the output increased from a valuation of \$1,203,108 in 1894 to \$1,658,976 in 1895. In 1891 the output was valued at more than \$2,000,000. The latter part of 1895 showed much improvement over the earlier part of the year, and for this reason the producers anticipate much better business in 1896.

Slow collections marked the course of business throughout the year. As was the case in many States, small producers in considerable number shut down altogether, but they will probably resume business again when conditions are more favorable. Prices declined somewhat, and this fact, of course, made it necessary to handle much larger quantities of stone to bring up the valuation to its present amount.

Iowa.—The value of the limestone output in Iowa fell off from \$616,630 in 1894 to \$449,501 in 1895. While this decrease is quite con-

siderable, it is fully accounted for by the strained financial conditions which were apparently keenly felt throughout the State. The resources of Iowa in limestone are undoubtedly large and important, and as developments go on they will be more and more a feature in the annual products from the State. Some of this limestone quite closely approaches the crystalline condition characteristic of marble and, indeed, some of it is used for ornamental work as marble, and with good effect. About one-third of the output is burned into lime, but the prime importance of the stone lies in its adaptability for building and ornamental uses. The industry is widespread and the output comes from a large number of comparatively small producers rather than from a few operating upon a large scale, thus making the production of stone a matter of importance to the masses of the people.

Kansas.—Most of the output in Kansas is devoted to building purposes, and of that a considerable amount goes into bridge work. Quite an increase in output was realized in 1895, so that the entire yield was valued at \$316,688.

Kentucky.—Some improvement in the industry is apparent for 1895, namely, from \$113,934 in 1894 to \$154,130 in 1895, but the total still falls somewhat below the output of former years. Much of the limestone of Kentucky is hydraulic, and this is treated of in this report in the article on cement. Kentucky oolite is well known for its beauty as a building and ornamental stone.

Maine.—The limestone of Maine is almost entirely burned into lime, which enters quite largely into the markets of the more important cities on the Atlantic Coast, particularly New York. The output of 1895 was valued at \$700,000, while that of 1894 was \$810,089. In 1890 the output reached the figure \$1,523,500, and in 1892 \$1,600,000, but since the latter year production has decreased, perhaps on account of competition with Canadian lime.

Maryland.—After the publication of the report for 1894 it was found that a number of duplications of figures for output had occurred, making the total much higher than it should have been. The proper total for Maryland in 1894 is \$350,000. Operations in 1895 were curtailed by reason of the general depression in business, so that the total for the year is \$200,000.

Massachusetts.—Limestone production was at a low ebb during 1895. Production fell off from a valuation of \$195,982 in 1894 to \$75,000 in 1895. Abandonment of the business by large numbers is the reason for the decline.

Michigan.—Business improved very considerably in 1895. Producers complain, however, of slow collections for the entire year. Most of the product was used for building and roadmaking. Prospects for 1896 are good.

Minnesota.—The output fell off from \$291,263 in 1894 to \$218,733 in 1895. Most of the product is used for building.

Missouri.—A decided gain was made in the output of the extensive and commercially important quarries of this State. The valuation for 1894 was \$578,802; for 1895 it was \$897,318. Three-fourths of the product is used for building and road construction, and the remainder is burned into lime.

Montana.—The output of limestone in Montana increased from \$92,970 in 1894 to \$95,121 in 1895. Most of the product is used as flux in smelting operations, while the remainder is burned into lime.

New Jersey.—The value of the output in 1895 was \$150,000. This amount is about the average annual output for the State. The usual complaints of poor business were made by many of the producers.

New York.—The limestone industry of New York State is one of much importance because of the wide range of uses made of the stone and the further fact that the stone is of fine quality for all these uses. The value of the total output in 1895 was \$1,043,182. Of this total \$610,206 is the value of lime made, while an amount valued at \$406,991 was devoted to building and roadmaking. In the intelligent selection and application of stone to roadmaking, few States are in advance of New York. The value of the limestone output in 1894 was \$1,378,851. A decrease for 1895 is thus apparent, but it is hardly more than the present condition of finances would naturally produce. Operators speak encouragingly of the prospects for 1896.

Ohio.—The stone industry of Ohio is about equally divided between sandstone and limestone so far as the total value of the output is concerned. The limestone area is a wide one, and the industry is important to the masses of the people, since there is a large number of small concerns which in the aggregate foot up a large output. In addition to these are a few large concerns which annually contribute a considerable addition to the total for the State. The value of the product in 1895 was \$1,568,713; the corresponding figure for 1894 was \$1,733,477. A comparison of these figures shows a falling off in output, which is readily explained by the dullness of trade generally and the slowness of collections throughout the year. Some improvement is noted for the latter part of the year, and this leads naturally to the conclusion that 1896 will show material gains.

Pennsylvania.—The limestone industry of Pennsylvania is the result mainly of a very large number of small operators, although there are besides these a comparatively small number of producers operating upon a large scale. For the output of all kinds of stone the State stands first; there is, in fact, no kind of stone in commercial use which is not produced within its limits. In the production of slate it stands far in the lead of any other, as has already been stated in the slate report of the present article. While, with the exception of slate, there are no individual localities which stand out prominently for their stone output in the sense that makes Quincy, Mass., or Westerly, R. I., remarkable, it is at the same time true that there are a great many

places at which a moderate amount of commercially valuable stone is produced regularly and uninterruptedly year after year. The hard times have, of course, affected all industries in Pennsylvania in much the same way as other States, but in spite of such conditions the value of the limestone output amounts in 1895 to \$3,055,913. A little more than half of this is the value of lime, half a million dollars worth of which was used for blast-furnace flux, while the remainder is used for ordinary building and roadmaking. A large quantity of the lime made is used for agricultural purposes. Considerably more attention is being given at present to the improvement of roads than formerly, and this accounts for no small part of the increase in output for the past two years.

Tennessee.—The value of the limestone output for 1895 was \$156,898. Somewhat more than half of this figure represents the value of lime made.

Texas.—The value of the limestone product in 1895 was \$62,526. The output was greater than that of 1894.

Vermont.—Limestone production in 1895 did not come up to the total for 1894. In the last named year the output was valued at \$408,810, while the total for 1895 amounted to \$300,000. More than half of this value is that of the lime produced.

Virginia.—The product fell somewhat behind in 1895, being valued at \$268,892; the difference, however, as will be seen by referring to the table of production, is not great.

Wisconsin.—The limestone output of this State is an important item. The annual product has been very steady for the past five years, and has ranged from \$543,000 to \$814,000. More than half the value of the entire product is the value of lime made.

THE LIMESTONE QUARRIES OF EASTERN NEW YORK, WESTERN VERMONT, MASSACHUSETTS, AND CONNECTICUT.

By HEINRICH RIES.¹

There are in the region given above several well-marked limestone belts presenting sufficiently distinctive characters to permit the following classifications:

1. The dolomite area of Westchester and Dutchess counties, N. Y., containing the quarries at Sing Sing, Tuckahoe, Pleasantville, and Patterson.
2. The Cambrian limestone belt, including the quarries at Newburg and Stoneco, N. Y.
3. The Helderberg limestones, of importance at Rondout, Catskill, Hudson, and South Bethlehem.

¹ These notes are furnished with the kind permission of Mr. F. S. Witherbee, president Troy Steel Company, for whom they were collected.—RIES.

4. The Trenton limestones, with quarries at Glens Falls, Hoosick Falls, and Whitehall, N. Y., and Fairhaven, Vt.

5. The Stockbridge limestones, quarried at various points between Canaan, Conn., and North Pownal, Vt.

6. The Vermont marble belt, extending from Dorset to Middlebury.

7. The Black River limestone, quarried at Leicester Junction, Winooski, Swanton, and Highgate Springs, Vt.

In these seven areas there are about 50 quarries, most of which are in operation. This does not include small openings which were operated a short time and then abandoned.

1. THE DOLOMITE AREA OF WESTCHESTER AND DUTCHESS COUNTIES, N. Y.

Tuckahoe, Westchester County, N. Y.—The quarries at Tuckahoe are the most extensive, and are all opened in the same stratum, which extends northeast and southwest and has a thickness of about 40 feet. The three firms are O'Connell & Hillery, Norcross Bros., and the Tuckahoe Marble Company, also known as J. Sinclair & Co. The rock in all is a magnesian limestone of granular character and moderately hard. Its character is quite constant. The bed dips steeply to the west and is bounded by beds of impure micaceous dolomite. O'Connell & Hillery's is the most southern quarry, and is but a short distance east of the Tuckahoe Railroad station. The rock is used chiefly for making lime, but recently the manufacture of marble dust has been commenced. No special methods are used in quarrying, but a wire-rope tram proves an economical means of transporting the rock to the kilns. The rock from this quarry shows the following composition:

Analysis of limestone from O'Connell & Hillery's quarry, Tuckahoe, N. Y.

	Per cent.
CaCO ₃	70.10
MgCO ₃	25.40
Insoluble	2.40
Total	97.90

The Tuckahoe Marble Company's quarry is three-fourths of a mile to the north. The quarry is about 400 feet long and 40 feet deep. The output is used for building purposes. Norcross Bros.' quarry is about one-fourth of a mile north of the preceding. The rock is very similar in character, but the quarry is smaller. The marble is sawed and dressed at the works. Two analyses have been made of this stone, No. 1 by Professor Egleston and No. 2 by the writer.

Analyses of limestone from the Norcross Brothers quarry, Tuckahoe, N. Y.

	No. 1.	No. 2.
	<i>Per cent.</i>	<i>Per cent.</i>
Insoluble.....		1.33
Lime.....	30.16	30.68
Magnesia.....	21.25	20.71
Carbondioxide.....	47.30	46.66
Ferrie oxide.....	.21	.21
Water.....	.02	.16
Silica.....	.24	
Alumina.....	.19	
Loss.....	.63	
Total.....	100	99.75

Sing Sing, Westchester County, N. Y.—There are two quarries at Sing Sing, one belonging to Mr. Henry Marks, the other to the Ossinning Lime Company. Both are on the east slope of the hill overlooking the river at the south end of the town. In Marks's quarry the rock is a granular, fine-grained limestone, dipping steeply to the west, and is apt to vary somewhat in composition. Its chief use for many years has been as a flux for the New Jersey Zinc and Iron Company, of Newark, N. J., whose chemist has kindly supplied the following analysis:

Analyses of limestone from Sing Sing, N. Y.

	<i>Per cent.</i>	<i>Per cent.</i>
Silica.....	6.77	5.94
Iron and alumina.....	1.81	2.82
Lime.....	45.02	29.05
Magnesia.....	3.61	20.05
Phosphorus.....	.027	

The rock is carted down to the river for shipment.

The Ossinning Lime Company's rock is similar to Marks's in the upper portion of the quarry, but in the lower portion it is white and coarsely crystalline, resembling the Pleasantville rock. This portion is used for making an excellent grade of lime. The rock is carried to the kilns at the river on a narrow-gauge tramroad.

Pleasantville, Westchester County, N. Y.—The Pleasantville quarry is also operated by O'Connell & Hillery, successors to the Cornell Lime Company. It is the largest quarry in the county. The limestone is remarkably uniform in its character, and on account of its white color and coarsely crystalline character has been called "Snowflake marble."

Nearly the entire output of the quarry is used for marble dust. The composition of the limestone, as given in the Sixteenth Annual Report of the United States Geological Survey, Part III, page 468, is as follows:

Analysis of Pleasantville (N. Y.) marble.

	Per cent.
Calcium carbonate.....	54.62
Magnesium carbonate	45.04
Iron carbonate .....	.16
Alumina .....	.07
Silica .....	.10
Total	99.99

Small quarries have been opened up at Scarsdale, Westchester County, and Patterson, Putnam County, but they are no longer in operation.

2. THE CAMBRIAN LIMESTONE BELT.

Newburg, Orange County, N. Y.—There is a small quarry on the southwestern edge of Newburg, Orange County, operated by Miller Brothers. The rock is a blue, finely crystalline limestone with a marked bedding. The limestone is crushed and screened and then used for macadam roads in the vicinity.

Stoneco, Dutchess County, N. Y.—One of the largest quarries in the State is at this locality, which is 2 miles above New Hamburg, on the Hudson River. It is owned and operated by the Hudson River Stone Company. The rock is a hard, fine-grained, siliceous limestone, and the quarry has a working face about 500 feet long and 20 to 40 feet high. Tracks are laid from the dumping chute along the New York Central Railroad track to many points of the quarry face, thus giving a large working capacity. The limestone is crushed to many sizes and used for railroad ballast or road material. The rock powder is sold in large quantities to the asphalt paving companies. The plant is situated between the river and the railroad track and affords excellent facilities for shipment.

3. THE HELDERBERG LIMESTONE QUARRIES.

The Scutella limestone is of importance, and is worked by Benjamin Turner and the Newark Cement Company, at Rondout; by Mr. George Holdredge, at Catskill, and by Mr. F. W. Jones, at Hudson. At South Bethlehem the Tentaculite limestone is of importance, and is there quarried by Mr. P. Callanan.

Rondout, Ulster County, N. Y.—Mr. Turner's quarry has been but recently opened. It is a small opening on the hillside about 200 feet above Rondout Creek, and between Rondout and Eddyville. The stone is sent down a chute to the creek, where it is loaded onto barges. It closely resembles in its character the limestone in the Newark Cement Company's quarry. This latter is a coarsely crystalline, fossiliferous limestone of moderately pure and rather uniform character. The bed is about 40 feet thick and dips rather steeply to the northwest, having a shaly limestone as a hanging wall and a cherty lime rock as a foot wall. The stone has been worked to a depth of nearly 100 feet from the surface and for a distance of about 700 feet north and south along the strike. The track, which comes from the docks about a mile distant, enters the cut through a tunnel and branches, the two arms going to the working face at either end of the quarry. The rock burns to a brown lumpy lime, and, according to Prof. F. L. Nason, 2,000 tons are quarried and sent to Newark, N. J., every year for lime manufacture.¹

Catskill, Greene County, N. Y.—The Empire Stone Quarry at this point is owned and operated by Mr. George Holdredge. It lies on the ridge a mile west of the town. The rock is similar in every respect to that at Rondout, but the beds dip less steeply to the northwest. There is a capping of less massive rock, which varies in thickness from 2 to 8 feet, being heaviest at the south end of the quarry. Under this, two benches, each about 4 feet high, have been opened up. In former years the rock is said to have been used for flux, but its only use now is for dimension blocks. The nearest shipping points—Catskill Creek and the West Shore Railroad—are both about a mile distant, and if the rock is to be shipped it is carted down the hill to these points. The consumption of the stone is mostly local, however.

Hudson, Columbia County, N. Y.—Becrafts Mountain, near Hudson, is capped with a considerable bed of the Scutella limestone. Several quarries have been opened up in it, all owned and operated by Mr. F. W. Jones. The stone is like that at the preceding localities, and needs no special description. Some dimension blocks have been taken out from time to time, and the quarrying of the rock for marble was attempted, but it is rather soft for this purpose. At present the quarries are operated chiefly to supply flux to the Burden Iron Works at Troy, N. Y. The rock has to be hauled 600 to 1,000 feet to the switch from the New York Central Railroad. The following two analyses, which were kindly furnished by Mr. Jones, may be taken as representative of the Scutella limestone at the various localities in the Hudson Valley. No. 1 is by Professor Egleston, and No. 2 is by the chemist of the Burden Iron Works.

¹ Twelfth Ann. Rept. N. Y. State Geologist.

Analyses of Scutella limestone, Hudson Valley, New York.

	No. 1.	No. 2.
	<i>Per cent.</i>	<i>Per cent.</i>
Lime.....	51.40	
Calcium carbonate.....		91.70
Carbon dioxide.....	41.191	
Magnesium carbonate.....		3.51
Magnesia.....	2.233	
Alumina.....	.635	1.01
Ferric oxide.....	1.819	.55
Silica.....	1.842	1.89
Sulphur dioxide.....	.145	.049
Phosphorus.....	.149	.022
Water.....	.271	
Total.....	99.683	98.731

South Bethlehem, Albany County, N. Y.—The Tentaculite limestone is of importance at this locality as furnishing an excellent road material. Mr. P. Callanan's quarry has a working face 500 feet long and 90 feet high, and the stone is fine-grained, massive, and tough. The quarried material is carried by cars to the crusher, where it is broken, screened, and then shipped. The powdered rock is used for asphalt pavements.¹

4. THE TRENTON LIMESTONE AREA.

Glens Falls, Warren County, N. Y.—The quarries are well known, and have been in operation for a number of years. They are all situated along the river on the edge of the town, and in common show the following section, beginning at the top:

	Feet.
Thin-bedded, impure black limestone.....	12-15
Black limestone.....	2- 3
Fine-grained black crystalline limestone.....	15
Total.....	33

The upper bed is used for building material, and is now also used in the manufacture of Portland cement. The lower 15 feet are used for making a good grade of lime. In former years much of it was polished, and made a pretty black marble.

The companies manufacturing lime at Glens Falls are the Glens Falls Lime Company, the Sherman Lime Company, and the Jointa Lime Company. The lime made is rather soft and is said to airslake quickly. It has to be hauled about a mile for shipment. The Portland cement

¹ Prof. F. L. Nason, Thirteenth Ann. Rept. N. Y. State Geologist, p. 280.

is made from a mixture of the upper black limestone and the Champlain clays found overlying it. The composition of the Glens Falls lime, as given on the business card of the associated companies and analyzed by Mr. J. H. Appleton, is as follows:

Analyses of Glens Falls (N. Y.) lime.

	No. 1.	No. 2.
	<i>Per cent.</i>	<i>Per cent.</i>
Lime.....	96.46	97.60
Magnesia.....	.64	.36
Iron and alumina.....	1.70	.80
Water and carbon dioxide.....	1.20	1.24
Total.....	100	100

Analysis of limestone rock, Glens Falls, N. Y.

	<i>Per cent.</i>
Calcium carbonate.....	94.98
Iron and alumina.....	1.26
Silica.....	2.13
Magnesia.....	Trace.
Total.....	98.37

Smiths Basin, Washington County, N. Y.—The Keenan Lime Company has several quarries in the ridge to the east of the railroad. The rock is mostly dark-gray to bluish-black, fine-grained, and moderately hard. Its massive character has been somewhat destroyed by the shearing and folding to which the rock has been subjected. The beds have a general dip to the southeast, and the upper ones in each quarry are more or less shaly and siliceous. The company is now working a quarry at the south end of the ridge and carting the rock to the kilns about an eighth of a mile distant. The quarries in the north end of the ridge have been chiefly used as a source of flux for Troy, but are temporarily inactive. This lime has been analyzed, as follows, by Prof. J. H. Appleton:

Analysis of lime from Smiths Basin, N. Y.

	<i>Per cent.</i>
Moisture and carbon dioxide.....	2.08
Insoluble.....	1.06
Iron and alumina.....	.58
Lime.....	95.50
Magnesia.....	Trace.
Total.....	99.22

Two additional analyses, No. 1 of the limestone and No. 2 of the lime, which were made at the Albany and Rensselaer Iron and Steel Company's laboratory in Troy, showed—

Analyses of limestone and lime from Smith's Basin, New York.

	No. 1.	No. 2.
	<i>Per cent.</i>	<i>Per cent.</i>
Lime	54.15	94.07
Magnesia .....	.39	.79
Carbon dioxide	42.95	3.04
Alumina .....	.08	.20
Ferrie oxide .....	.02	.07
Silica .....	.97	1.93
Phosphoric acid .....	.01	.01
Water	1.47	.....
Organic matter .....	.06	.....
Total	100.10	100.11

The limestone is burned in continuous acting kilns.

Fairhaven, Vt.—J. F. Harris's quarry is situated adjoining the Delaware and Hudson Railroad, between Whitehall and Fairhaven. The quarry was at one time operated by the Arana Marble Company. The material they sought to use was a reddish-brown variegated limestone found chiefly in the southwestern end of the quarry and called "onyx." The limestone is not sufficiently massive and homogeneous, however, to permit the extraction of blocks or slabs of moderate size. The chief use now is for flux. The rock in most parts of the quarry is quite low in silica, according to figures furnished by the owner, and its proximity to the track renders shipping easy.

Hoosick Falls, Rensselaer County, N. Y.—Three small quarries have been opened on the hillside to the west of the town. They are owned and operated by Messrs. John Dolin, Con Caffrey, and M. Parsons, to supply a local and intermittent demand. The rock consists of irregular beds of slaty, bluish black limestone, and a lighter-colored, fine-grained limestone. It is very irregularly bedded and its chief application is for road metal and foundations or stone walls.

5. THE STOCKBRIDGE LIMESTONE BELT.

Around Canaan, Conn., this formation is a magnesian limestone and is important as a source of lime, but farther north, in Massachusetts, it extends from West Stockbridge to North Pownal, Vt., with quite

uniform character, being quite rich in lime and having usually a low percentage of silica.

Canaan, Conn.—Four firms operate lime quarries, all of which are to the east of the village. They are Chas. Barnes Sons, Pierce & Freeman, the Anchor Lime Company, and Camp & Eddy. The rock is the same character in all of them, being a rather coarse-grained yellowish or bluish white (depending on its depth from the surface) magnesian limestone. Barnes's quarry is half a mile from the railroad, Pierce & Freeman's is connected with a switch from the New England Railroad, and the quarry proper is approached through a cut several hundred feet long, in which there is a tramroad for hauling the stone to the kilns. At the Anchor Lime Company's quarry the rock is raised to the top of the kiln by means of a wire-rope tram. Petroleum is used for burning the limestone. The kiln is continuous in its action, and there is one burner at the base of the kiln. Its operation has been successful thus far.

West Stockbridge, Berkshire County, Mass.—The only firm at this locality is Truesdell & Furey, who have two quarries, one at the station and the other about 500 feet west of it. In the first the rock is mostly a gray, moderately fine-grained limestone, with occasional white bands. The quarry is about 100 feet long and 40 feet deep. The stone is chiefly used for lime, but a neighboring blast furnace consumes a small quantity. In the larger quarry the limestone has a similar character, but is somewhat finer grained. Both give a good grade of lime. An analysis of the lime from the smaller quarry gave lime, 91.12 per cent; magnesia, 3.81 per cent.

The Gross Brothers, of Lee, Mass., are opening a marble quarry about 2 miles southeast of Stockbridge, along the railroad, but at the time of the writer's visit, in January, 1896, the weathered rock had not yet been entirely removed.

Lee, Berkshire County, Mass.—The marble quarries half a mile south of the station, and owned and operated by Gross Brothers, have been worked for a number of years. The rock is a soft, rather fine-grained white dolomite, with streaks of gray. The main quarry is a rectangular opening about 40 feet deep. The stone is quarried with gadding machines and its chief use is for floor tiles and headstones, large quantities of the latter having been made for the Government. In addition some lime is made. It is burned in a continuous-acting kiln, and gives a lumpy, slow-slaking lime.

New Lenox, Berkshire County, Mass.—Hutchison Brothers have two quarries about 3 miles west of the depot. The one supplies a coarse-grained, hard, gray limestone, which in certain portions of the quarry may contain micaceous streaks, while the other supplies a soft, white limerock. The rock is hauled to the kilns, which are near the depot.

An analysis of the lime, made by Mr. W. M. Habirshaw, showed—

Analysis of lime from New Lenox, Mass.

	Per cent.
Lime.....	95.66
Magnesia.....	.76
Iron and alumina.....	.17
Silica.....	1.14
Carbon dioxide.....	None.
Loss by ignition.....	3
Total.....	100.73

Farnham Station, Berkshire County, Mass.—The Farnham Lime Company's quarry is $1\frac{3}{4}$ miles from the depot, on the opposite side of the mountain. The rock is a gray granular limestone. That at the north end of the quarry is much lighter colored and makes a softer lime. The working face is about 40 feet high and 200 feet long. After mining, the limestone is hauled by teams to the kilns at the station. Each team hauls five loads of 6,000 pounds per day. Continuous kilns are used.

Cheshire, Berkshire County, Mass.—Three-quarters of a mile north of the preceding quarry is that of the Cheshire Lime Manufacturing Company. The rock is in every respect like Farnham's. An analysis of the limestone by Davenport & Williams gave:

Analysis of limestone from Cheshire, Mass.

	Per cent.
Silica.....	0.31
Iron and alumina.....	.23
Calcium carbonate.....	98.80
Magnesium carbonate.....	.37
Organic matter.....	.35
Total.....	100.06

Renfrew, Berkshire County.—The Stockbridge limestone, which is well developed at this locality, forms a cliff 90 feet high on the hillside overlooking the town. The Adams Marble Company, which has recently begun operations, has made two small openings at the summit of the cliff. The rock is a rather soft, white, saccharoidal limestone, and after quarrying is lowered to the foot of the ledge, where it is sawed and dressed. The following is the composition, as determined by Prof. E. E. Olcott.

Composition of limestone from Renfrew, Mass.

	Per cent.
Calcium carbonate	99.60
Magnesium carbonate .....	.49
Iron and alumina .....	.55
Silica .....	.63
Total	101.27

The nearest shipping point for this material is the Renfrew station of the Fitchburg Railroad, about three-quarters of a mile distant. The company proposes laying a tramroad down the hill. Messrs. J. Follet & Son's quarry is several hundred feet farther down the slope toward the track. It has been in operation a number of years and has a working face about 50 feet high and 400 feet long. The stone is similar to that mentioned from the preceding quarry, and is generally white, although local bands of carbonaceous matter are not uncommon. The limestone in the upper portion of the quarry is somewhat softer. A tramroad about 500 feet long transports the rocks to the kilns. These are of the old-fashioned type, the rock being too soft to stand the rubbing action of a continuous kiln. The lime is very white. The two following analyses, No. 1 by P. S. Burns and No. 2 by H. P. Eddy, show its composition:

Analyses of lime from Renfrew, Mass.

	No. 1.	No. 2.
	<i>Per cent.</i>	<i>Per cent.</i>
Lime	98.13	96.63
Magnesia .....	.42	.88
Silica .....	.36	.81
Alumina .....	.15	.47
Ferric oxide		
Carbon dioxide .....	.60	.12
Water .....	.20	
Total	99.86	98.91

A third but smaller quarry in this same rock has been recently opened by the Farnham Lime Manufacturing Company along the road halfway between Renfrew and North Adams.

North Adams, Berkshire County, Mass.—Mr. G. Rich is operating a quarry about $1\frac{1}{2}$ miles north of the depot, at a locality known as the Natural Bridge. The stone is similar in composition to that at Renfrew, but contains a larger proportion of carbonaceous matter, 25 to 30 per cent of the rock being a dark gray. There is also a vein of quartz

several feet wide down the center of the quarry face. The rock is mostly used for making marble dust.

North Pownal, Bennington County, Vt.—The Stockbridge limestone forms a large outcrop northwest of the station, but is of quite different character from the beds in Berkshire County. Here it is a hard, gray, fine-grained, massive limestone of moderately homogeneous character. It is well exposed in Follet Brothers' quarry, and shows a passage upward into a siliceous limestone, of which there is about 6 feet. This has to be stripped in quarrying. The North Pownal stone makes a harder lime than that quarried at Renfrew, but it is of a grayish shade. A sample of the lime analyzed by R. Schuppaus gave—

Analysis of lime from North Pownal, Vt.

	Per cent.
Lime.....	98.14
Magnesia.....	1.40
Silica.....	.27
Alumina.....	.11
Ferrie oxide.....	.08
Total.....	100

The Burden Iron Works, of Troy, have a quarry adjoining Follet's, but it is inactive at present.

6. VERMONT MARBLE BELT.

Most of the quarries in this belt are between Rutland and Middlebury, but a number of openings have been made on Dorset Mountain.

East Dorset, Vt.—Friedley's quarry is a half mile north of the depot and 1,000 feet above the railroad track. The marble works are by the track, and a gravity plane over a mile long brings down the marble. The quarry face is 90 feet in height, and the upper 40 feet of bad rock has to be stripped or the good stone gained by chamber workings. The latter method is usually resorted to, and several large caverns in the hillside indicate the amount of stone that has been removed. The marble is a bluish white, good grade of stone. Most of it is shipped to Philadelphia for building purposes. Several dikes penetrate the marble in the old workings and are known by the workmen as "ore bodies."

The Dorset Marble Company has its works at East Dorset, but the quarries are on Dorset Mountain, near Manchester. The marble is white, with occasional gray mottling. This company has but recently commenced operations.

West Rutland, Rutland County, Vt.—The quarries are a short distance northwest of the railroad station, the largest being those of the

Vermont Marble Company. They have made a number of openings following downward on the dip, and so much of the material between them has been removed that they now practically form one enormous quarry extending along the strike for nearly 700 feet and down on the dip for 280 feet. At this depth the bed begins to turn and the dip decreases. The marble bed has a thickness of 150 feet at the top, but narrows to 75 feet at the bottom. It is divisible, however, into well-marked layers, which, though varying somewhat in thickness in different parts of the quarry, retain their distinctive characters. The following section of the quarry from hanging wall to foot wall was kindly given me by Mr. Howard, the superintendent:

Section in marble quarry at West Rutland, Vt.

	Feet.
Top, blue.....	} 20
Top, white.....	
Green stripe.....	2
Thin statuary.....	3-6
Striped monument.....	2-6
Statuary.....	3-6
Average layer, half green, half white.....	4
Brocadilla.....	2, 6-8
Crinkly (siliceous; half light, half dark).....	2-3
Light, Smith } Mottled, Smith }	} Light, nearly pure white..... 4-6
Jackman layer (6 in. green striped, 2 ft. 6 in. white)...	
Sherman (half dark green, half white).....	3-6
Italian blue.....	15-20
Mottled limestone, of no value.....	

The green color is due to chloritic mica. There is necessarily a large amount of waste material, and Mr. Howard estimates that the refuse from the shops is about 250 tons per week. The chief use of the marble is for monuments and tombstones. The rock is cut out with channeling machines and the blocks are hoisted out of the quarry with large derricks. When the blocks have to be brought from the lower portion of the quarry, they are hoisted successively by several derricks located at different levels. At present the company is following the bed downward on the dip, and also running a level along the strike to the south about 50 feet below the surface. After this has been carried a sufficient distance, they will begin to sink on it. Electricity is used to light the workings. The stone is sawed, cut, and polished in the shops near the quarry. The following analyses of the West Rutland marble were furnished by the Vermont Marble Company.

Analyses of West Rutland (Vt.) marble.

	Blue.	White.	Statuary.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Insoluble.....	.28	.40	.70
Carbon dioxide.....	43.82	43.66	43.65
Lime.....	55.27	55.26	55.50
Magnesia.....	.28	.15	Trace.
Iron and alumina.....	.30	.20	.15
Total.....	99.95	99.67	100

It is interesting to note the slight difference that there is between the blue and the white. The following two additional analyses were made by Mr. J. N. Harris:

Additional analyses of West Rutland (Vt.) marble.

	Blue.	White.
	<i>Per cent.</i>	<i>Per cent.</i>
Silicate of alumina.....	.22	.62
Carbon dioxide.....	44	43.80
Lime.....	55.15	54.95
Magnesia.....	.57	.59
Organic matter.....	.05	.....
Total.....	99.99	99.96

The white and white-striped layers seem to disappear to the north, for at the quarries of the Albertson Company and of the True Blue Marble Company, three-quarters of a mile to the north, only the blue marble is found. These quarries are from 50 to 75 feet deep. The marble is a fine-grained, granular, bluish stone, and is used for monumental and structural purposes. It is sawed at the quarry. Some years ago the True Blue Marble Company attempted the manufacture of lime, but it was abandoned. All the West Rutland quarries are connected by means of a switch with the Delaware and Hudson Railroad.

Proctor, Rutland County, Vt.—The Vermont Marble Company's works are next to the railroad station, and the main quarry is a few hundred feet to the west. The opening is 200 by 125 feet and 140 feet deep. The layers are vertical for about two-thirds of this depth, and then spread out to the northeast and southwest. The best beds seem to dip to the southwest, and the quarrying at the bottom of the pit is trending in that direction. While the different layers are fairly well marked, they are not so persistent in their character as those in the West Rutland quarry. The workable thickness of the bed at the top

is 125 feet, but surface indications to the north of the main quarry opening point to a pinching out of the marble bed. No statuary marble or blue marble is found in this quarry. The layers in the main quarry are enumerated as follows, from the southwest to the northeast: xa, xb, xc, etc., to xy, xz, Z, Y, X, etc., to C, B, A, A1, A2, A3, A4, etc.

Most of the blue marble dressed at Proctor comes from the "Mountain Dark" quarry, 2 miles from Proctor, and from the quarry at Pittsford. The latter is known as the "Pittsford Blue." The marble at Proctor is quarried by channeling machines operated by steam power, but the company is now introducing both channeling machines and pumps to be operated by electricity. There is a fall of 125 feet of water in the ravine behind the shops, which, diverted into turbine wheels, supplies abundant power to operate the sawing, polishing, and other dressing machinery, as well as the dynamo which operates the lights, and will also operate the machinery in the quarry. Altogether this is probably one of the best-equipped quarrying plants in the country. The sand for the saws is obtained from a neighboring hill and is brought over on a wire-rope tramway. Most of the marble is converted into monuments and tombstones, but the company has recently undertaken the manufacture of thin marble slabs for electrical switchboards. The preparation of these requires considerable care, as they have to be exact in their dimensions. An analysis of the Proctor marble furnished by the company showed—

Analysis of marble at Proctor, Vt.

	Per cent.
Insoluble.....	0.35
Carbon dioxide.....	44.02
Lime.....	55.00
Magnesia.....	.25
Iron and alumina.....	.20
Total.....	99.82

The two following analyses of Proctor marble are given in the Mineral Resources for 1889:

Additional analyses of marble from Proctor, Vt.

	Light.	Dark.
	<i>Per cent.</i>	<i>Per cent.</i>
Calcium carbonate.....	96.30	98.37
Magnesium carbonate.....	3.06	.79
Iron carbonate.....	.053	.034
Insoluble.....	.63	.63
Organic matter.....	.004	.08
Manganese oxide.....		.005
Total.....	100.047	99.909

Brandon, Rutland County, Vt.—The Brandon Italian Marble Company has a quarry in operation three-quarters of a mile southwest of the station. It is about 50 by 100 feet and 50 feet deep. The marble is mostly white or creamy white, with occasional gray mottlings, and dresses easily. There is one streak 4 feet wide in the center of the quarry which is said to be too hard to work, and has therefore been discarded. The marble is sawed and dressed at the quarry. A number of small quarries have been opened between Middlebury and Rutland, but most of them are inactive.

7. THE BLACK RIVER LIMESTONE BELT.

The quarries in this rock are at Leicester Junction, Winooski, Swanton, and Highgate Springs.

Leicester Junction, Addison County, Vt.—The Brandon Lime and Marble Company has been in operation here for a number of years. The quarry is about 500 feet west of the station. The workable bed, which is about 40 feet thick, dips to the east between two beds of impure limestone, and the material used is a hard, finely crystalline, rather brittle, gray limestone. The bed has been followed southward along the strike, so that now the quarry consists of a cut 25 to 30 feet deep and several hundred feet long. As the width of the cut is not over 30 feet, the capacity of the quarry is limited. The rock is burned in continuous kilns, and gives a lumpy lime. The kilns are arranged with special grates, so that any fine lime is separated. This amounts to about 2 barrels in twenty-four hours. The following analysis of the lime was made by C. T. Lee:

Analysis of lime from Leicester Junction, Vt.

	Per cent.
Lime.....	98.262
Calcium carbonate.....	.409
Magnesia.....	.299
Silica.....	.383
Ferric oxide.....	.647
Total.....	100

The Leicester Marble and Lime Company's quarry is half a mile south of the station. The rock is similar to that in the other quarry, but is more massive, slightly darker, and often contains streaks of calcite. These streaked portions are usually discarded, as they make a gray lime.

Winooski, Chittenden County, Vt.—Two miles north of Winooski is a lime quarry belonging to S. H. Weston. It adjoins the Central Vermont Railroad track. The rock is a uniform, finely crystalline, gray limestone, which is at times siliceous. Most of the stone is burned in

the kiln at the quarry, but some is shipped to the steel works at Nashua, N. H.

Swanton, Franklin County, Vt.—The same limestone formation quarried at Winooski is mined $1\frac{1}{2}$ miles from Swanton by J. P. Rich. The quarry is of considerable size, but the character of the rock is extremely uniform. It is massive, hard, and brittle. A switch connects it with the Central Vermont Railroad. The following three analyses show the composition of the lime, No. 1 being by C. Sharpless, No. 2 by F. C. Robinson, and No. 3 by J. R. Chilton:

Analyses of lime made at Swanton, Vt.

	No. 1.	No. 2.	No. 3.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Lime.....	98.47	99.29	98.84
Magnesia	1.12	.46	.12
Ferrie oxide.....	Trace.	.12	.....
Silica.....	Trace.	.10	.02
Carbon dioxide.....	.45	.....	1.02
Alumina and manganese.....	.....	Trace.	.....
Total	100.04	99.97	100

Highgate Springs, Franklin County, Vt.—Mr. L. H. Felton's quarry at this locality is in the same limestone, and is so similar to Rich's that no further description of it is required. The quarry is a large shallow opening about 200 by 75 feet. It is connected with the kilns by a narrow-gauge tramroad. An analysis of the stone by Prof. S. P. Sharpless gave:

Analysis of limestone from Highgate Springs, Vt.

	<i>Per cent.</i>
Lime.....	55.83
Magnesia	Trace.
Iron and alumina.....	.10
Silica .....	.40
Carbon dioxide.....	43.65
Total	99.98

The lime contained 99.80 per cent of calcium oxide. The kilns are connected with the railroad by means of a switch, and they are also located sufficiently close to Lake Champlain to permit shipment by water.