STONE.

By William C. Day. (a)

General condition.—In view of the universal financial depression that prevailed during a part of the year 1893, it is, of course, unnecessary to state that the stone industry underwent its full measure of suffering. In the New England States production in 1892 had suffered on account of serious labor disturbances, so that many contracts which should have been fulfilled in that year were held over until the following year. That was one of the causes which made production unusually brisk in the early part of 1893, i. e., until about the 1st of June, and it may be emphatically asserted that, had these conditions been maintained throughout the year, 1893 would have gone far ahead of any previous year in the amount of product, as well as in general prosperity for both employers and employés.

Answers to statistical inquiries addressed to stone producers have been carefully prepared and are exceptionally full, and they show, for the great majority of the States, a heavy falling off in product, due in all cases to the same cause—financial stringency.

An increase in the total value will be noticed in the tables of production for some States. It will, however, be also noticed that such States include those in which the stone industry is comparatively new and which have not yielded a large amount of product in any year. Some individual firms have reported quite decided improvements in business for the year, but in every case the reason for such increased prosperity has been exceptional, and in many cases consists in the fact that the stone has been supplied for public works, such as Government buildings, harbor and coast improvements, or State and municipal building, paving, etc. In the South, even public improvements, such as paving in cities, etc., were curtailed or entirely interrupted because of the impossibility of selling bonds for the purpose of securing cash for the maintenance of such work. Thus, for instance, the granite block paving industry of the South suffered to the extent made manifest in the tables of production in this report.

In view of the depressed condition of the stone industry, it might naturally be supposed that the number of operators in 1893 is much less than for previous years. This supposition applied to the latter half

a The very efficient aid furnished by Mr. Wm. A. Raborg, of the U. S. Geological Survey, in the preparation of this report, is hereby gratefully acknowledged.—W. C. D.

of 1893 is quite true. A great many operators went out of business after June or July, but a large proportion had done very well until that time, so that when the number of operators for the year as a whole is considered it makes a good showing; but at the same time, when we consider the future, it is very evident that the year 1894 will run behind even still more than 1893, unless there is a revival of the general conditions of trade greater than it is reasonable to expect.

Production of stone, by kinds, in 1892 and 1893.

Kinds.	1892.	1893.
Granite	$12,627,000	88,808,934
Sandstone	8,265,500	5,195,151
Limestone	18,392,000	13,947,223
Marble	3,705,000	2,411,092
Slate	4,117,125	2,523,173
Bluestone	1,600,000	1,000,000
Total	48,706,625	33,885,573

This table shows a decrease of $14,841,052, or 30.5 per cent. For the individual kinds of stone the percentage decreases are as follows: Granite, 30.1; sandstone, 37.1; limestone, 24.3; marble, 34.9; slate, 38.7; bluestone, 37.5.

The limestone industry has fallen off least. This is easily understood when we consider the essential uses to which limestone is put, such as the manufacture of lime, both for building and agricultural purposes, building, road-making, and blast-furnace flux. The falling off in the other kinds of stone shows no great percentage of variation.

Among the trade developments which may be considered of general interest to the stone producers was the movement towards a change in the methods of measuring stone. This was brought forward significantly by Mr. Sylvester Marshall, president of the National Association of Quarry Owners, at the Indianapolis meeting of the Ohio Valley Cut Stone Contractors' and Quarrymen's Association. He spoke of the confusion of the units of measurement as a disadvantage to the stone producers, second only to lack of practical experience in the stone business among the factors which go to make stone production unprofitable. A uniform standard of measurement should be adopted. The prevailing sentiment among the quarrymen of the country seems to favor selling stone by weight and discarding the old form of selling by the cubic foot, cord, perch, or yard, as being too cumbersome and allowing too many leaks, and especially as the railroads have largely adopted this weight system in transporting stone, as with other merchandise. Mr. Marshall called attention also to such great differences in price, as between 20 cents received at the quarry by a producer of buff Bedford limestone and $1.50 paid at the building in Chicago, where it is used after having passed through too many hands. He insisted that prices should be quoted at the quarry and should be on a uniform standard of measurement by weight.

GRANITE.

The following table shows the production of granite by States in 1893. The total for 1892 was $12,627,000, showing for 1893 a decrease of $3,818,066, or 30.1 per cent. The general reasons for this decline have already been discussed and shown to be the severe financial stringency which began to be felt about June 1.

The product of granite in 1893, by States.

States.	Value.	States.	Value.
Arkansas		New York	$181,449
California	$531,322	North Carolina	122,707
Colorado	77,182	Oregon	11,255
Connecticut	652,459	Pennsylvania	206,493
Delaware	215,964	Rhode Island	509,799
Georgia	476,387	South Carolina	95,443
Maine	1,274,954	South Dakota	27,828
Maryland	260,855	Texas	38,991
Massachusetts	1,631,204	Utah	590
Minnesota	270,296	Vermont	778,459
Missouri	388,803	Virginia	103,703
Montana	1,000	Wisconsin	133,220
New Hampshire	442,424		
New Jersey	373,147	Total	8,808,934
Nevada	3,000		

The following is a consideration of the individual granite-producing States:

Arkansas.—While the granite output in 1892 was valued at $40,000, practically nothing was done in 1893.

The possibilities of successful granite quarrying in the Fourche mountain region are apparently very great.

The Braddock quarry, owned by Mr. James S. Braddock, consists of a 200-foot front, with the possibility of extending this to half a mile. The quarry runs into the side of the mountain, and the depth reached is 10 to 12 feet. The stone, although very hard, is easily quarried on account of its natural joints. Increased capital is needed for successful working.

California.—Granite production in California has fallen off from $1,000,000 in 1892 to $531,222 in 1893. Although the agricultural interests were prosperous, the year has been an exceedingly poor one for the granite industry, some producers pronouncing it the worst in the history of the industry in the State. Prices were low and money hard to get. Many quarries shut down during the year.

The establishments employing convict labor were occupied, as in the past, in the construction of the Folsom dam and canal by the Folsom Water-Power Company.

Colorado.—The value of the output in 1892 was $100,000; in 1893, $77,182.

Although certain firms in this State made an increase in their output during the year, such gain appeared to be due to the fulfillment of

Government, State, or municipal contracts. Private contracts were hard to obtain and business was very much depressed after July 1.

Connecticut.—The falling off in this State from $700,000 in 1892 to $652,459 in 1893 is not so great as might have been expected, judging from the serious losses in other States. Business for the year commenced in May and was very good until about the 1st of August, when it dropped off materially. In some cases in Connecticut, as well as other New England States, contracts were held over from 1892 because the strikes in that year prevented their fulfillment, so that business for 1893 was correspondingly increased. Everything indicates that but for the financial depression of the latter half of the year a large output would have been secured.

Delaware.—Production fell off from $250,000 in 1892 to $215,964 in 1893. This product comes from a small number of quarries which, all things considered, did fairly well during the year.

Georgia.—Much of the granite produced in this State is used for paving blocks. The failure of certain Southern cities to sell bonds for cash to continue paving operations contributed largely to the falling off in the granite industry from $700,000 in 1892 to $476,387 in 1893. The prospects are so very poor that some of the producers predict even a worse condition of the industry in 1894. Quite a number of quarries stopped operations entirely.

The Diamond Blue Granite Company was organized early in 1893 for the purpose of operating granite quarries at Hutchins Station, Georgia. The following gentlemen are the officers of the company: Charles Estes, president; E. S. Johnson, secretary, and J. O. Mathewson, treasurer. The capital stock of the company is $80,000 paid in, with the privilege of increasing it to $300,000. Sixty-three acres of land have been secured, and operations on quite a large scale are looked for.

Maine.—The depressed condition of finances was felt in Maine a elsewhere. Many quarries stopped operations altogether in the latter part of the year. Not only was there much less demand for paving blocks, but the prices were much lower. The product of 1893 was valued at $1,274,954, while in 1892 the figure was $2,300,000. Present indications for 1894 are not good. Some of the business of 1893 was the result of delay in filling contracts in 1892 because of the labor troubles.

Maryland.—The value of the output in 1893 is $260,855, against $450,000 worth for 1892. As in many other States, business was very good until June 1, and even considerably in excess of that for the same period of the previous year, but after that time demand for stone collapsed, making the outlook for 1894 very poor.

Massachusetts.—In this State a product valued at $1,631,204 was secured, while that for 1892 was valued at $2,200,000. Strikes in 1892 caused some contracts to be held over until 1893, making a good volume of business for the early part of the year. Dull trade, low prices,

and slow collections were the universal characteristics of the trade business for the latter part of the year.

Minnesota.—Without any exception the stone producers of this State report a depressed state of affairs for the year, and particularly the latter half. The value for 1893 was $270,296; for 1892 the figure was $360,000.

Missouri.—The value of the output in 1893 was $388,803; in 1892 the corresponding figure was $325,000. A decided gain for this State is evident, and was due to the extensive operations of one or two firms, one of which was filling a contract for the new city hall at Saint Louis. A number of the producers in the State, however, reported business as depressed.

Montana.—Production in this State dropped from a valuation of $36,000 in 1892 to $1,000 in 1893.

New Hampshire.—The value of the product of 1893 was $442,424, while for the previous year it was $725,000. Certain producers at Concord report exceptionally good business, but at most other producing localities in the State reports very much resemble the discouraging ones from other parts of the country. Considerable business was done in the early part of the year, some of which was in fulfillment of contracts held over from 1892 by reason of the strikes in that year.

New Jersey.—The falling off in this State was not so great as in many others; this is due largely to the extended operations of a single firm. The total for 1893 was $373,147 and for 1892, $400,000.

New York.—Prospects in this State were unusually good in the early part of the year, but the financial troubles asserted themselves as elsewhere, with the usual results, reducing the total of $200,000 for 1892 to $181,449 in 1893.

North Carolina.—The conditions which prevailed in this State during 1893 very much resemble those of Georgia. Much of the output is for paving and curbing, and owing to the restricted sale of city bonds operations in this line were reduced. The figures, however, for 1893, namely, $122,707, are only slightly behind those ($130,000) for 1892. From this it may be inferred that but for the financial troubles the output would have considerably exceeded that for 1892.

Oregon.—Production increased from $6,000 in 1892 to $11,255 in 1893. These figures are, however, so small as to be of very little significance further than to indicate that under favorable conditions a much greater advance would have been made.

Pennsylvania.—In 1892 the total output was valued at $550,000; in 1893, $206,493. Low prices, slow collections, and restricted demand were reported from all parts of the State.

Rhode Island.—It is interesting to note that while in this State production declined from $600,000 in 1892 to $509,799 in 1893, the decline is not so great as in many other States long recognized as among the leading granite producers. The cause of the comparatively prosperous

condition of Rhode Island in the past year is, perhaps, that the strikes of 1892, which were quite severely felt, left a number of contracts to be filled in 1893.

A number of the producers, although not the largest, report very dull business. The first half of the year was considered unusually good.

South Carolina.—The volume of the output increased from $60,000 in 1892 to $95,443 in 1893. The number of producers in the State is at present small.

The jetties in course of construction at Charleston were supplied with granite from the quarries of the State.

North Dakota.—Production fell off from $50,000 in 1892 to $27,828 in 1893.

Texas.—Production in 1892, $50,000; in 1893, $38,991.

Vermont.—In spite of hard times a decided advance was made, namely, from $675,000 in 1892 to $778,459 in 1893.

This increase resulted mainly from the achievements of the first eight months; business in the last four was generally pronounced dull. The number of producers and also of granite cutters and workers is increasing at Barre. Few, if any, localities in the country stood the financial depression any better than Barre.

Virginia.—The industry in this State suffered quite markedly, production falling off from $300,000 in 1892 to $103,703 in 1893. While a few important producers did quite good business, others report very serious losses owing to the prevailing troubles.

Wisconsin.—In 1892 the product was valued at $400,000; in 1893 at $133,220. The year opened up well, but fell off very much later on.

MARBLE.

The total value of the product in 1892 was $3,705,000; in 1893 the total was $2,411,092, a decrease of $1,293,908, or 34.9 per cent.

The following table shows the product of marble by States in 1893.

Product of marble in 1893, by States.

States.	Value.
California	$10,000
Georgia	261,666
Idaho	4,500
Maryland	130,000
Pennsylvania	27,000
New York	206,926
Tennessee	150,000
Vermont	1,621,000
Total	2,411,092

The following statements relative to the conditions of the marble industry in the several States show how the year 1893 stands as compared with 1892.

California.—The decline from $115,000 in 1892 to $10,000 in 1893

simply means that a number of the quarries have shut down entirely, owing to the prevalent dullness in all kinds of stone production. The product includes about $27,000 worth of onyx from the celebrated quarries of Messrs. Kesseler Brothers.

Mr. Frank A. Kimball, of National City, California, has taken out samples of variegated marble, some of which have been worked to a finish. The prospects of future development seem to be good, and an effort is being made to develop the property on a commercial scale.

According to the Mining and Scientific Press specimens of a number of varieties of marble, notably a dark, mottled specimen suitable for building purposes, have been taken from what is designated the Caldwell Consolidated Marble Mine, Calaveras county, six miles from Valley Spring, and midway between the latter place and San Andreas. A narrow-gauge railway has been surveyed within 1 mile of the quarry, which is elevated above the road, making it possible to transport stone by tramway to the railroad. Blocks of the stone have been tested by marble-workers at Stockton and San José, and the results are favorable to the product.

It is said that slabs of any desired size can be obtained.

Arizona.—The well-known deposits of onyx in the Big Bug Mining district, Yavapai county, have not been worked since 1891. The large amount of waste material associated with the onyx, as at present developed, makes the quarrying expense heavy, and has discouraged the investment of capital until further developments shall demonstrate a better condition as the deposit deepens.

Georgia.—The value of the output in 1892 was $280,000; in 1893, $261,666. During the first six months of 1893, the marble industry in this State was pronounced by the leading producers as in the most flourishing condition it had ever enjoyed, but after that demand was very light and business exceedingly dull. Two of the producing firms have shut down entirely.

It is said that the Piedmont Marble Company at Marble Hill, near Tate, Georgia, is to furnish all the marble required by the proposed new Saint Luke's hospital in New York City. This will mean a very important stimulus to the further development of the Georgia marble.

Idaho.—Production in this State is of quite recent date and the volume of the output in 1893 is $4,500. Indications are that this amount would have been exceeded but for the general depression.

Maryland.—The value of the product in 1892 was $105,000; in 1893, $130,000, a gain of $25,000. Much of the work done was upon contracts made in 1892. Very little new business was offered in the latter part of 1893, and the indications for 1894 are consequently not encouraging.

Michigan.—The Northern Michigan Marble Company has been engaged in the preliminary work of opening up a marble quarry in Dickinson county. A spur track 1¾ miles long connects it with the Metropolitan branch of the Chicago and Northwestern railroad. The

officers of the company are: Edwin Porter, of Chicago, president; Robert C. Harper, vice-president; F. W. Woodruff, treasurer; L. Soule, secretary; and A. L. Foster, superintendent. The general office is in Chicago and the local office at Foster City, Dickinson county.

During the summer of 1893 a considerable quantity of the product was shipped to various marble works for test as to its capabilities for polish and ornamentation, with satisfactory results. The quarry has been equipped with modern machinery and a force of 17 men has been employed with the intention of putting the stone on the market in 1894. Sawing and polishing mills are to be erected at the quarry.

Pennsylvania.—The value of the output in 1892 was $50,000; in 1893, $27,000. The explanation for this decrease is the same as for all other States.

New York.—In 1892 $380,000 worth of marble was quarried, and although production in 1893 fell off to $206,926 the general tone of the reports made is not so gloomy as that which characterizes many other States. It is said that one of the quarries of black marble at Glens Falls has been entirely exhausted. The last of it was quarried in 1892. A number of quarries at Tuckahoe, although reporting light demands, seem to have done fairly well.

Tennessee.—From a product valued at $350,000 in 1892 there was a decrease of $200,000 in 1893. This was due to poor business for the latter half of the year for all quarries which continued in operation, and to the complete shutting down of a number of quarries before the end of the year.

Vermont.—The value of the output in 1892 was $2,275,000; in 1893, $1,621,000. Business was universally reported good for the first part of the year, but very much depressed for the latter half. A number of quarries suspended operations and others curtailed work and reduced the number of employés quite materially.

Virginia.—Development work is being prosecuted on the onyx quarries of the Virginia Onyx Company in Rockingham county. The quarries are about 4 miles from Mount Crawford station on the Shenandoah Valley branch of the Baltimore and Ohio Railroad. The company is now prepared to fill orders, and a considerable product in 1894 is anticipated.

SLATE.

This industry seems to have suffered severely from the same causes which have made production of other kinds of stone exceptionally low. The total value of the output for the United States in 1892 was $4,117,125, while the corresponding figure for 1893 was but $2,523,173.

The following table gives the output of the year by States:

Product of slate, by States, in 1893.

States.	Roofing squares.	Value.	Other kinds of slate (value).	Total value.
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

The following paragraphs show the condition of the slate industry in the various productive States:

Georgia.—Twenty-five hundred squares of roofing slate were the output of each of the years 1892 and 1893; the value for the latter year is $11,250; for 1892, $10,625.

The Georgia Slate Company has been formed for the purpose of consolidating under one management all the Rockmart slate quarries from which the entire output of the State is taken. Success in these quarries, operated on a larger scale than heretofore, depends upon the favor found for them in Southern cities. Among the latter, Atlanta has been the most liberal buyer, having secured the entire output of 1892. The prospect for 1894 is said to be fair. The general manager is Mr. W. L. Craig.

Maine.—The number of slate producers in this State is limited to less than half a dozen, but production of fine roofing slate has been progressing for a long term of years. The value of the output in 1893 was $139,200; of this amount $124,200 was the value of 18,184 squares of roofing slate. The value of the output in 1892 was $250,000, all for roofing purposes.

Maryland.—The value of the product quarried in 1892 was $116,250, nearly all for roofing purposes. The corresponding figure for 1893 was $237,884. The Maryland quarries are immediately on the line dividing Maryland and Pennsylvania, and together with the quarries on the Pennsylvania side of the line constitute what is known commercially as the Peach Bottom slate region. Most of the slate is at present from quarries on the Maryland side; of these there are 4 active quarries, and 2 on the Pennsylvania side.

New Jersey.—The slate business of this State is not a very important industry, the productive region being really a continuation of a much larger field in Pennsylvania. Twelve thousand dollars represents the value of the output in 1892, and $3,653 that of the product in 1893. It is entirely used for roofing purposes.

New York.—The figures, $210,000 for 1892, and $204,982 for 1893, indicate comparatively little decrease in activity for this State. Of the unique and valuable red slate of Washington county only about

3,500 squares were quarried; this slate commands a price of $9 or $10 per square, and is produced at no other locality in the world.

In October the slate quarries of Granville stopped all quarrying until the demand for their product should increase. Considerable stock on hand had accumulated at that date.

Pennsylvania.—The value of the slate product in 1892 was $2,333,000; of this amount $1,925,000 was the value of 550,000 squares of roofing slate, and the difference, $408,000, that of manufactured articles. In 1893 the value of the output was $1,472,275, $1,314,451 being the value of 364,051 squares of roofing slate, while the balance, $157,824, was the value of slate for all other purposes. The decline is very considerable and the outlook for 1894 is not encouraging.

Early in the year the industry was in unusually flourishing condition and the product for the twelve months would doubtless have quite largely exceeded that of any year previous had it not been for the general depression in business of all kinds.

Utah.—The slate of Utah comes entirely from quarries near Provo City. These quarries are still in the stage of preliminary development and the product can not yet be considered as on the market. Seventy-five squares valued at $6 per square, and $400 worth of flagging were produced during the year.

Vermont.—Owing to the same general causes of business stagnation the output of Vermont fell off from $1,014,000 in 1892 to $535,732 in 1893. Business was unusually good during the early part of the year, but came to almost a complete standstill in the latter half. Many quarries stopped entirely, after having accumulated large quantities of stocks on the banks. Others reduced force and continued to operate on diminished time. Still others quit the business entirely with no apparent intention of resuming operations.

Virginia.—The total value of the output in 1892 was $150,000; in 1893 the figure was $117,347. Of this amount $12,500 represents the value of slate for purposes other than roofing. While roofing slate constitutes the greater part of the product, it is nevertheless interesting to note that the production of mill stock has commenced. Heretofore roofing slate only has formed the entire output.

SLATE IN GREAT BRITAIN.

Wales.—Next to coal, iron ore, and salt, slate ranks highest in value in the mineral products. The flourishing condition of the slate industry in North Wales is well shown in an article in the English Mining Journal, Railway and Commercial Gazette, written late in 1893. It is of interest, especially as much of our slate quarrying is fashioned after the Welsh methods. For many years the slate trade was injured by the high wages which followed the war between France and Germany, although the first effect of this war was to increase the demand in

Germany for slate for repairing damages to property. But this led also to the opening of many new small quarries, and the consequent unsettled state of prices. A long period of depressed prices followed, and the usual extinction of small companies. The only good effects to the producers was a reduction in royalties of from 25 to 75 cents on the ton according to the quality of the slate vein. With the low prices production declined, and stocks were reduced in 1891 and in 1892. There were practically no stocks in 1893. Thus, in 1891, Port Madoc (from which point shipments are best available), shipped 133,145 long tons, against an output of only 118,273 long tons at the Festiniog quarries, the point of production.

In 1892 the deliveries were 153,837 tons, against a production of 122,108 tons.

The following tables show the production of slate in the United Kingdom for 1892.

The first table shows the total slate product.

Production of slate in the United Kingdom, 1892.

	Quantity.	Value.
	Long tons.	
Mines under the metalliferous mines regulation act	141,993	$2,114,226
Open work	276,248	2,878,413
Total for 1892	418,241	4,992,639
Total for previous year	415,029	4,803,235

The following table shows the production of roofing slate, by districts, from open works included in the above table.

Production of roofing slate in the United Kingdom, in 1892, by districts.

Districts.	Quantity.	Value.
	Long tons.	
Cardiganshire	319	$2,385
Carnarvonshire (including Denbigshire)	256,240	2,627,837
Cornwall	960	6,930
Lancashire	6,380	93,397
Merionethshire	9,841	119,327
Montgomeryshire	2,022	24,731
Westmoreland	516	3,806
Total	276,248	2,878,413

SANDSTONE.

The following table, giving the production of sandstone by States for the year 1893, shows a total of $5,195,151. The total for 1892 was $8,265,500. A decrease in value of $3,070,349 is evident. The causes which brought about this falling off are identical with those which have produced similar disastrous results in all other kinds of stone.

Very complete and satisfactory replies from the producers show the

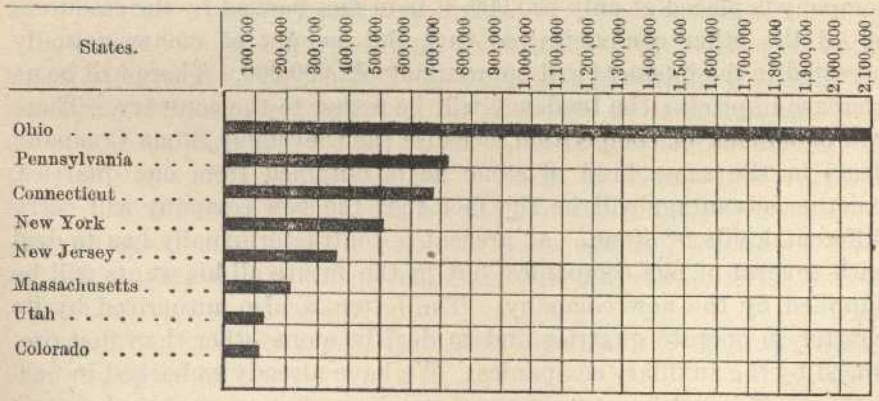
same state of affairs in all parts of the United States. Firms which did a really thriving business are few, and their prosperity was due in all cases to exceptional circumstances, such as the fulfillment of contracts on Government or other public buildings. Many railroad developments were discontinued in the latter half of the year, thus materially affecting the production of sandstone for bridge building, which ordinarily calls for a large amount of sandstone in sections where it is to be obtained.

Production of sandstone in 1893, by States.

States.	Value.	States.	Value.
Alabama	$5,400	Missouri	$75,701
Arizona	46,400	Montana	42,300
Arkansas	3,292	New Jersey	267,514
California	26,314	New Mexico	4,922
Colorado	126,077	New York	415,318
Connecticut	570,346	Ohio	2,101,932
Georgia	.....	Oregon	.....
Idaho	2,005	Pennsylvania	622,552
Illinois	16,859	South Dakota	36,165
Indiana	20,000	Texas	77,675
Iowa	18,347	Utah	136,462
Kansas	24,761	Virginia	3,830
Kentucky	18,000	Washington	15,000
Maryland	360	West Virginia	46,135
Massachusetts	223,348	Wisconsin	92,193
Michigan	75,547	Wyoming	100
Minnesota	80,296		
		Total	5,195,151

It would be mere repetition to discuss for each State the condition of the sandstone industry, and only those States which present some feature of particular and exceptional interest will be individually considered. The predominance of Ohio is well shown by the following graphic table:

Rank of States producing sandstone.



VALUE OF THE SANDSTONE PRODUCT IN THE PRINCIPAL PRODUCING STATES IN 1893.

Ohio.—The following facts relative to the important sandstone interests of Ohio have been gleaned from articles in Stone for March and July, 1893:

Eight years ago a number (nearly half) of the sandstone producers in northern Ohio united under one management, forming what has

since been known as the Cleveland Stone Company, which has been steadily increasing in the extent of its real estate possessions, quarry property, and (with the exception of 1893) in the magnitude of its annual sales.

In February, 1893, a number of firms which had declined to join in the formation of the Cleveland Stone Company, united, forming the Northern Ohio Stone Company.

The names of the firms forming this combination are: The Ohio Stone Company, the Malone Stone Company, the Grafton Stone Company, the Forest City Stone Company, the Baillie Stone Company, and the Elyria Stone Company. The capital stock of the new combination is stated as $25,000. Mr. W. C. Stewart, general manager of the new company, says:

"The various companies have been working under a disadvantage, and it has been felt for a long time that if our interests could be united it would be beneficial to all concerned—the public as well as ourselves. The various companies will retain their individuality as before, but the new arrangement will make it possible to carry on the business in a more economical manner. In the past each company has been obliged to keep men on the road to sell stone, maintain a distributing yard at Cleveland, and bear the other expenses of a complete business organization. This business will be transacted in the future by this new company. Half the yards in Cleveland will be closed, traveling salesmen will be called in, and other expenses will be correspondingly reduced. As an example of the saving, it might be said that to keep a man on the road costs about $3,000 a year. The different companies have arranged to sell their product to this central company, and the latter will dispose of it to dealers. While the capital stock of the new company is placed at only $25,000, it is in fact backed by the resources of all the other companies, so that the amount of money actually invested in the business will approximate $2,000,000. There will be no increase in prices; the tendency will be rather to the contrary. There will be no lack of competition, because the Cleveland Stone Company deals in the same kind of stone as is obtained from our quarries. Another advantage will be the fact that the new company will carry different kinds of stone. At present a contractor usually has to deal with several of our companies, but in the future all his wants will be supplied by the new company. The latter is also authorized by its charter to operate quarries and to deal in stone other than that produced by the auxiliary companies. We have already embarked in business, as it is neither a trust nor a monopoly, but an improved system of transacting business that will be of general advantage."

Later in the year the Central Ohio Stone Company was formed with headquarters at 9 North Cleveland avenue, Canton, Ohio. The officers of this combination are Mr. Joseph B. K. Turner, president; Mr. Wilber Winfield, secretary, and Mr. J. B. Gabriel, treasurer.

The great bulk, if not all, of the sandstone interests of northern and central Ohio, is thus seen to be under the control of three combinations. The future of these companies will doubtless be regarded with interest by those engaged in the production of sandstone.

The value of Ohio's sandstone output in 1893 was $2,101,932; the value of the product in 1892 was $3,300,000.

This State stands far ahead of any other in the am ount of sandstone produced. The next State in order of output is Pennsylvania, in which the sandstone product was valued at $622,552. An important use of some of the sandstone of Ohio and Michigan is for grindstones and whetstones. A large part of the product of the country in this line of manufacture, and practically all of the grindstone output, comes from Ohio and Michigan, which together yielded in 1893 a product valued at $338,787. Of this amount $60,615 covers the output in Michigan, while the remainder belongs to that of Ohio.

LIMESTONE.

The limestone output in 1893 is valued at $13,920,223. The corresponding total for 1892 was $18,392,000. A decrease of $4,471,777 is apparent from these figures. The percentage decrease is 24.3, which is less than that for any other of the various kinds of stone quarried in the United States. The above figures include the values of limestone used as such for building, road-making, and blast-furnace flux.

When we consider the importance of limestone as such and the indispensability of lime in building of all kinds, as well as its use for agricultural purposes, it is not surprising that the limestone industry, as a whole, should more nearly hold its own in times of severe financial stringency than work in other kinds of stone which depend mainly upon building alone for their application.

The suspension of many building operations which, but for the hard times, would have been carried through during 1893, affects both the quarrying of limestone for structural purposes as such and the production of building lime. Many blast furnaces have shut down during the year, thus curtailing the output of stone for use as blast-furnace flux. The universal verdict from all parts of the country is good business for the first half of the year and little demand, low prices, slow collections (causing failures), suspension of operations, reduction of working force, for the second half.

The following table gives, by States, the values of limestone quarried in 1893:

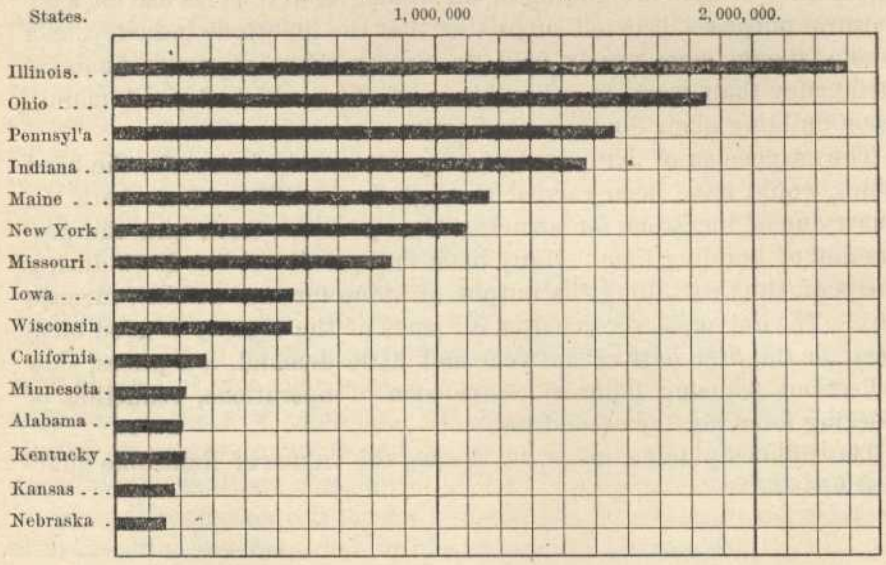
Product of limestone in 1893, by States.

States.	Value.	States.	Value.
Alabama	$205,000	Montana	$4,100
Arizona	15,000	Nebraska	158,927
Arkansas	7,611	New Jersey	149,416
California	288,626	New York	1,103,529
Colorado	60,000	Ohio	1,848,063
Connecticut	155,000	Oregon	15,100
Florida	35,000	Pennsylvania	1,552,336
Georgia	34,500	Rhode Island	24,800
Idaho	1,000	South Carolina	22,070
Illinois	2,305,000	South Dakota	100
Indiana	1,474,695	Tennessee	126,089
Iowa	547,000	Texas	28,100
Kansas	175,173	Utah	17,446
Kentucky	203,000	Vermont	151,067
Maine	1,175,000	Virginia	82,685
Maryland	.....	Washington	139,862
Massachusetts	156,528	West Virginia	19,184
Michigan	53,282	Wisconsin	543,283
Minnesota	208,088		
Missouri	861,563	Total	13,920,223

Gains in production have been made in a few States in which limestone quarrying is a new industry, but in practically all States where the stone has been produced a falling off in output has been the result.

The leading State in limestone-quarrying is Illinois. Operations in this State produced in 1892 an output valued at $3,185,000 and in 1893 at $2,305,000. The formation within the last two or three years of the Western Stone Company, composed of previously existing firms operating quarries at Lemont, Lockport, and Joliet, is the most significant act bearing upon the limestone interests of the State that has recently occurred.

Rank of principal States producing limestone.



VALUE OF LIMESTONE PRODUCED IN THE UNITED STATES DURING THE YEAR 1893.

[In millions of dollars].

Indiana.—The limestone industry of Indiana owes its magnitude and importance to the enormous deposits of oolitic stone, known as Bedford

stone. The oolitic-stone production has suffered quite severely from the hard times, and a number of suspensions and even failures were the result. The first half of the year showed up better than for the same fraction of any previous year, but in July, August, and September there was almost no demand. From September until the close of the year business improved somewhat.

Ohio.—In Ohio the total values of products in 1892 and 1893 were, respectively, $2,025,000 and $1,848,063, making a decline in activity apparent, but not so serious a falling off as has been experienced in other States of large production. About one-third of the total value in Ohio is that of lime produced; the remainder is used for building, blast-furnace flux, and road-making.

Maine.—Considerable interest attaches to the figures representing the output of the State of Maine, for the reason that all the quarried limestone in this State is converted into building lime, which supplies many of the large markets on or near the Atlantic coast. The value of the lime output in 1892 was $1,600,000; in 1893 the figure was $1,175,000. This comparison may be regarded as some measure of the relative activities in building in the large Eastern cities, which depend chiefly upon Maine as a source of lime supply.

Pennsylvania.—In Pennsylvania limestone is quarried for the same large variety of purposes as in Ohio, although the annual output has never been so great as in the last-named State. The output of limestone and its products in 1892 was valued at $1,552,336. Much of the lime made in this State is used for agricultural purposes. Blast furnaces annually consume a large quantity of limestone as flux. The curtailed operations of many of the furnaces caused, of course, a considerable reduction in the quarrying operations for this purpose.

New York.—New York State seems to have suffered in its quarrying interests less than many other of the important States. The output of 1892 was valued at $1,200,000 and that of 1893 at $1,103,529. Business flourished in the early part of the year to a greater extent than in the same period of 1892, but the falling off of the latter part of the year much more than neutralized the gain.

BLUESTONE.

The value of bluestone quarried in 1893 is estimated at $1,000,000, while for 1892 the product was valued at $1,600,000.

It is impossible to obtain, by direct canvass of the bluestone producers, figures which are comparable in accuracy to those easily obtained in all other kinds of stone. The difficulty above indicated is due to the peculiarities of the bluestone industry as prosecuted in the productive States—New York, Pennsylvania, and New Jersey. A certain amount of the stone is quarried from regularly organized quarries with a definitely invested capital and plant or facilities for quarrying, but in addition to the stone taken from these regularly operated quarries a large amount is quarried irregularly and spasmodically by men who invest no capital

and have no organization as producers of stone. Their operations are conducted as follows: Provided with a very simple equipment of the most ordinary quarry tools, they dislodge the stone found on land belonging to other persons and transport it to a number of shipping points, selling it there to dealers who make a business of collecting it in this manner and then shipping it to the place of consumption. The dealers pay the individuals who quarry the stone an amount which compensates them for their time and labor, while the owner of the property receives a certain definite percentage from the dealer for the amount of stone thus taken from his land.

The following article, which appeared originally in the Kingston (New York) Foreman, and which later appeared in the January (1894) number of Stone, gives a very fair statement of the bluestone industry for the year 1893:

"The bluestone industry has not resulted as satisfactorily at the close as was expected at its beginning. The money panic in July, August, and September seriously affected the building trades all over the country, and in consequence the dealers in building materials began to reduce stock and builders to suspend work where it was possible to do so. Prices of bluestone at quarries were reduced and a corresponding reduction in selling prices followed. Some of the wholesale dealers who were caught with large stocks on hand at this time were heavy losers, and in some instances partial suspension of shipments followed. An effort to stimulate the market by making a reduction in prices resulted in loss to the dealers in many cases, and as usually follows such a course, still deeper depression followed in every department of trade, the purchaser being tempted to buy when no real demand existed. As a result the wholesale dealers find they have large numbers of accounts on their books which are unpaid, in place of the stocks they were so anxious to get rid of. Besides this, prices were so low that the margin of profit was entirely lost on forced sales. The retail dealers in all the cities go into the winter with smaller stocks than have ever been known. The quarrymen in the Ulster section have suffered more probably in proportion than the wholesale dealers, for the reason that the drought of midsummer cut off some of their grains and hay, besides the garden vegetables upon which they depended for food. In a measure, to compensate for this loss, it is the intention of the wholesale dealers to keep their yards open all the present winter and receive stone for cost. This will make quarrymen quite comfortable through the winter and will enable them to strip large blocks for the season of 1894. The outlook is quite promising in the amount of stone that will be required next season, but the prices that will prevail will undoubtedly be low. In the absence of any form of a combination dealers become over anxious to make sales, and so they dispose of their stock, often to a disadvantage. Already prices have been quoted for next season's delivery, which are much below any that have been given since 1886. Such conditions are not usually alarming

to the quarrymen, as in such cases sales are increased, orders are delayed, production stimulated, and in consequence the prices realized by the quarrymen are good. Shipments of bluestone for the season of 1893 have been far below those of previous years."

The following article in the July number of Stone is of interest as showing the peculiarities of the bluestone quarrying industry:

"The quarrying of bluestone probably requires as much skill if not more than any other kind of stone, a fact often overlooked, and a potent factor in the success or failure of a quarryman. It seems to be the general impression among a great many users and perhaps a few of the producers of this most useful and durable stone that a man need only find a deposit of salable quality of bluestone, and no more than usual proportion of top to bed, with the usual shipping facilities, and success is assured, but for any one who has been closely connected with this especially interesting business it is easy to find the reason why a quarry has not paid. The causes are usually radical, and one of the first flaws after ascertaining that the quarry contains stone in fair quantity will be found by looking into the system of quarrying, and here is frequently a drawback to the prosperity of the quarry.

"The peculiar formation of bluestone and the fact of its being found in comparatively small deposits, make machinery impracticable, a quarry in Chenango county, New York, probably being the only one which uses any of the modern machinery or blasting devices in quarrying, such as the Knox system in use at this place. Some few of the other large quarries, perhaps, are using the Knox system in blasting their top rock, and quite a number are equipped with steam drills. It is safe to say 90 per cent. of all the bluestone is quarried by hand wedges and sledges. Flagging is a large percentage of the kind produced and runs from one-fourth inch thick up. The beds usually produce the thinner stone on top, running heavier as the bed is worked down. Nearly every quarry has its own peculiar formation. Quarries within 400 or 500 yards of each other frequently differ greatly as to quality and formation. As a rule the best quarrymen have worked in the quarries from the time they have been able to do anything, and as that is usually pretty early in life, many of them have gained such knowledge of the work that they know to a certainty how the stone will work as soon as they see the bed, without raising a lift. It is only after long work at quarrying that a man becomes expert. In raising the flag is is very necessary that they come up in as large pieces as possible, that the cutters may get the larger-sized stone most in demand and for which the best prices are obtained. A good quarryman will handle a lift with utmost skill, driving the wedges just enough to give it the proper strain to free itself from the bed of stone, and yet not so to strain it that it will break under the stonecutter's tool, or perhaps before it is raised. There are no general rules or directions to follow out, but only to use the knowledge and skill obtained by long and close attention to the work."

EXHIBITS OF STONE AT THE WORLD'S COLUMBIAN EXPOSITION.

In response to the timely suggestion of Mr. F. J. V. Skiff, Chief of the Mining Department, nearly every State which made a display of mineral products exhibited some kind of building stone, so that profusion and wide distribution of stones suitable for building purposes made one of the impressive features of the Exposition. Not only was the United States well represented, but also many other countries, and in a number of cases these foreign exhibits were surprisingly comprehensive. This is particularly a matter of congratulation, considering the great expense and risk incident to transporting such heavy and yet fragile material as stone, especially in the form of slabs.

The following States were represented by exhibits of building stones: Arizona, California, Colorado, Connecticut, Idaho, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, and Wyoming.

Among the specimens exhibited were many which represent well-known sources of supply which have their essential characteristics fully set forth in the several volumes of Mineral Resources, but, in addition, many new sources of fine building stone were brought to notice. In fact, there was a greater contribution of new material in this line than in any other.

Arizona.—The kinds of stone represented were sandstone, lithographic stone, and onyx.

The sandstone came from Flagstaff, and is of a brown and unchangeable color, fine grained, and moderately hard. The quarries are actively worked.

The lithographic stone and the onyx are satisfactory as far as the present developments show.

California.—Included in the display from this State were specimens of sandstone from Sespe, Ventura county; greenish colored sandstone from Niles; serpentine from Amador county; onyx from Kesseler's quarry; marble from Colton, San Bernardino county, and from the Inyo Marble Company in Inyo county, and slate from the Chili Bar Slate Company.

The exhibit of onyx was very fine and showed well the capabilities of the product for ornamental uses. Some of the slabs were so cut and polished as to give the effect of landscape drawings or paintings. Artistically the work on the stone was of a high order.

The marble from Colton, San Bernardino county, is coarsely crystalline. Its color is white streaked with black; in the form of columns it presented a handsome appearance. The marble from Inyo county shows quite a number of varieties in color and its adaptability to interior decoration, as well as for outside building, was apparent.

Colorado.—The chief exhibit included a variety of granites, marble, sandstone, and lava stone. Among the granites may be mentioned what is known as Platte canyon granite, which was shown in columns over 6 feet high and 1 foot in diameter. This stone seems to be highly feldspathic. It is quite coarse grained. The prevailing color is due to feldspar. The polish is very satisfactory and there is no evidence of knots or streaks.

The so-called Arkins gray granite was exhibited in the form of a polished column. It is quite fine grained and has occasional dark spots. It takes a fine polish. Arkins red granite is medium grained, polishes well, and contains occasional dark spots and streaks of a pinkish brown shade.

Cotopaxi granite is quite fine grained. The specimens shown were not so well polished as others. Aggregations of feldspar in places give white spots here and there.

A fine 12-foot column of rose granite formed an important item of the exhibit. This stone is beautiful in color, takes a fine polish, and is, in general, free from knots and streaks. There are a few places where a lack of transparency in the quartz gives the appearance of spots, but these are not sufficiently pronounced to interfere with the uniformity of color. The workmanship involved in turning and polishing this column is very fine.

Among the marbles was a polished column surmounted by a carved cap. The stone is mixed blue and white and quite similar in appearance to some of the Vermont marble. The stone takes a fine polish and is quite fine grained. It was taken from the quarries of the Western Granite and Marble Company. The other samples of marble exhibited are hardly deserving of special mention, some of them being only imperfectly crystallized and not specially attractive. As marble quarrying in this State is still in its infancy better products may be looked for.

The Colorado Marble and Mining Company, of Denver, displayed specimens of ornamented and polished marble from quarries at the head of Youle creek, Gunnison county. This marble is nearly white in color, polishes very well, carves to a line, and seems well adapted for ornamental purposes.

The exhibit of sandstones was quite full and satisfactory. Columns of Kenmuir red sandstone exhibited by Greenlee & Son, of Denver, consisted of sandstone of medium grain and which cuts well into ornamental work.

A column of Coal Creek sandstone consisted of buff stone susceptible of ornamentation. Pleasant valley red sandstone is of a purplish color, finer grained than the two just considered, and probably has greater crushing strength.

A specimen of St. Vrain red sandstone showed medium grain and was susceptible of rubbing down to a fairly smooth surface.

The Pleasant valley quarries are in Larimer county, within 10 miles of Fort Collins. They are well equipped with steam drills and other first-class quarrying machinery. The stone is said to be free from alkalies and any substances which tend toward disintegration. Its weight is 160 pounds to the cubic foot, crushing strength 12,000 to 15,000 pounds to the square inch. It has been used in quite a number of buildings in Denver, Pueblo, Kansas City, Chicago, St. Louis, Omaha, and New York City.

The so-called lava stone is light in color and also in weight. It is cheap and is used to some extent in Denver for foundations and for interior construction.

Connecticut.—Granite and sandstone were represented in the stone exhibits from this State. The granites were from New Preston, New London, Sterling, Niantic, and Stony Creek. The sandstones were from Cromwell, Portland, and Rockland. The specimens showed satisfactorily the desirable qualities of these well-known building stones.

Idaho.—The exhibit from this State included so-called marble, sandstone, and magnesian limestone. Very little information was obtainable.

Indiana.—The well-known oolitic limestone of this State was exhibited by columns about 20 feet high and by a large number of variously tooled, rubbed, polished, lettered, and ornamented specimens which showed well the capabilities of the stone in all the uses to which it is put. A comparison of this stone with the Kentucky oolite showed that they differ markedly in the average size of the constituent granules, those of the Indiana stone being noticeably smaller. The Indiana oolite is known as the buff and the blue; the latter is said to come from the greater depth.

Sandstone and oilstone were shown from Paoli. This stone is very uniform in texture and of fine grain.

Iowa.—Many specimens of stone were exhibited, but information in regard to operations of quarries or analyses and tests of stone new to the trade outside of local business was entirely lacking, and hence the exhibit necessarily lost much of the interest which might have otherwise attached to it.

Kansas.—A large number of specimens of limestone and sandstone from many localities in the State was displayed. An unusual amount of pains in testing, analyzing, and labeling these specimens had been taken, and the collection was therefore of much interest. The following tables were compiled from the labeled specimens. The determinations were made by Dr. S. W. Williston, of Lawrence, Kansas.

Tests and analyses of Kansas building stones.

LIMESTONE. (*See* note, p. 565.)

Counties.	Formations.	Crushing strength.	Weight per cubic foot.	Specific gravity.	Ratio of absorption.	Analyses.						Remarks.
						Insoluble matter.	Oxides of iron and alumina.	Calcium carbonates.	Magnesium carbonates.	Sulphates.	Moisture.	
		Pounds.	*Pounds.*			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Johnson		19,279	165.4	2.65	.01	8	1.35	90	.12	0.02	.....	From Ottawa; average from 3 blocks.
Allen		.....	.....	.....	.....	1.53	1.75	94.12	2.72	.....	.....	From Humboldt.
Leavenworth		7,862	168.5	2.70	.02	5.91	2.47	89.88	1.11	.38	.....	From Lansing; average from 5 blocks.
Do		15,961	169.1	2.71	.004	6.20	3.31	88.17	1.88	.28	.04	From Lansing.
Cowley	Permian	.....	165.4	2.65	.045	13.60	2.55	76.16	7.63	.....	.....	From Arkansas City; fine-grained and homogeneous; no appearance of fossils.
Do	....do	4,555	157.3	2.52	.07	4.25	.85	94.06	.62	.....	.....	From Winfield.
Marion	....do	.....	167	2.67	.07	5.13	3.15	53.16	38.33	.....	.....	From Marion; this stone appears to have nearly the composition of dolomite. It is fine-grained, takes a smooth surface, and is gray in color.
Do	Carboniferous	5,824	169.8	2.72	.01	6.85	1.91	59.21	30.09	.95	.90	From Marion.
Do	Permian	8,196	167.6	2.68	.05	13.51	1.65	61.64	22.72	.....	.....	From Marion; produced by I. Kuhn & Co.; dark gray; not perfectly homogeneous, occasional spots.
Do	....do	13,711	170.7	2.73	.04	6.75	1.59	51.65	40.51	.....	.....	Produced by I. Kuhn & Co.; average from 4 blocks, 5 miles northeast of Marion.
Do	....do	12,364	168.2	2.69	.03	5.51	1.24	91.50	1.62	.....	.....	
Clay	....do	10,291	170.4	2.73	.05	9.50	6.40	60.04	24.72	.....	.....	From Clay Center; average from 3 blocks.
Butler	....do	2,727	162.9	2.61	.01	5.04	.96	93.32	1.06	.....	.....	From El Dorado.
Douglas	Carboniferous	11,630	167.6	2.68	.007	3.53	1.07	94.18	1.16	.....	.....	Crushing strength is the average from 5 blocks; from Lawrence.
Franklin		2,940	162	2.59	.03	1.18	3.09	92.71	2.64	.....	.....	From Greeley.
Leavenworth		8,223	170.4	2.73	.01	12.97	3.06	78.46	1.16	2.32	.....	From Lansing.
Marshall		4,216	158.8	2.54	.06	13.89	4.29	80.10	1	.39	.....	From Beattie; average from 5 blocks.
Do		9,810	163.2	2.61	.03	8.75	2.37	84.89	2.80	.78	.25	Do.
Do	Carboniferous	6,543	163.5	2.62	.05	14.01	1.34	80.31	3.87	.....	.....	From Beattie; average from 4 blocks.
Riley	Permian	3,272	159.1	2.55	.07	.....	.....	.....	.....	.....	.....	From Monterey; quarried by Ulrich Bros.
Wabaunsee		.....	166.3	2.67	.01	6.22	1.74	89.68	1.99	.....	.....	From Alma.
Do	Carboniferous	7,646	161.3	2.58	.05	9.12	.70	88.55	1.25	.....	.....	From Alma; quarried by A. Zechser.
Do		2,891	154.4	2.49	.06	10.37	2.49	84.53	2.35	.....	.....	Crushing strength is the average from 5 blocks.
Chase	Carboniferous	7,907	162.9	2.61	.04	7.30	1.05	90	1.60	.03	.....	From Strong City; average from 6 blocks.
Do		6,800	161.6	2.59	.04	8.57	3.62	84.72	1.75	.90	.....	From Cottonwood Falls; quarried by Bittiger Bros.; crushing strength, average from 4 blocks.

Tests and analyses of Kansas building stones—Continued.

LIMESTONE—Continued.

Counties.	Formations.	Crushing strength.	Weight per cubic foot.	Specific gravity.	Ratio of absorption.	Analyses.						Remarks.
						Insoluble matter.	Oxides of iron and alumina.	Calcium carbonates.	Magnesium Carbonate.	Sulphates.	Moisture.	
		Pounds.	*Pounds.*			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Cowley		12,567	164.5	2.63	.01	3.34	1.69	93.98	.94	.....	.....	From Cambridge; quarried by H. Heddeman; average from 5 blocks.
Do	Carboniferous	3,649	153.5	2.46	.08	.....	.....	.....	.....	.....	.....	From Cambridge; average from 5 blocks.
Lincoln	Benton Cretaceous	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	No data; known as Lincoln marble, but is hardly a marble, not being sufficiently crystalline.
Hodgeman		.....	.....	.....	.....	5.06	2.08	91.30	.87	not det.	.44	From Jetmore.
Hamilton	Benton Cretaceous	.....	.....	.....	.....	4.81	3.07	90.63	.84	...do..	.08	From Coolidge.
Norton	Loop Fork Tertiary	4,277	156.3	2.51	.06	8.29	a.90	89	2.00	.....	.....	From Norton; crushing strength, average from 4 blocks.
Cherokee	Subcarboniferous	9,520	166	2.66	.003	8	.69	97.32	.80	.....	.....	From Galena.
Allen		.....	167.3	2.68	.02	2.75	5.91	91.02	.14	.....	.....	Iola Marble Company.
Do		7,683	166	2.66	.02	2.63	1.76	94.10	1.54	.....	.....	Average crushing strength from 5 blocks.
Montgomery		7,731	169.8	2.72	.006	16.15	1.91	79.25	1.80	.....	.....	From Independence.
Barber		10,349	163.5	2.62	.01	1.85	1.95	94.62	1.49	.....	.....	Average from 6 blocks.
Franklin		12,809	167.3	2.68	.008	1.18	2.38	94.77	1.07	.....	.....	From Lane; quarried by Hanway.
Do		(14,415) (16,609)	169.8	2.72	.006	3.82	a.77	94.21	1.30	.....	.....	Do.
Do		10,469	167.9	2.69	.009	3.94	1.20	93.61	1.20	.....	.....	Do.
Do		12,354	167.9	2.69	.006	4.79	1.18	93.30	1.26	.....	.....	Do.
Anderson	Carboniferous	14,647	168.2	2.69	.004	4.30	.81	92.76	.95	.23	.43	From Garnett.
Do		4,399	154.2	2.47	.04	.61	a1.51	97.32	.32	.43	.....	Do.
Jackson		11,095	163.5	2.62	.02	10.93	2.02	83.99	2.66	.14	.....	Quarried by A. W. Charles.
Woodson		14,145	168.2	2.69	.007	6.80	2.60	88.03	2.04	.21	.....	From Yates Center.
Elk		10,162	166.2	2.66	.008	.66	2.13	93.49	3.04	.36	.....	From Moline.
Leavenworth		5,515	160.4	2.57	.02	17.49	4.09	69.97	2.06	.37	.....	From Soldiers' Home.
Wabaunsee		5,273	156.3	2.50	.06	3.27	2.61	92.50	1.62	.....	.....	From McFarland; average from 5 blocks.
Miami		2,036	128.2	2.50	.06	1.50	.95	96.50	.74	.....	.....	From Fontana.
Do		13,802	165.4	2.65	.004	1.35	1.32	96.09	1	.....	.....	From Fontana; crushing strength, average from 4 blocks.
Do		4,625	145.4	2.33	.04	2.44	.82	95.57	.80	.....	.....	From Fontana; crushing strength, average from 5 blocks.
Jefferson		8,767	169.8	2.72	.005	6.98	1.04	90.01	1.66	.....	.....	From Winchester.
Nemaha		6,757	161.6	2.59	.05	11.97	3.59	81.98	1.20	.55	.29	From Sabetha.

Leavenworth		12,266	161.1	2.71	.01							From Lansing; crushing strength, average from 5 blocks.
Brown		4,721	164.5	2.63	.06	11.83	5.53	81.91	1.56	.05		From Horton; owners, Frey Bros.; crushing strength, average from 5 blocks.
Douglas		10,339	166.6	2.67	.01	2.29	1.79	95.02	.79			From Lawrence; crushing strength, average from 5 blocks.
Do		11,038	166.6	2.67	.01	8.02	2.05	88.54	1.29			From Lawrence.
Allen		17,160	168.8	2.70	.068	1.99	1.21	95.20	1.10			From Humboldt; crushing strength, average from 3 blocks.
Do		11,267	166	2.66	.02	3.79	1.07	93.20	1.01	.20		From Humboldt; crushing strength, average from 5 blocks.

a Iron in ferrous state.

All of these limestones are fossiliferous in appearance. The surface appears to polish very well. Fossil outlines are very distinct in most of them. The prevailing color of the samples is a sort of gray, occasionally brownish. The polished surface of certain bluish-gray specimens is quite dark. The polish of some of these stones is very good indeed.

Tests and analyses of Kansas building stones—Continued.

SANDSTONE.

Counties.	Formations.	Crushing strength.	Weight per cubic foot.	Specific gravity.	Ratio of sandstone absorption.	Analyses.						Remarks.
						Insoluble matter.	Oxides of iron and alumina.	Calcium carbonates.	Magnesium carbonates.	Sulphates.	Moisture.	
		Pounds.	*Pounds.*			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Jefferson		1,612	152.3	2.44	.12	94.35	2.35	1.14	1.01	.42	.....	From Valley Falls; quarried by James McGinty.
Barber	Jurassic	2,023	159.5	2.55	.08	91.12	6.80	1.21	.80	.....	.....	
Osborne		1,323	154.5	2.47	.11	87.25	9.13	1.90	1.20	.27	.....	From Natoma; average from 3 blocks.
Phillips	Loop Fork Tertiary	13,619	150.7	2.41	.01	97.38	2.20	.28	.10	.....	.....	From Woodruff; appears to be a conglomerate, general color greenish gray; average from 5 blocks.
Do	do	.....	.....	*a* 2.28	.16	97.22	1.11	.75	.76	.08	.....	From Long Island.
Jefferson	Carboniferous	8,057	153.2	2.45	.01	97.71	1.31	.21	.54	23	.....	Quarried by Ezekiel Marsh; average from 5 blocks.
Neosho		6,526	161.3	2.58	.06	86.29	5.85	4.11	2.61	.....	.....	From South Mound; average from 4 blocks.
Do		.....	.....	.....	.....	64.64	5.01	29.82	.47	.....	.....	Do.
Do		6,161	161.3	2.58	.04	82.58	5.70	9.78	1.88	.....	.....	From South Mound.
Montgomery		.....	152.3	2.44	.06	95.35	2.69	undet.	undet.	1.39	.....	From Independence.
Crawford		6,756	163.5	2.62	.04	86.57	6.78	4.12	1.55	.20	*b* .59	From Farlington; quarried by Armstrong; argillaceous; average from 4 blocks; sample has a petroleum odor, dark gray color, greasy; average from 3 blocks.
Linn		3,887	132.9	2.31	.005	87.91	.89	2.22	1.75	1.41	*c* 7.13	
Woodson		3,526	145.7	2.33	.09	98.71	.63	.27	.03	.....	.....	From Yates Center; crushing strength, average from 7 blocks.
Linn		6,962	147.3	2.36	.02	82.69	3.07	6.50	1.55	.41	*c* 5.59	From Pleasanton; crushing strength, average from 5 blocks.
Crawford		.....	.....	.....	.....	84.04	3.67	8.94	3.23	.....	.....	From Farlington.
Neosho		6,526	161.3	2.58	.06	86.29	5.85	4.11	2.61	.....	.....	From South Mound; crushing strength, average from 4 blocks.
Do		6,161	161.3	2.58	.04	82.58	5.70	9.78	1.88	.....	.....	From South Mound; crushing strength, average from 6 blocks.
Crawford		6,756	163.5	2.62	.04	86.59	6.78	4.12	1.55	.20	.....	From Farlington; crushing strength, average from 4 stones.
Linn		3,696	144.2	2.31	.02	76.57	4.09	9.11	.31	.22	.....	From Pleasanton; organic matter, bitumen, etc., 9.20 per cent.

a Specimen contains a good many cavities, which accounts for its low specific gravity. *b* Organic matter. *c* Bitumen, etc.

Kentucky.—The exhibit from this State included a large number of specimens of limestone and a smaller number of sandstone. Of the limestones the Bowling Green oolite is the most interesting and important. The capabilities of the stone were well shown. An oolitic stone known as Craneyville stone, from Caldwell county, is quite distinctly different from the Bowling Green stone. It has a good cleavage, which makes it valuable for splitting into curbing and flagging stones. A decidedly hard limestone is that quarried by the Hopkinsville Stone Company in Christian county.

Maine.—A very large number of specimens of granite from this State were displayed in the form of a collective exhibit which formed an item of much interest among the stone displays. The celebrated roofing slate from Brownville was also on exhibition.

Massachusetts.—The extensive resources of Massachusetts in granite, sandstone, marble, and serpentine were well shown by representative and well-prepared specimens. Granites from all the numerous quarry regions were shown, also sandstone from Longmeadow and marble from the following localities: North Adams, Van Deusen, West Roxbury, Stoneham, Bolton, and Lee.

Michigan.—The display of stone included handsome exhibits of Portage entry stone and brownstone quarried by the Detroit Brownstone Company. Also buff sandstone known as Waverly sandstone.

One of the most interesting stone specimens is a serpentine found near Ishpeming. This stone is not yet on the market, but considerable has been done in the way of securing opinions from experts at home and abroad.

The following is an analysis of the stone:

Analysis of serpentine from Ishpeming, Michigan.

Constituents.	Per cent.
Silica, SiO_2	33.80
Alumina, Al_2O_3	1.65
Chromic oxide, Cr_2O_3	0.42
Ferrous oxide FeO	9.79
Oxide of zinc, ZnO	0.30
Lime, CaO	3.46
Magnesia, MgO	31.74
Sodium oxide, Na_2O	0.32
Manganese and nickel	Trace.
Carbon dioxide CO_2	5.66
Water	12.86
Total	100.00

Opinions from European experts indicate that this stone could compete, perhaps at a slightly lower price, with popular European products, even with the Italian Verde des Alpes. The supply appears to be considerable and the stone occurs in masses which are said to be capable of yielding blocks or slabs large enough for any uses to which the stone would be put. Transportation facilities are at hand and the commercial production of the material may be expected.

Minnesota.—The kinds of stone represented in the exhibit from Minnesota included granite, quartzite, jasper, slate, and marble. Among the Minnesota products the most important and interesting at present is the so-called "pipestone red jasper," a metamorphic quartzite rock of intense hardness, varying in color from cherry to violet. With a crushing strength of 23,000 pounds to the square inch, the stone is not only beautiful, but of great durability. Some fine polished specimens, as well as rough stones, were displayed.

Missouri.—Sandstone, marble, onyx, limestone, lithographic stone, and granite were on exhibition. The collective exhibit was a very instructive one, as showing the varied stone resources of the State.

The marbles exhibited were variegated, the prevailing color in some being gray and in others brown. Some of them look much like Tennessee marbles. While some of the specimens showed a fair polish, others were somewhat pitted and non-homogenous. A sample of onyx from Pulaski county indicated some possibilities of getting fine material, though the sample shown was not more than fair.

A sample of lithographic stone from Cape Girardeau appeared to be very satisfactory indeed; a specimen of lithographer's work done upon it seemed to leave little, if anything, to be desired; the impression exhibited was very perfect in all details. The abundant and well-known limestones of the State were fully shown, as also a number of granites, including notably a cube of pinkish red coarse-grained highly feldspathic granite from the Syenite Granite Company, of Saint Louis.

Montana and Nevada.—Both of these States were represented in the stone exhibit, but many of the specimens indicated nothing more than future possibilities, and information in regard to scientific examinations and tests was not available. The exhibits were, however, sufficient to show that granite, porphyry, jasper, marble, limestone, sandstone, and onyx are well worth further investigation and test.

New Hampshire.—The well-known New Hampshire quarries were represented, and while the collection might have been much more complete, it was satisfactory so far as it went.

A cube exhibited by the Great Falls Granite Company was particularly beautiful, somewhat resembling one of the dark Swedish granites. It showed a beautiful polish and a marked contrast between the polished and cut surfaces, so that lettering and ornamentation showed. The granites of this State are so well and favorably known that extended comment is unnecessary.

In addition to the natural granites, some so-called artificial molded granite was exhibited by the New Hampshire Molded Granite Company, of Keene. The product seemed to be strong and durable.

New Jersey.—The stone on exhibition was mainly sandstone from well-known sources. Some granite and trap rock were also shown, as well as hand specimens of granite, marble, limestone, barite, and conglomerate, by the State Geological Survey.

New Mexico.—A number of beautiful specimens of ricolite and some serpentine marble and onyx were shown. A specimen of landscape serpentine giving the effect of a painting was very unique and beautiful. For special information in regard to the serpentine, the reader is referred to Mrs. Lydia J. Cadwell, Adams Express Building, Chicago. Mr. Owen McDonald, of Hillsboro, New Mexico, can give information in general with regard to the State's resources in stone.

New York.—From both the commercial and purely scientific standpoints New York's exhibit of stone of every kind was very complete and satisfactory. Many of the sandstones shown were so compact and fine grained as to be susceptible of not only an exceedingly smooth surface, but almost a polish. The celebrated red slate of Washington county was shown in the collective exhibit, and also by a special exhibit from Pritchard's quarry in Middle Granville. Marbles from nearly all the quarrying localities were well displayed. A collection of road-making materials was also shown, together with information as to results of practical experience with them. From the educational standpoint the New York stone collection was unquestionably the finest at the Exposition.

North Carolina.—The stone resources of this State were exhibited in a manner highly creditable to those in charge of the State's exhibit. Fifty-seven different exhibits are on record in the official Exposition catalogue, and much care and interest in selecting and preparing specimens were apparent to the visitor. The kinds of stone included granite, sandstone, limestone, marble, serpentine, and slate. Among the granites may be mentioned a fine black (probably biotite) granite from Lilesville. This stone polishes beautifully and shows a strong contrast between the polished and rough surfaces. A highly feldspathic pink granite from Dunn's mountain, Rowan county, is one that for beauty would commend itself to consumers. The exhibit of the Mount Airy Granite Company consisted of a circular wall of rough stone, presenting a fine appearance. The quarries of this company were represented by photographs, which show such location of the quarries as would promote ease of quarrying. The granite collection showed clearly that the people of the State are alive to the fact that they possess not only durable but beautiful granite and in enormous quantities. Although quarrying operations on a thoroughly modern scale as to equipment are of recent date, rapid strides have been made in transportation facilities, the lack of which offered at first the most formidable obstacle to development. Near Raleigh are several quarries, among which may be mentioned the so-called graystone quarries, which are in active operation. The Henderson quarry in Granville county is a hard, dark-colored granite, eminently suited for paving blocks. Near Wilson, in Wilson county, is a reddish granite resembling Scotch granite and suitable for monumental purposes. In Alamance county, near Graham, is a dark-gray granite suitable for fine work. In Surry county, near Mount

Airy, are the Mount Airy granite quarries, the stone from which is used for heavy masonry and for paving. A granite quarry near Kernersville furnishes stone suitable for and used in monumental work. Dunn's mountain, near Salisbury, is a mass of white, highly feldspathic granite, which has been used with good results in the Government building at Raleigh. A notable granite is also that taken from quarries near Mooresville, Iredell county. This stone is well adapted to monumental work as well as rough building.

Both brown and gray sandstone were exhibited, showing well the resources of the State in this line.

North Carolina marble, taken from the gorge of the Nantahala river, is beginning to attract general attention as a marble similar to the Georgia marble, and said to be sold under that name. It varies in color, being white, black, rose colored, and variegated. A Georgia company is now operating quarries in this region.

Although no slate is quarried in the State it exists near Egypt, at Goldston, and is found at a third point, 4 miles from the mouth of Rocky river.

Ohio.—The well known sandstones and limestones of Ohio were fully represented. Among the sandstones were exhibits of the Ohio grindstones, which are too well known to need special mention here. Limestone was shown in great abundance, not only for building but also, by many specimens of stone, for burning into lime. These latter were accompanied by specimens of lime made from the stone. Columns of Berea stone, furnished by the Cleveland Stone Company, were used in the edifice erected on the space allotted to Ohio in the Mining building.

Oregon.—The kinds of stone exhibited included a few specimens of granite, sandstone, limestone, and marble. Of these the most interesting is perhaps that of marble which came from the quarries of the Variety Marble Company, in Douglas county. About 30 men are employed at these quarries. The operations are of quite recent date.

Pennsylvania.—Pennsylvania's exhibit of stone of all kinds was one of the best as a collective exhibit. A very large number of specimens were displayed in a single collection, while there were in addition several special exhibits of a notable character. It is to be regretted, however, that satisfactory information in regard to many of the specimens was wanting. The same remark applies equally well to a number of State exhibits. All of the kinds of stone known to the general trade were abundantly represented. Among the well known quarrying centers represented were the Avondale limestone quarries; Schweyer and Liess, of King of Prussia; the old Bangor Slate Company, the Big Bed Slate Company, the Hard Vein Slate Company, the Pen Argyl Slate Company, the Peach Bottom Slate Producers' Association, the East Bangor Consolidated Slate Company, the Blue Valley Slate Company, Globe Hard Vein Slate Company, E. W. Evans & Company, F. M. Hower, Imperial

Slate Company, of Wind Gap; Jackson Brothers, of Pen Argyl; R. L. Jones & Company, of Delta, and W. W. Jones, of Belfast. From this enumeration it is evident that the slate of the leading slate-producing State was well represented. Among other well known producers of other kinds of stone may be mentioned the Conshohocken Stone Company, the Hummelstown Brownstone Company, the Swatara Brownstone Company, Leiper & Lewis, of Chester, and a number of producers of Beaver Valley sandstone, which for certain uses has made an enviable reputation.

Schweyer & Liess, of King of Prussia, exhibited a 2-inch-thick slab of marble, 16 feet 2 inches by 6 feet 9 inches, probably one of the largest slabs of marble of that thickness ever quarried. An analysis of this marble shows the following composition:

Analysis of marble from King of Prussia, Pennsylvania.

	Per cent.
Calcium carbonate $CaCo_3$	98.157
Silica SiO_2	.771
Alumina Al_2O_3	.167
Ferrous oxide FeO	.542
Magnesia MgO	.509
Phosphoric acid P_2O_5	.048
Organic matter	.132
Total	100.326

The following is an analysis of Meriontown refractory firestone:

Analysis of firestone from Meriontown, Pennsylvania.

	Per cent.
Silica SiO_2	92.75
Alumina Al_2O_3	4.685
Oxide of iron	1.785
Lime CaO	trace.
Magnesia MgO	.270
Total	99.490

One of the most interesting items of the State's exhibit was a small core of the recently discovered Avondale marble. Analysis shows this to be a dolomite. It shows a crushing strength of over 22,000 pounds to the square inch and an exceedingly low percentage of absorption. This stone will undoubtedly prove to be a valuable building marble, although it is too coarsely crystalline for fine statuary work.

A specimen of green and white mottled serpentine of considerable hardness formed an interesting exhibit. The specimen was taken from a source near Easton.

An exhibit of sandstone by Paul A. Oliver, of Oliver's Mills, was shown in the form of a window jamb. A portion of the stone was beautifully polished, showing the specimen to be a very fine-grained, hard, and durable sandstone. This specimen is decidedly unique.

A small but fine specimen of black marble was exhibited by the Brookside Club of Williamsport. No quarrying operations have been undertaken, but the stone merits further investigation.

South Carolina.—The Winsboro Granite Company, of Winsboro, exhibited three one-foot cubes of two grades of light, highly feldspathic, fine-grained granite. The polished surface is much darker in color than the rough surface, and lettering shows well. The coloring is not always perfectly uniform, owing to white knots. The stone is undoubtedly a valuable building stone.

South Dakota.—In the exhibit from South Dakota were samples of a uniform, but rather soft, red sandstone, which was shown in a number of carved figures. Besides this were some polished samples of Sioux Falls quartzite in the form of polished columns. This stone shows occasional small knots, which will not take a polish, but these do not seriously interfere with its beauty. The stone, although beautiful enough for ornamental work, is at present quarried for paving purposes, the blocks being in use in Chicago, where they have given satisfaction. The stone splits easily into paving blocks, and it is claimed that it can be worked for this purpose more cheaply than granite. A crushing strength test gave about 22,000 pounds to the square inch. The quarrying of this stone has been going on for about ten years, and is becoming fairly well known to the country at large as well as to such of the Western cities as have had practical experience with it.

Tennessee.—Two exhibits, one of sandstone and the other of marble, were shown. The necessity, however, for exhibiting Tennessee marbles was not great, since these marbles were in use in the Exposition buildings themselves.

Utah.—Granite, sandstone, slate, and onyx were included in the exhibit from Utah. The onyx varies in color from white to brown, green, and variegated. Only small samples were shown, and none of it is as yet quarried. It contains here and there opaque, chalky looking spots, which, of course, form a drawback. It is said to occur in seams from 3 or 4 inches in width to several feet and to extend for long distances. It is believed that commercially successful quarrying will result from further development of the deposits. The slate exhibits from Provo City revealed some samples which somewhat resemble Vermont slate in color, which is purple and green. The specimens showed good cleavage, and there seems to be no doubt that good roofing slates could be made.

Vermont.—In the abundance, variety, and beauty of its marble exhibits Vermont, of course, far surpassed all other States. In the Mining building was a collective exhibit in which the following well-known firms were represented: Bardillo Marble Company, of Brandon; Barney Marble Company, of Swanton; Brandon Italian Marble Company, of Brandon; Columbian Marble Company, of Rutland; Corona Marble Company, of Brandon; J. K. Freedley & Son, of East Dorset;

Mallet's Bay Marble Company, of Colchester; S. F. Prince and Company, of South Dorset; Smith and Brainerd Marble Company, of Middlebury; True Blue Marble Company, of Rutland, and the Vermont Marble Company, of Proctor. The specimens were well selected and included a great variety of shades of color. Educationally this collection was very satisfactory indeed. In addition to its display in the Mining building, the Vermont Marble Company had another of manufactured articles and works of art in the Manufactures building.

Granite was exhibited in the Mining building by the Ascutney Granite Company, of Windsor; the Co-operative Granite Company, of Calais; Jones Brothers, of Williamstown; Lyon Granite Company, of Dummerston; North Haverhill Granite Company, of Montpelier; W. A. Rice, of Woodbury; C. H. Stearns, of Hardwick; Vermont Granite Company, of Montpelier; Vermont Quarry Company, of Montpelier, and the Wetmore and Morse Granite Company, of Barre.

In the Manufactures building a cooperative association of granite producers in Barre made a fine display of their carved, polished, and dressed products, such as monuments, tombstones, etc.

It is safe to say that the Barre granite, for uniformity, fineness of grain, beauty of polish, susceptibility to carving, freedom from knots, streaks, or flaws, had no superior at the Exposition from any part of the United States.

The well-known Vermont slate was represented by specimens from the Eureka slate quarries at Fair Haven.

Virginia.—Granite, marble, onyx, and slate were included in three exhibits from this State. It must be said, however, that justice was hardly done to Virginia's well-known and extensive resources in the line of building and ornamental stone.

Washington.—Some possibilities in the way of slate, marble, and other building stones were shown, but information in regard to the specimens was not obtainable.

West Virginia.—Collectively the exhibit of stone from this State showed well its quite abundant resources in sandstone and limestone. Among the sandstones may be mentioned exhibits by the Alderson Brownstone Company, headquarters at Richmond, and the Virginia Brownstone Company, of Hinton. A number of sandstones in West Virginia have won good reputations as bridge stone and some of them are valuable material in the erection of buildings.

Wisconsin.—Granite, sandstone, and limestone were shown. Granite was displayed by the Amberg Granite Company, the Berlin and Montello Granite Company, the Cohn Granite Company, and the French Granite Company. These firms made a very creditable showing, large blocks of beautifully polished stone being used in the construction of a railing around the State exhibit in the Mining building and in a pavilion.

The Marblehead Limestone Company showed their product in the

form of a series of steps which demonstrated the desirability of the stone for such use.

Of the sandstones the Ashland Stone Company, the Prentice Brownstone Company, and the Superior Stone Company had very creditable exhibits.

Wyoming.—Much credit is due to the enterprise shown in getting up the best obtainable collection of building stones to show the resources of this Territory. Granite, marble, sandstone, and onyx were shown, Very little actual quarrying has been done, and naturally many of the specimens being taken from the surface did not show the best stone, which would doubtless be obtained by going deeper. It was, however, definitely shown that the above-mentioned stones are to be obtained in large quantity and probably, in many cases, of fine quality.

SOME OF THE FOREIGN STONE EXHIBITS AT THE WORLD'S COLUMBIAN EXPOSITION.

MEXICO.

Lower California.—The exhibit of the New Pedrara Onyx Company in the east gallery of the Mining building was most remarkable, both for the quality and quantity of its material. Onyx, both in rough and polished state, was shown in solid blocks and slabs up to 6 feet in length, while the space was inclosed by a balustrade 3 feet high of solid onyx of the most delicate pearl-white and greenish tints, with pink and red veins and markings. The striking feature of the onyx, aside from its beauty of color and translucency, is its freedom from flaws, cracks, or holes, as well as from inclosures of flint, which detract so much from the value of most Mexican onyx. Every piece rings under the hammer like a bell. The company claims that slabs of great size, up to 9 or 10 feet square, can readily be obtained from its quarries. The quarries are located in Lower California, in latitude 30°, or about 200 miles south of the international boundary. The region, though rich in mineral resources, is as yet undeveloped, and the onyx is hauled at present by wagon to the bay of San Carlos on the Pacific coast, a distance of about 60 miles on a down grade, and thence shipped by water. The onyx occurs in several layers or beds, from 1 to 3 feet in thickness, lying on or near the surface, interbedded with calcareous conglomerate and tufa. It it evidently a thermal spring deposit, of comparatively recent geological formation. On the company's property, which comprises about 5,000 acres, are two deposits about 3 miles apart. The one now being worked extends over about 20 acres, and on it in places three distinct beds or layers of onyx have been opened within 20 feet of the surface, so that an immense amount of the material is readily available. Prof. S. P. Merrill, of the National Museum and author of "Stones for building and decoration," who examined this property in the summer of 1892 for the purchasers, considered it the most remarkable deposit of onyx yet discovered.

ITALY.

The Italian display of marbles and of rough and carved alabaster in the Mining building constituted an attractive and instructive exhibit of the varied resources in lines which have made Italy famous. For the finest carving and most delicate statuary work the Italian marble is acknowledged the world over to have no superior. The possession of this high grade of statuary marble and the artistic temperament of its people have together conspired to make this country the headquarters not only for talented sculptors but for skilled artisans and stonecutters. In view of these facts there naturally exists in all countries where art is prized a demand for Italian marble, both rough and manufactured. While this demand for the finest statuary marble and its products from Italy is unquestionably well founded and legitimate, it should be remembered that for the great majority of purposes, such as building and interior decoration, our own country is just as well able to supply the demand for marble of the greatest variety in color and the most perfect susceptibility to polish and fine finish. The variety in the marbles found in the United States is very great indeed, and the prosperity of the industry in the past is a sufficient testimonial to the acceptability of our own products for all the uses to which marble is put.

The following item relative to the marble industry in the valleys of Carrara, Massa, and Seravezza will be found of interest as showing the extent of the industry and the nature of the product quarried:

"The marble quarries belong to the Upper Trias formation, and are found between more or less crystalline schists. Below these marbles there is a zone of compact limestone one called 'grezzoni,' belonging to the Middle Trias. The marble-bearing zone extends over an eliptical-shaped area covering more than 78 square miles. At the present time marble quarrying on a large scale is carried on only in the valleys of Carrara, Massa, and Seravezza. In recent years quarrying has also been carried on in the valleys of Arno and Vinea with increasing success. Of the various kinds of marble quarried in the Italian Alps, common white marble is largely predominant, and constitutes the principal part of this trade. It is used for all kinds of purposes, such as for monuments, architecture, staircases, and pavements. Next in importance is the 'bardiglio,' a grayish marble, of which there is a beautiful variety with black and white veins called 'bardiglio fiorito.' This variety is largely used for tombstones, monuments, and furniture. The statuary marbles form an important class. In consequence of their very fine grain and white color, they are used for sculpture, museums, churches, and all other places which are protected from the effects of the atmosphere. There are also the colored marbles, which are expensive. The trade in these marbles is very limited, and the same may be said of the black and of some Cipolin marbles. The total number

of quarries actually worked in the above-mentioned provinces is about 500, and there are more than 700 either not at present being worked or abandoned. There are also about 170 establishments for working and sawing the marble. The marble trade gives employment to 9,104 workmen, of whom 5,899 are employed in the quarries, 900 in carrying and loading the marble, 675 in the sawmills, and 1,630 in the studios and works."

EGYPT.

Among the foreign stone exhibits of special interest should be mentioned one by Messrs. Farmer and Brindley, of London, of carved and polished samples of ancient Egyptian porphyry, which, however, instead of remaining ancient, promises to become one of the most modern products in this highly prized kind of stone.

From a publication by Mr. W. Brindley on this subject, it appears that, important as these ancient Egyptian porphyry quarries were under the Cæsars, they became lost to history on the decline of Roman power in Egypt, and for fifteen centuries the world has been ignorant of their whereabouts and has had to obtain supplies in this line by the shameful destruction of the beautiful work of the ancients.

"The old quarries have now been rediscovered and are found to contain immense masses of the most beautiful porphyry, the supply being practically inexhaustible. A concession for their reworking has been granted to me [W. Brindley] by the Khedival Government of Egypt for a long period of years on advantageous terms.

"These ancient quarries of imperial porphyry are situated at the Mons Porphyrities (now called by the Arabs, Gebel Duchan) of the old geographer, Ptolemy. This mountain is on the Egyptian Red Sea coast, about 20 miles inland from the ancient port of Myos Hormos, which port is opposite the island and light-house of Shadwan and near the entrance to the Gulf of Suez. This harbor (now called Abu Shaar) is sheltered from the north winds, and has ample depth of water for barges to load alongside.

"The old Roman route from India and Persia to Europe began the caravan journey at the port of Myos Hormos and passed alongside of Mons Porphyrities, where it joined the old Porphyry road from the quarries to the Nile; the old caravanseries and reservoirs for water still exist all along the route through the desert to Keneh on the Nile.

"The first stage of this road was from Myos Hormos to a station at the foot of the Porphyry mountain, a distance of about 20 miles. The road has a gentle gradient of about 1 in 80, and all the way it is smooth and level, being composed of shingle, made solid with sand which is firm enough for a carriage to drive over. If a narrow-gauge railroad were laid on the surface, loaded trucks would descend, requiring only slight brake power to regulate their speed, the empties being sent back by oxen or camels.

"On the sides of the mountain are some six or seven ancient quarries

with the various roads up to them. Some of the quarries are a little above the level of the valley. The largest of them is on the peak, Lykabettus, near the top of the mountain, up to which there was a wide-pitched road or slide, used for the descent of the large blocks, some of which must have been over 20 tons in weight. This peak is one high solid mass of choice red porphyry, about 120 feet broad and 60 feet high, and it is still capable of producing an almost unlimited supply, and blocks of immense size are still obtainable.

"The road for their removal requires either repair or a new block slide, as, owing to the rainstorms of twelve or fifteen hundred years, the old broad-pitched road is in part destroyed. The quarries have not been worked, at the latest, since the Mohammedan invasion of Egypt. The great columns as seen in Rome and Constantinople, the huge sarcophagi and basin (16 feet across) of the Vatican, all, no doubt, came from this quarry at Lykabettus.

"Mitchell, the geologist lately in the employ of the Egyptian Government, specially surveyed one quarry for Mr. Brindley, which the latter had not time to visit, and he reports that there are in that quarry alone 2,000 cubic yards of porphyry obtainable at little cost, the value of which in Europe, reckoned at only half the price now paid for porphyry, would be worth at least £162,000 ($810,000).

"It is proposed to do all the quarry work by the aid of native workmen, who are both abundant and cheap, first-class practical quarrymen and masons being obtainable at half a crown a day and laborers at much less.

"In working porphyry it splits up readily with wedges, and this was the ancient method. Now, blocks can be divided quicker and truer by the aid of 'plug and feathers,' a hold being made 3 inches deep in twenty-five minutes, simply by hand power. It can be sawed into slabs quickly by the aid of chilled iron shot, as now used in granite cutting. Turning can be done about as cheaply as for granite by the new system of Brinton's revolving cutters, and it injures the cutters less than granite, as the latter contains quartz, while porphyry is only of feldspar hardness.

"The present average price of antique porphyry is about £7 per cubic foot; two new columns, 7 feet in length and 1 foot in diameter, recently made in Venice for a Paris house, sold for £800. The supply is a monopoly and the quantity practically unlimited.

"It is intended to take the blocks from the harbor to Abu Shaar by native sailing barges to Suez, where it would be measured by the Egyptian Government for royalty dues. From Suez it would be shipped direct to London."

NEW SOUTH WALES.

The exhibits of stone of all kinds from this country at the World's Columbian Exposition were very fine and impressive. The various rough and manufactured products showed the fact that almost any

desired kind of stone may be obtained in abundance. Most of the public and private stone buildings of the city of Sydney are built of Triassic sandstone taken from quarries in the vicinity of the city. This stone is pleasing in color and entirely satisfactory as to durability. It is easily worked and is susceptible of ornamentation. Blocks weighing 50 tons may be quarried without difficulty.

Granite from Mornya and Trial bay was shown. The former is of even texture and good quality. It has been used in the form of columns in the Sydney post-office. The Trial bay granite is of pink color, due to flesh-colored feldspar, and has been used in a breakwater and in public buildings at Trial bay. Syenite from the Bowral quarries is a stone of great hardness and durability, and on account of these qualities was selected as the material of which to construct the buttress and piers of the Hawkesbury railway bridge between Sydney and Newcastle, the largest bridge in Australia. The foundations of some of these piers extend 190 feet below the bed of the Hawkesbury river. This stone has been adopted as the best for all railway construction. It is also used for curbing in Sydney. Serpentine is obtainable, but is not quarried at present.

In the Cowra district diabase porphyry (verde antique) is obtainable, but is not worked.

Marbles are found in considerable variety from the Mullion, Momlam, and Cow Flat districts. White marble from the Cow Flat quarries has been used in the form of tiles constituting the flooring of the great hall of the Sydney University, but is at present used only for lime burning.

Black and light mottled marble from the Marulan quarries has been used with the Cow Flat marble in the flooring of the University of Sydney. Like the latter, it is used only for lime burning.

The marble from Moonbi is red and white coralline marble. These quarries were worked at one time, but not at present.

Black marble with white coral markings, presenting a handsome appearance, is obtainable at Briar Park, Rockley. No quarries have yet been operated.

Roofing slates of excellent quality have been obtained in the Goulburn, Bathurst, and Gundagai districts.

OTHER COUNTRIES.

The following information relative to foreign building stones is taken from a number of monographs by Mr Hjalmar Lundbohm, of the Geological Survey of Sweden. Mr. Lundbohm has had exceptional opportunities as the result of extensive travels to become an authority as to the merits of the various kinds of stone in the leading producing centers of the world, and also to become familiar with the quarrying methods and the processes used in dressing, cutting, and polishing the products for use. His publications are of special interest, since

few scientists, if any, before him, have given so much attention to the study of stone from the economic as well as the scientific side over so large an area of the globe. His travels included visits to the leading quarrying centers of the United States, as well as to those treated by him in the following pages.

QUARRY PRODUCTS, BUILDING AND ORNAMENTAL STONES OF SWEDEN

"Though the stone industry, as one of the more important means of livelihood, is of a comparatively recent origin in Sweden, the use of rocks for constructive and decorative purposes dates back to an early period. During the mediæval age, when church architecture was flourishing, the comparatively soft rocks, such as limestones and sandstones, were used very extensively. The cathedrals of Upsala, Linköping, Skara, Lund, and other cities, as well as the ninety-four country churches of Gotland built before 1350, and well known to all who are interested in the Gothic and Roman style of architecture, show that the builders of that period possessed good judgment as to quality of stone and methods of use as well as skill in masonry, which has not been surpassed in later times. During the following centuries, at various periods, the stone industry showed high development, especially in the seventeenth century and the early part of the eighteenth, when Swedish architecture reached its most flourishing condition, and fine buildings such as the royal castle in Stockholm and others were erected. This period was followed by one of decadence, characterized by a tendency to substitute for natural stone the cheaper artificial stone and plaster. In a large and sparsely populated country like Sweden this was quite natural so long as means of transportation were undeveloped. Later, as the country became traversed by numerous railways and canals, the stone industry again became more prominent, thus benefiting the national architecture as well as constituting an important item among the industries of the nation.

"The stone industry has to do with the following rocks, mentioned in the order of their commercial importance: Granite and some other crystalline siliceous rocks, Silurian limestone, Cambrian and Silurian sandstones, Archæan crystalline limestone, clay slates, mica schists, etc. In addition porphyry is used for decorative purposes.

"The Archæan rocks, especially granites and gneisses, occupy very extensive areas, and as these rocks show such variety as regards color and structure, there is an ample supply of the most excellent materials. Probably no other country in Europe presents so many different kinds of granite suitable for building and decoration.

"The term granite is generally applied by stonecutters and architects to a great number of different rocks, such as gneiss, hyperite, diorite, gabbro, diabase, and others. Using the term in its commercial sense, the most important granite quarrying districts are to be found

in the provinces of Bohuslän and Halland, on the west coast of Sweden, and Skäne, Blekinge, Östergötland, and Upland, on the Baltic Sea.

"In Bohuslan a true granite occupying a large area along the coast is quarried. The color of the rock is generally light gray, sometimes light red, and the structure, varying from very fine grained to medium and coarse grained, is in most cases very homogeneous. As types of the granites of this region may be mentioned one of red color, coarse, and somewhat resembling the famous granite of Peterhead in Scotland, and another gray or pink in color, of fine and close grain. There are many varieties of this latter type, some of which are very soft, some rather hard, of the same character as the granite of Westerly, Rhode Island. In consequence of the favorable situation of this district and the excellent quality of the granite, it has been quarried extensively and exported to Germany, Denmark, and England. The principal products are building stone for docks, harbors, and bridges, paving stone and monuments. The most important quarries are at Malmön, Näset, and Lysekil, in the southern part of the district, and at Iddefjorden, near the Norwegian border.

"In Halland two different kinds of gneiss occur, and are quarried at many places on the coast. One of these varieties, found at Varberg, contains pyroxene, and is dark green and very granitic; it takes a high polish, and has a reputation as one of the most beautiful monumental stones. Large quantities are exported to Germany, Scotland, and during recent years, to a small extent, to America. The other gneiss in Halland is rather hard, fine grained, and variable in color. It is used almost entirely for street work, the products being exported to Germany and Denmark.

"The province of Blekinge takes a prominent position among the productive granite districts, not only on account of its geographical situation, near one of the principal purchasers, Germany, but also because of the superiority of its granites and gneisses. These are red and gray, generally fine grained and suitable for building and street work. Large parts of Berlin and other cities in Germany are paved with stone from one firm, which has employed for many years more than 1,000 workmen.

"In Småland occur numerous varieties of red granite, the most important of which are found at Vanevik and Visbö, south and north, respectively, from Oskarshamm. One of these, medium grained and containing blue quartz, is very extensively used for monuments in Germany, and during recent years has been shipped to Scotland and America, where it is known as 'Red Swede.'

"In a small area at Graversfors in Östergötland were several granites of extraordinary beauty. One of these is coarse grained, contains brownish feldspar and blue quartz; another, well known by American monument dealers under the name Swedish Rose, contains dark red feldspar and deep blue quartz. Both are used chiefly for monumental purposes in Sweden, as well as elsewhere.

"In the vicinity of Stockholm are numerous quarries of a gray, fine or medium grained granite, very much resembling those of Aberdeen and Dyce in Scotland. The capital has some very fine quays, bridges, and pedestals of this stone.

"Near Norrtelje, in Upland, are quarried red and gray granites used for building in Stockholm.

"Within the last few years it has become customary in Germany to use black granite for tombstones and monuments, and in consequence of this quite a number of diorite, hyperite, and diabase quarries have been opened, especially in the southern part of Sweden. The most important of these are near Lake Immeln in Skåne, and near Vestervik in Småland.

"Owing to the abundance of good granite in Sweden quarrying has been undertaken only at places where circumstances were favorable. Thus it is that the more important quarries are all situated in the vicinity of good harbors; ease of quarrying has also been considered, resulting in the selection of places where the rock showed regular bedding and jointing and homogeneous structure. Production is consequently inexpensive, although methods of quarrying are in many cases not so advanced as in America and Scotland. Steam cranes are used only to a limited extent, and steam drills have hardly been tried for the reason that wages are very low, and hand drillers exceedingly clever. Even dressing and polishing are carried on very slowly, though generally with great accuracy. It may be said that too much work is often expended upon finishing.

"Some of the larger works are engaged chiefly in the production of paving blocks. German cities are the principal purchasers, and as their requirements as to quality of the blocks are severe and inflexible and as competition is keen, the paving-block industry has advanced to a high degree of excellence in its products.

"The price of labor in the granite industry is generally a little higher than for other kinds of work in Sweden, but as compared with wages in America, those of Sweden are very low. A skilled stonecutter earns about $220 per year.

"The great markets for the granite industry are in Germany, Denmark, and England. In the northern part of Germany most of the large cities have many large structures of Swedish granite. As examples of these may be mentioned bridges and docks, etc., in Hamburg, Kiel, Wilhelmshafen, and a large number of houses and monuments in Berlin. The high duty which is placed in Germany upon sawed or polished granite work has been very unfavorable to the Swedish stone industry, and in consequence of this large quantities of raw stock are at present exported to Germany. Official statistics furnish the following figures on exports of Swedish stone, the greater part of which is granite:

Exports of stone from Sweden.

Period.	Annual average.
1881–1885	$340,000
1886–1890	670,000

"The enormous masses of felsite porphyry and some other hard rocks occurring in the province of Dalarne attracted attention on account of the great beauty of the rock as early as the last century. After careful investigations at that time a plant was established at Elfdalen and supplied with ingenious machinery for polishing, and the enterprise was carried on with great interest. Not less than thirty different varieties of rock have been worked; many of those are fully comparable to the ancient porphyries or even more beautiful. Many of the products, such as urns, vases, table tops, tombstones, etc., were exported, making the porphyry works at Elfdalen famous all over Europe. One of the most remarkable works is the great sarcophagus of the Swedish King, Carl XIV, Johan. On account of the hardness of the rocks and other difficulties, the economic result became gradually less successful until a few years ago, when the plant at Orsa, in Dalarne, was re-equipped with more modern appliances and success was again attained.

"The Silurian limestone being of excellent quality for both constructive and decorative purposes is quarried at a large number of places, and no other rock is at present used as building material to so great an extent.

"Among the numerous Archean crystalline limestones in Sweden there is only one which has been used to any extent, viz, the beautiful green ophicalcite, occurring in large quantities in the mountain range, Kolmarden. The rock is very desirable for interior work and has been used in the royal castle of Stockholm, the great opera house of Paris, and many other monumental buildings.

"The pre-Cambrian and Silurian sandstones are quarried at a few places for building purposes, and the same rocks are also used for grindstones and whetstones, and scythestones of silica schist and clay slate are manufactured on a small scale."

ENGLAND.

The principal granite quarries in England are situated at Shap Fell, in Westmoreland, at Mount Sorrel, in Leicestershire, in Cornwall and Devonshire. The peculiar porphyritic granite from Shap Fell is a fine-grained reddish-brown mass, with numerous crystals of a red feldspar from 2 to 4 centimeters long, often well developed. This granite is capable of being quarried in very large blocks and has been used, to a great extent, both in and outside of England, for architectural purposes. No other granite of this kind is at present used.

At Mount Sorrel a very fine-grained red, hornblendic granite is quarried, which is used very extensively, principally for paving stone and macadamizing. At the close of 1889 the quantity of stone produced was about 120,000 tons annually. More than half of this was for macadam.

Cornwall.—The largest granite areas of England, and those of greatest importance from a technical point of view, are situated in Cornwall and Devonshire, in the southwest corner of the country, where the rock forms five large and several small ranges of heights, surrounded by clay slates and other species of rock. The granite there is of a peculiar quality, and, although somewhat varying in different localities, it is nevertheless always clearly distinct from the other granites of Great Britain and from at least the majority of continental granites. This is true, not only as regards petrographic condition, but also in a technical sense. A quality common to most of its varieties is a light gray, at times almost white color, due to its principal constituents, white feldspar and gray quartz. (*a*) Besides these it generally contains both white and black mica, and, not rarely, tourmaline. The structure is generally medium grained, in certain tracts porphyritic, owing to the occurrence of well-developed feldspar crystals, up to 2½ to 4 inches long, which become especially distinct after polishing.

That which, above all, determines the value of the rock is its regular cleavage and its well-developed fissility in three directions perpendicular to each other. In most quarries there are found horizontal joints or bottom joints, which often follow the external forms of the land, and approach more or less to the horizontal plane; and two systems of vertical joints, forming very nearly right angles with each other. Blocks of all desirable dimensions may, as a rule, be prepared with exceeding ease. As an example, we may take the following: At Colcorrow, Tregarden, and Cottage the interval between the bottom joints varies, as a general thing, between 4 and 10 feet; at Colcorrow, which is one of Mr. John Freeman's best quarries, a block 23 by 20 by 16 feet was taken out; another was 61 feet long and 4½ by 4½ feet at one end and 3 by 3 feet at the other; a rock mass lying in place and free from joints was 42 by 31 by 57 feet in dimensions, and one at Cottage 17 by 12 by 17 feet. At Polkanuggo, near Penryn, at one time there was taken out a block 9 by 9 by 90 feet, and, as a newspaper notice cast doubts on the correctness of the statement, the owner offered to furnish blocks 115 feet long.

In the five areas mentioned, granite is obtained, according to report, in several hundred quarries, of which the author visited 13. The firm of John Freeman & Sons, in Penryn, which, in all respects, is the most prominent, is stated to work nearly 60 quarries with about 1,000 men. The method of quarrying differs essentially from that used in Scot-

(*a*) A Swedish granite, resembling the one in question, occurs on Gåsö, in Bohuslän.

land, and rather resembles that used in Sweden. All the quarries are comparatively small, and, as a rule, employ no more than 20 or 30 workmen. Advantage is taken of natural slope, and where this is lacking the work has not been pushed deeper than 18 to 27 feet, except in a few places. A consequence, or rather, perhaps, a cause of this is the fact that steam cranes as a general thing are not used, which, however, at least as regards the largest firm, is due to altogether peculiar conditions, which need not be touched on here.

Rock quarrying is generally so conducted that colossal blocks are first loosened by blasting and afterwards subdivided. The mode of procedure will be best illustrated by a few examples.

In a quarry at Sheffield, near Penryn, the block was gotten out in the following manner: After being loosened from the inclosing rock on the surface and on two vertical sides, a hole 4½ inches in diameter was drilled to a depth of 4 feet, where a sloping crack was encountered. In that hole a single charge of 8 pounds of powder was exploded, with the effect of liberating and moving the block without causing any notable new cracks. The movement carried it, respectively, 4½ inches and 3 inches from the side walls. Thereupon it was wedged apart in place by vertical and horizontal wedge nails.

At Tregarden, where the vertical systems of cracks do not always coincide with the directions of cleavage, a block about 11½ feet high was blasted out by means of a charge of powder of nearly 30 pounds, in a hole about 11½ feet deep and 4½ inches in diameter. No other large blast cracks could be discovered besides those by which the block was liberated. When there are no horizontal cracks, horizontal holes are drilled. At Cheesewring, north of Liskeard, however, the cleavage in this direction is slight, so that horizontal charges do not accomplish the object aimed at, without splintering the rock. Accordingly the hole is generally vertical, but is made deeper than the intended block by an amount equal to the height of the charge, and in this way a crack is generally formed, departing more or less from the horizontal plane, on a level with the top of the charge.

The following examples of rocks blasted out will further elucidate the method, as well as the quality of the rock:

Rock blasting for quarry purposes in Cornwall, England.

Quarries.	Dimensions of blocks.	Drill, depth.	Hole, diameter.	Charge.
	Feet.	*Feet.*	*Inches*	*Pounds.*
Polkanuggo	19 by 28½ by 16½	18	.....	18
Colcerrow	30½ by 23 by 14½	14	3	30
Do	*a*2,000	.....	.....	30
Cheesewring	16 by 12¼ by 6 to 9	8	4	*b*25 *b*54

a Tons. *b* Two charges.

The drill hole at present is made with drills 2 to 4 inches broad—sometimes still broader. It is stated that three men can drill a hole 33 inches deep with a 4-inch drill. As, however, it is difficult to produce round holes with so large a diameter, it is preferred at times to make them triangular, placing them so that one side of the triangle in a cross section at the charge becomes parallel with the cleavage in the rock. In one of Mr. Freeman's quarries a machine drill was employed, constructed in the firm's own workshop; it was fed from the boiler of a steam crane.

That a mode of quarrying like the one here described involves various advantages, under the supposition that the durability of the granite is not thereby impaired, is evident. It renders possible a much more rapid extraction of large quantities of stone than by the ordinary wedging method, but it also presupposes certain qualities in the latter which are probably not possessed by other granites. It is certain, however, that the drilling of such wide and deep holes is very expensive, and in many cases, therefore, it is probable that the method employed in the granite quarries of Stockholm, of using small holes and charging these with powder and very little dynamite, is preferable.

In Mr. Freeman's quarry, as well as in those mentioned in Scotland, the rock is taken out at the owner's expense by day laborers, and the stonecutter, whose work is always by the job, receives the wedged-out blocks. In this way it is easier to keep the quarry in good condition than if it were all job work. The larger quarries in Cornwall, in fact, are very well managed, all refuse rock being carried off, and no useless rock left behind in case it should be apt to present a hindrance. At the same time, owing to the position of the quarry, there is lacking the advantage of being able to dispose of smaller blocks, and as paving stone is not produced to any large extent the piles of rubbish have quite a different appearance from what they have in Scotland. As a general thing none but hand cranes are used, which are fastened with chain guys so stretched that the arm can be swung around. All quarries are situated at a greater or less distance from the ports, with which some are in direct connection by means of railways, while from the larger number the rock has first to be hauled from 1 to 6 miles by means of horses. Notwithstanding this, the granite from Cornwall is considerably cheaper than that from Scotland.

No long wedges are ever used in Cornwall, and deep guiding holes only when thin plates are to be wedged out. The ordinary small wedge holes are oftenest made with a peculiar drill called a jumper. It consists of a bar of steel or steeled iron, sharpened at both ends in the same manner as an ordinary rock drill, 4 to 5 feet long and provided in the middle with a ball-shaped thickening serving in part to increase the weight, which sometimes amounts to 20 pounds, and in part to permit the tool to be held firm. With this tool the workman pounds out the hole, standing on or (if the hole is sloping or horizontal) by the

stone and grasping the drill with one hand above, with the other below the ball. For a hole 2½ inches deep there were required at Carnsew 112 blows when the drilling was done *against* the cleavage. The two points of the tool are somewhat different from each other in breadth. Ordinarily four men work together in such manner that the first begins each hole and the others continue in their turn, so that it is finished by the last. The hole is usually 1 inch wide at the mouth and one-half inch at the bottom.

In the quarry at Sheffield it was stated that one man is able with the jumper to drill 20 holes, each 2½ inches deep, in one hour, and that four men in most cases drill 400 vertical of 200 to 240 horizontal holes, 2½ to 3 inches deep, in ten hours. At another place 80 holes were stated as the average for each workman per day (ten hours).

In any case it seems hardly probable that this tool affords a larger product of work than the small Scotch wedge drill. Whether it admits of comparison with the pointed chisels used in Sweden for cutting out small broad-wedge holes, I will not venture to say.

In Cornwall the wedges are 4 to 5 inches long, at the upper end nearly 1½ inches thick, and have a four-sided, slowly tapering point. The plates resemble the Scotch, but are coarser. A deep groove is generally cut before wedging.

Examples of borings with jumpers and wedging.

Dimensions of blocks.		Number of holes.		Time spent in drilling and wedging.	Number of workmen.
Length.	Height.	Vertical.	Horizontal.		
Feet.	*Feet.*			*Minutes.*	
7¼	4½	21	.....	.....	.....
6	6	26	.....	.....	.....
5	2½	11	.....	9	4
5	2½	17	.....	17½	4
5½	4	15	.....	15	4
4½	2	15	.....	13	4
6	2½	15	5	30	3

SCOTLAND.

In Scotland and some parts of Ireland granite is of common occurrence, while in England it occurs in comparatively small quantities. In Scotland it is quarried in Aberdeenshire, Kincardine, Kircudbrightshire, Argyleshire, and to a small extent on the island of Mull, in Perthshire, Banffshire, Sutherland, and on the Hebrides. The large quarries in Aberdeenshire, which, without question, occupy the first place among those of Great Britain, are situated in two districts, one in the neighborhood of Aberdeen, and the other near Peterhead. The granite quarried in the former district is generally gray but occasionally red. In the Peterhead district the granite quarried is generally white. In Kincardine, south of Aberdeen, the granite is partly gray,

medium-grained, used for paving stones and curbing, and partly red, finer grained with dark quartz at Hill O'Fair. This latter granite is principally used for polished monuments in Aberdeen. In Kircudbrightshire, southeastern Scotland, granite occurs in very large quantities. The principal quarries are situated at Dalbeattie. The rock is a light grayish-red, medium-grained, and beautiful. It is used for building stone and monumental purposes. A large export trade has been carried on, not only to English cities, but even to Russia and South America. At Argyleshire, in the west of Scotland, granite is quarried at a number of places, but is generally sent elsewhere to be dressed. The largest quarries are at Loch Awe, where several kinds of dark and light colored granite have been quarried for bridge building and monumental work. In the latter case the blocks are sent to Aberdeen. The granite from the southwestern part of the isle of Mull is coarse-grained and of a red color. It was formerly used very extenssively for polished columns, etc., in London.

On the islands of Guernsey and Jersey, Herm and Sark, in the English Channel, are numerous quarries of red and gray fine grained hornblendic granite, which is almost entirely used for paving stone, curbing, and macadam. The quantity of granite sent from Guernsey is stated to be at least 220,000 tons annually.

Ireland is said to have large deposits of good and beautiful granite, but the granite industry of that country seems not to have been developed to any great extent. The most important granite districts are situated in the vicinity of Newry on the east coast in Wicklow, Carlow, and Wexford, south of Dublin, in Galway on the west coast, and at Donegal on the northwest coast.

Scotch quarrying.—The quarries at Kemnay, northwest of Aberdeen, occupy the first place in point of size, methods of work and mechanical appliances, among all those in Great Britain, and beyond doubt have few rivals in Europe. Like the neighboring quarries at Corrennie, Toms Forest, and Cove, they are worked by John Fyfe, of Aberdeen. The first named are situated at the railway station of Kemnay, 16 to 19 miles from Aberdeen, whither all the stone is sent that is intended for polishing, or to be sent elsewhere by vessel. The rock is a light gray or almost white, fine grained granite, at times somewhat veined with white mica. It bears no little resemblance to certain of the light colored granites occurring pretty generally in Ångermanland, Sweden.

The cleavage of the rock is on the whole irregular, but vertical, and highly inclined cracks predominate. The quarrying is carried on in three open quarries, situated high up on the slope of a hill, the largest of which is stated to be about 300 feet deep. On the floor of the quarry there is a steam crane movable on rails; on the gallery, two fixed steam cranes. The hoisting of the broken and wedged-apart rock and of the chips is effected partly by two iron wire trolleys, partly

by a colossal fixed steam crane. In the two smaller quarries the work is done by 6 steam cranes and one iron wire trolley; thus there are altogether 10 steam cranes and three wire trolleys. The latter consist of strong stands of iron wire, either single or double, and on these run small trucks which carry up the hoppers of strong plates, in which the stones are loaded. By means of a special line the wagon may be stopped at any point of the track and the basket dropped to the bottom of the quarry to be filled; after this has been done by means of a steam crane or by hand, the line is hauled in till the basket reaches the truck, whereupon the latter is drawn up. It is impracticable, for several reasons, to give here a more detailed account of this ingenious arrangement. The stone hoisted up in one or the other way is loaded directly on railway cars and conveyed along the slope to a side track coming from the railway, or, if it is to be farther worked up, to the workshops situated farther up, which is done by means of a steam winch with ropes of iron wire.

About 500 workmen are here employed. It is a remarkable circumstance that not a single horse is employed in this or the other quarries belonging to the firm, but all work not done by hand is performed by steam power, which is here employed to such an extent and in so practical a manner as to be equal to anything that can at present be imagined.

Of the enormous quantities of stone quarried and moved from the deep quarry to the workshops and thence to the railway, in an incredibly short time, as compared to what is done in Sweden, the larger part is used for building bridges, harbors, and docks, and similar large works; a considerable amount is sent to Aberdeen to be used as building stone and for monumental purposes. The chips produced in quarrying, and small pieces, are worked up into paving stones. To illustrate the magnitude of the operations, it may suffice to mention that in August of last year there were sent from Kemnay, according to statement, 4,000 tons of granite. The owner of this quarry furnished all the granite used for the Forth bridge, near Edinburgh, amounting to 56,000 cubic feet. Another one of the larger orders of the firm is said to have had a value of £80,000.

Mr. John Fyfe began forty years ago to work up the granite at Kemnay, which at that time was almost an uninhabited place, but is now a well-built town of considerable size. Ten years later the steam crane was introduced, and with this the Scotch granite industry may be said to have entered on an entirely new stage.

The hewing is done at Kemnay mostly by hand, although there is also found there a machine constructed by Brunton & Trier for working on plane surfaces, of which more will be said farther on.

The granite quarry of Corrennie lies near the top of a high mountain ridge, south of the railway station of Tillyfourie, about 20 miles northwest of Aberdeen. The granite is medium-grained, consists of

pale red feldspar and gray quartz and very little mica. In general it has a massive and homogeneous structure and is easily worked. Among Swedish granites the one that most resembles it is perhaps the red medium-grained granite (No. 1) at Graversfors, in which, however, the feldspar is of a darker red and the quartz blue, but of less brilliant color.

The jointed structure, which is somewhat irregular and in some places strongly developed, impedes the quarrying at Corrennie. In a certain part of the quarry the systems of cracks are few and rather regular but always much inclined. There are no horizontal cracks. In exceptional cases blocks 13 to 19 feet long have been furnished from this quarry. The natural dip, or the slope of the rock compared to the horizontal plane, is rather slight, and it has been only partly used in quarrying, by penetrating in straight against the dip for some distance and then turning toward both sides, by which method deep pits were formed out of which the stone is lifted with three steam cranes of respectively 7, 10 and 15 tons' carrying power, to be next loaded on trucks and distributed below the slope. This is done in pretty much the same way as in the quarry at Tillyfourie described farther on. The larger part of the stone is sent away in the form of hewn blocks, to be worked up at Aberdeen and elsewhere, especially for monuments and as building stone. The smaller blocks and the chips are made into paving stones. The output was stated to be about 100 tons a month.

Among the quarries of Tillyfourie, belonging to Messrs. Mowlem & Co., of London, only one is at present worked, which lies high up on the slope of the mountain ridge north of the station. The rock is a medium-grained, gray, micaceous and veined granite, with small, scanty, pale red crystals of feldspar, but slightly marked. It is comparatively loose, cleaves easily in the direction of the cleavage, less easily across the cleavage, is not suitable for monumental purposes, and is employed exclusively for coarser building stone, curbstone, paving stone, etc. The patches of gneiss appearing here and there do not for the present cause any notable inconvenience. The jointed structure is quite irregular and the cracks are sometimes numerous, pretty much as in the Stockholm granite. The largest block ever taken out weighed 30 tons. As a rule it is not possible to produce blocks weighing more than 10 tons.

The rock resembles somewhat the coarse granite on Sterno in Blekinge which, however, is coarser and contains less mica.

The quarrying is done in a quarry about 115 feet broad and more than twice as long and at most 30 feet deep, which is being rapidly widened both downward and toward the sides. Here, too, it might have been possible, though not without difficulty, to obtain a natural down grade, but it has been thought preferable to push the quarrying downward. The taking out and loading is done by three steam cranes, each of about 10 tons carrying power, which, like the drilling machines,

are fed from two fixed steam boilers. The cutting is done for the most part in open sheds, situated at the lading places near the railway. Thither the blocks are conveyed along the steep slope on a railway which has a double track above, and is so arranged that the descending loaded trucks draw up the empty ones. The wagons are drawn by means of a steel wire line running through two horizontal covered sheaves, where there is a brake. The line is kept in the track by means of steering sheaves and vertical rollers. The slope of the railway track is from 8° to 13°.

The granite, which is, perhaps, most prized among all Scotch granites for monumental purposes, is quarried 3 to 5 miles south of Peterhead, in two quarries at Stirlinghill and in seven at Longhaven. The rock is red and coarse to medium-grained; its main ingredients are bright red feldspar and dark gray quartz, the latter mineral forming large granular aggregates. At the same time it contains yellowish white feldspar with a very subordinate amount of small grains of dark green hornblende. The combination of minerals with so different and striking colors gives to the rock a characteristic "lifelike" appearance, which in Scotland is regarded as one of the most important qualities in material intended for monuments and similar purposes. The principal color of the rock, however, is red, although it varies somewhat; the darkest rock is most highly esteemed, and is the only kind used for work intended to be polished, while the lighter-colored kind, often occurring in the same quarry with the former, is used as building stone and is sold cheaper. The difference in color between the "polish quality" and "dress quality" is often very slight. In general the rock is usually homogeneous, in as much as the minerals above mentioned are everywhere uniformly blended, a peculiarity on which great (perhaps too great) value is placed. Large or small patches of hornblende, etc., occur at times, but, as a general thing, offer no great inconvenience.

The Peterhead granite is more regular in its cleavage than that described above. The dominant system of cracks, however, is vertical, and true horizontal cracks occur but exceptionally.

The older quarries at Stirlinghill, together with those that are now worked there, testify to an incredibly large output. Like those at Kemnay, these are worked in deep quarries.

The rock is hoisted up with two steam cranes, chips and refuse are conveyed by rail to the neighboring seashore, and the blocks are hauled by road to Peterhead. A railway to that point, however, is in process of construction.

The quarry is owned by Messrs. Alex. Macdonald & Co., Limited, the oldest and largest firm for the production of monuments in Aberdeen, which at the present time, for its own account and for sale, ships from here every month from 100 to 150 tons of granite, suitable for monumental purposes, and still larger quantities of "dress quality" for building purposes.

Some of the quarries at Longhaven are very large, one being about 90 feet deep, and these, too, as a general thing, form vertical shafts, out of which the stone is hoisted by means of steam cranes. In all the quarries thus far named in the Peterhead tract, altogether 14 such steam cranes are at work, out of 10 to 15 tons' carrying power. A workman estimated the amount of stone here quarried at 140 tons per month for each one of the 9 quarries, a figure which, however, can not claim any great accuracy.

One of the oldest large granite quarries in Great Britain is that of Rubislaw, near Aberdeen. Already one hundred years ago this work is said to have developed considerable activity. The rock is gray, of uniform fine grain, and bears no little resemblance to the Stockholm granite, but is somewhat darker, and not rarely verges upon red. It is regarded, and with undoubted justice, as an unusually strong and good granite, and has obtained an exceedingly extensive employment, both as building material and paving stone, in Aberdeen and elsewhere, and for monuments, etc. The cleavage as a general thing is irregular and of about the same nature as in the Stockholm granite. Vertical or highly inclined systems of cracks often occur.

The quarry occupies an area of 6 to 7½ acres. At the east and west end of the large opening granite posts 30 to 60 feet high are worked out in shafts driven down at least 140 feet below the surface. In one of these shafts one steam crane works on the bottom and three on the upper rim, one of them lifting the stone to a height of 130 feet.

From the description of the quarry thus given it is seen that the quarrying is here done in a way different from that practiced in Sweden. There the quarrymen endeavor, wherever there is a possibility, to utilize the natural slope, whereby, however, the quarry becomes widely extended whenever the work is conducted on a large scale. The Scotch prefer to concentrate the work on a single point; ordinarily some slope is found, and then the work is pushed straight against the slope and afterwards toward the sides, so that the quarry assumes a kettle-shaped appearance. As soon as it becomes too extensive a shaft is sunk from the bottom to a depth of 60 to 100 feet or more, and this is widened until it is as wide as is deemed suitable. Then a new shaft is sunk from the bottom, and from this the work is again pushed out towards the sides. Such a system would be impossible without steam cranes or other apparatus similar to them in point of working capacity. That which in mining terminology is called the getting out, the getting up, and the getting off, or, in other words, the moving of the quarried stone in the quarry, its hoisting out of the quarry, and the transportation of it to the workshop and the lading places, in cases where the space is so confined and the quantity so great as here, could not be done by hand power, which, moreover, would be too costly. Accordingly, as stated before, the steam crane is here employed to an unheard-of extent. One or more of such cranes, fixed or movable, are placed on

the bottom of the quarry or on its edge, so as to control the whole quarry with their arms. This secures the quick, safe, and cheap performance of most of the work which elsewhere, with great waste of time and power, is performed by crowbar and hand power, or at least by slow-working hand cranes; that is to say, the turning and moving of the block in and out of the quarry, etc.

Another necessary requisite for the systematic conduct of the work of quarrying by the method in question is that rubbish shall be promptly removed from the quarry, and that useless portions of rock shall not be left behind there, in case they should become a hindrance to the work, either at once or afterward. What is called "quarry-robbing" must not occur. In order to avoid it the steam crane is indispensable.

For steam cranes of 1 to 20 tons the price at Aberdeen varies between £100 and £750.

The Swedish granites as a general thing have a more favorable cleavage than the Scotch, and for that reason the method of quarrying described above will not perhaps be found advantageous in all cases. The list of prices at the end of the paper shows that even now the cost of quarrying is lower in Sweden, but it would most certainly be still further reduced by a more systematic method, which moreover would always hasten the rate of output.

Even the loosening of the stone is done in Scotland in a manner more or less different from that in use in the most of the Swedish granite quarries. In the latter the rock is for the most part divided into slabs, and the quarrying is easily done by wedging and by a very small amount of blasting. If it is proposed in this way to take out a block of certain dimensions, the attempt as a rule is successful. But we also have granites with irregular cleavage in which the same method as in Scotland might be employed, and it is proper therefore to describe them by means of some examples. The method consists in this, that large masses of the rock are loosened at once by blasting, whereupon they are first divided along the natural cracks, and then, by wedging and "setting," into regular blocks, a method of work which is in great degree facilitated by the fact that the demand for granite is great, so that the producer may count on finding a market for blocks of all possible dimensions. The blasting itself is done in rather a remarkable way.

Along the crack in a portion of rock bounded by a perpendicular crack situated, say, 10 or 15 feet from the free side, a number of holes are drilled, say 3, about 20 feet deep. These are first charged with a very small quantity of powder, and fired simultaneously by means of fuses of equal length, or still better by wires from an electric battery. The charge is so small that the explosion can not do more than simply widen the hole and open the cracks near it. Next, the same hole is filled with a somewhat larger charge, and this is repeated three, four,

or five times, until the connection between the desired block and the adjoining rock is so completely severed, and the drill hole so large, that the block can be thrown down on the bottom of the quarry by a single powerful charge in each drill hole.

At Stirlinghill a block 8 to 10 feet broad, 15 to 18 feet long, and 20 feet high, free on one side, which was perpendicular, and on the other sides bounded by more or less distinct cracks, had been blasted out by means of a single hole 3 inches in diameter and 24 feet deep. According to foreman's statement there were used in that hole for the first charge about 5 pounds of powder, for the second 10, for the third 12, for the fourth and last 100 pounds. The position of the drill hole and the size of the charge are of course determined by the condition of the rock masses and the natural cleavage, of which as much advantage is taken as possible. The result therefore depends in high degree on the workmen's judgment and their knowledge of the rock. The advantage of this mode of blasting, as may readily be imagined, lies in this, that large quantities may be gotten out with few drill holes, without at the same time giving rise to new cracks, which would be the case if the whole mass was blasted out with a single charge. (*a*)

The division of the blocks is everywhere effected by wedging in round holes with very small wedges and steel plate. These have now begun to be used in Sweden, but as they are entirely unknown in many, if not in most of the quarries, it may be well to describe them here.

1. The wedge usually employed is four-sided, three-fourths inch long, one-half inch each way at the upper end, two-fifths by one-sixth inch at the point; the plate is semicircular in section, as broad as the wedge below, and gradually narrowing upward. When wedge and plate are set up as shown in the drawing, the wedge in being driven down works along a large part of the length of the drill hole.

When high blocks are wedged, it is customary to drill either all the holes, or every other, or every third, or still fewer, very deep, and into these are introduced jointed wedges, consisting of gradually narrowing bars, hammered flat, and semicircular plates, which may be 8 feet or more in length. Broad wedges are hardly ever used.

Judging by the number and depth of the wedge holes, the granites in most of the quarries above named are not easy to wedge. It may be interesting to compare the Scotch with the Swedish granites as regards

a Another method, first proposed by Mr. George Elliott, of Newcastle, for avoiding too many blasting cracks, is based on the employment of unslaked lime as blasting material (Journal of Iron and Steel Institute, 1882, N. 1). This is accomplished by forcing finely pulverized burnt lime under high pressure into cylindric cartridges 2½ inches in diameter, inclosed in air-tight and water-tight shells. The cartridges having been placed in the drill holes, and these having been packed, water is pumped into the cartridges by means of iron tubes fixed in them and provided with fine holes. The lime is slaked, and by its slow but powerful expansion the rock is parted. The method has been employed with advantage in coal mines, but to what extent it has been found practicable in granite quarries the writer does not know.

toughness, and for that purpose will here introduce some observations from various quarries:

Quarry.	Block.		Wedge hole.	
	Height.	Length.	Interval.	Depth.
	Feet.	*Feet.*	*Inches.*	*Ft. In.*
Peterhead	2⅛	6	4.7	2 2
Do	2⅛	22	5	2 2
Tillyfourie	.....	.....	4½–5½	2
Kemnay	4½	.....	5¼	4
Rubislaw	.....	.....	3	2
Do	3¾	15¼	3¼	{a 2 10 b 3

a Sixteen holes. b Thirty-four holes.

The holes intended for blasting, generally 2½ to 3 inches in diameter and about 20 feet deep, are mostly drilled by hand with chisel drill. A gang of 3 men drill on an average 1 foot per hour, sometimes a little more. In several places an attempt has been made to use machine drills, but for such large diameters and depths this is said in general not to be very advantageous; this may be due to difficulty in applying the drill, etc. At Tillyfourie, however, one machine drill is used, driven by an engine. It was mounted on a pedestal with three legs, easy to place in different positions, and, when set up, required one man for attendance. With a cross-shaped bit of 3 inches it was stated that up to 3 feet were accomplished; with a bit of 2½ inches, 3⅔ feet an hour. The drill had been used to a depth of 13 feet, but was guaranteed by the manufacturer for a depth of 20 feet. After drilling down 1⅓ to 1½ feet, a sharpened bit had to be set in.

Wedge holes on the other hand, at least when they are deep, are mostly drilled in the quarry above mentioned by means of machine drills, always driven by steam, either from fixed boilers or from the steam cranes. These smaller drill machines are usually mounted on a small wagon, which may be moved to and fro on a plank road or a railway. This wagon is placed directly on the block, in case it is large, otherwise it is put on a scaffolding over the block. The drilling is easily managed by one person. The product of the work was stated at Corrennie with a drill of 1½-inch to be as much as 10 feet per hour, and a workman there had drilled 80 feet in eleven hours, including the time of moving the drill, a result which was not regarded as uncommonly high. At Peterhead for a drill of nine-tenths to 1 inch, 11 feet per hour and 90 to 110 feet per day were recorded, when holes 3 feet deep were drilled.

Evidently these machines are most applicable when there is question of getting out thin slabs in great number, and of working granite that is difficult to wedge, having ill-defined cleavage, and requiring deep wedge holes, for not only can these be thus drilled faster than by hand, but they are more easily kept in the same plane, whereby the wedging is facilitated and the work of dressing is saved.

Cost of English steam drills.

For holes of a maximum diameter of—	Depth.	Cost.
	Feet.	
1½ inches	9 to 11	*£32
2 inches	11 14	36
2½ inches	14 20	44
3 inches	20 23	48
3½ inches	23 28	56

* At J. Henderson's, in Aberdeen.

Mounted on three legs these machines are 20 per cent. dearer.

Smaller wedge holes are often drilled in Scotland by hand, and as the diameter rarely exceeds seven-tenths to nine-tenths inch, the work proceeds very rapidly. At times two workmen drill in company, one beginning and the other continuing in the same hole.

The following table shows the production of all kinds of stone in the United Kingdom in 1892 by countries and for the whole Kingdom in 1891.

Production of stone (all kinds) in the United Kingdom, 1892.

	Value.
England and Wales	$35,727,704
Scotland	5,058,921
Ireland	1,394,856
United Kingdom	42,181,481
United Kingdom for 1891	42,308,100

GERMANY.

Granite occurs only in the middle and southern portions of the kingdom, but it is quarried in numerous places. The principal districts are Silesia, Saxony, Bavaria, Baden, Hesse, Rhenpfalz, and in Alsace near the French border, and finally in the Hartz. The largest quarries are in Silesia, Saxony, and Bavaria. The German granites are with few exceptions gray, and vary from fine to medium grain. Some of them are unusually soft and easily worked. On account of this softness they are generally thought in the northern part of Germany to be less qualified for paving stone than the hard granite, which is brought from Sweden. In Bavaria and some other places diorites and other green stones are quarried for paving stone and monumental purposes. The granite industry of Germany is very closely connected with that of Sweden. Some of the largest German granite firms have their own quarries in Sweden, and many buy their raw material from these or other Swedish quarries.

FRANCE.

In France, at least in Paris, comparatively small quantities of granite are used, on account of the comparative ease and cheapness with which limestone is worked. Large granite quarries are, however, worked principally in Normandie, Bretagne, and Voges. The granite from Normandie, which seems to be the one used most, is quarried at Montjou, in the neighborhood of Vire. This is gray, fine grained, of about the same structure and color as the granite of Vermont.

In Bretagne and Voges medium and coarse-grained granite of a gray and reddish gray is quarried.

BELGIUM.

The famous paving-stone quarries at Quenast are, with regard to size, production, and methods of working, probably better developed than any other paving-stone quarries in Europe, and these quarries show in a very striking way how important a systematic arrangement of work is, and how an industry which in itself seems to be of so little importance can, by a proper system, become so great as these quarries are. A good detailed description of them is given by Prof. E. Dietrich, of Bremen, in a volume entitled "Die Baumaterialien der Steinstrassen."

Quenast.—The Quenast quarries are situated at the station of the same name, 14 miles south-southwest from Brussels, 2½ miles from the station Tubize on the line Brussels-Mons-Paris. A track 3 miles long makes connection with the canal from Charleroi to Brussels and other places.

It is thought that the quarry was worked as far back as the sixteenth century, but it was only since the beginning of the present century that paving stones were quarried to any considerable extent. In 1846 steam power began to be employed, the numerous earlier quarries were gradually united under one ownership, communication was improved, and since the present wealthy company, the Societe anonyme des Carrieres de Porphyre de Quenast, took the business in hand, in 1864, and bought up the larger part of the tract in which the rock can be gotten out, the quarrying was organized on the present exemplary plan. The company is said to own 438 acres of land, of which the quarries in operation and begun and the workshops occupy about 175 acres.

The rock here obtained is dense, sometimes quartz-bearing syenite or diorite (usually, however, called porphyry), somewhat variable in color, mostly greenish gray. The structure may most aptly be compared with that of some of the Swedish diabases. Like these, the rock has no definite directions of cleavage, but yet, in small pieces, cleaves pretty straight; otherwise the fracture is spherical. The hardness is far greater than that of granite, and would seem to be most nearly equal to that of the dense diabase; and at the same time the rock possesses great toughness, so that the edges wear off but slowly.

Worn surfaces become smooth. It is mostly used for paving stones and macadam, etc., of which further mention will be made.

In the largest quarry visited, which is about 1,800 to 2,400 feet long by about 600 feet broad and nearly 240 feet deep, the quarrying goes on simultaneously on 6 or 7 stair-like benches or galleries about 21 feet high, and of course greatly varying in breadth. The quarried stone, which is worked up in part inside and in part outside the quarry, is put on small wagons and by means of hoisting apparatus is carried up an inclined plane to one of the galleries, where the wagons are put on rails and drawn by endless chains up and out through the little tunnel which connects the quarry with the workshops and the lading places. No cranes are used. The rock is always loosened by means of blasting. The drilling at the time of my visit was done merely by hand, inasmuch as it was necessary to limit the production; otherwise machine drills are used. The drilling was done at first by three persons working by the day; now it is done by two, working by the job. One drilling set consists of 8 drills, whose dimensions are given in the following table:

Dimensions of Belgian stone drills.

Number.	Length.	Diameter of drilling rod.	Diameter of bit.
	Feet.	*Inches.*	*Inches.*
1	1½	1 1/10	1½
2	1½	1 1/10	1⅝
3	2¾	1	1 3/16
4	3	1	1⅛
5	3¾	1	1⅛
6	4½	1	1⅛
7	5¼	1	1 1/16
8	6	9/10	1 1/20

At present the drilling is not carried deeper than 6 feet. The section of the drill is cross shaped. The hammer weighs 26 to 30 pounds. Two men, working by the job, accomplish 8 to 10 feet in ten hours, or as much as three men formerly did when paid by the day. Machine drilling saves time and power, and permits the boring of much deeper holes, and is therefore employed to a large extent. After trying most of the drilling machines constructed for such purposes, selection was made, according to Dietrich, of Dunn's and Ingersoll's, which work with a pressure of 3½ atmospheres and delivers about 3,000 blows in a minute. The machines weigh respectively 286 and 484 pounds, are simple and easily managed, and seldom need repairing. A new machine, constituting a medium between the two systems named, was constructed in the shops of the quarry itself. It weighs 3½ pounds.*a*

a In the work by Dietrich, above cited, a more complete description is given, both of the construction of the drilling machines and of the drills themselves, and of the arrangement of the driving gear, etc. Various kinds of drilling machines are described in a number of essays by Prof. G. Nordenstrom and Prof. C. A. Angstrom in the annals of the Iron Exchange and in the Transactions of the Society of Engineers, to which those interested in the subject are referred.

The bit of the drills used is cross shaped, and so arranged that the hole can be cleaned out without removing the drill. For vertical holes a set of 20 drilling rods is used, the least of them, which is used first, being 2½ feet long with 4½ inches in diameter on the bit; the largest, 20 feet long with a bit of 2½ inches. A drilling set for horizontal, or nearly horizontal holes, which for the most part are not so deep, consists of 10 drills, the smallest and largest of which are respectively 2 and 9 feet in length and 2½ and 1½ inches in diameter of bit. The drilling rods are always of steel.

The power used for the drilling machines is generally compressed air, which can be conducted without difficulty over greater distances, and presents several other material advantages over the direct employment of steam power.

With one of the drilling machines above named, of which there were about twenty in use in 1885, 20 to 25 feet can be drilled in ten hours, all loss of time in moving the machine, changing the drilling rods, etc., being included.

A necessary condition for maintaining the system of quarrying and transportation above described is that the surfaces of the galleries shall always be kept at the same height, and as the quarrying is now done by the job, a constant and careful supervision of the work must be exercised in order that this condition may be fulfilled. Otherwise the galleries would quickly cease to be horizontal, for the loosening of the stone which lies nearest the foot of every bench requires the greatest amount of work. However, this object is obtained by moving the tracks on each gallery inward from the edge of the gallery before the continuation of the work strictly requires it, the removal of any remaining portions of the rock being done at the expense of the workmen. As the rock is mainly used as paving stone, no pains are taken to get large blocks, the aim being to get out a large number of stones of indefinite dimensions as quickly and cheaply as possible.

In working up, the largest pieces, after being blasted out, are again divided by blasting; wedging is not practiced. The cleaving or division into paving stones is somewhat different from that used in the case of granite. By means of a hammer provided with a sharp edge, weighing 26 to 33 pounds, a fine groove is hewn on one side of the generally irregular stone, and then a few blows on the smaller end of the block generally suffice to split it along the groove with a pretty even surface. Hammers of less weight, 13 to 26 pounds, are also used. When regular blocks have been obtained, they are worked up in the usual way with the dressing hammer (weight, 7 pounds). The workman who does the grooving keeps his right foot stuck in a colossal flat wooden shoe, the bottom of which is at least 0.1 meter square in size, and against this the block is braced while working. While dressing the blocks the workman is generally seated. The cheaper paving stone, only roughly dressed, is finished in the quarry, while the finely-

dressed kinds are finished at the lading places. The dressing is always done by the job. The workmen, united into gangs of 3 to 12, generally 4 men, do the blasting and other work at their own expense, and deliver the stone finished for a certain price at the storage in the quarry. The machine drilling is done by the company at the expense of the workmen and upon their demand.

In Quenast, contrary to what is done in most other quarries, as a general thing only paving stone of certain dimensions is produced, which is kept in store and sold at a fixed price. If special dimensions are ordered a higher price is asked. Of course this arrangement, which is remarkably favorable to the company, is rendered possible by the superior qualities which the rock in question is thought to possess. The various kinds kept in store may be divided into four classes, distinguished by the ratio between the thickness of the stone at the "cup" and at the "root" (upper and lower side):

(1) Ordinary paving stones, diminishing downward by 1.1 inch on each side.

(2) Ordinary rough-dressed paving stones, diminishing downward by nine-tenths inch on each side.

(3) Half-fine dressed paving stones, diminishing downward by seven-tenths inch on each side.

(4) Fine-dressed paving stones, diminishing downward by one-half inch on each side.

Within each one of these classes there are found partly cubic and partly prismatic stones of various dimensions, so that by form and size the various kinds may be divided into 8 classes. All in all, 27 different kinds are worked.

By way of example a table is given of the average selling prices on the railway car at Quenast (according to Dietrich, 1885).

Average prices of Belgian blocks on cars at the quarry in Belgium.

	Number of stones per square yard of street surface.	Price of stones required for 1 square yard of street surface.
Ordinary paving stones:		
6 to 8 inches	30 to 31	$1.17
Edges, 5 to 5½ by 8 to 9 by 5½ to 6 inches	30 31	1.09
Ordinary rough-dressed paving stones:		
6 to 8 inches	30 32	1.34
Edges, 5 to 5½ by 8 to 9 by 5½ to 6 inches	30 32	1.24
Half-fine dressed paving stones:		
6 to 8 inches	31 33	1.53
Edges, 5 to 5½ by 8 to 9 by 5½ to 6 inches	32 34	1.54
Edges, 4 to 4½ by 6 to 7 by 5 to 5½ inches	49 51	1.46
Fine-dressed paving stones:		
6 to 8 inches	31 33	1.64
Edges, 5 to 5½ by 8 to 9 by 5½ to 6 inches	32 34	1.65
Edges, 4 to 4½ by 6 to 7 by 5 to 5½ inches	49 51	1.56
Edges, 4 to 4½ by 6 to 7 by 5½ to 6 inches	49 51	1.94

The most interesting feature of this quarry is the system of transportation, which could hardly be more complete anywhere else.

Transportation between the various galleries of the quarries, the freight platforms, the crushers, and the dumps is effected by a system of double tracks, which all converge at a single point. At this point cars may be run upon a trackless cast iron turntable and switched from one to any other track. The cars are drawn by endless overhead chains which are seized by a grip attachment on the car. This grip consists of a forked-shape incision in a strong iron arch stretched across the car. The chains are kept in motion by a number of perpendicular axles rotated by steam power. Empty cars are raised by the descent of loaded cars where possible, and in other cases by transmission of power through the medium of compressed air. If, for any reason, the chain should let slip a car on any of the inclined tracks, it is caught by a simple automatic device and thus prevented from doing harm.

The greatest grade in the case of tracks for chain transportation is 35 per cent. In the following table, after Dietrich, data are given concerning the material of transportation:

	Pounds.
Weight of rails per running yard	22
Weight of wagon, empty	858
Weight of wagon, loaded	2,178
Weight of chain per running yard for main tracks, thickness of link 1 inch	30
Weight of chain per running yard for side tracks, thickness of link nine-tenths inch	21
	Feet.
Speed of chain per second on main tracks	3
Speed of chain per second on side tracks	2
Interval between wagons	30-60

In 1885 there existed in this quarry 5,500 yards of track for chain transportation and 15,000 yards of other track, and 10,000 yards of railway track of normal gauge between the platforms and thence to the station. For the chain transportation 700 wagons are used, each holding one-half cubic yard, on the platforms 60 dumping wagons, and in and around the quarry 200 other track wagons. Of all the stone quarried at Quenast, about 50 per cent. is sent off in the form of paving stone of various kinds. The remainder is worked up by means of a stone crusher in a very practically arranged factory into macadam and finer gravel, for which the rock, owing to its toughness, is very suitable.

The trucks, laden with cast-off material from the quarry, are carried forward by means of chains to the factory, are placed on dumping apparatus, and emptied into large funnels discharging into the stone crushers, After the stone has passed through these it drops into a somewhat inclined rotating cylinder provided with holes, and is there sorted into gravel of the following grades: (1) Macadam, four-fifths to to 2½ inches in size; (2) ballast gravel for railways, one-fifth to four-fifths of an inch; (3) sand for gardens and promenades, one-fifth of an inch. From the sorting drum the gravel falls through large funnels

directly down into the railway trucks. The sand, however, is once more subjected to sorting in flat sieves. The stone crusher itself, constructed after the Blake system, is stated by Dietrich to have jaws 2 feet high. The upper opening or mouth is 1½ feet long and 1 foot broad; the lower can be made narrow or wide at pleasure. The movable jaw strikes 300 blows a minute. There are 6 crushers of this kind in the factory, only 2 of which are held in reserve. Each pair of stone crushers, with a sorting drum belonging to it, is driven by a steam engine of 100-horse power. It was stated that each crusher could work up in one hour 31 tons of stone, which agrees pretty closely with Dietrich's statement of 10 cubic yards. The sorting drums, which make 15 revolutions a minute, are 36 to 40 feet in length and 3½ feet in diameter. The upper part, which drops the sand, has round holes; the middle part, for the ballast gravel, has rectangular holes; the lowest, for macadam, round holes. By making the last-named part somewhat longer than the others, and by giving to the drum a suitable inclination, it has been possible to make the ratio between the more valuable macadam and the less valuable fine-grained product equal to 3:2. The cost of production in the stone-crushing factory of 1 cubic yard of macadam, ballast gravel, and sand together was stated by Dietrich to be 41 cents, of which wages were 14 cents; coal and oil, 6 cents; rent, etc., 21 cents. The selling price, which of course varies, was in 1885 stated to be—

	Per 10 tons.
Macadam	$5.83
Fine sand	5.83
Ballast gravel	2.90 to $3.90

At the time of Mr. Lundbohm's visit in 1888 the number of workmen was about 2,000. Dietrich mentions 2,200, divided as follows:

In the quarry:	
Drilling, blasting and dressing	1,075
Sorting, accounting, and lading	440
Working up the stone on the platforms	350
Chain transportation, turning trucks	40
Transportation on platforms and lading	90
In crushing factory and for transportation thither	100
In repairing shop	50
For removal of earth, etc., in the quarry	55

A stone-worker employed in the quarry was stated to earn on an average 68 cents per day, but sometimes even $1.17 or $1.36; an ordinary workman in the quarry, on the average, 50 cents, and occasionally 58 cents a day. These wages are comparatively low, but it must be noted that the workmen enjoy the advantage of cheap and comfortable dwellings, erected by the company, which also takes care that the means of living are obtained cheaply, has established schools, etc.

The amount of paving stone worked up is stated to be 180,000 to 190,000 tons annually. According to a table given by Dietrich, it has

increased between 1873 and 1884 from 16,497,135 pieces of paving stone (120,852 tons) to nearly 24,500,000 pieces (222,000 tons) per year. Of this 33 per cent. belong to classes 2, 3, and 4, that is to say, they are dressed; the rest is only coarsely hewn. Assuming 250 actual working days per year, the daily production amounts to nearly 100,000 pieces of paving stone.

The production of macadam is stated at 90,000 cubic yards, that of ballast gravel and sand at 60,000 cubic yards per year.

The area supplied by the products of Quenast, despite the rather high freight charges, extends far beyond the boundaries of Belgium. Thus large quantities of paving stone are sent to Holland and France, and even to more remote places, such as Cologne, Berlin, Petersburg, Bucharest, etc. The same is true of the other products, or, at any rate, of macadam. The manager of the Mount Sorrel Granite Company in England reported that even along the east coast of England the great Belgian work competes with English firms in this article.