"Our Building Stone Supply"

By George P. Merrill

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"That upward of $25,000,000 is invested in the stone quarries of the United States is doubtless scarcely realized by the majority of persons.

"Building stones are of themselves so unattractive to the ordinary observer, and the methods of quarrying and working so laborious and uninteresting, that one is apt to ignore utterly the source of origin of the material, and admire it only in its finished state. Few of those who admire the beautiful work of the sculptor's hands, or the genius of the architect and builder, as displayed in some elegant brownstone or marble front, give even a passing thought to what the material of construction really is, and what its original source may have been.

"Yet if he who passes along the principal streets of any of our large cities will but for a moment consider how literally incased he is by stone walls, stone pavements under his feet, stone houses on either hand, he will at once become impressed with the fact that somewhere must exist vast resources to supply this enormous quantity and great variety of material, and large business interests be involved in its production and preparation for the market.

"But until the publication of the returns of the tenth census, it is doubtful if any but those actually engaged in the preparation of this work fully realized the extent of the industry. From this report it appears that during the year ending May 31, 1880, there were in active operation in the United States 1,525 quarries of building and ornamental stones of all kinds,* representing an invested capital of $25,414,497, and giving employment during the busy season to upward of 40,000 men. The total product of the combined quarries was 115,380,133 cubic feet, valued in the rough at $18,365,065.

(* This does not include the very many quarries of stone used for paving or lime burning, but only those whose product is actually used wholly or in part for building or ornamental work.)

"Granites came first into use in this country, probably more on account of their ready accessibility than from any desire on the part of the people for so refractory a material, the

matters of transportation and cost of working being then as now the controlling items in deciding what substances were to be employed. As early as 1650, a building long known as the 'stone house of Deacon John Phillips' was erected in Boston from rough stone found in the immediate vicinity or brought as ballast from England. Another early stone building was the 'Old Hancock House,' which was constructed from bowlders of Braintree (Quincy) granite. Neither of these is now standing. In 1749-54 Kings Chapel, which is still standing on the corner of School and Tremont Streets, was erected. This also was of bowlders of the Quincy stone, and was a seventy times seven days' wonder to all who beheld it. Considering the methods employed in getting out the stone, it was indeed a remarkable structure, for we are told that the bowlders were broken by first heating by fire, and then letting fall heavy iron balls upon them from a considerable height. Crude as was the method, the building still stands in a better state of preservation than many that have been erected since; and singularly enough, the wonder does not seem to have been that the stone could be worked at all by these means, but rather that enough good stone was obtainable, and it was universally conceded that enough more like it could not be found to build another!

"The granite bowlders dotting the Quincy commons continued to furnish for many years the chief stone used in the vicinity for foundations, steps, and like purposes, and were from time to time the subject of State legislation, lest a too indiscriminate use of the material should exhaust the supply. Early in the present century, however, granite began to be brought into the city from Chelmsford or Westford (Hitchcock says the latter), and stone buildings became more common. In 1810 was erected the Boston Court House, in 1814 the New South Church, and about the same time the Congregational House on Beacon Street, the Old Parkman House on Bowdoin Square, the University Hall in Cambridge, and in 1818-19 the first stone block in the city, a portion of which is still standing on Brattle Street.

"In the above year, stone from the same source was also shipped to Savannah, Ga., for the construction of a church at that place, but this also was obtained largely from bowlders, and such a thing as a permanent quarry systematically worked was almost unknown. The demand for large quantities of stone for the construction of the Bunker Hill Monument caused the opening of extensive quarries in Quincy in 1825, and the construction of what has been called the first railway in America to transport the quarried material. From this date the development of the quarrying industry has gone on constantly and rapidly. It is stated that as early as 1837 the total output of all the quarries of Quincy was 64,590 tons, valued at $248,937, in the production of which some 533 men were employed.

"In 1845 the value of the total product had increased to $324,000, although the number of men employed was but 526. In 1855 there appears to have been a falling off, since the value of the product of that year was but $238,000, and but 324 men furnished with employment. Twenty-five years later (1880) the census returns for the town of Quincy and West Quincy showed a total of some thirty quarries, producing annually not less than 723,000 cub feet of stone, valued at $226,440, and giving employment to some 820 men.

"Over half a century of use has made the Quincy granites so well known that I shall refer to their qualities but briefly.

"Exceedingly tough and hard, of a coarse texture, and deep blue gray color, they give an appearance of peculiar solidity and strength to all buildings in which they are used, while the fact that they admit of a high lustrous polish renders them peculiarly adapted to the finer grades of

monumental and decorative work. For the latter purposes they are coming more and more in vogue, and appearances indicate that with present prices and tastes the days of Quincy granite for merely rough building purposes are over, and henceforth it must be known more properly as an ornamental stone.

"Nevertheless, there are few stones that have exercised a more pronounced effect upon American architecture.

"In Boston alone, out of the 312 buildings with exterior walls constructed wholly or in part of granite, 162 are of the Quincy stone. Figures, if obtainable, would, I am inclined to believe, show a like proportion in other of our Eastern cities.

"At about the date of the opening of the 'Bunker Hill Quarry' at Quincy, a granite quarry was also opened in the adjacent town of Gloucester, a 'town heretofore noted only for its fishery interests,' and not long after others were opened at Anisquam, but which were soon abandoned. Quarries at Rockport just beyond Gloucester were opened in 1827, and are now in a flourishing condition, though the first year's business is said to have resulted in a net loss of $15. The celebrated quarries at Bay View, now the property of the Cape Ann Granite Company, were opened in 1848. This is now one of the best equipped in all its appliances of any quarry in the country. The material, of which there is an annual output value of nearly a quarter of a million dollars, is coarse, but exceedingly strong, and of a blue gray or greenish color.

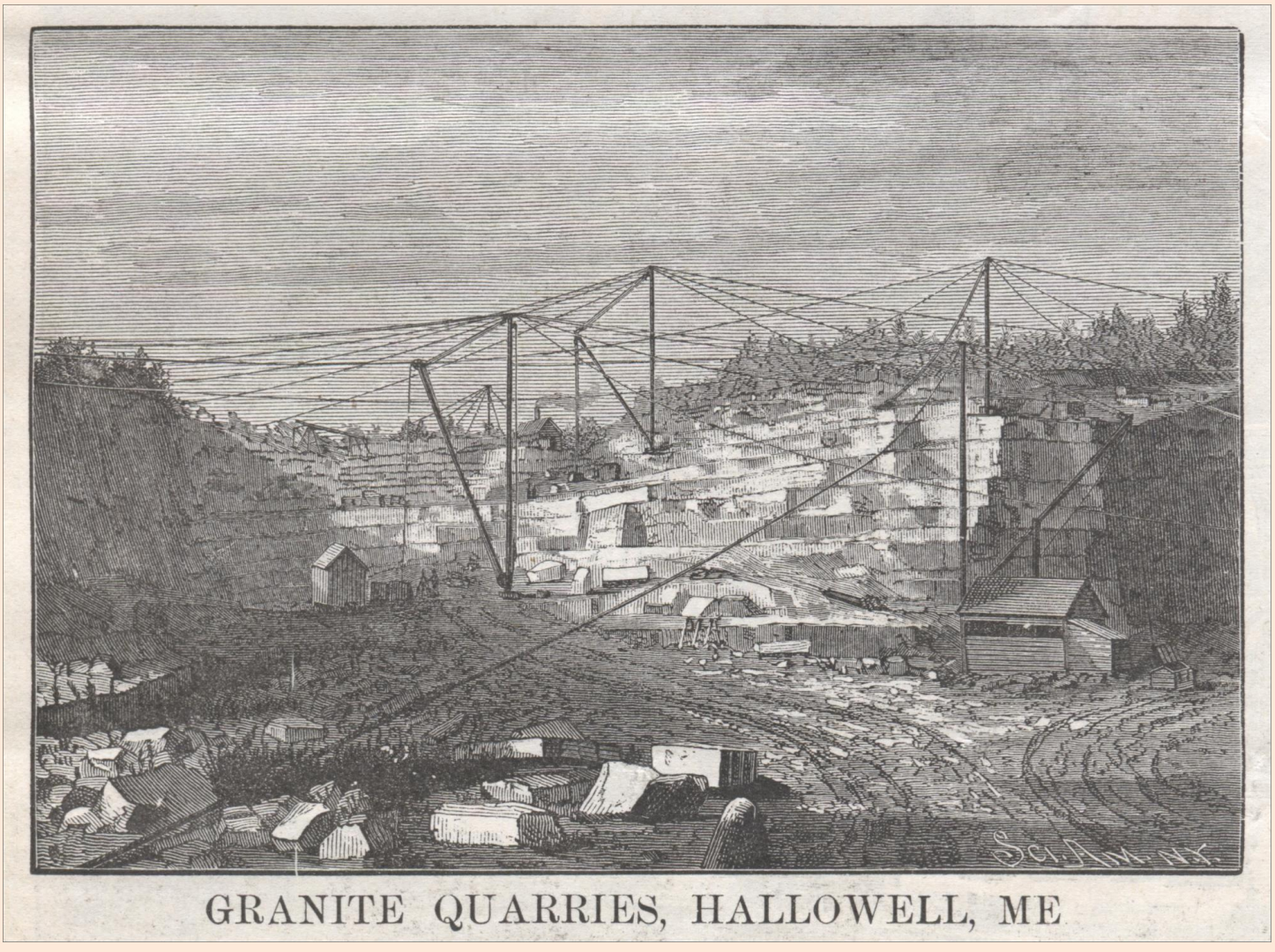
"To those who have seen and admired the Butler mansion on Capitol Hill in Washington, nothing need be said in praise of the material for massive structural purposes.

"To take up the history of the granite industry as it spread out from these few starting points would far exceed the prescribed limits of this article an unnecessarily tax the reader's patience as well. We will then but briefly allude to a few such quarries as have gained a national reputation from the quality of their material, and leave interested parties to seek elsewhere for further details.*

("* See 'On Stones for Building and Decorative Purposes' by the author, now in course of preparation.)

"Whoever has taken the delightful sail from Portland, Maine, to Mt. Desert, Grand Manan, and Eastport, cannot have failed to mark the rocky barrenness of much of the coast and the adjacent islands. The 'cold gray granite' is everywhere pushing out its unprotected front, apparently alike defying the attacks of man and nature. The rare excellence of many of these outcrops for quarry sites early made itself evident to the shrewd and energetic business men of New England, who were not slow to take advantage of them. It is stated that in 1837, out of 125 acts of incorporation granted by the State legislature, not less than thirty were for granite-working companies, three of which were to be located in the immediate vicinity of Augusta and Hallowell, while the others were to be scattered along the eastern borders of the State, mostly directly upon the coast. The Hallowell granite quarries, being among the earliest, shall first receive our attention. Situated some two or three miles out of the town, the rock lies in the quarries in the form of huge imbricated sheets of all thicknesses up to eight or ten feet. So slightly do they adhere to one another, that it is but necessary to free the stone at the sides by a

few drill holes and blasts to obtain blocks of almost any required size. The material is almost white in color, and of so fine and even a grain that it can be utilized for all manner of constructive purposes, excepting, perhaps, interior decorative work. One can but experience a feeling of surprise on passing into the companies' shops to find himself surrounded on all sides by sculptors of American, Spanish, Italian nativity busily engaged. In reproducing from plaster models by dint of hammer and chisel a great variety of imitative forms, not of course excepting the mythical winged figures which in our youth and ignorance of the possibilities of anatomy we have been taught to suppose represent the future forms of those who are sufficiently good in this world to be rewarded in the next. The Hallowell Granite Company have fully demonstrated the fact that the art of sculpture is not limited to the use of one particular material, and it is stated, indeed, that in spite of its increased hardness, a granite statue now costs but little more than one of marble. This is due, however, in part to the fact that less detail is brought out in the granite than when the latter material us used.



"Granite Quarries, Hallowell, Maine"

"Those who imagine that the Egyptian obelisks are among the largest single blocks of granite ever quarried should visit the works on Fox Island, or Vinalhaven, as it is now called, in Penobscot Bay. Here will be found a thriving village of some 3,000 souls, dependent for its prosperity almost altogether upon the extensive granite quarries in the immediate vicinity, and whose proximity is impressed upon the traveler the moment he lands from the steamer at the wharf, by the immense masses of stone lying about in every direction. The rock occurs here in such masses that the size of blocks obtainable is limited only by the means of handling. Single pieces have been loosened from the bed of such size and shape as to make four such pygmy shafts as that transported from Alexandria to succumb to the rigors of an American climate in Central Park, while blocks of 200 tons weight are so abundant as to cease to excite remark. The Wolff monument in Troy, N. Y. – 60 feet in height by 5 ½ feet square at the base – is the largest single block ever finished by this company, or indeed in the United States. But in this case, as in others to be mentioned, the size is governed only by demand and transportation facilities.

"To Maine belongs the credit of producing the only red or pink granite that can at all successfully compete in our markets with the imported Scotch granites or those from the Bay of Fund, New Brunswick, though excellent varieties for general building, and which are used to a less extent, occur in several other States.

"The beautiful pink granite used in the construction of the new Trinity church in Boston is from Dedham, Massachusetts, while the coarser stone used in the new City Hall at Albany was taken from quarries at Milford in the same State. The two beautiful columns of deep red granite in the Senate Chamber of the new Capitol building at Albany are from quarries on one of the Thousand Isles in the St. Lawrence, while the four large pillars of pink porphyritic granite in the Assembly Chamber were furnished by quarries at Leetes Island, Connecticut.

"The celebrated Concord, N. H., granites are from quarries in the immediate vicinity of the city from whence they derive their commercial name, and are quarried to the value of some $200,000 annually. This stone closely resembles that of Hallowell, Me., and is used for similar purposes. Although popularly known as the Granite State, New Hampshire ranks but fifth as a granite producer, being preceded by Maine, Massachusetts, Rhode Island, and Connecticut. Granites of excellent quality also occur in the Archæan formations of the Appalachian system as far south as northern Georgia, though they are now but little quarried. Near Richmond, Va., occurs an excellent bed of this stone, which furnished the material for the State, War and Navy department buildings in Washington.

"A coarse red granite, very poor in mica and of excellent quality for massive structures, occurs in inexhaustible quantities in Iron County, Missouri, and is being extensively used in Chicago, St. Louis, and other Western cities, both in polished and rock faced work. Other gray granites, to which we can barely allude for lack of space, occur near Concord, N. H., where they have been quarried for many years.

"Ever since the discovery of the wonderfully beautiful effects produced in marbles by the early sculptors and decorators, these stones appear to have been regarded by people at large with a sort of veneration amounting in some cases almost to fetichism; and any stone to which the name is now applied seems generally accredited with possessing all the qualities of beauty and excellence of those first used. This is, however, far from the case; and while the name includes

stones of rare beauty, it is also made to cover others suitable only for general building purposes, and which are perhaps poor at that.

"To dream that one dwells in marble halls does not therefore necessarily denote a condition of perfect bliss, but it may be a state of abject misery, since one can scarcely imagine a more dreary material for interior decorations than many of our white and bluish marbles, but which are, nevertheless, used with amazing consistency. Even the crude expression of boyish enthusiasm, designed as a monument to the Father of his Country, that now rears its lofty head out of the malarial emanations of the Potomac flats, was built wrong side out in deference to the state of popular opinion. Interiorly it is of the finest quality of Maine and Massachusetts granite, while exteriorly the dead white marble walls are already seamed and stained so as to be quite unsightly on a close inspection.

"From a scientific standpoint, there is no difference between a marble and ordinary limestone or dolomite, the rocks having precisely the same composition and origin, but the one possessing such color and structural peculiarities as render it desirable for ornamental or decorative work, while the other through the lack of these same qualities is relegated to the more ordinary purposes of general construction."

"Generally speaking, we may say that a marble is a limestone (or dolomite) that has undergone just the right degree of metamorphism to develop in it points of beauty, render it capable of receiving a smooth surface and high polish. In many of the most beautiful marbles the metamorphism has proceeded only so far as to harden the stone without destroying its fossil remains, while in others these have been entirely obliterated and the rock become crystalline throughout. Little as it seems to be seems to be appreciated, it is this crystallization alone that renders so many of the American marbles inferior to those of the French Pyrenees, Italy, and Northern Africa.

"Nearly all our native stones of this class are too coarsely crystalline. This not only renders the production of a perfect surface difficult, but the cleavage facets reflect the light from below the surface in such a way as to cause it to be studded with innumerable minute silvery points, quite destroying its uniformity. However good the color may be, a stone of this nature must always rank lower than one that is so fine grained and compact as to appear non-crystalline or amorphous.

"Marble, though one of the most beautiful of rocks, has yet a most ignoble origin. At the bottom of some old Devonian or Silurian sea, there accumulated through untold ages vast beds of dead corals, shells, and other marine animals, embedded in fine calcareous mud. Throughout succeeding ages these were further buried by sand and mud, to be finally, by heat and pressure, hardened into stone. Not stranger is it that the dust of Alexander be found stopping a bung hole, or that 'imperious Caesar, dead and turned to clay, might stop a hole to keep the wind away,' than that the slimy ooze of a seas bottom, full of all manner of dead and uncanny things, becomes by nature's processes an object of beauty, admired alike by the most esthetic, fastidious, and vulgar minded.

"Of the $2,000,000 worth of marbles annually produced in the United States, more than one-half ($1,350,000 worth in round numbers) is from quarries in Vermont, and the remainder nearly

altogether from Massachusetts, New York, Pennsylvania, Maryland, and Tennessee.* The material is imported to the value of about $600,000 annually, the supply coming largely from Italy, though smaller amounts are brought from France, Belgium, Portugal, Egypt, and Algeria.

("* The census returns give figures for limestone and marble combined. By going over the original schedules I was able to obtain the following approximations for the output of such as are put upon the market as marbles, for the census year:

Vermont	$1,340,000
New York	224,500
Massachusetts	238,125
Maryland	65,000
Tennessee	173,600
	$2,031,225

"The narrow belt of limestone from which is obtained the supply of Vermont marble extends from a point beyond the Canadian line throughout the entire length of the State, and thence through western Massachusetts and Connecticut to Long Island Sound. Since early in the present century numerous quarries have been opened along this belt, but at the present writing the most extensive lie within the limits of the little village of West Rutland, cozily nestling among the green hills of central Vermont. The quarries themselves, to which the village owes its entire business prosperity, lie along the western base of a low range of hills, which, to the ordinary observer, give no sign of the vast wealth of material concealed beneath their gray and uninteresting exteriors.

"In the quarry the stone is found in layers from two to four feet in thickness, often mottled and streaked, and varying in color from pure white to deep blue gray and almost black. These layers, instead of lying horizontally one upon another, are at the surface steeply inclined and almost on edge, so that the same quarry at the same time may be producing marbles of half a dozen grades of color and quality.

"In quarrying, the best beds are selected, and upon their upturned edges excavation is commenced; first by blasting, to remove the weathered and worthless material, and afterward by channeling, drilling, and wedging, no powder being used lest the fine, massive blocks become shattered, and rendered unfit for use. The quarry thus descends with almost perpendicular walls to a depth of sometimes more than 200 feet, when the beds are found to curve, and pass under the hill.

"In following them, the excavations assume the appearance of vast artificial caverns, from whose smoke-blackened, gaping mouths one would little suppose could be drawn the huge blocks of snow-white material lying in gigantic piles in the immediate vicinity. Some of these have been partially roofed over to protect them from snow and rain, and seem rather mines than quarries. The scant daylight at the bottom is scarce sufficient to guide the quarryman in his work. As one peers cautiously over into the black and seemingly bottomless abyss, naught but darkness and ascending smoke are visible, while his astonished ears are filled with such an unearthly chorus from clanging quarrying machines, puffing engines, and shouting laborers, as is comparable with

nothing within the range of our limited experience. The reader is therefore permitted to draw upon his own resources if comparisons are essential.

"The descent to the bottom of the pit is by means of numerous flights of wooden and suspiciously shaky-looking steps, bolted to the quarry wall. One passes down flight after flight in turn, each time to find himself only on a narrow, wet, and slippery ledge of rock, which serves as a landing to the flight below. At last the bottom is reached, and 200 feet below the surface of our sphere we look up at the gloomy wall of rock overhead, dripping with moisture and black with smoke, with an involuntary shudder of dread lest we are never to find our way to the top again. Everything is cold and dripping wet, and the atmosphere of that heavy, clammy feeling that can be described only by the suggestive work *dank*.

"Steam channeling machines moving slowly back and forth over their narrow roadbeds spitefully strike upon the rock clanging blows with long chisels which rapidly produce deep grooves some two inches in width and of any desired depth up to several feet. Closely after these follow the gadding machines, which drill or bore circular holes along the bottom and sides of the blocks, into which wedges are introduced and the stone split from its bed. The Wardwell channeling machine, which is the one most commonly in use, cuts a continuous groove at the rate of 75 to 150 square feet per day, thus doing the work of from 25 to 50 men by the old hand process. As the expense of operating the machine is only about $10 per day, the advantages of this method are obvious. It is claimed for the diamond gadder that it will do its work at the rate of 180 feet per day in rock of as soft and even a texture as marble. By the old hand methods, 12 feet was considered a fair day's work Three men are required for each channeler and two for each gadder, while a large force is employed in handling the loosened blocks and preparing the way for the machine.

"In spite of their threatening aspect, accidents at the quarries are, we are told, very rare. Nevertheless, it is with a feeling of relief, as well as one of weakness at the knees from continuous climbing, that we find ourselves once more on the surface, and breathing the dry, pure air which comes wafted gently down the valley.

"The line of quarriers extends along the Rutland valley, at varying intervals, for a distance of several miles. Abandoned quarries abound in the form of deep pits, with perpendicular sides, filled to an unknown depth with dark, greenish-looking water, covered with floating debris and slimy algæ, reminding one of some huge mediæval mote or dungeon, as described by Scott.

"The marbles of the Vermont belt, although most excellent of their kinds, are, with a few exceptions, either on account of their colors or unsatisfactory textures, but are largely used for general building, counters, tiling, and monumental work. The Vermont statuary, although of soft and even grain, and a beautiful stone to work, is of too dead white a color, lacking the peculiar translucency and waxy appearance of its Italian prototype. Other important stones which must not be passed over unnoticed, are the very hard, close-grained red and white 'Winooski' and 'Lyonnaise' marbles from Malletts Bay and Swanton. These are much used for tilings, and are susceptible, in proper combinations, of good effects in decorative work. But as displayed in the halls of the new Capitol building at Albany, the effect is anything but satisfactory. The fault, here, however, is largely due to improper care in selection and preparation of material.

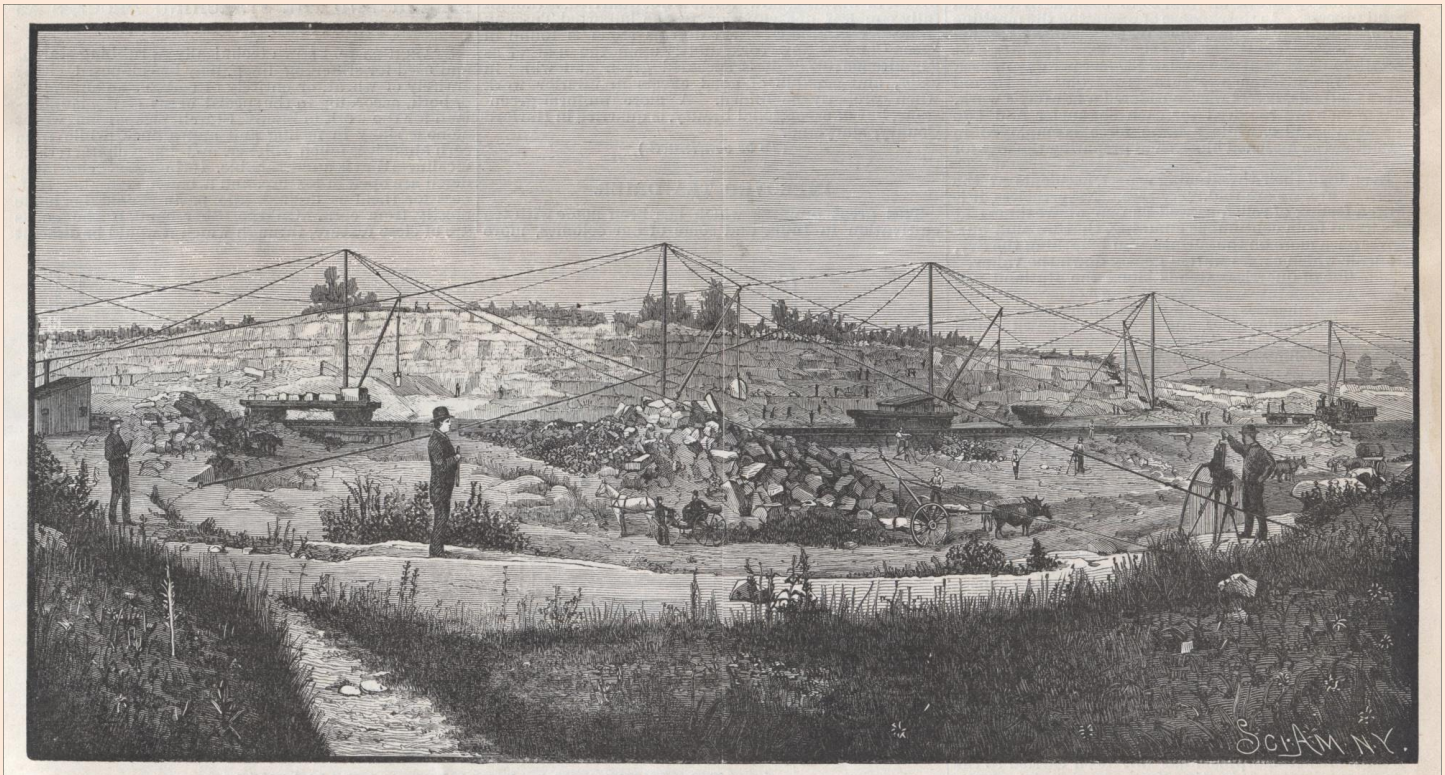
"The marbles of New York are also largely suitable only for general building, owing to this same defect. Two varieties from Chazy and Plattsburg, in Clinton County, are, however, notable exceptions. In these the process of metamorphism has not been carried to the same extremes as in the Vermont stone, and the resultant effects of pink and red fossil shells embedded in a gray and reddish background are very pleasing. Under the names of 'Lepanto' and 'French gray,' these stones are now in the market, and, with the exception of those of Tennessee, have been more used for furniture and interior decorations than any other American marbles.

"The finest marble for general decoration work which the country yet affords is undoubtedly that of Hawkins and adjacent counties in eastern Tennessee. Since its first introduction into the Capitol building at Washington, this stone has been a universal favorite, and justly so. In colors varying from light pinkish, mottled with white, through all shades to deep chocolate red, it offers sufficient diversity to suit the most fastidious, while the closeness and compactness of its texture, with almost absolute freedom from flaws, renders the production of larger surfaces, without recourse to the process of filling, than is possible in any other marble, native or foreign, with which the author is acquainted.

"The recently introduced marbles from Pickens County, Georgia, although scarcely known as yet in our Eastern markets, are worthy of notice. Like the Vermont marbles, they are rather too coarsely crystalline for the finest kinds of decoration, but the colors are such that they will doubtless be more sought. One variety, of a bright flesh pink, is especially unique, being totally unlike anything else now in the market, though a similar variety is abundant in certain parts of North Carolina, at present not readily accessible.

"One of the most unique marbles in this country is found in the beds of Devonian limestone near Charles City, Iowa. The rock is of exceedingly fine and compact texture, non-crystalline, and full of fossil shells and corals. The colors are dull, varying form light drab to brownish, but it acquires a smooth surface and quite uniform polish, showing to beautiful advantage the fossil remains, often six or ten inches in diameter, firmly embedded in the fine drab ground-mass.

"It is stated by Prof. Seely that the earliest attempts at systematic quarrying of marble in New England (and doubtless in America) were those of Philo Tomlinson, who began operations at Marbledale, in the town of New Milford, Connecticut, about 1800. Other quarries were soon after opened, and in 1830 as many as fifteen were in active operation, and as many mills for sawing were in operation within a distance of three miles. The produce was sent to all parts of the country. Soon after this date competition set in from other localities, particularly from Dover, New York, and Rutland, Vermont, and by 1850 the business had proved so unremunerative that the last quarry was abandoned. Marble quarries and mills were also in active operation at West Stockbridge, in Massachusetts, as early as 1802 or 1803, and these furnished the marble for the City Hall in New York city. Work was stopped here in 1855, owing to competition of Vermont and Italian marbles.



QUARRIES OF FLYNT GRANITE CO., MONSON, MASS.*

"Quarries of Flynt Granite Co., Monson, Massachusetts"*

(* "W. N. Flynt & Co.'s granite quarries, situated a mile north of the village of Monson, on a spur track of the New London Railroad, were first opened eighty years ago by agents of the United States Government, who took from there stone for the foundations of the Springfield armory. In 1825, Rufus Flynt put four or five men to work in the quarry to supply the local market, and the front of the Chicopee bank building in this city was soon after built of this stone. Since 1836, W. N. Flynt, son of Rufus Flynt, has had charge of the work, and has greatly enlarged the business until at present the yearly output of stone is about 20,000 to 30,000 tons, valued at $150,000 to $200,000. The quarry land owned by the company amounts to 500 acres, all underlaid with granite, only a small part of which, however, has yet been worked. The stone lies in horizontal layers, from one to twelve feet thick, and wedges are mainly depended upon for getting out even the largest masses of rock, powder being only used to lift the loosened layer from its bed. The largest single piece which has yet been taken out was 354 feet long, 11 wide, and 4 high, and 1,104 edges were used in detaching it. The present workings are on the slope of a hill, and, although 75 feet below the crest of the hill, and above the surrounding country, so that water gives no trouble, and the rock is the more easily handled. From March to December about 100 quarrymen and 40 stone dressers are employed, and during the winter an almost equal force is kept at work. Last year 28,403 tons of granite were shipped, and in all branches of the work between 600 and 700 men were employed. – *Springfield Republican.*")

"Of the may marble quarries in Vermont, those in East Dorset are believed to have been longest systematically worked, Prof. Seely stating that one Isaac Underhill began operations here as early as 1785, the product being utilized for fire jambs, chimney backs hearths and lintels. Other

quarries soon opened, and from 1785 to 1841 nine were in operation at this place. The first marble gravestones ever finished in the State are believed to have been the work of Jonas Stewart, in 1770. Prior to the introduction of Italian and Rutland marble, about 1840, the Dorset stone was in greater demand than the supply was sufficient to meet. At West Rutland, works were first put in successful operation about 1838. At the present time not less than fifteen quarries are in operation, affording employment altogether to about 2,000 men.

"The so-called 'verdantique' marbles are entirely different from those just mentioned, being composed largely of serpentine or of serpentine in combination with calcite. Extensive beds of this rock in the vicinity of Roxbury, Vermont, are capable of furnishing an inexhaustible supply of this beautiful material. Owing to cost of working, however, it is not quarried, although fully equal, if not superior, to the important Tuscany stone. A granular variety of this stone is found in Essex County, New York, and is upon the market as 'ophite marble.' It is speckled green and white in color, and capable of good effects in interior work when properly combined. A more uniform green stone, but of exceptional beauty is quarried in Harford County, Maryland."

(To be continued.)

(See Next Page for the conclusion of this article.)

"Our Building Stone Supply"

By George P. Merrill

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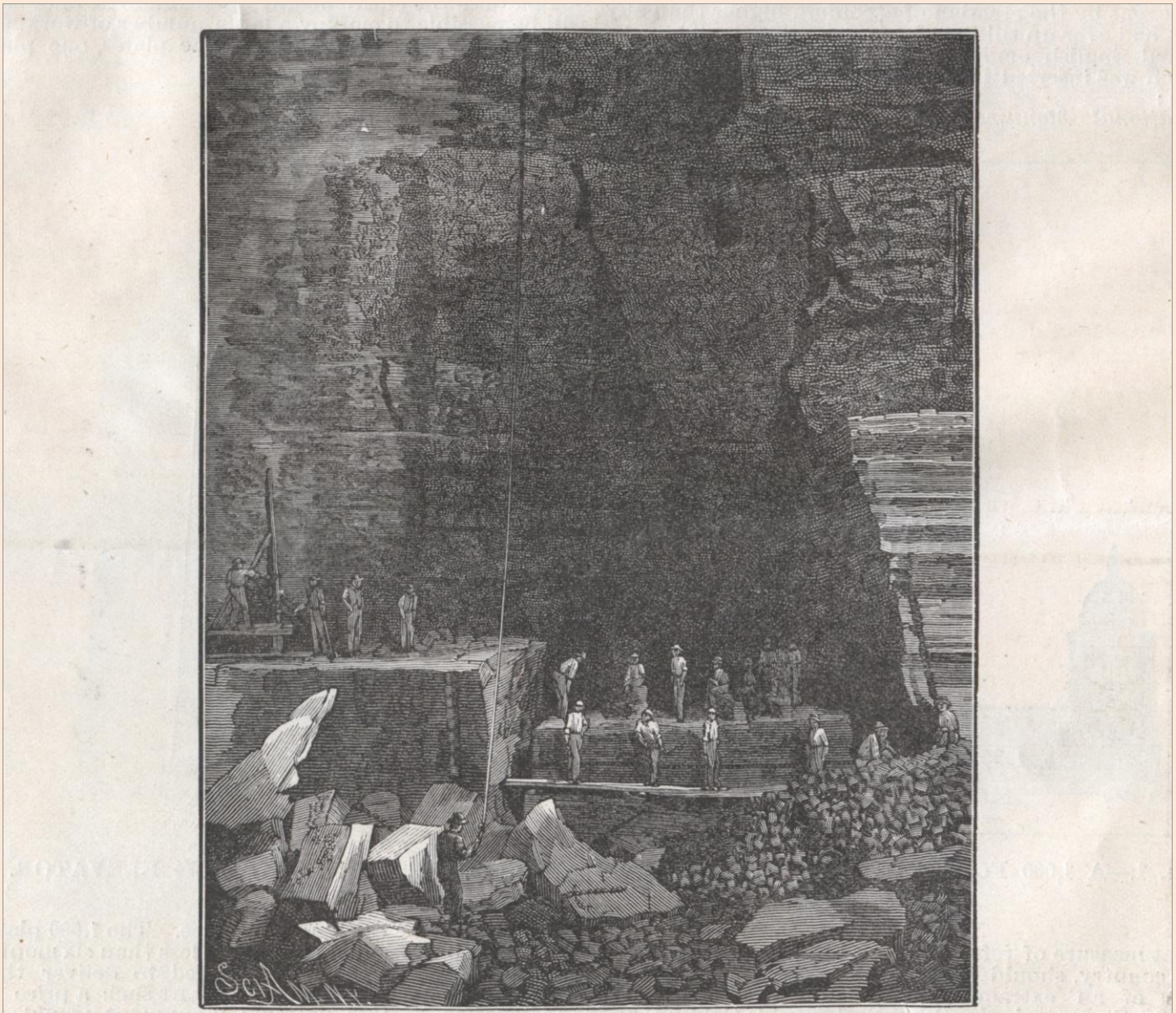
Continued from Supplement No. 577, page 9212

"Of limestone other than marbles, stones used only for general building, but which, owing to color and lack of polish, are unsuitable for decorative work, we have time and space to notice only the fine grained, light colored varieties of Indian, Illinois, and Kentucky. These are often oolitic in texture, and vary from almost white through dull cream color to drab. The evenness of the grain of these stones, their softness, and at the same time toughness, render them adapted in a remarkable degree, to general building and highly carved work, especially for country residences, and in cities where there is but little smoke or gaseous exhalations from manufactories. For work of this kind there is no stone, native or foreign, with which they can compare, though they bear a very close relationship to the Bath (England) oolite, which has been in use since early in the thirteenth century. The American oolites are, however, harder and less absorptive, the latter item being one of importance in a climate so trying as that of the United States.

"The quarrying of sandstone or *freestone*, as it is so often called, appears to have begun with the itinerant working of the extensive beds of Triassic brownstone in the vicinity of Portland, Connecticut. It is stated that the first quarry here was opened 'where the stone originally rose high and hung shelving over the river.' The value of the material was early recognized, and it began to be utilized for building and for monuments soon after the settlement of Middetown, on the opposite bank of the stream. The quarries were at this time regarded as common property, and were worked on occasion demanded, both by the people in the immediate vicinity and by those living at a distance, who carried off the material in scows, boats, and vehicles of various sorts, nor thought of giving anything as an equivalent. This system of free quarrying had assumed such proportions as early as 1665, that on September 4, of that year the citizens of Middletown assembled and voted that 'whoever shall dig or raise stone at ye rocks on the east side of the river (now Portland) for any without the town, the said digger shall be responsible to ye town twelve pence pr. tunn for every tunn of stones that he or they shall dig for any person whosoever without the towne; this money to be paid in wheat and pease to ye townsmen or their assigns for ye use of ye towne, within six months after the transportation of said stone.'

"How soon the surface rock was exhausted, and it became necessary, as now, to go below the level of the ground for suitable material, we are not informed, but the quarry thus opened was at length disposed of by the town, and has passed through various hands, among whom the names of Shaler and Hall have ever been conspicuous.

"The present industry is comprised in three large quarries, extending from a point near the ferry northward along the river for some three-fourths of a mile. These vary from 50 to 150 feet in depth, and their total yield of stone of all grades, during the time of their operation, has been roughly estimated at 4,300,000 cubic feet. The rage of progress has been given as follows: In 1850, the number of men employed at the three quarries was 900, with 100 yoke of oxen, 30 vessels being regularly employed to convey the quarried material to market, each vessel carrying from 75 to 150 tons and making from 20 to 30 trips each season. Two years later, the number of men regularly employed had increased to 1,200 while 200 more were engaged on contract work.



PORTLAND SANDSTONE QUARRIES—SPLITTING OUT THE STONE WITH WEDGES.

"Portland Sandstone Quarries – Splitting out the stone with Wedges."

The stone, even at this date, had found its way to markets as far west as Milwaukee and San Francisco. The census returns for 1880 showed that the total number of hands employed to be but 925, with 80 yoke of oxen and 55 horses and mules. The falling off in numbers may be considered due to the introduction of machinery and improved methods of working. The total product of the three quarries for this year was about 781,600 cubic feet, valued at not less than $650,000. A fleet of 25 vessels of various kinds was regularly employed in conveying this material to market. In their present condition, the approaches to these quarries are more interesting than beautiful. The entire landscape is of a brownish color, and an ankle-deep fine, penetrating dust is everywhere prevalent.

"The ground is strewn with huge blocks of stone, about and among which swarm the busy workmen and the ever-present small boy and omnivorous goat. The beds of stone lie nearly horizontal; and in quarrying a natural point face is often selected as the quarry wall, which is followed down to any practicable depth, leaving thus an absolutely perpendicular wall on three sides, from 100 to 150 feet in height. The fourth side is usually less abrupt, allowing passageway for teams and workmen. In getting out stone, large masses of several hundred tons weight are first loosened from their bed by means of blasting, the drill holes being sometimes twenty feet in depth, ten inches in diameter, and charged with from twenty-five to seventy-five pounds of powder. These large blocks are then broken up by cutting, with picks, long grooves, into which iron wedges are inserted at intervals of a few inches from one another. Workmen armed with heavy hammers then pass along this line, dealing telling blows upon the wedges, until the stone yields to the strain, and falls apart. The blocks are then attached to a steam windlass and drawn to the surface. In getting out the finer class of material, channeling machines are used to some extent, as in quarrying marble. Once out of the quarry, the blocks are attacked by workmen armed with what are simply ordinary pickaxes with short straight points, who trim off all superfluous and waste material. The blocks are then slung, by means of chains, under the axles of exceedingly awkward and overgrown looking pairs of wheels and drawn by oxen to the river's bank, where they are loaded upon vessels. Very little of the stone is dressed at the quarries, nearly all being shipped in the rough to New York and other large cities, where it is worked up as occasion demands. It is found in all our leading markets, and several cargoes have even been shipped to San Francisco via Cape Horn.

"The quarries are actively worked only from May to November, and this not because the inclemency of a New England winter is too much for the quarriers, but rather on account of the stone itself, which is much more seriously affected by extremes of temperature. All stones, and sandstones especially, contain, when freshly broken from the quarry bed, varying amounts of moisture, or quarry water, as it is technically called. If exposed to freezing while in this condition, they are, if not actually burst and ruined, at least rendered less tenacious. In many localities it is necessary to flood the quarries with water, or cover them with earth, on the approach of cold weather, to prevent serious damage from this cause.

"But the Connecticut brownstone is not of interest from an economic standpoint only. To the geologist and all lovers of nature, it has furnished many an hour of honest study and pleasing recreation. The lithologist will tell us that this entire formation of hundreds of feet in thickness, extending from Long Island Sound to northern Massachusetts, and having an average width of twenty miles, is entirely made up of fragments of granite or gneiss; that under his microscope the water-worn particles of quartz, feldspar, and mica are still readily distinguishable. And indeed

we may accept it as a foregone conclusion that this whole formation is but an indurated sandbank. Proof positive of this would seem to be furnished by the ripped and wave marks which are even now found separating the various layers of stone, just such marks are as today being formed under our modern sea beaches and river banks; and also by the fact that in quarrying it is not uncommon to uncover the tracks of some huge bird or reptile, who, wading in shallow water to gain his daily meal, left the imprint of his three-toed feet in the soft mud, to slowly petrify and be again brought to light after thousands of years have elapsed.

"But all our sandstones are not brownstones, and neither is the entire supply brought from Connecticut. Massachusetts, New Jersey, Pennsylvania, and Maryland also furnish large quantities of this material, while the deep blue gray 'bluestones' or flagstones of New York and Pennsylvania, and the 'Euclid bluestones' and 'Berea grits' of Ohio are almost too well known to require especial notice. The first mentioned of these are found in New York State, in a comparatively narrow belt west of the Hudson River, mainly in Albany, Greene, and Ulster Counties, and belongs geologically in great part to the Hamilton group of the Devonian formations.

"In the ledge the stone occurs in layers varying from a few inches to three or four feet in thickness, and which adhere to one another with such slight tenacity as to readily separate by bars and wedges, without the use of explosives. The quarries are mostly shallow affairs, and the methods of operating them crude in the extreme. It was from a quarry of this stone, in Sullivan County, that was obtained the monster flagstone, 25 feet long by 15 feet in width, which now forms a portion of the sidewalk in front of the Vanderbilt residence on Fifth Avenue, New York. The size of this stone was, however, limited in this, as in many other instances, only by the means of transportation, neither railroad bridges nor canal locks allowing passage for blocks of larger dimensions. But one of the most important sandstones at the present day is that known as the Berea grit, or more popularly perhaps the Ohio freestone of Ohio.

"This stone, which belongs geologically to the subcarboniferous formations, and which differs from the Triassic brownstone in having had all its ferruginous coloring matter leached out of it by the prevailing organic matter of the coal age, occurs in beds from 10 to 73 feet in thickness and occupying a belt of country extending from the southeastern corner of Ashtabula County westward into Erie County, and then southward to the Ohio River. In quantity, it is needless to say, it is inexhaustible. In color, it is light, almost buff, of fine and even texture, and soft enough to work readily and evenly in any direction. It is by far the most common sandstone now in use, both for general building and for trimming purposes, in the United States.

"Its chief defects are pyrite (sulphide of iron) specks, which rust and stain the stone, and its liability in finely carved work to succumb to the crumbling effects of frost. I cannot leave this subject without calling attention to the wonderful evenness of the bedding of the stone as displayed in the quarries and as described by Prof. Orton. In some of the quarries in Trumbull County, it is stated that blocks of the stone ten feet square and only one and a half inches thick have been extracted, and with surfaces so smooth and even that a straight edge laid upon them would touch at every point.

"In one case, a strip one hundred and fifty feet long, five feet wide, and three inches thick, was reported as raised from the quarry bed, and the various layers of the stone, though closely compacted, are perfectly distinct, and adhere to one another, 'scarcely more than sawn planks in a pile.' Truly, had the stone been laid down for the express purpose of being quarried, the conditions could scarcely have been more favorable. As an illustration of the extent to which the stone is utilized, it may be stated that in the town of Berea alone, nearly forty acres of territory have been quarried over to an average depth of forty feet.

"A few words in conclusion regarding the future of the industry. Of materials for all ordinary purposes of construction the supply is inexhaustible. With the increasing wealth and culture of the people, the demand for other substances than wood and brick is certain to increase. In no State are the resources as yet taxed to their utmost, even are they fully known. The fact that Maine and Massachusetts are at present producing two-thirds of all the granite rock used is not due to lack of equally good material in many other States, but rather to the ready accessibility of the quarry regions by both rail and water routes, and proximity to the leading markets. Virginia, North and South Carolina, and perhaps Georgia, together with some of the more northern and western States, contain granites of equally good quality, but poorer facilities for quarrying, lack of market and means of transportation, together, it is in many cases to be feared, with lack of enterprise, have left the quarries unopened, or if worked at all, only in such a way as to cause them to be overlooked as permanent sources of supply. The two first named States will doubtless continue for many years to furnish, as now, a large share of the granite used in this country. With marbles, limestones, and sandstones, however, the case is quite different, since the quarries of these stones are nearly all situated inland, and are dependent, largely, upon railways for transportation facilities.

"With the opening up of lines of railways, then, throughout the South and West, we may expect the quarry products of these regions to enter sharply into competition with those of the more eastern States. North Carolina contains very promising outcrops of both marble and sandstone, but which are now scarcely at all worked, for the reasons just mentioned.

"The white, colored, and pink marbles of Georgia, are already in the markets of Chicago and Philadelphia, and it will be a question only of quality and adaptability that shall decide whether or not these shall drive the Vermont marbles before them, as those of Massachusetts and Connecticut were, in their time, driven out by those of Vermont.

"Beautiful sandstones of warm and mellow tint are to be found in many of the Western States and Territories, which are not now quarried, simply because there is no near demand for the material, and transportation is expensive. Let such local demand arise, as some time must, as shall cause the quarries to be once opened, and there is reason to suppose the stone will be sent out to other States, now supplied from Eastern sources.

"The people of the United States have, as yet, much to learn in the way of properly quarrying and utilizing the quarried material. Accustomed to things on a large scale, the quarryman seems scarcely to think of carefully picking and working the choice pieces of small size, however beautiful they may appear. If the material cannot be obtained in blocks or slabs of large dimensions free from flaws, away it goes into the dump and is forgotten. I remember to have

seen in the immense piles of refuse about the quarriers in Vermont, many beautiful blocks of a blue-black and white breccia marble, which, because it did not yield a perfect surface on sawing and was somewhat flawed, was at once discarded. The same material in any other country would be carefully backed and filled, and if sent to the United States, would find a ready market for wainscotings and interior decorative work.

"The same may be said regarding the breccia marbles of Maryland. There is scarcely one of the foreign marbles now imported, excepting the common white and clouded varieties, but requires filling, if indeed it is not so fragile as to require a backing of cheaper material to give it strength; yet we are not content to work our own materials, unless, as is the case with the colored marbles of Tennessee, slabs of almost any required size can be obtained free from all flaws and blemishes.

"Our great need at the present time is a richly colored marble for interior decorative work, such as the Siena yellow, the French griotte, or the so-called Numidian marbles from Tunis and Algeria. The supply of the so-called 'onyx marble' is also very limited.

"The San Luis Obispo rock is scarcely seen in our Eastern markets, the supply being obtained chiefly from Mexico and Egypt. It is possible that search for the latter stone has been carried on neither intelligently nor systematically, and it seems very probable that some of the stalagmitic deposits on the floors of our numerous caves may yet prove of economic value. Blocks and slabs of this stone from the Luray caves and now on exhibition in the National Museum, are of no mean quality, though pieces of large size cannot be obtained, owing to its extreme brittleness and many flaws. It should be noticed that in most marbles those variously colored veins and streaks which lend beauty to the stone are, in reality, flaws, and weaken, while they otherwise enhance its value.

"American taste in only too many instances apparently fails as yet to fully appreciate the incomparable beauty and majesty of a stone structure over one of brick. This must be almost painfully evident to any one who has had occasion to compare the inharmonious piles of red brick and galvanized iron which constitute so large a share of the residences in our capital city with the more elegant and substantial appearing dwellings of Baltimore and other more Eastern cities. Yet Washington has an abundance of excellent stone in the near vicinity, and is within easy communication of all the leading quarry regions of the country.

"Great difficulty is often experienced, I am told, in getting new varieties of stone introduced into the markets and into general use. While the fact may be recognized that materials now in use are not in all cases satisfactory, few feel like assuming the responsibility of trying a new variety, or an old variety from a new sources – a fact that is doubtless largely due to ignorance of what constitutes a really good stone, or what the latent qualities of any stone, good or bad, may be. This hesitancy on the part of architects or builders to accept a newly discovered and untried material has often added greatly to the cost of building, through the payment of freightage for hundreds and perhaps thousands of miles, when equally good stone could, it may be, have been obtained within one-tenth of that distance, or possibly close at hand. Thus, Quincy granites have been carried into Maine, to be used within three miles of the Hallowell quarries, and the same stone was also used in building the custom house at Savannah, Georgia. A stronger illustration still is offered in the case of the first stone building erected in San Francisco, which is stated to

have been of granite brought from China; and even this is scarcely equaled by an occurrence of very recent date, that of the shipment of two cargoes of Portland brownstone to this same city via Cape Horn. Such a hesitancy to accept untried materials might seem laudable were those selected in their places in all cases of the first quality. Such, however, is not the case, and the selection in only too many instances seems to be governed by a mere whim or caprice of the party in authority. A point of great importance, and one that does not seem to be fully realized, is, that not all stone from the same quarry, or even from the same stratum, is equally good. That is especially true of sedimentary rocks, the different layers of which vary, not only in texture and color, but also in strength and durability. It is safe to say that there is scarcely a branch of building construction that demands more careful supervision and inspection than that relating to the selection of the stone to be used. If we can judge from results, no such inspection is called for in the majority of cases, or perhaps even thought of; and, after the contract is let, the contracting party is at liberty to palm off such materials as he sees fit, provided the blemishes are not too self-condemning.

"A pressure test is made upon a single specimen, and this, worthless as it is, suffices for all – color, strength, and durability of the whole formation – from whence it is taken. Fancy a farmer seeking to sell his still unharvested crops by exhibiting to his customers a single sample each of apple, potato, or whatever it may be, and expecting thus to barter away his whole supply, subjected to no further inspection. Such an idea is, of course, too ridiculous for consideration, and yet this is, in altogether too many cases, what is done in the line of building materials. The contract calls for Maine and Massachusetts granite or Connecticut and Ohio sandstone, and nothing more. We may get good and we may get bad, the chances being in favor of an indiscriminate mixture of both. In all cases where expensive structures are to be erected, every stone should pass under the eye of a competent inspector, fully authorized to accept or reject material as his judgment dictates. Such a position will be found difficult to fill; but it is none the less essential.

"A peculiarity that cannot fail to strike one who studies the census returns is the close relationship that exists between the amount of capital invested and the value of the annual product. In very many cases they will be found nearly equal, the variations either way being but slight. This quick return of capital does not, however, denote an extremely well-paying business, but rather one in which the chief outlay is in labor rather than costly machinery and other fixtures. A good quarry in the hands of a shrewd and strong company is undoubtedly a well-paying property, but very much of the smaller ones are merely capable of affording employment to their owners or lessees, at fairly remunerative wages. This last is said to be especially true regarding many of the 'bluestone' quarries of New York State."