REPORT ON BUILDING STONES

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By Prof. JAMES HALL

The following report on building stones was communicated to the Commissioners of the New Capitol in 1868. The report was called for before it could be properly completed, and much material intended for incorporation, was never finally prepared for publication. At that time the author was promised further facilities for continuing and completing the work, but these were never granted, and the report, in its very incomplete and unsatisfactory condition, has remained as originally published. The small number of copies at that time issued was quite insufficient to supply the demand; and the author has been frequently solicited to republish the report. This has been postponed from time to time, in the hope of being able to add matter of interest, and especially some tables of the comparative strength and resistance to crushing force. But these data still remain as they were recorded in 1868; and there is no prospect of being able to resume a work which, if properly carried out, would be of important economic value.

The report is herewith communicated as originally presented. It forms a part of the work accomplished by the author since assuming the charge of the State Museum of Natural History in 1866. It may very properly be regarded as the result of museum work. It is illustrated by the museum collections of marbles, building stones, etc., chiefly in the material occupying the shelves along the sides of the entrance-hall of the State Museum on State street.

January, 1886.

GENERAL ABSTRACT OF CONTENTS OF REPORT.

PRELIMINARY ADDRESS.

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II. Marbles or Metamorphic crystalline limestones, their Geological position and Geographical distribution.

III. Limestones not Metamorphic, compact or sub-crystalline; their Geological position and Geographical distribution.

IV. Sandstones or freestones, and their varieties; their Geological position and Geographical distribution within the State of New York.

V. On the selection of Building Stones, and the cause of their decay.

VI. General composition and comparative durability of Building Stones.

VII. Modes of determining the character and strength of Building Stones.

VIII. Causes affecting the durability of Building Stones, which are inherent in the Stone itself.

IX. Causes affecting the durability of a Stone, which are accidental, or due to artificial or extraneous conditions.

X. Results of trials of the strength of various Stones with tables of comparison for other Stones. Incomplete.

XI. Catalogue of the principal Stones in Collection, which have been submitted to the Commissioners for their inspection, or collected during the examination.

PRELIMINARY REPORT.

[Communicated to the Commissioners of the New Capitol in 1868.]

HON. HAMILTON HARRIS,

Chairman of New Capitol Commissioners:

DEAR SIR — According to instructions received from yourself and Hon. J. V. L. Pruyn in June, 1867, I proceeded to examine the quarries of building stone within the limits of the State of New York, and also those in adjacent States from which materials had been, or were proposed to be offered for the building of the New Capitol.

To this object I devoted the greater part of my time during the remainder of the season, returning from my last journey on the 4th of December; leaving the investigation, however, very far from being completed. During this time I visited many of the quarries within the State of New York and others in the State of Massachusetts, and some in Connecticut, Vermont, New Hampshire, Maine, and Ohio.

In order to have before you the tangible results of this investigation, I have brought to Albany, and deposited in the Geological Rooms, specimens from the greater part of the quarries examined. In nearly all cases the specimens were freely contributed by the proprietors of the quarries, and some of them in the most liberal and handsome manner, as I shall have occasion to mention in the course of my report. Other specimens have likewise been promised for the collection, from quarries examined, and from others not visited. The materials now arranged in the Hall of the Geological Rooms, though far from complete, constitute a valuable and instructive series of building stones; from among which, I believe, satisfactory selections may be made, not only for the construction of the New Capitol, in its foundations and superstructure, but they will serve as a guide for architects and others in the selection of materials for other purposes.

I had hoped to be able to finish my observations upon the quarries, and the general distribution of building material, during the present season; but other duties have prevented this, and I would respectfully suggest that some further examination, particularly in some parts of New York, be authorized by the Commissioners before the Report shall be considered complete. I venture to suggest this,

believing that a more acceptable service could not be rendered to the building and economic interests of the State; and the New Capitol Commissioners have an opportunity of rendering this service to the general welfare of the community, while fortifying themselves with all available information to govern their own action in the selection of materials, not only for the exterior walls, but for interior use and decoration.

For the latter object, I would very earnestly recommend that specimens from all formations yielding marble, or of limestone bearing a good polish, be used in some part of the New Capitol work. With this object in view, I have already procured specimens of some of these stones, but the collection in this department is scarcely begun.

I have already recommended to you certain localities from which foundation stones may be obtained. In this statement, I think I omitted, or did not definitely specify, the locality of gneiss or granite in the Highlands on the Hudson river, of which the quarries at Breakneck and Butter hill offer good examples.

As a preliminary to our inquiries after *proper building stone*, we may first consider what are the materials with which we have to deal. The rocks or varieties of rocks offered in nature, and from which we are compelled to make our selections, may be named under the following heads:

1. GRANITES, including SIENITE, GNEISS, etc.
2. MARBLES, *or* METAMORPHIC CRYSTALLINE LIMESTONES.
3. LIMESTONES, *not metamorphic, compact or subcrystalline.*
4. SANDSTONES *or* FREESTONES, *and* their varieties resulting from admixture of clay or carbonate of lime, etc.

In the first place, it should be understood that under each of these heads there is an almost infinite variety in *texture*, *color*, *power of resistance* to *pressure*, *durability*, etc.; that the substances named are very widely distributed, and that they vary in different and distant localities; that a *sandstone* is rarely a purely siliceous rock, or a *limestone* a purely calcareous or calcareo-magnesian rock; other materials foreign to their strict constitution, according to the usual designation, enter into their composition, and, for the most part, to the injury of the mass. In the purely sedimentary rocks, which have undergone no subsequent change, the sandstones are more or less permeated by argillaceous matter or clay, which constituted a part of the original sediment, and which may be uniformly mingled throughout the entire mass, or may form thin layers or seams separating the harder layers. In either case it is a dangerous ingredient; for no rock with clay seams can long be exposed to the weather, without a greater or less degree of separation or disintegration; and when any considerable amount of the same material is distributed through the mass, its ready absorption of water renders it equally dangerous to the stability and integrity of the whole. Placed beneath the surface, and beyond the reach of frosts, the conditions are different, and such rocks last for an indefinite period of time.

The same remarks hold true with regard to limestones; and there are few limestones that are not marked by partings of shale or clay, which, in the course of time, weather into open seams, causing those unsightly appearances so common in structures of this kind.

In the granite and crystalline limestones, other causes, as the want of cohesion among the particles, presence of destructive agents or liability to chemical changes, and seams or patches of foreign matter, are symptoms to be guarded against. It is not because a rock offered as a building stone is a *granite*, a *marble*, a *limestone*, or a *sandstone*, that it is good or bad; but this characteristic is to be sought in other conditions, and the objectionable feature may be accidental or adventitious.

One other condition should be remembered. These materials used for building are not promiscuously distributed over the country, but are restricted to certain geological formations, and can only be found within certain limits. Although we find granite, gneiss, and various sienites, with crystalline limestone, in the mountainous regions of Northern New York, it would be quite absurd to look for rocks of this kind in the Catskill mountains. We find white and variegated marbles in the region skirting the Highlands on the east, and extending through Western Connecticut, Massachusetts and Vermont; but no well informed person expects this material in the Helderberg mountains, or in the hills of the southern counties of New York. Investigation has shown that certain kinds of rock, or rocks of similar but very distinct characteristics, are confined to certain geological formations, and do not occur out of these; and again, that these formations have certain limits which are already defined and well understood. Geology has so well defined these matters, and the association of certain rocks and minerals, that when told that a known geological formation covers a portion of country, we know what kind and character of rocks and other mineral products to expect.

In a State where the geological structure is so well known as that of New York, I think I may be allowed to speak of the various building materials under the heads of the several geological formations to which they belong, or in which they occur; thus conveying general information, while treating of the *special subject*.

All the GRANITES, *granitic*, *sienitic*, or *gneissoid* rocks of the State are confined either to the northern portion, known as the Adirondack region, from the name of the high mountain range in its central part; or to the Highland region along the Hudson river, which is of the same geological age as the northern portion, and all belonging to the Laurentian System.

In the northern part of the State, CRYSTALLINE LIMESTONE, of various colors, is associated with granitic or gneissoid rocks; the same is true, in a less degree, of the granitic region of the Highlands.

The WHITE and VARIEGATED MARBLES, so much in general use, belong to a different geological age and constitute a distinct belt of

formation, running to the eastward of the Highlands generally, and occupying portions of Westchester and Dutchess counties in New York, and thence extending into Connecticut and Massachusetts. The ordinary gray or dark-colored bluish limestones and the various colored sandstones have a much wider distribution, but are still limited to certain belts of country.

Treating these in their order, we may arrange and discuss them as follows:

I.

Granites, including Sienites, Gneiss, or Gneissoid and Sienitic Rocks; their Geological Position and Geographical Distribution.

The term granite, in its strict signification, means a crystalline rock composed of quartz, felspar and mica in intimate mixture, the separate minerals being composed of crystalline grains. It is a very common condition of the granitic rocks, that the mica may be absent, and in its stead we have hornblende, and in this form the rock is termed a sienite.* On the other hand, the presence of mica in thin scales, forming lamination, or rendering the lines of bedding visible by coloration or otherwise, produces what we term *gneiss*; though some geologists would apply the term *gneiss* to all stratified granitic rocks.

The proportion of mica in gneiss is not necessarily larger than in some of the granites; but the faces of the thin laminæ being arranged parallel to the lines of bedding and the freest line of cleavage, causes it often to appear in larger proportion.†

Quartz, felspar and hornblende without mica or with a very small proportion of this mineral constitute some of the best granites; while in the lighter gray or whitish gray granites, the quartz, or quartz and felspar, are the chief component parts, and there is little either of hornblende or mica. The grains or aggregations of these minerals may sometimes be so large that each one presents its distinctive mineralogical or individual character, becoming so coarsely crystalline as to be unfit for building purposes.

Granites of New York.

In the lower portion of the Adirondack region, or the Laurentian System bordering Lake Champlain and extending from Saratoga to Clinton county, the rocks consist mainly of a gray gneissoid granite, which is sometimes traversed by coarser crystalline veins, and sometimes nearly or entirely losing its gneissoid character from the small proportion of mica, but always regularly stratified. The latter character is presented in the exposures at Little Falls and other places;

* The Egyptian sienite or syenite, according to Delesse, contains mica.

† A distinction has sometimes been made between gneiss and granite, that the one is stratified and the other not. This does not hold true; for nearly all, if not all, the granites that are extensively quarried are stratified, and I believe all of them cleave in one direction more freely than in another, while the other free line of cleavage or breaking is rectangular to the first.

while the true compact gneiss is seen at the quarries in Saratoga county, and the partial or entire absence of the mica characterizes the rock at many localities farther to the north. This gray gneissoid rock graduates downward, through alternating beds of variable character, into a hornblende rock, and becomes a compact dark-colored sienite extremely hard and tough in its character.

The same general features prevail in the granite rocks in the Highlands as exposed along the Hudson river, the strata being tilted at a high angle. In many places, however, the lines of bedding become obscure, the mica is to a great degree absent, and the rock assumes the character of a true granite. The principal points of exposure, where the gneiss or granite of the Highlands has been quarried, are at Butter hill, on the west side of the river, and at Breakneck on the east side. In some portions of the mass, at both of these localities, the rock loses in a measure its gneissoid character, and presents a comparatively even admixture of the component parts. At both localities the rock is penetrated by trap dykes, which have affected the beds adjacent to them; and these, together with other causes, have produced a more than ordinarily fractured or jointed condition of the rock.

In the higher part of the Laurentian series, and in localities more inaccessible to means of transportation, we have the highly felspathic granites of the central portion of the Adirondack region. These are usually coarsely crystalline and of a dark color, but weathering to a lighter hue. They have nowhere been brought into use for building purposes; and not being within the limits of reasonable cost of transportation, it is scarcely worth while to indicate their localities more particularly.

Granites of New England.

The granites examined beyond the limits of the State belong to an entirely different geological age from those of New York, and present a different aspect in the aggregation of their component parts. They moreover differ among themselves, in a very extreme degree, both in color and texture; varying from the dark-colored compact sienite of Quincy and the neighborhood, through the lighter-colored varieties of the same locality and that of Chelmsford and other places, to the greyish-white varieties like that of Rockport on Cape Ann. All the quarries that I have examined along the coast are free from mica; and when hornblende is not present, we have the quartz and felspar only. The dark colors are usually due to the presence of hornblende; the reddish or brownish colors, to the colored felspar; and some of the quarries offer a granite of quartz, brownish felspar and dark hornblende, giving thus within these ranges a considerable variety of color, due either to the original color of the substances, or to the proportions in which they are mingled in the mass.

The principal quarries that came under my observation were those of Quincy and Weymouth, Rockport on Cape Ann and Dix island