California Building Stones circa 1887

Excerpts from

"Building Stones"

By Prof. A. Wendell Jackson

From *Seventh Annual Report of the State Mineralogist*
For the Year Ending October 1, 1887
California State Mining Bureau, Sacramento: State Printing Office
1888

(This book is available on Google Books.)
http://books.google.com/books?id=dR4TAAAAYAAJ&dq=%22seventh+annual+report+of+the+state+mineralogist%22+california&source=gbs_navlinks_s

This transcription, which begins on the next page, is presented on the Stone Quarries and Beyond web site in the California state section.
http://quarriesandbeyond.org/states/ca/california.html

Peggy B. Perazzo
Email: pbperazzo@comcast.net
July 2011

California Building Stones circa 1887

Excerpts from

"Building Stones"

By Prof. A. Wendell Jackson

From *Seventh Annual Report of the State Mineralogist*
For the Year Ending October 1, 1887
California State Mining Bureau, 1888, pp. 205-213.

"We had hoped that the following communication from Hon. W. W. Morrow would have created sufficient enthusiasm to have induced the citizens of our State to at least have sent us a showing approaching a respectability. The within incorporated circular was scattered throughout the State, but with the exception of that which is incorporated in the article by Professor A. Wendell Jackson, the response has been immaterial, although promises have been plentiful:

> "San Francisco, April 4, 1887.
> "Hon. Wm. Irelan, Jr., State Mineralogist, San Francisco, California.
>
> "Dear Sir: I have heard it frequently stated that no discovery has yet been made on this coast of any good building stone other than that of the granite formation.
>
> "I cannot believe this to be true, and I have always met such statements with the assertion that beds of good quality of sandstones were known, while quarries of basalt, and even rhyolite, have been developed.
>
> "But it is claimed that our sandstones are not desirable, either in color or structure, and that the other stones are not convenient to market.
>
> "In view of the fact that large, substantial buildings are about being erected in San Francisco and elsewhere on the coast, with every prospect that a season of building enterprise is upon us, I would recommend that your Bureau should give special attention just now to an investigation of building-stone quarries, or deposits, in this State. Full and reliable information upon this subject would, I think, aid very materially in securing the opening of such quarries and the erection of substantial buildings of stone for private as well as business purposes.
>
> "The material for the new Post Office building will soon be a question of importance to the General Government, as well as the people of this community, and it would be of great advantage in securing liberal appropriations for the construction of the building, if

we were able to show that we have a good variety of building stone of a durable quality and of sufficient quantity near enough to San Francisco to warrant us in saying that the erection of a substantial and imposing structure may be undertaken upon a moderate estimate for such building materials. This question has already been raised, and I think we should be prepared to meet it fully with all the information that can be obtained.

“I therefore commend this subject to your careful attention, in the hope that an examination be made in the direction indicated.

“Yours very truly,

“Wm. W. Morrow.”

Circular From the State Mining Bureau.

“*To Quarrymen, Architects, and Builders:*

“Wm. Irelan, Jr., State Mineralogist, with the cooperation of A. Wendell Jackson, Professor of Mineralogy, Petrography, and Economic Geology, in the State University, proposes to make an exhaustive investigation of the building stones of the State, and to that end invites your active assistance in procuring the necessary material. The report will cover Mineralogical Description, based on Microscopical Examination of thin Sections; Chemical Composition, where necessary; Density; Tests of Strength; Permanence of Color; Absorptive Properties for Moisture and Water; Weathering Properties; Resistance to Heat; and General Adaptability to Structural Purposes.

“For the purpose of this series of investigations, the following material will be required for each stone examined.

Ten (10) cubes of one and one half inches, roughly dressed.
Two (2) cubes of two inches, roughly chipped.
Two (2) cubes, cut out conformably with the bedding of the rock, of two and one half inches, if rock is soft, and one and one half inches, if rock is hard.
Ten (10) hand specimens, roughly chipped to the size of four and one half inches by three and one half inches by one and one half inches.
Six (6) hand specimens, polished on one side and roughly dressed otherwise, of the size of four and one half inches by three and one half inches by one and one half inches.
Twenty (20) thin chips or flakes, approximately one and one half inches square.

“In the preparation of the cubes, it is important to mark which is the edge and which the bedding side, unless this is sufficiently obvious from the texture or grain of the rock.

“All of the foregoing specimens should be carefully selected from a sufficient depth to insure fresh material, and as complete freedom as possible from weathered surfaces. In addition, one or two specimens, particularly illustrating the natural weathered surfaces, should be sent.

“Each specimen must be carefully wrapped, and all packed firmly in a wooden box, and addressed, with inclosed label, to the ‘Mining Bureau, Pioneer Building, san Francisco,’ *freight or express charges prepaid*.

“A letter should likewise be addressed to the State Mineralogist, giving detailed information as to the exact locality and extent of deposit, present means of transportation to nearest market, buildings in which the stone may already have been used, and the name of the owner of the quarry.”

~ ~ ~ ~ ~ ~ ~ ~ ~

“**William Irelan, Jr., *State Mineralogist*:**

“Dear Sir: I take pleasure in sending to you the results obtained in the testing of a few California building stones. The work was undertaken so late in the year that comparatively little could be accomplished in time for publication in this year’s report, and even this can be presented with but little critical comment. The main interest attaching to this kind of work must lie in the thorough examination of all the available building stones of the State, and their comparison, not only with one another, in order that strong and weak points of each may be well brought out to the end that the appropriate selection of material may be made for any given work, but also with the most celebrated building stones of the East and of Europe, the good and bad qualities of which have been determined by the actual test of use for decades or centuries. It is the belief of the writer that a very large variety of ornamental and useful stones will be furnished by the Mountains of this State. The number already discovered is large, and a proper appreciation of their beauty and value is sure to follow the systematic investigation into and publication of their merits. The difficulty of access to places distant from the railways has been a great obstacle to fruitful returns for the labor of prospecting and opening quarries; but difficulties are diminishing each year, and the natural result is already evident in the increasing interest taken by quarrymen, architects, and capitalists in our building stone resources. In no country now inhabited by the more highly cultivated races of mankind are the natural conditions for the durability of constructions in stone more kindly than here. Still it behooves us to move carefully now in the very beginning of the development of our quarry resources, in order to avoid such costly mistakes as have been made both in the East and Europe in the selection of stone for elaborate private and national structures. The construction of the new Post Office building in San Francisco will soon make it a matter of great practical importance, as well as of general interest, to know what building stones the State can furnish that shall meet all the requirements of durability, strength, and beauty. The following results as a mere beginning in this direction are formulated as a contribution from the Mineralogical Department of the State University towards a better knowledge of our resources in this direction.

“Before proceeding to the description of results, a few words concerning the methods of examination may be in place.* For purposes of an exact mineralogical determination, a thin chip of the stone is ground to an even surface with emery and water, on a rotating iron lathe, then ground fine with flour and emery of water. The side thus prepared is then cemented, by means of Canada balsam, to the small square of thick plate glass, which furnishes the means for holding it steadily while the rough side is gradually ground away, first with coarse then with fine emery, until the section of rock is perfectly transparent, not exceeding 0.025 to 0.05 mm. in thickness. The section is then transferred to a microscope slide, covered with a thin glass cover, and is then ready for study and for permanent record. Three sections of each stone are prepared, one parallel to the bedding, and one in each of the two directions at right angles to each other and to the bedding.

(* "See Geol. Of Minnesota, vol. I, p. 185.")

"The determination of the specific gravity was made in the usual way with an analytical balance. Roughly cubical specimens of about 75 grammes weight were dried at 100° C. to a constant weight (six days), weighed in air, and then weighed suspended in water by a horsehair, after prolonged immersion. The weight of the dried cube divided by the loss of weight on suspension, in water, was taken as the specific gravity. The weight of one cubic foot was then calculated from the weight of a cubic foot of water equal to sixty-five and one half pounds.

"The crushing strength was determined by the Riehl testing machine of the Mechanical Department of the University, through the courtesy of Professor Hesse, the kindly cooperation of Mr. Sladky. The maximum capacity of the machine is fifty thousand pounds, so that the size of the cubes used was necessarily limited to less than the usual two-inch cube. The tests were made at the last moment before the transmission of this report, on but two specimens of each rock, one on the bed and one on the edge, and consequently must be considered only approximate. During the coming year they will be carefully repeated with a large number of cubes of each rock.

"The absorption of moisture was determined by exposing carefully dried, roughly cubical fragments, of about seventy-five grammes weight, in a saturated atmosphere of water-vapor for seven weeks. The specimens were placed on a glass shelf under a bell jar over standing water. The absorption of water was determined by exposing still another set of stones of about seventy grammes weight, in a vessel of water for – days. They were carefully dried and weighed first, and the increase of weight after immersion represented the amount of water taken up.

"The action of carbonic acid was determined by immersing carefully dried and weighed rough cubes of the same size as the preceding, in water kept saturated by carbonic acid. The loss of weight was inconsiderable unless the stone contained an appreciable amount of carbonate of lime.

"The exposure of weighed fragments to strong corroding acid and chlorine fumes, was made to determine the weathering and staining effect that could be produced within the short period of exposure (seven weeks), as indicative of what might be expected from the long continued exposure to the natural weathering agencies in buildings. The effect of dry heat was obtained by exposing cubes of stone in a muffle furnace raised to a red heat. The cubes were gradually heated up to a full redness and then changes of color, cracking, or softening noted. The cubes were then removed, and after cooling below red heat, plunged into cold water and further changes noted.

"The tests thus noted by no means furnish all the information it is desirable to obtain concerning the rocks examined. It is hoped that the final report may include the results of the examination of the quarries to determine the extent of the supply, appearance, and behavior of the stone on weathered surfaces, and facilities for quarrying and transportation; further, an enumeration and examination of the structures in which the stone has been used, and the cost of delivery in the San Francisco market.

"Five sets of stones have been received; two kinds of Santa Susanna sandstone from the Gilbert Stone Company of Los Angeles; one sandstone from Robert Rangeley, of Henley, Siskiyou County; Colton marble from Colton Marble and Lime Company, of Colton; and a volcanic tufa from the Campo Seco Stone Agency, San Francisco. I give below the results thus far obtained form an examination of these stones.

Santa Susana Sandstone.

(Los Angeles County, California)

"Two varieties of this stone were sent by the Gilbert Stone Company, one very coarse-grained and the other very fine-grained.

I. Coarse -Grained Sandstone

"*Macroscopic*. – To the unaided eye the rock appears as a very coarse-grained, light grayish-yellow sandstone, consisting of subangular, smoky gray quartz granules, from 5 mm. in diameter downwards, averaging perhaps about 1.5 mm., dull yellowish-white, soft granules, apparently of kaolinized feldspar, numerous small, black, and a few white, mica scales; the whole cemented together by a very slight yellowish argillaceous cement.* An occasional bluish-black slate fragment is observable. The stone can made to crumble somewhat in the hand on the edges and angles, but in larger fragments it holds well together.

(* "The term 'cement' is technically used in geology, with reference to the finely divided or fine-grained material which holds together the larger grains of quartz or other mineral entering into the composition of the sandstone. This cementing material, or 'cement,' is ordinarily clay, carbonate of lime, oxide of iron, or silica, more or less mixed with finely comminute particles derived by attrition from the larger grains, whence the four chief classes of sandstones: the *argillaceous*, the *calcareous*, the *ferruginous*, and the *silicious*.)

"*Microscopic*. – Thin sections could be prepared only after suturing the fragments to be ground with boiling Canada balsam, and allowing them to cool and harden. Sections were thus obtained thin enough, but they went to pieces during the final mounting. The above mentioned constituents are all readily recognizable. The quartz is greatly in excess in sharply angular granules from the largest size (5 mm.) down to minute grains. The quartz substance is quite clear, or with bands of clouds of tiny liquid cavities, with movable bubbles, minute yellowish patches of hydrated ferric oxide, now and then a few colorless cylindrical microlites (perhaps apatite), or thickly interpenetrated in every direction with long, exceedingly delicate hair-like forms (possibly asbestos).

“The feldspar is present both as potash and as soda-lime feldspar; its granules rarely exceed 1 mm. or 1.5 mm. in diameter, and diminish from this down to the minute particles which make up the cement. It presents every stage of decomposition, and consequent softening, from comparatively fresh substance, showing the brilliant bands of plagioclase between crossed nicols in polarized light, down to the more or less completely kaolinized mass that has become dull, white, soft, and opaque. Roughly estimated the quartz makes up perhaps three quarters of the granular constituents, and the feldspars and mica scales the remainder. The mica scales (the black largely in excess) are abundant and closely wedged in between the quartz and feldspar granules, with their cleavage surfaces mainly in the plane of the rock-bedding. The white scales are still fresh, and from their toughness add to the strength of the stone. The black mica has, however, lost its elasticity and toughness, and by its partial decomposition has furnished much of the yellow oxide of iron, to which the color of the stone is due.

“*Cement*. – The small proportion of cement present is easily seen in the thin sections. The above described granules are either in actual contact or separated by a thin film of yellowish argillaceous material, derived from the decomposition of the feldspars. In an uncovered section one can likewise discern delicate patches and films of snowy white substance, which is evidently the carbonate of line that effervesces at numerous detached spots when the surface of the stone is moistened with chlorhydric acid. Like the kaolin of the cement, it also was probably derived from the decomposition of the feldspars.

“The specific gravity of the stone is 2.62, whence the weight of one cubic foot equals 163.7 pounds. The amount of moisture absorbed in seven weeks equals 1.51 per cent of the weight of the stone, and the amount of water to 5.33 per cent. The effect of strong corroding acid fumes was very marked. The stone became somewhat discolored with yellow iron oxide stains, and crumbled considerably, losing 3.7 per cent of its weight standing untouched on the glass shelf upon which it was exposed, and 3.6 per cent more upon being brushed with a moderately stiff brush. The stone was entirely unaffected by heat, except that it changed color to a beautiful brownish-red, and subsequent exposure to water, while still hot, failed to crack or scale it in the least.

“The crushing strength, determined from a single cube for edge and another single cube for bed, amounts to five thousand eight hundred and twelve pounds per square inch for *bed*, six thousand eight hundred and twenty-eight pounds per square inch for *edge*. The dimensions of the bed-cube were 1.395 inch by 1.416 inch by 1.183 inch, and of the edge-cube 1.380 inch by 1.394 inch by 1.350 inch. In each case the last dimension was the height of the cube.

“***Occurrence***. – According to the sender, an official of the Gilbert Stone Company, Los Angeles, the stone occurs in bowlders, of which the company has an inexhaustible supply in the Santa Susanna Mountains, about eight miles southwesterly from San Fernando Station, on the Southern Pacific Railroad, in Los Angeles County, and about twenty-eight miles from Los Angeles City. Great difficulty is at present experienced in getting the stone hauled from the quarries to the railroad. The cost of hauling is $1.50 per ton, and the cost from San Fernando to Los Angeles is $1 per ton. The sandstone beds cover an area of two and one half miles in length by one mile in width, and the beds of the finer grained stone are said to be one half mile in thickness. Both the Southern Pacific and the Atchison, Topeka, and Santa Fe Railroads are expected to run through the immediate vicinity of these beds, and thus furnish a ready means of transportation to market."

II. Fine-Grained Sandstone.

"*Macroscopic*. – This variety differs in appearance from the former in the size of the grain. It is a beautiful evenly fine-grained stone, of nearly uniform light, grayish-yellow, minutely specked with black and silver-white mica scales. Under the microscope, all of the characteristics of the preceding rock reappear here. While a thin layer of the stone occurs now and then in which granules 1 ½ mm. diameter occur, in general the average grain does not exceed 0.15 mm. to 0.20 mm. Hardly a trace of effervescence is noticeable when the rock is moistened with chlorhydric acid, nor even when the rock powder is heated with acid.

"The specific gravity is 2.52; weight of one cubic foot is 157.5 pounds; absorption of moisture, 1.19 per cent; absorption of water, 6.19 per cent; loss on exposure to carbonic acid gas solution, 0.27 per cent. Exposed to acid fumes, the stone was stained brownish-yellow in spots, became loosely coherent on the surface, lost 7.77 per cent through quiet disintegration, and an additional 9.13 per cent by brushing. In the muffle furnace its color changed to a deep brownish-red, but no crack nor flaw developed in the stone up to full red heat, nor on subsequent immersion, while hot, in water. The crushing strength determined on cubes 1.425 in. x 1.465 in. x 1.359 in. (ht.) for *bed*, and 1.291 in. x 1.258 in. x 1.147 in. (ht.) for *edge*, resulted in 9.752 pounds per square inch for *bed*, and 7,380 pounds per square inch for *edge*. The specimens examined came from six to twelve inches from the face of the sandstone bed.

"For occurrence, see above under coarse-grained sandstone."

Henley Sandstone.

(Siskiyou County, California)

"*Macroscopic*. – The Henley sandstone is a moderately fine-grained, light bluish-gray stone, showing to the unaided eye, dark gray and whitish quartz granules, with numerous black and few white mica scales, held together by a slight argillaceous and calcareous cement. A somewhat free effervescence follows the moistening of the surface with acid. The stone will work easily, and in specimens appears quite free from flaws.

"*Microscopic*. – The quartz granules are most numerous. They are subangular in shape, varying in diameter from 2 mm. downwards, averaging 0.33 mm. The quartz substance is, in the main, quite clear, except for the fluid cavities that are thickly crowded in many of the granules. These cavities vary in size from 0.02 mm. down to the minutest dimensions. While mostly oval, they occur also in the most curiously irregular branching forms, and now and then in the familiar shape of the quartz crystal; the cavity repeating in negative the external dihexahedral form of quartz. Some are completely filled with fluid; others contain liquid with a little bubble in constant motion; others have a stationary bubble; others again are filled with a liquid that does not wet the sides of the cavity, so that it appears in the form of a bubble so large as to fill all except the outer irregularities of the cavity. Finally, some of the cavities appear to contain *two* bubbles, one within the other. We have in such cases two liquids that will not mix. In one such that was measured, the cavity was .008 mm. in diameter; the outer fluid .007 mm., and the inner one .004 mm.; the latter was in constant motion within the limits of the outer fluid.

"Feldspar granules are also present, constituting more than one third of the mass of the rock. The feldspar is usually so decomposed that its granules are whitish opaque in thin sections; the fresher granules still show, however, the banded structure of plagioclase in polarized light between crossed nicols.

"The numerous black mica scales are much decomposed, the different laminæ often forced asunder by opaque white calcitic decomposition products. The white mica scale are much fewer and, as usual, quite fresh. An occasional magnetic oxide of iron granule, not exceeding 0.1 mm. in diameter, is observable.

"*Cement*. – The cement consists of a mixture of argillaceous and calcareous material mixed with the finest granules of quartz and feldspar, and colored throughout slightly yellowish by the oxide of iron. The specific gravity is 2.63; weight of one cubic foot 164.5 pounds. The absorption of moisture equals 1.78 per cent, the absorption of water 4.07 per cent, and the loss by exposure to carbonic acid equals 0.35 per cent. Exposure to corroding acid fumes changed the color from gray to bright yellow, and rendered the stone crumbly on the surface. The loss by quiet disintegration was 3.27 per cent, and the further loss by brushing was 2.28 per cent, making the total loss 5.55 per cent.

"In the muffle this sandstone cracked and scaled somewhat below a red heat, and changed its color, on full red heat, to brownish-yellow. No further cracking was noticeable upon immersion of the hot cube in water.

"The crushing strength was determined on a bed-cube 1.418 in. x 1.354 in. x 1.271 in. (ht.) yielding 12,601 pounds per square inch; and on an edge-cube 1.309 in. x 1.404 in. x 1.476 in. (ht.), yielding 8,722 pounds per square inch.

"***Occurrence***. – The owner of the quarry, Mr. Robert Rangeley, of Henley, Siskiyou County, states that the sandstone beds are behind the town of Henley, and within one mile of Hornbroke Station on the California and Oregon Railroad; that the supply is inexhaustible, and that the stone was used in the construction of the abutments for the railroad bridge over the Klamath River."

Camp Seco Tufa.

(Calaveras County)

"*Macroscopic*. – The Campo Seco tufa is a dull, grayish-white, earthy-looking stone, that to the casual glance seems to be fairly homogeneous in color and compact in texture, except for the occurrence of irregularly-shaped, soft, snowy-white fragments, with delicate, silky luster, immediately suggestive of pumice fragments. They are from 30 mm. in length downwards, and are much softer than the surrounding rock. More closely observed, one sees, in the apparently compact mass, whitish fragments with glassy luster, whose good cleavage betrays their feldspathic character, brownish, angular fragments, otherwise similar to the surrounding stone, and a few minute hexagonal scales of black mica. All of these fragments lie imbedded in a whitish, earthy, but coherent mass, showing in hand specimen an apparently massive texture, no appearance of lamination being visible. On the cubes polished for the crushing tests, and on thin sections cut in the right direction, a very marked, banded texture is developed, due to alternating broader bands (3 mm.) colored delicately brownish-red and narrower bands of the whitish colored material; the bands are seen but faintly on a ground surface, and distinctly only on a polished surface.

"The stone is quite soft, easily admitting sawing into blocks and slabs, and yet is remarkably coherent, as the comparative high crushing strength testifies. Mr. Morton A. Edwards, of San Francisco, the sender of the specimens tested, states that two years' experience has proved that the tufa hardens somewhat on exposure to the weather.

"*Microscopic*. – Under the microscope the stone is seen to consist mainly of clear, colorless, sharply angular, and exceedingly irregularly shaped glass fragments, from 0.75 mm. in diameter to the minutest dimensions, in a cement of excessively finely comminuted isotropic material, which the highest objectives (x 1,000) resolves into colorless or slightly brownish oblong or rounded transparent granules.

"Through this mass are scattered fragments of fibrous and cellular pumice, filled with the characteristic elongated or rounded gas cavities, fragments of fresh samidin feldspar characterized by cleavage and Carlsbad twinning, plagioclase feldspar, recognizable by the bands in polarized light, and fragments of a brownish tufa; identical in general appearance and constitution with the mass of the stone, but with its cement colored brown and rendered opaque by iron oxide. All these fragments are of decidedly secondary importance in the composition of the stone.

"The specific gravity is 2.322; the weight of one cubic foot is 145.12 pounds. The amount of moisture absorbed in seven weeks is 2.02 per cent of weight of the stone, and the amount of water absorbed is 10.92 per cent; 9.62 per cent of water is absorbed within four days after immersion, so that the subsequent absorption is not considerable. The effect of exposure to strong acid fumes was inappreciable; the stone was not stained in the least, and was just as firm and coherent as when first exposed. The loss by exposure to carbonic acid solution equals 0.48 per cent. The effect of heat upon the stone is very marked. A comparatively low heat develops a clouded dark color and numerous superficial cracks. A full red heat fused the surface of the cube in contact with the muffle, shrunk the rock perceptibly, and subsequent immersion in water cracked the stone throughout, so that large fragments fell off in handling. The delicately shaded bands before described in the natural rock, became deep brownish-red in color, and very prominent.

"The crushing strength determined on a *bed*-cube 1.356 x. x 1.406 in. x 1.433 in. (ht.), gave 7,469 pounds per square inch; and on an *edge*-cube 1.325 in. x 1.402 in. x 1.461 in. (ht.) gave 7,252 pounds per square inch.

"***Occurrence***. – Mr. Edwards states that there is an inexhaustible supply of the quarries near Campo Seco, in Calaveras County. The stone has not yet been used in San Francisco."

Colton Marble.

(Los Angeles County, California)

"From the Colton Marble and Lime Company, of Colton, Los Angeles County, specimens were received illustrating three varieties of marble: a nearly pure white, a white clouded with gray, and a grayish-black finely mottled with white. Most of the specimens were of the clouded white variety, and the examinations made have special reference to this stone.

"*Microscopic*. – The clouded Colton marble is a medium-grained, granular limestone, homogeneous in texture, and so far as can be judged from hand specimens, quite sound and strong. It takes a good polish, but closely observed on a polished surface, unless the polishing has been very carefully done, a thick sprinkling of duller granules in the more perfectly polished ground can be seen. Two different kinds of granules are evidently present, with different degrees of hardness. Chemical examination showed the presence of about 6 per cent of carbonate of magnesia, and the subsequent microscopic examination proved that the stone was made up of granules, each showing the characteristic polysynthetic structure of calcite, due to repeated twinning parallel to – ½ R., and other granules without this twinning structure. This observation, taken together with the fact that a residue remains from digestion with cold dilute chlorhydric acid which is in part readily soluble in hot dilute chlorhydric, proves that the limestone is dolomitic and consists of a mechanical mixture of calcite granule (carbonate of lime), and dolomite granules (double carbonate of lime and magnesia). The former have the hardness of 3 in the Mohs scale, and the latter of 4. On the imperfectly polished surface, therefore, the polishing process has continued long enough to polish the softer calcite granules, but no long enough for the harder dolomite granules.

"The mechanical mixture of the two kinds of granules can easily be shown by etching a polished surface with cold dilute chlorhydric acid. The calcite readily dissolves, and the dolomitic granules are left in relief. A further residue insoluble in hot dilute chlorhydric acid exists. This consists of granules, which in thin sections of the marble may readily be distinguished, singly or in groups, lying between the carbonate granules now and then inclosed in them. They are colorless, about 0.25 mm. in diameter, polarize in brilliant colors, and have cleavage in one direction, with oblique extinction at a high angle. I reserve their determination for further study. The clouding of the marble is due to small scales and patches of graphite. The more numerous and more closely aggregated the scales the darker the clouding. The grayish-black marble contains the scales *very* thickly disseminated, and even the purest white variety is not entirely free from them. They mar the purity of the color by their appearance here and there in isolated scales or groups of scales.

“The specific gravity is 2.75; the weight of one cubic foot is 172.06 pounds. The absorption of water amounts to 0.021 per cent of the weight of the stone and of water to 0.13 per cent. The loss in the carbonic acid solution, after seven weeks’ exposure, amounted to 0.97 per cent. No change was observed at first when heated in the muffle, except, perhaps, an increased whiteness. At a full red heat it becomes mottled dull-white on a polished surface, loses its strength and coherence on the edges, and develops minute cracks all over the surface that do not penetrate far inward. Its general strength is fairly well preserved. Exposure, while still hot, to water, causes considerable disintegration on the edges.

“The crushing strength was determined on a bed-cube, 1.422 in. x 1.414 in. x 1.434 in. (ht.), giving 17,783 pounds per square inch, and on an edge-cube 1.469 in. x 1.429 in. x 1.519 in. (ht.), giving 17,095 pounds per square inch.

“Mr. O. T. Dyer, President of the Colton Marble and Lime Company, states that the company owns an inexhaustible supply of the marble in all shades and colors, and that the quarries are located at Colton, Los Angeles County, within one half mile of the junction of the Southern Pacific Railroad and the California Central Railroad. Both roads have built switches and side-tracks to the quarries. The stone can be quarried in large blocks without seams, suitable for large pillars, shafts, etc.

“A further study of this stone will be made for next year’s report.

“A. Wendell Jackson
“Professor of Mineralogy, Petrography, and Economic Geology, University of California.”