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State of California
Department of Public Works
Division of Highways
Materials and Research Department

March 16, 1964

Lab Auth. 24605-T

Mr. James M. Moose, Jr.
Attorney
Department of Public Works
Sacramento, California

Dear Sir:

Submitted for your consideration is:

REPORT

of

GEOLOGICAL AND LABORATORY INVESTIGATION

of

MARIPOSITE ROCK

from

SIGN RTE. X-Mpa-110-B

and

VICINITY

Study made by ..... Foundation Section
Under general direction of ..... T. W. Smith
Field work by ..... E. D. Drew
Report by ..... E. D. Drew

Very truly yours,

JOHN L. BEATON
Materials & Research Engr.

Attach
cc:LRGillis
JGMeyer

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Purpose of Investigation

The purpose of the study was to determine by geological methods and laboratory study the availability and classification of an ornamental stone called mariposite from a road cut 1000 feet southwest of the town of Coulterville in Mariposa County. The specific location is noted as State Sign Route X-Mpa-110-B, between Station 469+30 to 471+70. The work was authorized under W.A. No. 10T11H0249 X-Mpa-110-B, in a letter dated March 12, 1964, H. S. Fenton to J. L. Beaton.

Method of Investigation

A field review of the area was made in February 13 - 14, 1964, to study conditions at the cut and to obtain samples for classification and tests. In the course of the study samples of rock were obtained at other locations and active quarries in the area. Conversations were had with the operators at the active quarries to determine methods, costs, classification and uses of the mariposite rock. A bibliography was compiled of select references to mariposite and to localities in California where mariposite has been found.

Occurrence of Mariposite

Mariposite has been reported from twelve counties in California with thirteen locations noted from Mariposa County alone. Attached herewith a selected group of references and locality descriptions of the occurrence of mariposite in California.

Description and Origin of Mariposite

According to Knopf[1] the green mineral mariposite is extremely abundant along the southern part of the Mother Lode. Mariposite occurs as a minor constituent of the immense bodies of ankerite (ferro-dolomite rock). Although a minor constituent it imparts so distinctive an appearance to the ankerite masses that they are locally spoken of as mariposite rock. This rock has resulted from the hydrothermal alteration of serpentine, and the mariposite is restricted to ankiterized rock derived from serpentine. Mariposite can be identified only by means of chemical and microscopical tests; ordinary visual identification is worthless.

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[1]Knopf, Adolph, The Mother Lode System of California; U.S. Geol. Survey Prof. Paper 157, 1929.

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Murdock and Webb[2] state "Mariposite is essentially a muscovite characteristically colored green by the presence of some chromium. It is abundantly distributed in the gold belt of the Sierra Nevada and was described as a new mineral by Silliman, p 380. It is considered by some mineralogists to be identical with alurgite, Schaller, p 139." (See bibliograph). (Alurgite = ferrian muscovite) $6(H,K)_2O.2MgO.3Al_2O_3 12SiO_2$.

Monoclinic. In hexagonal plates and scales, foliated, micaceous. Cleavage perfect basal. Vitreous luster. Color apple green, white. Hardness = 2½ - 3. Sp. Gr. = 2.78 - 2.81 2.89.

Mariposite as an Ornamental Stone

Bowen and Gray[3] state: "The brightly colored, green variegated mariposite-ankerite-quartz rock from Mother Lode and adjacent vein systems has been finding favor, in recent years, as an ornamental stone in gardens, patios and the like. It has been quarried recently along Highway 49 between Bagby and Coulterville near the Specimen Group of gold mines and near the Virginia and Mary Harrison Mines. Production has been intermittent because of vagaries of demand and because the select, unstained Mariposite rock tends to occur in small masses. The chief detrimental impurity is discoloring iron oxide derived from original sulfide minerals. Select rock bring 20 to 30 dollars a ton on the retail market but selective mining and hand sorting make the initial cost of production high."

Laboratory tests

Texture: The texture of a rock is a function of the size, arrangement and uniformity of the constituent mineral grains. The texture of mariposite rock is variable and ranges from rock interspersed with abundant quartz to finely lamellar varieties.

Color: The popularity of a particular building stone depends largely on attractiveness of color and whether the color is fashionable. The most conspicuous feature of mariposite is its bright emerald green color. The more green color showing on the faces the more desirable the rock is for ornamental purposes.

Strength: A stone that has a crushing strength of 5000 pounds per square inch is considered satisfactory for ordinary use as construction material. Mariposite rock has a compressive strength of over 14,000 pounds per square inch.

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[2]Murdoch, Joseph & Webb, R.: Minerals of California: Calif. Div. Mines Bull. 173, pp 219-200, 1956.

[3]Bowen, Oliver E., & Gray, Jr., Cliffton H.: Mines & Mineral Deposits of Mariposa County, California: Calif. Jour. Mines & Geol., Vol. 53, Nos. 1 & 2, 1957.

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Porosity: Porosity expressed as the ratio of pore space to the total volume, varies with the rock type. Porosity permits water to penetrate rock thereby allowing physical and chemical forces to aid disintegration. A low porosity and absorption is desirable in a building stone. Mariposite has very low porosity and absorption.

Definition Rock and Stone

Rock and stone are often regarded as being synonymous. There is a distinction which should be understood when referring to rock that is to be used for commercial purposes. Bowles (1939) states "The term 'rock' is applied to a geologic formation in its crude form as it exists in the earth. 'Stone' is more properly applied to individual blocks, masses or fragments that have been broken from the original massive ledges for use in commercial application.

"Dimension stone is a term generally applied to masses of stone prepared for use in the form of blocks of specified shapes and usually specified sizes."

Building Stone

One of the principal uses of dimension stone is as a construction material. Included in this category is stone in any form that constitutes part of a structure; for example, window sills, walls, steps or fireplaces. Whereas, building stone formerly was a basic construction material, its present function is largely ornamental. Building stone is marketed as rubble, rough stone, ashlar and cut or finished stone.

Rubble, the crudest form of building stone, consists of irregular rock fragments, each having at least one essentially flat face. The stone is usually shaped by hand. It is used as a veneer on small commercial buildings, in private residences, for walls, patios, fireplaces, swimming pools.

Rough stone consists of rock masses that are rough shaped and of non-uniform shapes. This stone is usually shaped by hand.

Ashlar is a term applied to small rectangular blocks with sawed, plane or naturally cleft surfaces.

Flagging. Attractively colored rock types that split easily into slabs that are suitable for use as walks, patios and gardens around buildings and residences.

Mariposite should be considered satisfactory for any use required, except that the presence of FeS_2 (iron sulphide) frequently causes an iron oxide discoloration. The necessity of hand selecting and grading to obtain the more desirable greener rock make for a higher initial production cost.

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Description of Mariposite at Sta. 470+00

At the time of this study the cut had been excavated to approximately the proposed slope line and grade.

Exposed on the cut face was a triangular shaped outcrop of mariposite rock approximately 36 feet wide at the base tapering to the apex about 30 feet above grade. The mariposite rock at this location is intimately associated with and contains veins of quartz which tend to mask the usual green cast of the rock.

Due to the large percentage of quartz and other impurities the mariposite rock in the cut, based on the classification used by quarry operators in the area should be classified as average rock.

It is probable that a small amount of select rock was found in the cut, but this rock has been removed by "rock hounds" and local citizens.

Quarrying Feasibility at Sta. 470+00

Based on the field study of this site and other quarries and mariposite localities in the area it is my opinion that it would not be economically feasible to quarry mariposite rock at this locality.

Proximity of the existing State route a short distance above the outcrop would not permit the development of a quarry along the trend of the rock.

There are numerous deposits of mariposite nearby which can be developed without constriction by public facilities.

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MARIPOSITE LOCATIONS IN CALIFORNIA

and

DESCRIPTION OF OCCURRENCES

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Mariposite Rock Locations in California

Calaveras County

1. Reserve and Golden Gate Mines on Carson Hill

The area has been intruded by small masses of gabbro and serpentine. Widespread hydrothermal alteration has transformed most of the serpentine into extensive bodies of mariposite-ankerite rock. Present in smaller amounts are talc and sericite schists. (Calif. Jour. Mines and Geol., v. 53, Nos. 1 and 2, Jan.-Apr. 1957).

General Geology - The geology on Carson Hill is varied and complex - more so than that of any other locality in the Mother Lode belt. In general, the rocks consist of black phyllites, augitic tuffs and breccias, chloride schists, and amphibolite schists of several kinds, all striking northwest and dipping steeply east. As mapped by Ransome they are of Calaveras age. They have been closely folded, with the resulting production of steeply plunging folds and of abrupt variations in the degree of metamorphism from place to place. They have been intruded by small masses of gabbro and serpentine, and these igneous rocks have also been deformed: the gabbro is sheared and saussuritized, and the serpentine is in places transformed to talc schist. Widespread powerful hydrothermal alteration has put on the finishing touches, most notably by transforming much of the serpentine to great bodies of ankerite-mariposite rock. (Knopf, Adolph; U.S. Geol. Survey Rept. Paper 157, p. 73, 1929).

2. Butcher Shop Mine in the Hodson Area

Native gold and pyrite are in a northwest-striking and northeast dipping quartz vein. The hanging wall is serpentine with associated mariposite, and the foot-wall is Mariposa slate. (Calif. Jour. Mines and Geol., v. 53, Nos. 1 and 2, Jan.-Apr. 1957).

El Dorado County

3. Pyramid Mine 4 miles north of Shingle Springs

No description available.

Imperial County

4. Under corrections and additions to Bulletin No. 113. Mariposite, a muscovite with a characteristic green color due to the presence of chromic oxide has been reported from Imperial County. (Bradley, Walter W.: Calif. Div. Mines Rept. 35, p. 343, 1939).

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Kern County

5. Rand Schists - An especially interesting type of schist occurs a short distance southwest of the Bully Boy Mine. This schist consists of large thin plates of light gray to light green zoisite set in a matrix composed of greenish black serpentine, small crystals of albite and flakes of muscovite. Individual zoisite crystals may be as much as an inch in length, a half inch wide and an eighth of an inch in thickness. Schistosity is only poorly developed in the rock.

Scattered through the schists at various horizons there occur occasional small flattened lentils or nodules composed chiefly of a green chrome mica. These lentils vary from one-fourth of an inch up to an inch in thickness, the diameters usually being three or four times the thickness. They are easily separated from the surrounding schist and commonly weather out and remain on the surface.

Under the microscope this mica was found to be colorless in thin flakes. Thicker flakes, however, were light apple-green in color and slightly pleochroic.

The mica is probably related to fuchsite and mariposite, and possibly intermediate between them. The indices of refraction were intermediate between those of these two minerals, while in different flakes 2V varied from 0° to 40°. Dispersion of the optic axes was very strong ($r > v$). The character of the mineral was negative. (Rand Schist - Hulin, Carlton D.: Calif. Min. Bur. Bull. 95, p. 25, 1925).

Los Angeles County

6. San Francisquito Canyon

Nests and lenses in talc-sericite schists of the Sierra Pelona Series.

Mariposa County

7. Oro Rico Mine

Great thicknesses of vein matter consist of quartz-ankerite-mariposite rock although the included quartz lenses that cap the ridges are by far the most conspicuous parts of the vein.

8. Champion I Mine

Rock on the dumps is serpentine and greenstone and there is a serpentine-greenstone contact less than 100′ E. of the main shaft. Vein matter on the dump consists of sulfide impregnated quartz and quartz-ankerite-mariposite rock.

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9. Black Hill Mine

The vein is close to the contact between a serpentine intrusion and slate of the Mariposa Fm; but at the surface the wall rocks are entirely serpentine. Vein matter is chiefly quartz-ankerite-mariposite rock and the vein is more than 20 feet wide.

10. Malvina Group

Quartz-mariposite-ankerite rock is locally present.

11. Louisa I Mine

The Louisa is typical of the Mother Lode mines in northern Mariposa County. The prominent, massive, milky quartz reef and accompanying quartz-mariposite-ankerite vein matter crossing Highway 49 just below Coulterville make well-known landmarks in the southern part of the gold belt. Louisa claim.....The bulk of the vein consists of quartz-mariposite-ankerite rock derived in considerable part from hydrothermal alteration of serpentine....In the upper, oxidized parts of the vein system the quartz-mariposite-ankerite rock has been converted to a spongy, rust-colored, earthy rock consisting chiefly of yellow oxides of iron intermixed with quartz stringers.

12. Mary Harrison Group

Large areas of quartz-ankerite-mariposite rock are barren of values and the bulk of the vein matter was too low grade to mill.

13. Virginia Mine

Vein matter, which in places reaches a thickness of 150 feet (Fairbanks, 1890, p. 41) is predominantly ankerite-quartz-mariposite rock, more or less banded and altered.

14. Adelaide and Anderson Mine

In other places vein matter consists predominantly of quartz, ankerite, and mariposite, both massive and banded.

15. Red Bank (Stevenson Group)

Milky quartz, quartz-mariposite-ankerite rock and rusty silica-carbonate rock are the usual vein rock types.

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16. Pine Tree and Josephine

Massive carbonate rock - ankerite-mariposite-quartz rock probably derived by replacement of serpentine - 60 feet.

NOTE: All of the above descriptions in Mariposa County taken from Calif. Jour. Mines and Geol., v. 53, Nos. 1 and 2, Jan.-Apr. 1957.

The green micaceous mineral so characteristic of the Mother Lode in Tuolumne and Mariposa Counties,....occurs abundantly at the Josephine Mine, near Bear Valley. The mineral is in the form of fibers and minute irregular foils with ragged edges..... Macroscopically, it is not all green, some of it being nearly white..... Associated with mariposite at the Josephine Mine and at Quartz Mountain in Tuolumne Co., as well as many other points along the Mother Lode, is a white mineral which at some points appears to form veins in the mariposite. This is probably the mineral called ankerite by Silliman. An examination of this material by Dr. Hillebrande shows that it is ordinary dolomite mixed with quartz, and not ankerite. In the Josephine Mine, crythrite, and hydrous arsenate of cobalt, forms on surfaces and in seams of the rock adjoining the vein. According to the State Mineralogist of California danaite (cobaltic arsenic sulphide) is also found in the vein matter. (Turner, Henry Ward; U.S. Geol. Survey 17th Ann. Rept., pt. 1, pp. 678-79, 1896).

NOTE: For complete reference see - Mariposite, General References.

17. Mount Ophir

Veinlets of quartz penetrate the serpentine walls and locally form stock works. There is very little mariposite-ankerite rock in this segment of the Mother Lode system.

18. Greens Gulch and Green Gulch Extension

The vein matter is principally milky quartz containing native gold and auriferous pyrite. It locally contains quartz-ankerite-mariposite rock.

19. Washington I Mine

The principal vein at the Washington Mine.....and averages 6 to 8 feet wide. Vein matter is chiefly ankerite-quartz-mariposite rock in which large sheets and lenses of milky to glassy quartz several feet thick are locally developed.

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Nevada County

23. Idaho-Maryland Mine at Grass Valley

No description available.

24. Red Ledge Mine, Washington

No description available.

Placer County

25. Marguerite Mine

No description available.

Riverside County

26. San Jacinto Mtn.

Mariposite reported on the west side of San Jacinto Mountain.

San Diego County

27. Reported near Oak Grove.

Sierra County

28. Rainbow Mine

No description available.

29. Alhambra Mine, Poker Flat district

No description available.

30. Forest and other districts

No descriptions available.

Tuolumne County

31. Common in the Rawhide and other mines near Tuttletown

Rawhide vein....The vein actually worked lies alongside a much heavier vein composed largely of dolomite, talc, and mariposite (a green mica containing a small amount of chromium), with irregular stringers and bunches of quartz. (Turner, Henry Ward and Ransome, F. L.: U.S. Geol. Survey Geol. Atlas, Sonora Folio No. 4, p. 6, 1897).

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Mariposite - General References

Mariposite. Mariposa County (Provisional name).

Hanks[1] in 1884 described mariposite as: This is a mineral of an apple green color, found with quartz, on the Mariposa Estate, Mariposa County; and elsewhere on the great Mother Lode of the state. It has not yet been fully determined. It is referred by Dana to fuchsite. It was first described by Prof. Silliman, Dec. 2, 1867; see Proceedings of the Calif. Academy of Sciences, Vol. 3, fol. 380. It is represented in the State Museum by No. 1295, from the Josephine Mine, Mariposa Co.

Mariposite

Turner[2] described mariposite as: The green micaceous mineral so characteristic of the Mother Lode in Tuolumne and Mariposa Counties, and which was called Mariposite by Silliman, occurs abundantly at the Josephine Mine, near Bear Valley. Several specimens of this were obtained in 1893, and submitted to Prof. F. W. Clarke for analysis. Thin sections of the material were made, and those show that the mineral is micaceous, nearly colorless or slightly greenish, with brilliant polarizing colors, resembling talc or sericite. There appears to be no perceptible pleochroism. The mineral is in the form of fibers and minute irregular foils with ragged edges, and extenguishes nearly or quite parallel to the longer axis of the fibers. Macroscopically, it is not all green, some of it being nearly white. Two analyses by Dr. Hillebrande are appended, one of the green and one of the white mineral.

The thin sections show that there is carbonate, probably chiefly dolomite, mixed with the mariposite. This with some carbonate of iron was extracted with acetic acid followed by warm dilute HCl, the mariposite substance remaining unattacked. Dr. Hillebrande calls attention to the resemblance of the mineral in composition to pinite, and states that no definite formula is deducible. He determined the sp. gr. of the green mineral to be 2.817 at 29.5° C., and that of the white mineral to be 2.787 at 28.5° C. The occurrence of chromium in the green variety and not in the white suggests that to be the cause of the green color.

The analysis of the chrome muscovite is taken from Dana's Manual of Mineralogy, 1892 p. 619. The locality is Syersk, and the mica is said to be green. Some of the analyses of pinite

[1]Hanks, Henry Garber: Calif. Min. Bur., Rept. 4, p. 260, 1884.
[2]Turner, Henry Ward: U.S. Geol. Survey 17th Ann. Rept. Pt. 1, p. 678-79, 1896.

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given by Dana do not differ much from the analysis of the chrome muscovite, but they do not indicate the presence of any chrome sesquioxide.

Assocated with mariposite at the Josephine Mine and at Quartz Mountain in Tuolumne Co., as well as many other points along the Mother Lode, is a white mineral which at some points appears to form veins in the mariposite. This is probably the mineral called ankerite by Silliman. An examination of this material by Dr. Hillebrande shows that it is ordinary dolomite mixed with quartz, and not ankerite. In the Josephine Mine, crythrite, and hydrous arsenate of cobalt, forms on surfaces and in seams of the rock adjoining the vein. According to the State Mineralogist of California danaite (cobaltic arsenic sulphide) is also found in the vein matter.

ANALYSIS OF MARIPOSITE

		Percent		
		Green	White	Chrome Muscovite
SiO_2		55.35	56.79	46.17
TiO_2		.18	25.29	29.71
Al_2O_3		25.62		
Cr_2O_3		.18	None	3.51
Fe_2O_3		.63	1.59	2.03
Fe O		.92		
Ca O		.07	.07	-
MgO		3.25	3.29	2.28
K_2O		9.29	8.92	10.40
$(LiNa)_2O$	a	.12	.17 b	-
H_2O	c	4.52	4.72	5.42
		100.13	100.84	99.52

a - very strong lithium reaction
b - containing some K_2O
c - no water given off below 300° C

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West of Coulterville, the veins of the Mother Lode form two distinct lines. The eastern line, on which are located the Louisa, Mary Harrison & Virginia Mines, is characterized by the heavy croppings with the same abundance of dolomite and mariposite that are found near Penon Blanco.....Petzite, a telluride of gold, has long been noted in works on mineralogy as occurring at the Golden Rule Mine, but it has not been recognized in the present workings. The green micaeous mineral known as mariposite is particularly abundant in the large veins containing much dolomite, and gives to the vein rock a characteristic green color. Both the dolomite and mariposite are usually most abundant where the line of the lode passes through, or close to, areas of serpentine. Such are the veins of the Rawhide, App, Louisa, Mary Harrison, Virginia, Red Bank, Josephine and Mount Ophir Mines.

Rawhide Vein

Turner[3] states: As in the case of the majority of the mines along the southern portion of the Mother Lode, the vein actually worked lies alongside a much heavier vein composed largely of dolomite, talc, and mariposite (a green mica containing a small amount of chromium), with irregular stringers and bunches of quartz.... Near Penon Blanco the veins of the Mother Lode are very heavy, reaching a width of 250 feet. They are composed chiefly of dolomite, containing also some talc and mariposite. The dolomite is veined with quartz, which sometimes forms large and thick lenses.

[3]Turner, Henry Ward and Ransome, F. L.: U.S. Geol. Survey Geol. Atlas, Sonora Folio No. 4, p. 6, 1897.

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