

Mineralogy of the
Eagle-Shawmut Gold Mine,
Tuolumne County, California

by

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FOREWORD

The Eagle-Shawmut gold mine in Tuolumne County, California has been idle since 1947; however it was very productive during its years of operation. Eagle-Shawmut is typical of the dozens of mines that are located in this area, the Mother Lode belt. The purpose of this report is to give a detailed outline of this mine and the Mother Lode belt historically, and especially mineralogically.

1.0 INTRODUCTION

The Eagle-Shawmut gold mine is located on the north bank of Don Pedro Reservoir, Tuolumne County, California (Fig.1), two miles east of Chinese Camp and about 70 miles south of Sonora. The mine underwent two periods of operation from 1897 to 1926 and from 1938 to 1947. The mine yielded over 320,000 ounces of gold from a broad fracture zone in graphitic schist filled with quartz stringers. Ore mined consisted of quartz veins and the higher grade portions of the mineralized schist. Stopping widths ranged from 8 to 30 feet. The lowest workings were on the 3150 foot level. Yearly average ore grades during the 1897-1926 period of operation ranged from 0.08 to 0.26 ounces of gold per ton. During the last period of operation, about 60,000 ounces of gold was recovered from ore containing 0.08 ounce per ton. In this operation, a zone 700 feet long and up to 150 feet wide was mined by block caving from an adit level 450 feet below the outcrop. Reserves are estimated by the current owner as 4.0 million tons of 0.08 ounces of gold per ton ore above the 650 foot level. Additional ore is inferred to occur in the downward continuation of the ore zone. In 1950, completion of the Don Pedro Dam partially engulfed the mine. California state law prohibits the cyanide extraction process to be performed within a reservoir's drainage making any operation in the near future unlikely (U.S.B.M.,1948).

2.0 THE MOTHER LODE SYSTEM

The Mother Lode belt of California is a strip roughly a mile



FIGURE I.A

EAGLE-SHAWMUT AND DON PEDRO RESERVOIR

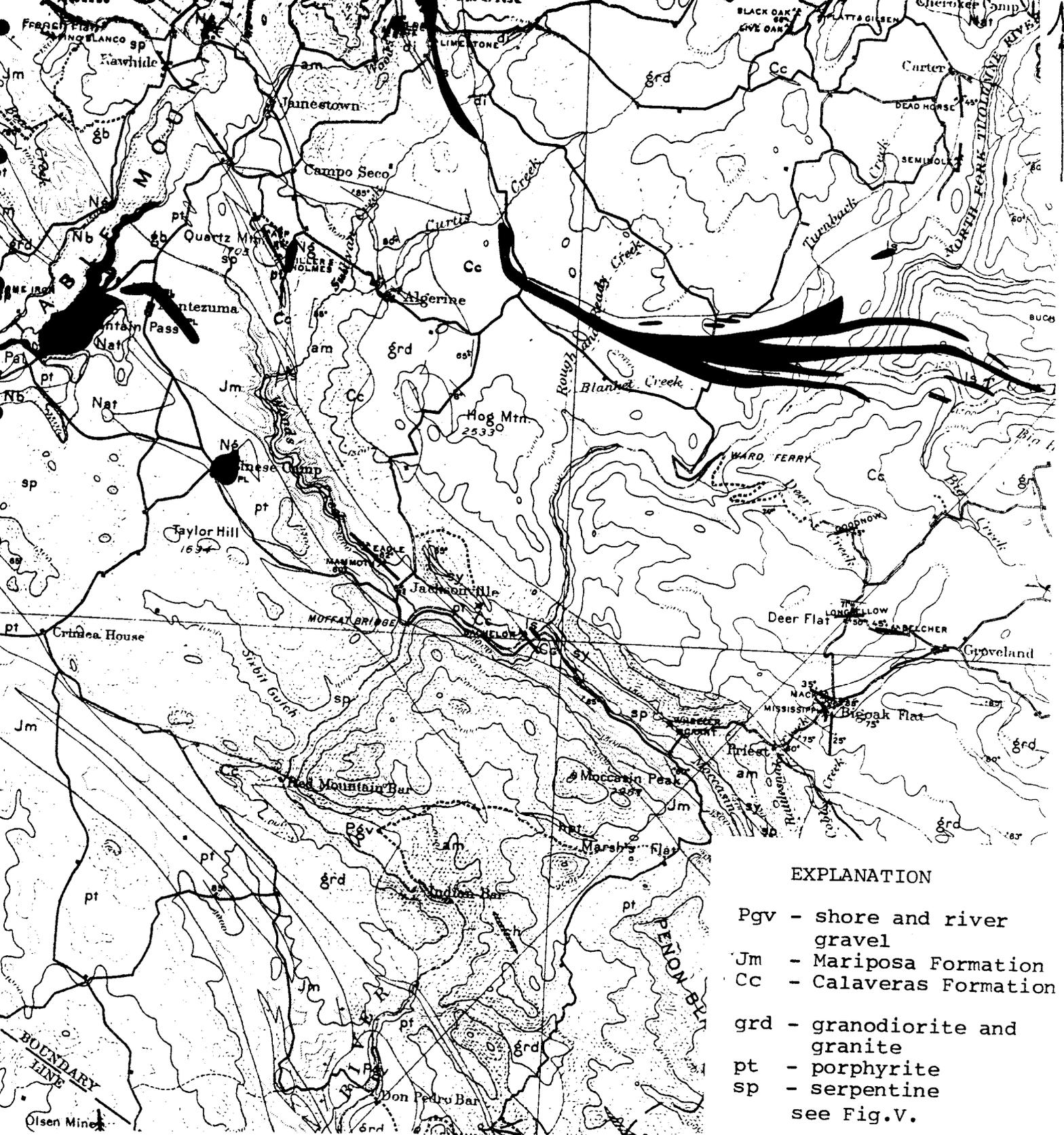


FIGURE I.B

wide extending for 120 miles along the lower western flank of the Sierra Nevada. It begins near George town, in Eldorado County, and extends to Mariposa, in Mariposa County (Fig.II). The five counties that it traverses - Eldorado, Amador, Calaveras, Tuolumne, and Mariposa - are known as the Mother Lode counties.

The Mother Lode belt is generally a hilly country of moderate relief. Its altitude above sea level is about 2700 feet at the north and 2000 feet at Mariposa. In the most productive part of the belt, which extends from Plymouth to Jackson in Amador County, the average altitude is about 1500 feet. The topography is rolling except where the belt is crossed by the larger streams from the Sierra Nevada. These streams - including the Mokelumne, Stanislaus, Tuolumne, and Merced Rivers, cross the gold belt in deep canyons. The cutting of these canyons and the tributary canyons that extend back from them has locally produced stretches of rugged country, including the Eagle-Shawmut area.

The country has in general a distinct southeast grain, the result of the control exerted on erosion by its bedrock structure. The ridges have the same general trend and as a rule consist of resistant belts of greenstone or serpentine that have withstood erosion. They are crossed in narrow valleys by minor streams including Amador, Sutter, and Jackson Creeks (Knopf,1929).

3.0 THE EAGLE-SHAWMUT MINE

3.1 History of Eagle-Shawmut

The Eagle-Shawmut mine was the property of the Eagle-Shawmut Mining Company during its productive years. Not much work had

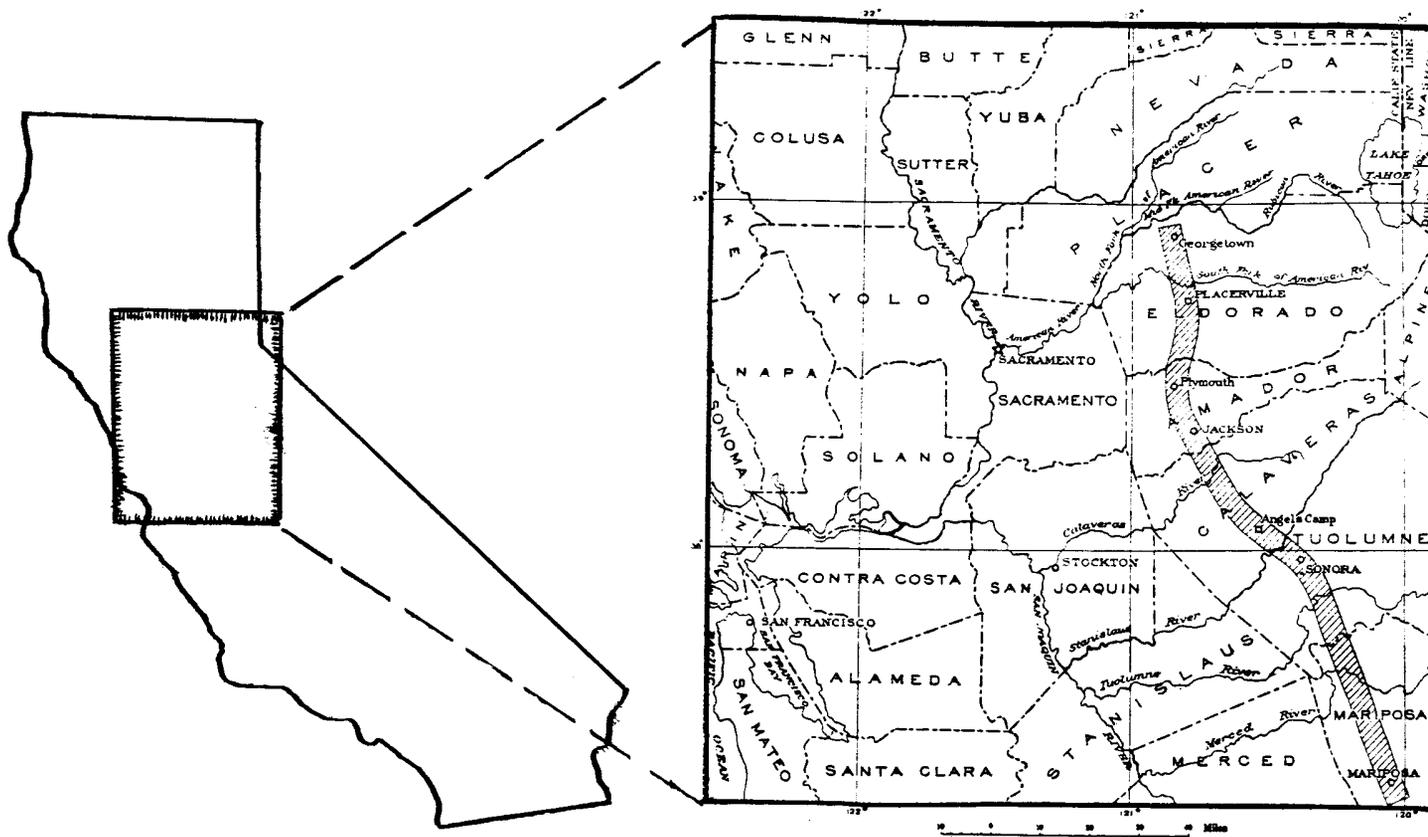


FIGURE II.

INDEX MAP SHOWING THE LOCATION OF THE MOTHER LODE BELT, CALIFORNIA

been done before 1896 when this company combined the Eagle and Shawmut claims. The mine was operated under this management until 1916, when the Tonopah Belmont Development Co., through a subsidiary known as the Belmont Shawmut Mining Co., obtained control under an option to purchase. Considerable exploration was done, but in November, 1923, work was stopped because of the low grade of the ore developed. During this period the mine was known as the Belmont Shawmut. In 1924 the original company had resumed operations, and the older name was in use. The mine enjoyed a much less profitable period from 1938 to 1947. In 1950, damming of the Tuolumne River made further operations improbable.

3.2 Structure of the Mine

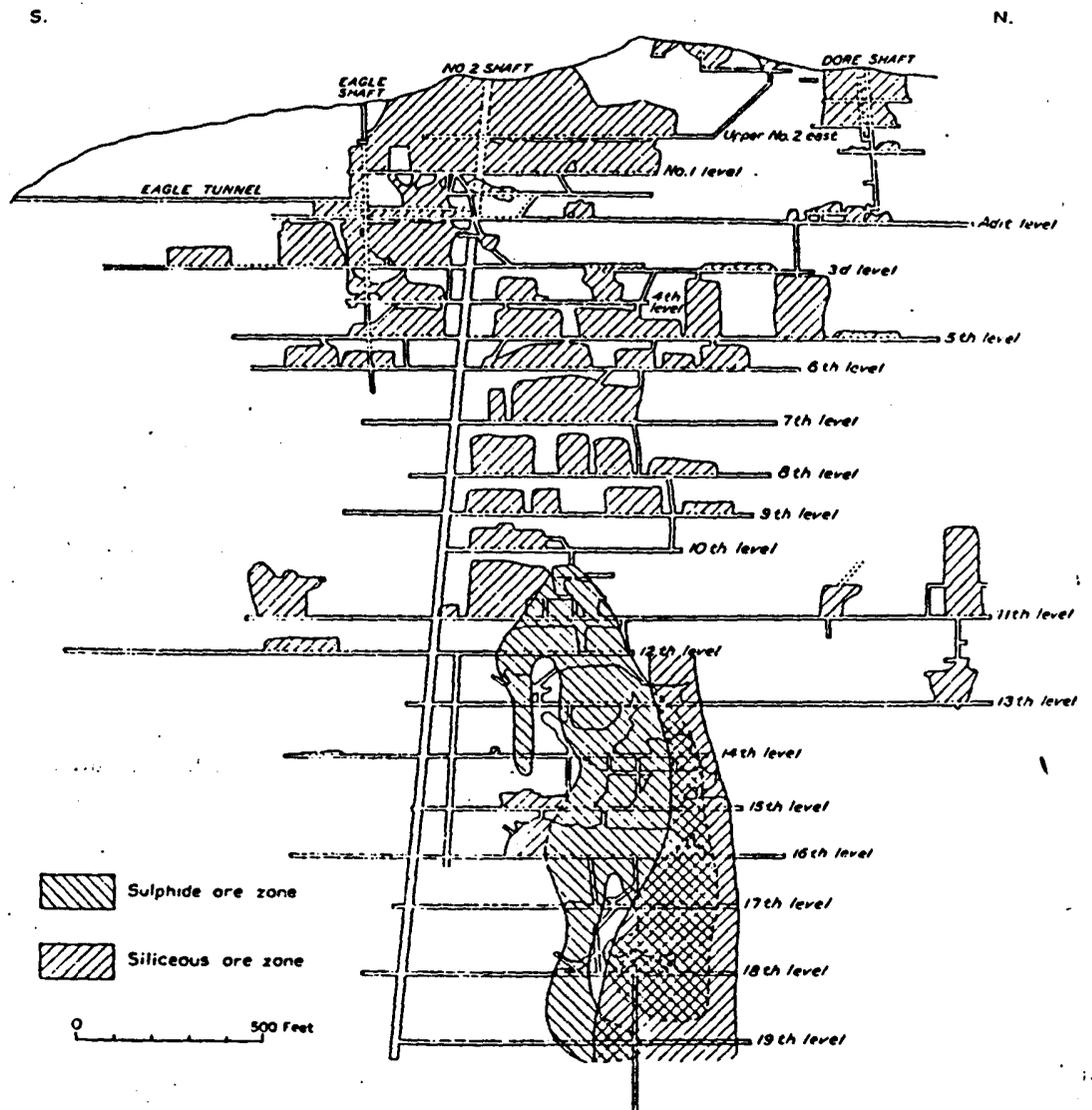
The Eagle-Shawmut mine is developed by a crosscut adit driven 1,100 feet through the footwall to the lode and connecting with an inclined shaft 2,163 feet deep. From this internal shaft have been driven at various intervals 19 levels. From the bottom of the nineteenth level a 900-foot winze has been sunk and two levels turned from it. The total vertical depth attained below the outcrop is 3,000 feet (Fig. III). Ore was treated by a 70-stamp mill (Plate I).

3.3 Geology of the Mine

The lode system worked in the Eagle Shawmut mine lies at the contact of the Mariposa slate and the Calaveras formation (Fig. IV), which here contains much greenschist. The southern

FIGURE III.

LONGITUDINAL SECTION OF THE EAGLE-SHAWMUT MINE, SHOWING
THE DISTRIBUTION OF ORE BY KINDS



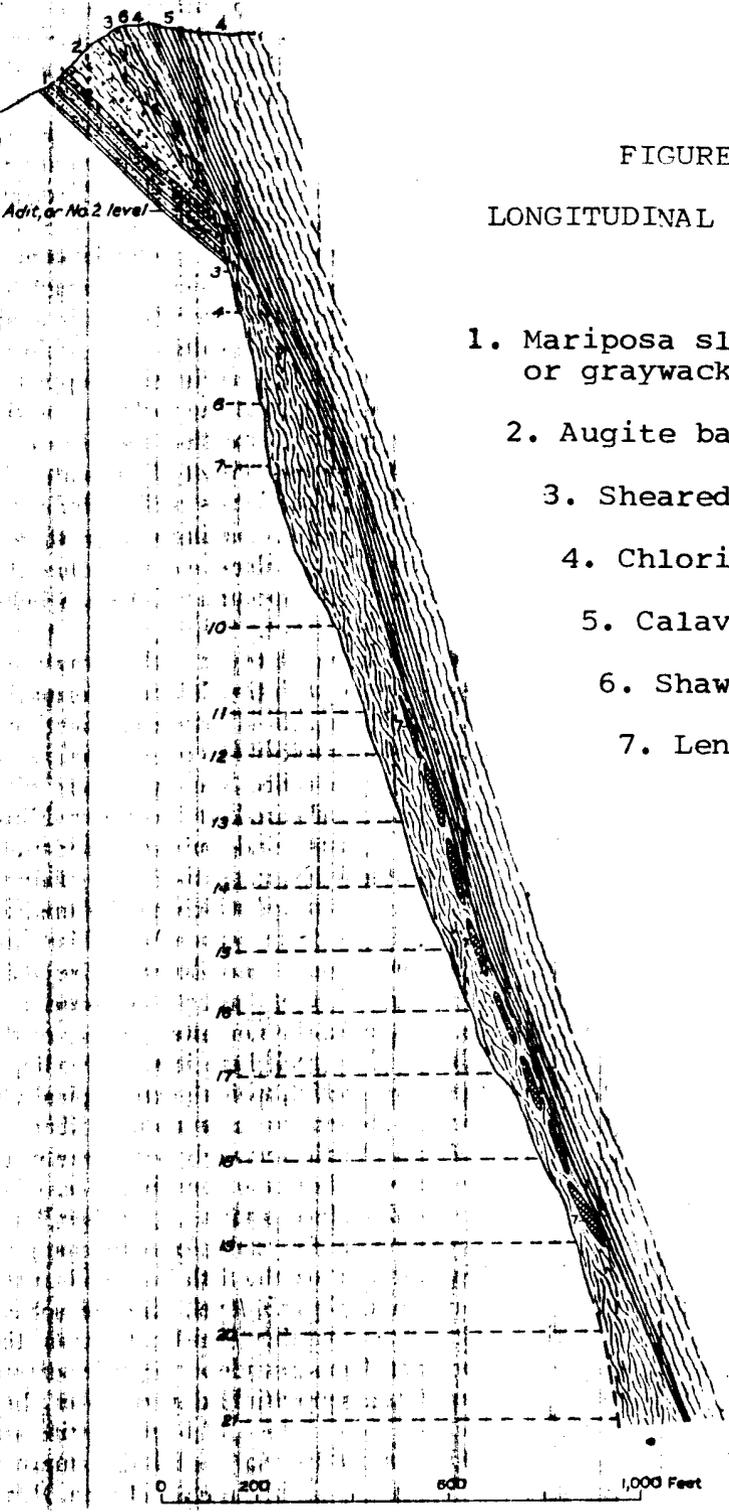


FIGURE IV.
 LONGITUDINAL SECTION THROUGH THE 610-FOOT WINZE

1. Mariposa slate with interbedded sandstone or graywacke
2. Augite basalt breccia and augite porphyry
3. Sheared pyroxenite (chlorite schist)
4. Chlorite-zoisite schist
5. Calaveras slate
6. Shawmut vein
7. Lenses of sulfide ore

from Knopf, 1929

FIGURE V.

STRATIGRAPHY OF THE MOTHERLODE BELT

SUPFICIAL ROCKS

Alluvium - Pal

Shore and river gravels - Pgv

} Pleistocene

SEDIMENTARY ROCKS

Andesitic gravel and sandstone - Nas

Ione Formation - Ni

Sandstone used for building, clay
conglomerate, and rhyolite tuff

} Neocene

Auriferous river gravels - Ng

Tejon Formation - Et

Sandstone and conglomerate
used for building

} Eocene

Mariposa Formation - Jm

Clay, slates, and sandstone, contains
rich gold quartz veins

} Juratrias

Mariposa Formation - Jms

Mica and andalusite schists,
contact metamorphic rocks

Calaveras Formation - Cc

Argillite, limestone, quartzite, and mica-
schist; contains gold quartz veins.

} Carboniferous

SUPERJACENT SERIES

BEDROCK SERIES

Reproduced from U.S.G.S., Sonora Quadrangle, 1895.

part of the system is marked by the immense outcrops of white quartz that extend from the summit of the ridge 1,400 feet south to Blue Gulch.

Four types of ore are distinguished. They are banded quartz, impregnated schist, dark and light sulfide ores. The principal ore in depth was the dolomite-sulfide ore, occurring in well-defined overlapping lenses 8 feet to 30 feet wide. The vein rolls, and the ore was in the crests of the anticlines. The sulfide content averaged 7%, and was even higher in the dolomite-sulfide ore, which was first encountered on the 17th level. There is a heavy gouge on the footwall side of vein which is six feet wide at the surface and is in contact with the vein between 1100 and 1400 feet in depth, but below is separated from the vein. Where cut in the workings it swelled excessively. Typical cross-sections of the formation at No. 3 and No. 18 levels showed practically the same sequence, with the 'bull quartz' or 'tale' on the footwall followed going toward the hanging wall by dolomite six to eight feet wide, assaying high in gold, at times, but generally low or medium grade, then a stratum of limestone, three to 11 feet wide, which is separated from the amphibolite schist of the hanging wall by 15 feet of black slate (Calaveras formation). Stopes were generally not over 200 feet long. Faults across the course of the lode bound the deposit on both ends, displacing the vein from east to west, looking south; but no important orebodies have been found on either adjoining property.

The Mariposa slates (Fig. V) are interbedded with many thin layers of sandstone averaging 2 inches in thickness. In strike they range from N 20 W to N 45 W within short distances. The cause of this diversity of strike is excellently shown in the main tunnel, which is the best place along the Mother Lode to see the close folding that has affected the Mariposa beds. At 200 feet from the portal the bottom of a perfect synclinal fold pitching 60 degrees S. is shown; the axial plane of the fold strikes N 32 W and dips 80 degrees E., and the fold causes the beds on its limbs to diverge 30 degrees in strike. Another similar fold is well shown 500 feet farther in. On the surface, near the Bull vein, the Mariposa slate incloses a belt of volcanic rock that includes an amygdaloid flow and a breccia composed of angular fragments of amygdaloid as much as 6 inches in diameter. At Blue Gulch the amygdaloid is 100 feet thick; it is a basalt crowded with augite phenocrysts and amygdules of calcite and chlorite. This belt of amygdaloid and breccia was mapped as metadiabase, but as the rocks are neither intrusive nor of diabasic texture that name can not be retained. Near the upper contact of the slate with the volcanic belt occur some lenses of limestone 2 to 3 feet thick, and near the old loading station there is a thicker mass, resting on black slate. Some thin lenses of conglomerate also occur in the slate below the amygdaloid breccia.

Between the Mariposa slate and the gray-green chlorite schists associated with the Calaveras formation on the east, is a narrow belt of pyroxenite or hornblendite or an allied hornblende-pyroxene peridotite. In this report it will be called the

pyroxenite dike. It has been powerfully sheared and converted into multiform chlorite schists, and subsequently these schists have been extensively ankeritized and silicified. These chlorite schists, some of which to the unaided eye are indistinguishable from serpentine schist, and their ankeritized equivalents are among the chief rocks in the ore zone. In one of the best exposures, the rock is an exceedingly crumbly lustrous green schist, which microscopically is found to consist of broken green amphibole fibers in a matrix of chlorite (Knopf, 1929). In this crumbly schist are some partly sheared lenses or horses of hornblendite, composed of thick hornblende. At places in the mine, as for example in the hanging wall of the Shawmut vein on the fifth level and in the footwall crosscut on the ninth level, chlorite schists occur that resemble serpentine schists; that on the ninth level, moreover, has a pseudoporphyritic texture much like that of the serpentized peridotites, but the apparent phenocrysts instead of being bastite are chlorite and are embedded in a chlorite matrix. The only obvious physical difference between them and serpentine is that they are softer.

The Calaveras rocks (Fig.V), dipping 70-80 degrees east, make an angle of 20 or so with the ore zone. They consist of black slates, which differ from the Mariposa slate in not containing interlayered sandstone, and siliceous slates and quartzites that are so fine grained that they verge on chert. The Calaveras rocks are also associated with gray-green chlorite-zoisite schists which are firm, tough rocks.

Structurally the Calaveras rocks, although older than the Mariposa slate, rest discordantly on the Mariposa rocks at

Eagle-Shawmut. This superposition of the Calaveras is the result of a reverse fault. Along this fault contact the pyroxenite dike was intruded and afterward sheared to chlorite schist of various facies.

The reverse fault along which the pyroxenite dike was intruded also cuts the dip of the hanging wall rocks. The angular divergence is small but it is shown by the presence in the southern part of the mine of black slate above the ore on the lower levels. On the upper levels the hard chlorite-zoisite schist occupies this position. A vertical section through the 610-foot winze (Fig. IV, Knopf, 1929) is a very good example containing the essential geologic features of the mine.

The Calaveras rocks were metamorphosed, probably at the end of the Paleozoic era, and after the metamorphism, igneous magmas invaded them, yielding diorite, quartz diorite, muscovite granite, and hornblende lamprophyre.

In late Jurassic or early Cretaceous time the region of the Sierra Nevada felt the onset of the Cordilleran revolution. The rocks were isoclinally folded and then were invaded by a succession of plutonic rocks, beginning with peridotite, which altered to serpentine, and ended with granodiorite. At the end of this epoch of igneous activity, the gold deposits were formed. Since the Cordilleran revolution the gold belt has remained above sea level. Erosion has stripped off several thousand feet of rock during that long period of time.

The gold is believed to have come from a deep seated magma source. The quartz came largely from the adjacent wall rock, and the water by which these substances were carried in solution came partly from the magma and largely from meteoric circulation.

As the thermal water rising in a fissure issues at the earth's surface only at certain openings, this localized efflux would determine more rapidly moving threads of current in the fissure. All other water in the fissure would be stagnant or nearly stagnant. Only those portions of the fissure in which the ore-depositing solution was actively flowing would become the loci of gold deposits.

The wall rocks of the Mother Lode veins have been profoundly altered by the ore-forming processes. Large volumes of rock have thereby been transformed. Carbonatization (ankeritization) was the chief effect, regardless of whether the rocks were slate, graywacke, quartzite, conglomerate, greenstone, amphibolite schist, chlorite schist, talc schist, or serpentine. Sericite, albite, pyrite and arsenopyrite were also commonly formed by chemical attack on the wall rocks. Gold also migrated into the wall rocks as already described (Knopf, 1929).



PLATE I.

70-STAMP MILL, EAGLE-SHAWMUT MINE

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