UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

GOLD DEPOSITS OF THE WESTERN SIERRA NEVADA

Field Trip Guide

by

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March 1 - 5, 1984

Society of Economic Geologists

Annual Meeting, Los Angeles, California

February, 1984

Open-File Report 84-169

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INTRODUCTION

The western foothills of the central Sierra Nevada have been the source of the bulk of California's past gold production. Although gold mining decreased greatly in the years during and following World War II, dramatic increases in gold prices coupled with advances in extractive techniques have rekindled interest in mining this metal in the State. In addition to production from the complex vein system of the historically famous Mother Lode and East Belt and West Belt (fig. 1), large amounts of gold have also been taken from the Grass Valley-Nevada City lode district and from Tertiary river channels and Quaternary alluvium of the foothills (fig. 2).

Although the geology of the western Sierra Nevada has been the subject of several recent studies, it is not well understood, and is the subject of considerable controversy. It is generally agreed that the strata of the western metamorphic belt occur in several separate fault-bounded structural blocks or tectono-stratigraphic terranes. Convergent plate tectonism governed the Paleozoic to Middle Jurassic development of the belt and the terranes collectively represent a collage of tectonically accreted blocks emplaced at various times along the western margin of the North American continent. The eastern flank of this collage was then episodically intruded by magmas of the Sierra Nevada batholith during the late Mesozoic.

A nearly flat lying sequence of scattered and discontinuously exposed Late Cretaceous and Tertiary marine sediments, river gravels, and volcanic mudflows and lavas rests on the deeply eroded metamorphic and granitic rocks of the western foothills. Where the stream gradients are nearly level, such as in the Central Valley, large amounts of Quaternary alluvium have been deposited.

Lode deposits. The Mother Lode is a 1 to 4 mile wide system of mineralized rock and en echelon quartz viens extending for 120 miles through El Dorado, Amador, Calaveras, Tuolumne, and Mariposa Counties. Most of the Mother Lode ore bodies are concentrated in or near the Melones fault zone, a zone marked by elongate serpentinite bodies, belts of pervasive shearing, and cataclastic deformation. Much of the past gold production has been from the quartz viens, however much of the present interest is in mineralized country rock; productive quartz viens are generally characteristic of the north portion of the Mother Lode, whereas immense persistent barren veins and enormous bodies of carbonate rock associated with mineralized country rock are most common in the southern portion.

The steeply northeast-dipping veins, in places localized in subparallel tabular masses, pinch and swell abruptly and rarely can be traced for more than a few thousand feet. Mineralogy of the veins is simple, consisting of milky quartz, in many places ribboned with bands of slate or schist, minor amounts of sulfide minerals, mostly pyrite, and free gold. Many of the world's finest crystalline gold specimens have been recovered from pockets in the veins.

Ore bodies occur in altered country rock of various types, but are commonest in mineralized greenstone and mineralized schist. Mineralized greenstone, known as gray ore, chiefly altered metavolcanic breccia and tuff, is composed of Fe-Mg carbonate with lesser amounts of sericite, albite, and quartz and 3 to 4 percent pyrite and arsenopyrite. It is interlaced with veinlets of quartz, carbonate, and albite. Mineralized schist, originally chlorite schist or amphibolite, also consists chiefly of Fe-Mg carbonate and subordinate sericite, quartz, albite, and pyrite. In both the mineralized greenstone and mineralized schist, gold is finely disseminated and associated

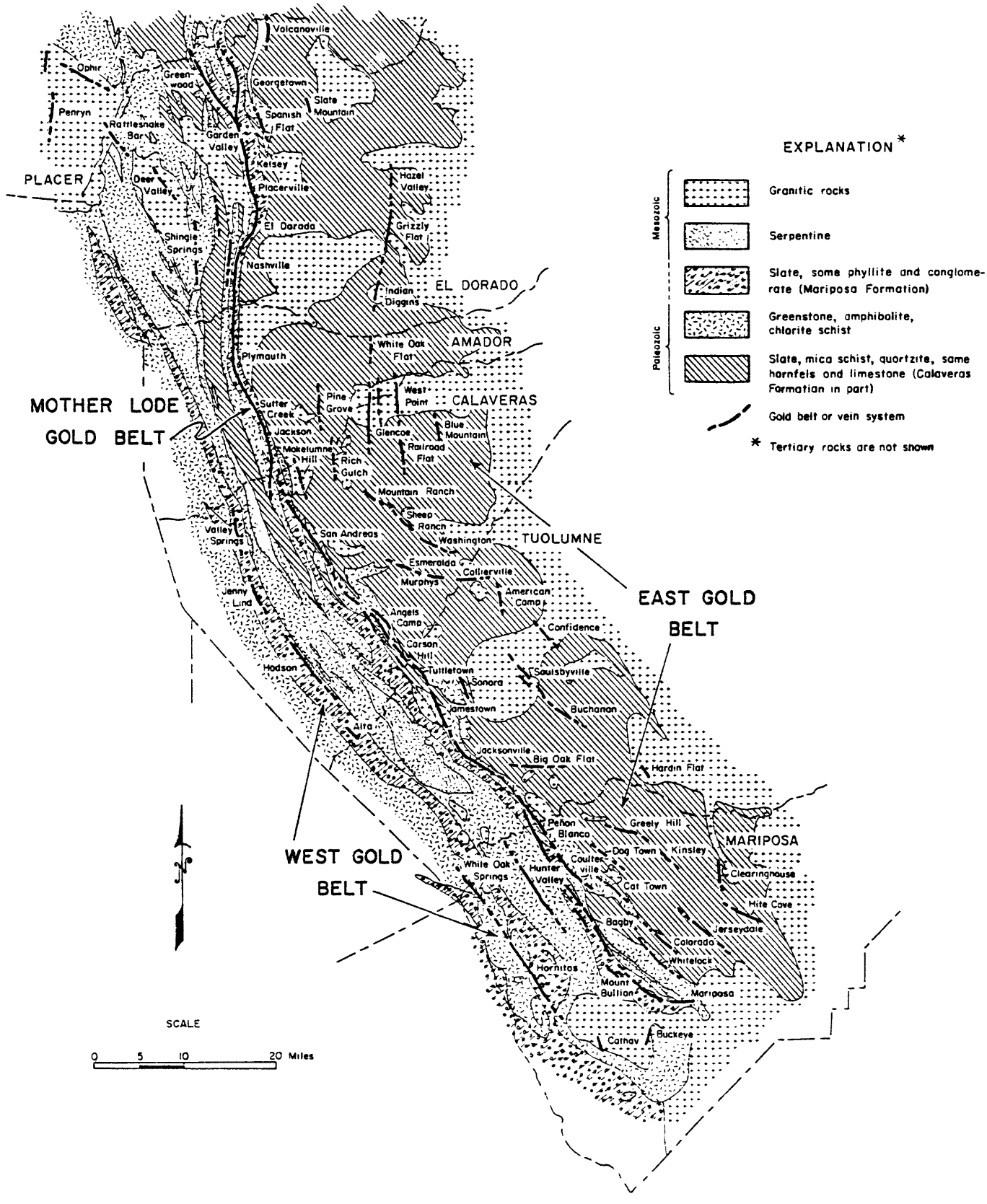


Figure 1. Major Rock Units and Lode-Gold Belts, Central Sierra Nevada. From Clark, 1970.

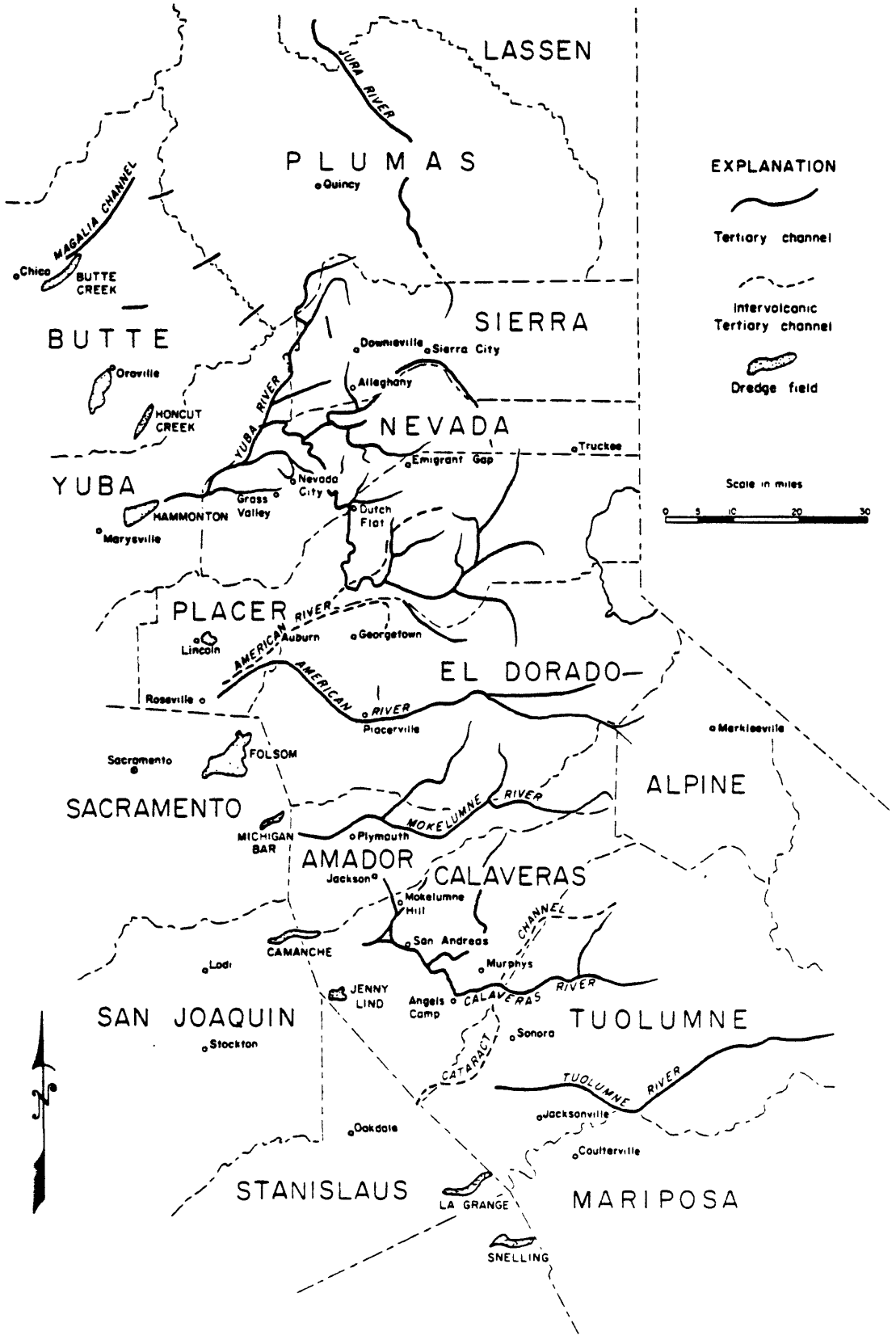


Figure 2. Tertiary River Channels and Dredge Fields, Sierra Nevada. From Clark, 1970.

with the sulfide minerals.

Gold deposits in two zones of mineralization, the East Belt and West Belt, flank the Mother Lode and occur 5 to 15 miles from it. The two belts are shorter and less continuous than the Mother Lode. Quartz veins of the East Belt cut a variety of rocks, and some of the richest deposits are veins in Jurassic granites. East Belt ores are more complex than those of the Mother Lode, containing appreciable arsenopyrite, chalcopyrite, galena, and sphalerite as well as pyrite. West Belt deposits are similar to those of the Mother Lode, with gold occuring with pyrite in altered metamorphic rock adjacent to quartz veins as well as in the veins themselves.

Gold-quartz vein systems of the Grass Valley-Nevada City district, Nevada County, are about 30 miles north of the Mother Lode. At Grass Valley, veins cutting a granodiorite body and adjacent metamorphic rock trend northerly and dip gently, whereas a second set of veins that cut serpentinite and amphibolite north of the granodiorite trend easterly and dip steeply. Vein quartz occurs in several forms, including comb quartz, milky quartz, ribbon quartz, and brecciated quartz, representing successive stages of mineralization. Carbonate minerals commonly accompany the quartz. Pyrite, sphalerite, galena, and less commonly arsenopyrite and chalcopyrite are present. Gold occurs along fractures in the sulfide minerals and in brecciated quartz. Several vein systems cut granodiorite at Nevada City, five miles northeast of Grass Valley. The granodiorite is in a mass separate from that at Grass Valley. Nevada City and Grass Valley ores are similar except for a common association of tetrahedrite with gold and galena in the Nevada City ores and a tendency for the Grass Valley ores to contain a larger amount of coarse gold.

Several isolated lode districts occur in the Sierra Nevada north of the Grass Valley-Nevada City district. Most of the gold produced from these districts has been from quartz veins cutting granitic or metamorphic rocks.

Placer deposits. Gold occurs in placer deposits of two different ages in the western Sierra Nevada. The older deposits are chiefly quartz gravels in relict early Tertiary river channels. Six major rivers, all except one of which flowed westward, the northernmost having drained to the north, made up the early Tertiary drainage system. Gold has been produced from deposits of all these rivers, however the most productive have been those of tributaries of the ancestral Yuba River in Nevada and Sierra Counties. Gravels deposited in the beds of these rivers were covered with volcanic debris late in the Tertiary, and new systems of drainage developed. Alluvium deposited during the later Tertiary volcanic episode contains little gold. As a result of Quaternary erosion, only scattered remnants of Tertiary channels have been preserved.

The younger deposits are placers within the present-day drainage system. Quaternary streams have cut deeply through the Tertiary deposits into bedrock, with subsequent accumulation of gold in deposits further downstream. These younger deposits range from numerous small but rich placers of a few cubic yards on the slopes of the western Sierra Nevada to a few large but low-grade deposits of hundreds of millions of cubic yards in the nearly level far western Sierra Nevada and eastern Great Valley. Two of the most extensive dredged areas in these large deposits are the Hammonton district on the lower Yuba River, Yuba County, and the Folsom district on the American River flood plain in Sacramento County.

SELECTED BIBLIOGRAPHY

The following are a few selected general references on gold in the western Sierra Nevada. The total number of published articles pertaining to gold in the region is voluminous.

Averill, C. V., 1946, Placer mining for gold in California: California Division of Mines Bulletin 135, 357 p.

Clark, L. D., 1964, Stratigraphy and structure of part of the western Sierra Nevada Metamorphic belt, California: U.S. Geological Survey Professional Paper 410, 70 p.

_____, 1976, Stratigraphy of the north half of the western Sierra Nevada metamorphic belt, California: U.S. Geological Survey Professional Paper 923, 26 p.

Clark, W. B., 1970, Gold districts of California: California Division of Mines Bulletin ~~170~~ 193, 186 p.

Jenkins, O. P., and others, 1948, Geologic guidebook along Highway 49-Sierran gold belt-the Mother Lode country (centennial edition): California Division of Mines Bulletin 141, 164 p.

Johnston, W. D., Jr., 1940, The gold quartz veins of Grass Valley, California: U.S. Geological Survey Professional Paper 194, 101 p.

Knopf, Adolph, 1929, The Mother Lode system of California: U.S. Geological Survey Professional Paper 157, 88 p.

Lindgren, Waldemar, 1911, The Tertiary gravels of the Sierra Nevada of California: U.S. Geological Survey Professional Paper 73, 226 p.

Logan, C. A., 1935, Mother Lode gold belt of California: California Division of Mines Bulletin 108, 240 p.

Moore, Lyman, 1968, Gold resources of the Mother Lode belt California: U.S. Bureau of Mines Technical Progress Report 5, Heavy Metals Program 22 p.

Wagner, J. R., 1980, Gold mines of California: San Diego Calif., Howell-North Books, 259 p.

Wilson, W. E. and others, 1982, Gold!: The Mineralogical Record, v. 13, p. 321-412.

Yeend, W. E., 1974, Gold-bearing gravel of the ancestral Yuba River, Sierra Nevada, California: U.S. Geological Survey Professional Paper 772, 44 p.

PROGRAM

First Day

Leave Los Angeles 1:00 pm, Thursday, March 1, 1984

Overnight stop, Merced, California

Second Day

Stop 1* Mariposa Slate

Stop 2 Josephine and Pine Tree mine

Stop 3 Oro Rico mine; talk by Robert Weir

Stop 4 Allochthonous limestone block in phyllite, Melones fault zone; talk by Leslie A. Landefeld

Stop 5+ Jamestown property

Slow drive - Placer diggings in limestone

Overnight stop, Sonora, California

Third Day

Stop 6* Carson Hill mine

Stop 7+ Mountain King-Royal property

Stop 8+ Blazing Star mill

Stop 9* Mehrten and Valley Springs Formations

Stop 10 Jackson overlook; Argonaut mine; talk by John E. Zimmerman

Overnight stop, Jackson, California

Fourth Day

Stop 11* Fremont mine

Stop 12+ Gold Bug mine; Melones fault zone

Stop 13 Coloma discovery site

Stop 14 Empire mine

Overnight stop, Nevada City, California

Dr. Bruce E. Taylor will talk on "Mother Lode gold deposits: a geological and geochemical overview" at a banquet dinner at the National Hotel

Fifth Day

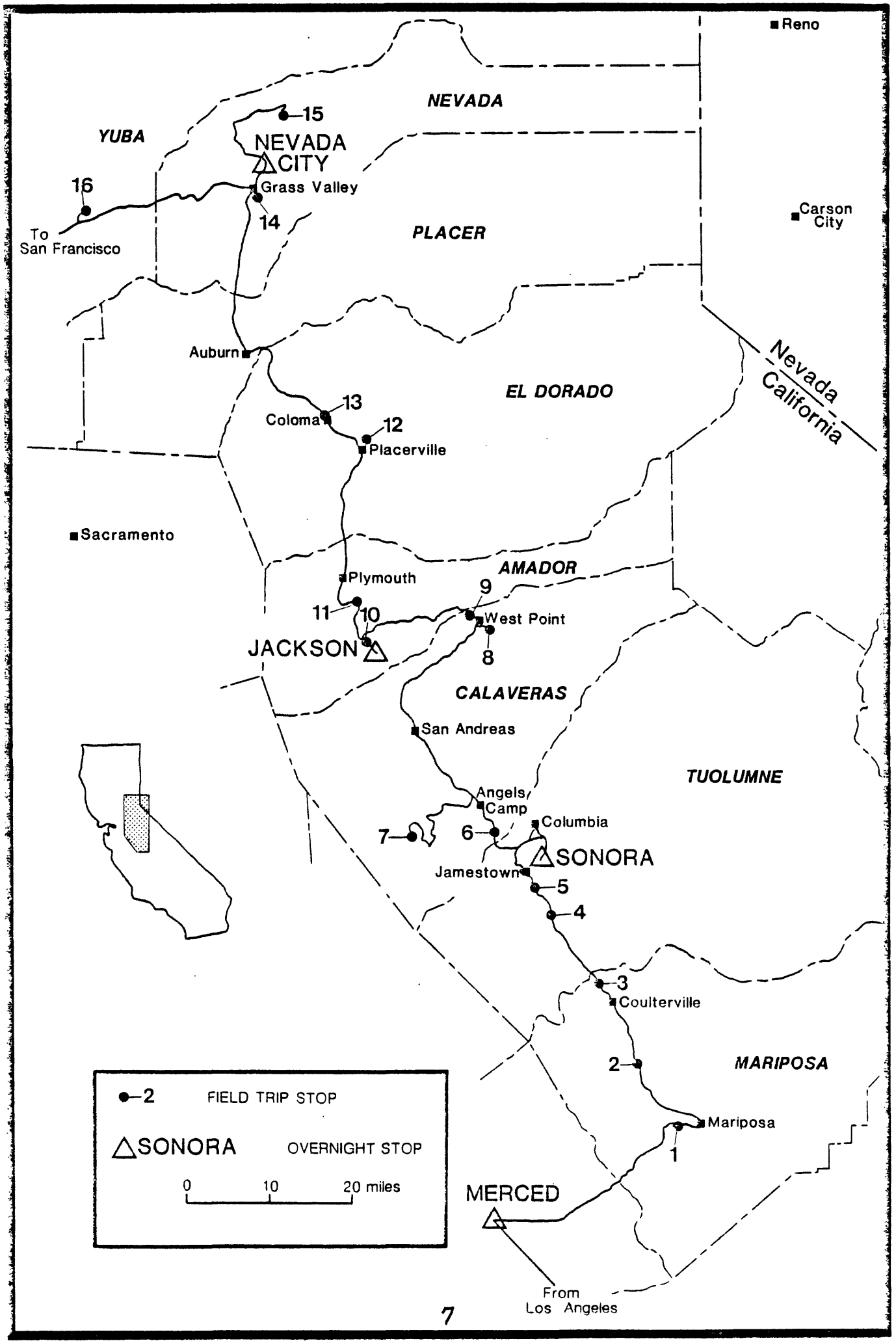
Stop 15+ San Juan Ridge property

Stop 16+ Yuba gold dredge no. 21

Arrive San Francisco approximately 5:00 pm, Monday, March 5, 1984

* Optional stop, depending on time or other factors

\+ Hard hat and safety glasses required at this stop


Reno
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Carson City
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EL DORADO
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Coloma
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Placerville
Sacramento
AMADOR
Plymouth
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West Point
JACKSON
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CALAVERAS
San Andreas
TUOLUMNE
Angels Camp
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SONORA
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Mariposa
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MERCED
From Los Angeles
2 FIELD TRIP STOP
SONORA OVERNIGHT STOP
0 10 20 miles

ROAD LOG

SECOND DAY

Mileage	
0	Junction of State Highways 99 and 140, Merced, California. Proceed east toward Mariposa.
14.3	Entering western edge of the Sierra Nevada foothills. The lower foothill region in underlain in large part by volcanic-derived alluvial sediments of the Miocene Valley Springs and Mehrten Formations.
15.0	Mariposa County line.
15.4	Although poorly-exposured here, rocks of the Sierra Nevada metamorphic belt are no longer covered by younger alluvial deposits. A large white quartz vein is exposed on the second ridge on the right. Numerous barren quartz veins crop out in this region.
15.8	First well-exposed metamorphic rock. For the next six miles or so the bedrock is mainly black slate which probably represents the southern continuation of the Upper Jurassic Merced Falls Slate.
21.9	Contact of metamorphic rocks with the Guadalupe igneous complex. Western portion of the complex is gabbroic. The complex has been dated at 140 m.y., setting a lower age limit on the Nevadan orogeny. Entering Cathey mining district.
28.4	Agmatite, consisting of mafic fragments totally enclosed in a granitic matrix, is exposed in roadcuts. The complex is granitic east of these exposures.
30.6	Contact aureole of Guadalupe Intrusive complex with metasedimentary rocks of the upper Jurassic Mariposa Formation.
31.7	STOP 1 Dials Rock Shop. Exceptionally well exposed Mariposa Slate east about 500 feet on the left. Isoclinal folds, smaller drag folds, and graded bedding in graywacke can be seen along the roadcut. The foliation trends northwest, parallel to bedding in the east-facing limbs. Joints, some with quartz filling, trend northeast, truncating the foliation.
31.9	Hydrothermally altered Mariposa Slate.
36.0	Serpentinite marking the Melones fault zone.
36.4	Mariposa city limits.
36.5	View of Mariposa mine and mill on right. This mine and others make up the Mariposa district, the southernmost mining district of the Mother Lode gold belt. The currently active Colorado Quartz mine, about five miles north of Mariposa, has produced exceptionally fine crystallized gold specimens.

37.4 Museum and stamp mill at history center on the left. Mariposa now has possession of the extensive California Division of Mines and Geology mineral collection formerly housed in the Ferry Building in San Francisco.

37.7 Turn left at junction of Highways 49 and 140. Highway 49, commonly known as the Mother Lode Highway, connects many of the towns and mining camps that sprang up along the belt soon after the California gold rush began in 1849.

40.8 Passing back through the serpentinite that marks the Melones fault zone. The highway crosses through serpentinite bodies along the fault zone several times in the next 30 miles or so.

41.6 Entering the Mount Bullion mining district. Most of the mines in this district are located on Mount Bullion which is visible on the right.

42.0 Town of Mount Bullion.

48.7 Town of Bear Valley. Bagby mining district.

51.3 STOP 2

Josephine and Pine Tree mines. Dumps and building foundation ruins at the head of the ravine to the south. These mines, among the earliest of the lode mines, operated intermittently from 1850 to 1944, part of the time under the ownership of Col. John C. Fremont.

Serpentinite, marking the Melones fault zone, is exposed in roadcuts along the highway. Mariposite, a chromian muscovite that occurs in carbonate rock associated with many gold deposits of the southern Mother Lode, was first described from the Josephine mine by Silliman in 1868.

Walk north along ridge about 500 feet. Due east, a few of the peaks of the high Sierra, over 11,000 feet can be seen rising above the forest-covered ridges along the skyline. On a clear day the tops of El Capitan, Half Dome, and Clouds Rest of Yosemite can be seen at the head of Merced Canyon. A broad relatively flat area north and east across the Merced Canyon represents an ancient land surface on which auriferous gravels were locally deposited.

Hell Hollow, the narrow gorge the highway follows below the mines to the Merced River, is the type locality of the Mariposa Slate. The rocks are mainly dark slate interbedded with black arkosic sandstone.

53.9 Merced River bridge - the old mining town of Bagby is now innudated by Lake McClure.

59.8 Entering the Coulterville mining district. Visable to northwest is the Virginia mine, where though one of the oldest patented claims in Mariposa County, recent activity is apparent. Note large quartz vein exposure capping Virginia Point above mine site.

62.2 Albitite dike on right. These unusual dikes, composed almost entirely of albite with minor quartz, muscovite, epidote, chlorite, and sodic amphibole occur mainly in contact zones between serpentinite and other rocks.

62.7 Mary Harrison mine site to the left.

63.9 Entering Coulterville. Whistling Billy, the small steam locomotive on the left, was used to haul ore from the Mary Harrison mine to the 40-stamp Potosi mill at the turn of the century.

66.2 View of Oro Rico mine workings ahead. Note quartz vein exposed on Penon Blanco Ridge.

67.1 STOP 3
Right side of road just past Haigh Ranch entrance. Quartz veins and altered country rock exposed along road into Haigh Ranch.

Robert Weir, master's candidate Pennsylvania State University, will summarize results of his current research on geochemistry of gold-bearing vein deposits of the southern Mother Lode. Bob's studies are intended to shed light on the genetic controls of gold transport and deposition. Much of his work has been concentrated at the nearby Oro Rico mine.

68.5 Tuolumne County line.

69.7 Haigh quarry (old Gharabaldi mine). Mariposite-bearing carbonate rock has been quarried for garden stone. Recently mariposite from this quarry has been dated at 116+3 m.y. by K-Ar and 115±3 m.y. by Rb-Sr. Introduction of gold was nearly contemperaneous with the development of mariposite.

73.0 Mocassin Creek. Entering the Jacksonville mining district.

74.3 Community of Mocassin on right. Hetch Hetchy aqueduct and power plant, State fish hatchery.

75.0 Junction of Highways 49 and 120 - turn left and continue on Highway 49-120.

77.2 Turn left on Jacksonville Road.

77.6 Stent Bridge. Tuolumne River and Don Pedro Reservoir. Town of Jacksonville and Eagle-Shawmutt mine downstream now innudated by reservoir.

78.0 STOP 4

Stevens Bar. Harriman mine below water level.

Large allochthonous limestone block in phyllite exposed in roadcut. These highly deformed rocks have been interpreted as part of a melange sequence occurring sporadically along the Melones fault zone. Elsewhere, similar limestone blocks have yielded poorly preserved Permian fossils.

Leslie A. Landefeld, PhD candidate, University of Western Ontario, will give a brief presentation on the geology of the Sierra Nevada foothills. Ms. Landefeld has recently completed field mapping studies in the southern Mother Lode region.

82.1 Entering Jamestown mining district. Belcher mine site on left, Anderson mine site on right.

83.3 View of Table Mountain to north. Table Mountain is a sinuous ridge formed from late Tertiary lava which filled a meandering river channel. Resistance to erosion has caused relief inversion.

83.6 Portal and dumps of Mazeppa mine near the southern extent of claim holdings of Sonora Mining Corp.

84.7 Golden Rule mine workings at left.

85.4 Take left at "T" and continue along Jacksonville Road.

85.7 View of Quartz Mountain, Sonora Mining Corp. project site, on left.

86.6 STOP 5

California Gold Project site entrance. Turn left and proceed 0.2 miles.

Workings of the Dutch and Sweeny mines are on the north side of the road. The App-Heslep mine site is to the south on Quartz Mountain. The Havard mine headframe is about 1-1/2 miles to the northwest. This mine group forms the core of the Jamestown mining district, and accounted for about one-half of the $24 million recorded gold production of the district. The mines are located along the Melones fault zone, which is locally characterized by the presence of mariposite-bearing carbonate rock and talc schist cut by numerous stringers and veins of gold-bearing quartz. The vein systems were extensively mined prior to World War II, however present economic interest is focused on finely disseminated gold and electrum in the mineralized hanging wall zone of the quartz vein system. A portion of the gold is of auriferous pyrite. Sonora Mining Corporation is awaiting use permits from Tuolumne County to develop four near surface ore bodies lying between the Crystalline mine on the north and the Jumper mine on the south.

87.1 Return to Jacksonville Road entrance and turn left.

87.7 Turn right at "T".

88.1 Stop sign - continue on.

88.2 Left at "Y". Entering Jamestown.

89.1 Keep right at "Y" at church.

89.2 Main Street - turn right.

89.4 Turn left on Humbug Street, cross Highway 49, and continue on Rawhide Road.

90.9 Top of Table Mountain. F. L. Ransome originally described latite from the railroad cut on the right.

Elsewhere in the western Sierra Nevada, rich placers have been found in auriferous gravels buried under late Tertiary volcanic rocks, however few of the drift mines which pass under Table Mountain were successful.

91.7 Turn right at "T" to continue on Rawhide Road.

91.9 Entering community of Rawhide.

93.7 Highway 49 - keep to right and head south.

96.6 Turn left on Shaws Flat Road. Entering the Columbia mining district.

Limestone of the Calaveras Formation; note the exhumed karst topography. Here within a radius of a mile, $55 million in gold was recovered and shipped between 1853 and 1870, making this one of, if not the richest area of placer ground in the world. Most of the gold was taken from gravels excavated by hand from potholes and crevices in the irregularly eroded limestone. The gold was coarse and nuggets weighing a pound were common; a nugget weighing 72 troy pounds was found in 1854. The deposits, while rich, were shallow and were soon worked out.

98.1 Turn right on Parrots Ferry Road.

99.3 Highway 49 - turn left. Entering Sonora mining district.

100.4 Sonora city limits.

THIRD DAY

0 Junction of State Highways 49 and 108, main street of Sonora. Head north on Highway 49.

7.1 Tuttletown and Tuttletown mining district.

10.0 Calaveras County line on Stevenot Bridge crossing of Stanislaus River (New Melones Reservoir). Entering Carson Hill mining district.

11.6 Massive quartz vein exposures to left.

12.4 STOP 6

Rest area at community of Carson Hill. Two large glory holes are visible on the northeast slope of Carson Hill to the south. The open stopes exploited a pair of ore shoots of auriferous schist on either side of the prominently exposed white quartz vein--the vein itself contains little gold. Carson Hill was one of the richest areas along the Mother Lode. Mines were active intermittently from 1850 to 1942, with an estimated production of $26 million. A 195 troy pound mass of 0.900 fine gold, the largest single piece ever taken in California, was found here. Telluride minerals were common in the ore, and calaverite ($AuTe_2$)and melonite ($NiTe_2$)were first found and described from this district.

There is a crude break in the type of Mother Lode mineralization in this general region. Productive quartz veins are generally characteristic of the Mother Lode to the north, whereas here and to the south there is prevalance of ore bodies of mineralized country rock, immense persistent barren quartz veins, and enormous bodies of mariposite-bearing carbonate rock.

14.0 Entering Angels Camp mining district.

15.3 More quartz vein exposures on left.

15.5 Angels Camp city limits. Made famous by Mark Twain's story "The Celebrated Jumping Frog of Calaveras County".

16.4 Utica mine site on left, now a city park. The depression is due to mine collapse.

16.5 Lightner mine site on left. Foundations and some of the machinery from the 40-stamp mill remain.

16.9 Angels Camp museum. Mining relicts and three-foot diameter core of serpentinite from Idaho-Maryland mine, Nevada County are visible from road.

17.2 Entering Altaville. Placer mining center.

17.5 Turn west on State Highway 4.

18.0 Passing through a quarter-mile wide band of highly sheared rocks of the Melones fault zone.

Crossing over into the foothills "melange" belt.

24.2 Crossing Bear Mountains fault zone.

24.4 Dumps and workings of Nassau (Pool) copper mine. Small massive sulfide mine typical of those found in the Foothill copper-zinc belt between Fresno and Oroville.

29.0 View of Copperopolis ahead. The Copperopolis mines, discovered in 1861, were one of the principal copper sources for the Union during the Civil War. They were last active during World War II. The massive sulfide ores consisted largely of pyrite and chalcopyrite and were markedly free of base metals other than copper.

29.1 Turn right on Rock Creek Road.

29.2 Northernmost mine dumps of Copperopolis copper district.

30.0 Located on far ridge one mile to southwest are mines and prospects of the Hodson mining district, site of the Mountain King-Royal project of Mother Lode Gold Mines Consolidated. The Hodson district is in the west gold belt of the Sierra Nevada.

34.2 STOP 7 Lunch stop
Turn left into north entrance of Mountain King-Royal project.

Mother Lode Gold Mines Consolidated (MLGM) A California based corporation, has been conducting exploration drilling on over 1500 acres of land in the Hodson mining district since 1980. As of 1982, MLGM had identified nine million tons of ore averaging 0.07 ounces of gold per ton. Disseminated gold mineralization in the Hodson district is developed in sheared and carbonatized slates and greenstone bodies occurring along and between numerous northwest trending thrust faults. These faults are commonly marked by quartz veins which were intermittently worked extensively for gold from the early gold rush days until World War II.

After tour, return to north entrance of project site. Reset odometer reading.

0 Rock Creek Road--turn right toward Copperopolis.

5.1 Turn left on Highway 4.

16.7 Highway 49 at Altaville; turn left. Entering San Andreas mining district.

21.9 Site of Big Four mine on right.

26.4 Waste dumps of Calaveras Cement Division of Genstar Corp. in distance to left.

27.2 Entering San Andreas.

29.0 Keep right at "Y" on Highway 49 north.

29.4 Passing over shaft of Commodore mine, now concealed by historic Highway 49 bypass.

29.6 Serpentinite along Melones fault zone exposed in roadcut.

32.2 Fluvial deposits of ancient Mokelumne River overlain by tuffs and gravels of the Valley Springs and Mehrten Formations.

35.0 Chili Gulch placer diggings. During World Wars I and II, optical grade quartz was recovered in Chili Gulch from crystal-bearing gravels. Entering southern extent of Mokelumne Hill mining district.

36.3 Outskirts of Mokelumne Hill. Turn east on State Highway 26 toward West Point.

41.6 Rich Gulch mining district.

47.9 Contact of granitic pluton.

48.5 South Fork of Mokelumne River.

51.3 Sandy Gulch - keep left at "Y".

53.0 Entering West Point. Keep right at "Y".

53.2 Turn right at stop sign at Bald Mountain Road.

54.6 Turn left on Jurs Road.

54.7 STOP 8

Entrance to Gold Rock Industries. Proceed to office 0.1 mile beyond gate. Tour of Blazing Star mill.

The Blazing Star mill was built in 1978 by Troy Gold Industries, Ltd., as part of their development of the Blazing Star mine. Mine operations ceased in 1982. Mr. Clarrie Lee purchased the mill and is processing ore mined from a number of his properties as well as offering custom milling services. Reported capacity of the Blazing Star mill is 240 tons per day.

Gold mineralization at the Blazing Star mine is typical of the West Point district specifically and the East Belt in general. Several quartz veins containing free gold cut surrounding granodiorite. The granodiorite pluton has recently been dated at 175 m.y. by Rb-Sr. Elsewhere, other East Belt deposits are present in plutons that also have yielded ~~Triassic~~ Jurassic dates. The veins consist of coarse-grained white quartz accompanied with fine gold, pyrite, arsenopyrite, chalcopyrite, and pyrrhotite. Galena and sphalerite are also commonly associated with gold in the West Point district; the presence of galena apparently is a local indicator of high grade ore.

Return to entrance and road intersection.

54.9 Turn left on Jurs Road.

56.5 Turn left on Winton Road.

56.8 Outskirts West Point. Keep right at "Y" and continue on West Point - Pioneer Road.

60.4 North Fork Mokelumne River and Calaveras - Amador County line.

62.9 STOP 9

Good exposures of ash deposits of the Valley Springs Formation and overlying lahar and intervolcanic gravel deposits of the Mehrten Formation. Note that the gravels are of volcanic origin, in contrast to the quartz-rich auriferous gravels which will be seen later.

Early miners drift mined under these rocks in hopes of locating buried placers.

65.3 Turn left on State Highway 88.

68.1 Entering Pine Grove and Pine Grove mining district.

69.4 Keep left at "Y". Most mines and prospects of the Pine Grove district are located north and southwest of this road intersection.

70.0 Turn right on Climax Road to the west.

74.8 On clear days, cooling towers of the Arroyo Seco nuclear power plant facility are visible ahead and slightly to the right.

77.4 Entering Jackson - Plymouth mining district. This was the most productive district of the Mother Lode, with reported production in excess of $160 million. View of Central Eureka mine on right and South Eureka mine on left.

77.9 Turn left on State Highway 49 at Sutter Hill.

79.3 STOP 10

Kennedy-Argonaut mine vista point. Read plaques. Note Jackson Butte, a Tertiary rhyodacite dome. Walk to base of Argonaut headframe.

John E. Zimmerman, Geologist, Gold Fields Mining Corp., will give a brief talk based on his recently completed University of Arizona masters thesis, "The geology and structural evolution of a portion of the Mother Lode belt, Amador County, California". John found that the Late Jurassic metavolcanic and metasedimentary island arc rocks of the Jackson area have undergone three deformational events. The first event generated major isoclinal folding and lower greenschist metamorphism, the second produced major strike-slip faulting, the Gold fault zone, and the third resulted in minor reverse faults. The first two events occurred during the Nevadan orogeny. Major gold-quartz veins were generated by shear-zone metamorphism induced

by late Nevadan movememt along the Melones fault zone, a mechanism John believes responsible for the formation of the entire Mother Lode belt, and were localized in the Gold fault zone.

Proceed to Jackson, 1.5 miles south on Highway 49.

FOURTH DAY

0 Junction of State Highways 49 and 88. Head north on Highway 49.

3.0 Sutter Hill. View of headframes and dumps of Central and South Eureka mines.

4.1 Old Eureka mine headframe and dumps on right.

4.4 Entering Sutter Creek.

4.9 Wildman-Mahoney mine site, plaque on right.

5.1 Lincoln mine site about 50 yards on right.

6.4 Entering Amador City.

6.7 Headframe, foundations, and dumps of Keystone mine.

6.8 Turn right on Water Street.

6.85 Turn left on East School Road.

6.9 Original Amador mine site on right.

7.1 Turn right at "T".

7.2 Keep left at "Y". Bunker Hill mine site.

7.8 Treasure mine site on right.

7.9 Quartz vein exposed in roadcut on left.

8.2 STOP 11
Fremont mine site.

The Fremont mine, which produced $5 million, most at the $20 per ounce gold price, is one of over a dozen mines in the Jackson-Plymouth mining district that has produced over a million dollars. The Fremont shaft is 2950 feet deep on a 51° incline with levels spaced at 200 feet. The 1350 level of the Fremont is connected to the 1500 level of the Gover mine, whose headframe is visible to the north and the mines were operated together. In addition to gold-bearing quartz veins, large amounts of mineralized country rock, or "gray ore", were mined. Some of these bodies were up to 70 feet wide.

The history of the Fremont mine is typical of many mines of the Mother Lode. Most gold production occurred between 1900 and 1920, followed by some activity in the mid 1920's and late 1930's. Since 1940, this mine property, like most others, received little attention until the price of gold began to rise in the late 1970's. Getty Mining Company now leases the Fremont mine property.

8.4 Gover mine site ahead; turn left at "T".

9.7 Drytown, the former home of 26 saloons. Turn right on Highway 49.

10.9 Junction of State Highways 49 and 16. Turn right and continue on Highway 49.

12.5 Plymouth city limits.

13.0 Eureka shaft headframe of Plymouth Consolidated mines on right.

17.3 Unknown mine site on right.

18.3 Consumnes River crossing and El Dorado County line.

20.3 Nashville mining district to right.

25.0 Entering El Dorado mining district. Main quartz vein system of the Mother Lode is located about a mile east of here. Ophir, Minihaha, and Pocahantos mine sites located along ridge on left side of road.

25.4 Church-Union mine sites located about one mile east of here. Parts of these properties now serve as a county refuse disposal site.

28.4 Entering El Dorado. Turn right following Highway 49.

30.5 Entering Diamond Springs. Southern extent of Placerville mining district located about a mile east of here.

Turn left and continue on Highway 49.

32.7 Entering Placerville.

33.0 View of Pacific mine site on ridge at right.

33.4 Turn right on Main Street.

33.6 Bedford Avenue, turn left. Note vertically dipping, highly foliated and sheared rocks exposed behind the pizza parlor on the right. These rocks, composed mainly of talc schist, mark the trace of the Melones fault zone. At this point the fault zone is about 1000 feet wide. The Pacific mine shaft and related workings followed quartz veins located within the talc schist of the Melones fault zone.

33.7 Cross U.S. Highway 50 and continue on.

34.5 STOP 12
Turn right into Bedford Park. Tour adit of the Gold Bug mine (see map). Cross street to traverse Melones fault zone. The zone is exceptionally well-exposed here, and shows almost all the typical alteration features found associated with the zone.

35.2 Bedford Avenue park exit, turn left.

36.1 Turn right at traffic light at U.S. Highway 50.

36.4 Turn right at junction of Highways 50 and 49 north (Spring Street).

37.2 Junction of Highways 49 and 193 (stay on 49). Highway 193 follows the Mother Lode belt 14 miles north to Georgetown, which is the northernmost extent of the Mother Lode.

44.5 Entering Coloma and the Coloma mining district.

45.0 STOP 13 Lunch stop
Gold Discovery State Historical Park. Visit exhibits which focus on discovery of gold and historical mining methods.

46.7 South Fork American River crossing.

56.6 Entering Cool. State Highway 193 from Georgetown rejoins Highway 49.

57.5 Cool limestone quarries.

60.2 Junction of the North and South Forks of the American River. Placer County line.

62.0 Auburn City limits. Follow Highway 49 through town. The Ophir mining district is located just west of Auburn.

63.5 Underpass - State Highway 49 and Interstate 80.

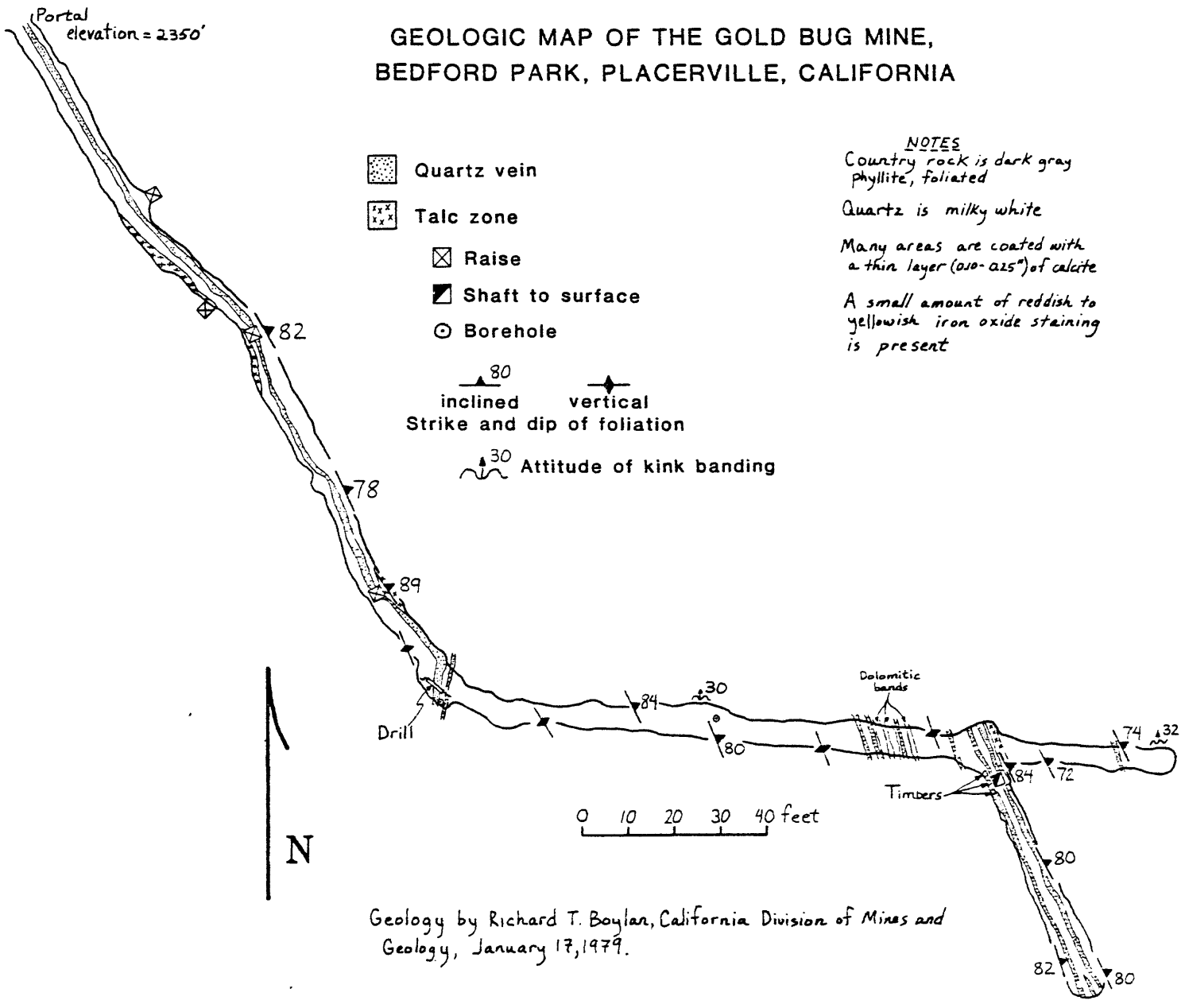
71.6 Bear River crossing. Nevada County line.

85.2 Grass Valley city limits and Grass Valley mining district.

86.0 Exit on Empire Street offramp. Turn right on Empire Street.

88.5 STOP 14
Empire Mine State Historical Park. What is known as the Empire mine was a consolidation of numerous mines and claims into a single ownership and management. Active from 1850 to 1956, the mine was incorporated into the California State Park System in 1975. Newmount Mining Corp. retains mineral rights. The mine was the richest in California, with a reported production of 5.8 million ounces.

Although most of Empire's equipment has been sold and many of the


Portal
elevation = 2350'
GEOLOGIC MAP OF THE GOLD BUG MINE,
BEDFORD PARK, PLACERVILLE, CALIFORNIA
Quartz vein
Talc zone
Raise
Shaft to surface
Borehole
80
inclined
vertical
Strike and dip of foliation
30
Attitude of kink banding
NOTES
Country rock is dark gray phyllite, foliated
Quartz is milky white
Many areas are coated with a thin layer (.010-.025") of calcite
A small amount of reddish to yellowish iron oxide staining is present
82
78
89
Drill
84
30
80
Dolomitic bands
74
32
84
72
Timbers
80
82
80
0 10 20 30 40 feet
N
Geology by Richard T. Boylan, California Division of Mines and Geology, January 17, 1979.

original structures have been torn down, the site is undergoing gradual restoration. A highlight of the park is the model of 367 miles of mine workings and the vein systems housed in a locked room where at one time only long-trusted employees of Newmount were allowed access. Arsenic is being leached into local waterways from a cyanided tailing pile in the park. According to a recent study by the U.S. Bureau of Mines, the tailings assay 0.24 oz Au/ton with a gross value of recoverable gold between $2.5 and $3.9 million at $400 oz/Au.

After touring park, retrace route to State Highway 49.

89.9 Highway 49 north on-ramp from Empire Street.

93.0 Entering Nevada City and Nevada City mining district.

93.5 Broad Street off-ramp - Nevada City

FIFTH DAY

0 Junction of State Highways 49 and 20 east about one-half mile north of Nevada City. Turn left here to continue on Highway 49 north. Note hydrauliced gravels along right side of road for next mile or so.

7.0 South Fork Yuba River.

10.9 Tyler-Foote Crossing Road, turn right.

18.3 First view of hydraulic workings in North Columbia mining district.

18.8 Fire access road, turn right.

19.4 STOP 15
Overview of hydraulic mining areas and site of Placer Service Corporation San Juan Ridge project.

The property consists of approximately 2200 acres of patented land owned by the San Juan Gold Company and leased by the Placer Service Corporation. The property is underlain almost entirely by Tertiary gravel deposits of the ancient Yuba River between Malakoff Diggings State Park and Badger Hill Diggings.

The deposits fill a channel measuring up to 6000 feet in width and up to 500 feet deep cut into metamorphic and intrusive rock of Paleozoic (?) and Mesozoic ages, and are divisible into two zones: an Upper "red gravel", characterized by an abundance of white quartz clasts with interstitial and interlayered red clay, silt, and sand, and a lower "blue gravel" characterized by an abundance of bluish-black clasts of siliceous slates.

Gold mining on San Juan Ridge can be traced back to the early days of the gold rush, but not until after 1852, when hydraulic mining was first introduced to California, did mining of these ancient stream channel deposits prove successful. Most of the mining activity on San Juan Ridge occurred between 1855 and 1884, during which time great quantities of gravel were stripped away by high velocity water streams directed from large nozzles up to nine inches in diameter. Large scale hydraulic mining ceased after the Sawyer decision in 1884 was issued, prohibiting the dumping of debris into the Sacramento and San Joaquin Rivers and their tributaries. There has been no significant gold mining activity on the property since then, but renewed production is planned to begin as soon as county permits are approved.

Exploratory drilling is currently being done on an unmined portion of an auriferous Tertiary channel.

After tour return to Highway 49 on Tyler-Foote Crossing Road.

28.2 Highway 49, turn left back toward Nevada City.

39.1 Junction of Highways 49 and 20. Turn right and continue through Nevada City to Grass Valley.

43.2 Junction of Highways 49 and 20 west (Main Street off-ramp, Grass Valley). Proceed west on Highway 20.

48.1 Rough and Ready and Rough and Ready mining district. Named for General Zachery Taylor.

57.5 Yuba County line.

57.9 Turn left onto Hammonton-Smartville Road.

58.8 Keep right at "Y".

60.2 View of Sutter Buttes, a Plio-Pleistocene volcanic complex, ahead.

65.4 Yuba dredgefields on left; Hammonton district.

68.1 Turn right at entrance to the Yuba Placer Gold Company dredging project.

69.2 Turn right toward shops and offices.

69.9 STOP 16 Lunch stop
Yuba Placer Gold Company offices. Yuba Placer Gold Company is a joint venture between Placer Service Corp., a wholly-owned subsidiary of the St. Joe Minerals subsidary of Fluor Corp., and Yuba Goldfields, Inc. Placer Service is the majority and managing partner of the venture.

Proceed to dredging area. A reconstructed Dredge No. 21 began digging on a 2,000 acre tract south of the Yuba River after a lapse of exactly 13 years. The dredge has been refitted to dig 140 feet below water level, and is the deepest digging gold dredge in the non-Communist world, however, rebuilding of Dredge No. 17 engineered to dig to 175 feet is planned. In full production, Dredge No. 21 is expected to process 4.5 million cubic yards of material in order to produce between 20,000 and 25,000 ounces of gold annually--see dredge specifications. The planned area of dredging has been drilled and estimated to contain 240,000 ounces of gold.

After on-board tour of dredge return to Highway 20, turn right toward Marysville, 8 miles to the west. Busses will proceed directly to San Francisco.

YUBA DREDGE 21
SPECIFICATIONS

Estimated annual capacity			4.5 million cu. yd.
Estimated annual gold production			20-25,000 ounces
Hull length			223 ft.
Hull width			68 ft.
Hull depth			11 ft. 6 in.
Height of rear gantry			101 ft.
Length of bow gantry			91 ft.
Bucket size			14 cu. ft.
Number of buckets			147
Bucket speed			0-29 buckets/minute
Length of ladder			230 ft.
Weight of ladder with buckets (ladder suspended by 28 parts of 1-3/4 inch wire rope)			730 tons
Digging depth (below water level)			140 ft.
Length of main stacker			225 ft. (217 c-c belt)
Length of swing stacker			52 ft. c-c belt
5 water pumps - total			17,900 gpm
6 sand pumps - total			12,520 gpm
Connected horse power - total including 2-400 hp D.C. variable speed motors for bucket line drive			2,685 hp.
High tension line voltage			60,000/4160V
Dredge voltage			440 V
Washing screen			9 ft. dia. by 50.5 ft. lg.
Jigs:	Roughers	48 cells	42 in. x 42 in.
	Cleaners	8 cells	42 in. x 42 in.
	Scavengers	4 cells	24 in. x 24 in.
Overall length (level)			453 ft.
Overall weight			3800 tons
Operator scheduled			24 hours per day
Normal shift			4 men

ACKNOWLEDGEMENTS

We are grateful to all who aided in preparation and arrangements of this trip, including members of the U.S. Geological Survey, California Division of Mines and Geology, and California Department of Parks and Recreation. Special recognition is given to Leslie A. Landefeld, University of Western Ontario; Bruce E. Taylor, University of California, Davis; Robert Weir, Pennsylvania State University; and John E. Zimmerman, Gold Fields Mining Corp., for their contributions. Access to properties and information on current operations have been provided by: Joseph B. Davis, Project Director, Sonora Mining Corp.; Grant W. Metzger, President, and Michael Burns, Project Geologist, Mother Lode Mines Consolidated; Clarrie Lee, Proprietor, Gold Rock Industries, Ltd; Robert Haverman, Placerville Gold Mining Company; Tom Meyer, Getty Oil Company; Jeffrey L. Zelms, President and General Manager, James J. Hodos, Project Manager, and Charles A. McLean, Production Manager, Placer Service Corp.