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Geologic Trips, Sierra Nevada

by Ted Konigsmark

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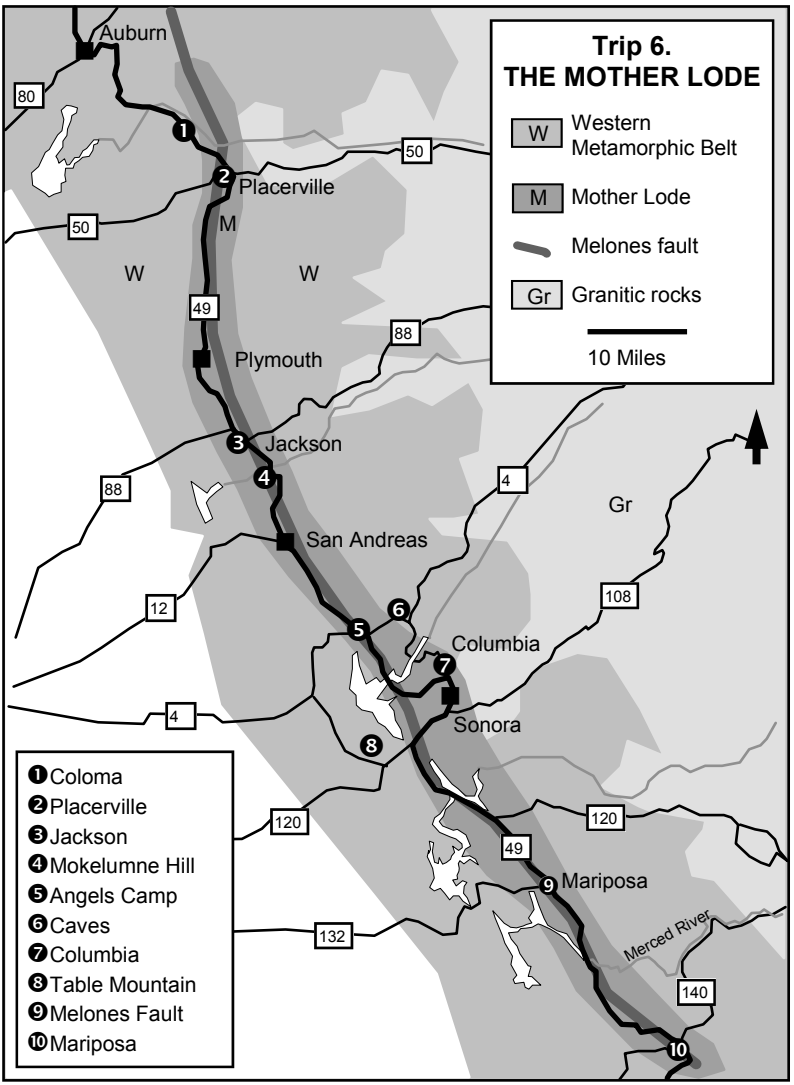


The Placer County Department of Museums operates six museums that cover different aspects of Placer County's gold mining activity. For information, contact Placer County Museums, 101 Maple St., Auburn, CA 95603 (530-889-6500).

Trip 6
THE MOTHER LODE
The Gold Rush

This trip begins in Coloma, on the bank of the South Fork of the American River, where the gold rush began. From there, the trip follows Highway 49 to Mariposa, passing through the heart of the Mother Lode. As the highway makes it way along the Mother Lode, it closely follows the Melones fault, weaving from side to side, but seldom leaving the fault for long. The Melones fault is one of the major faults within the Western Metamorphic Belt, and fluids generated in the deep parts of the Franciscan subduction zone left deposits of gold in the shattered and broken rocks along the fault. Most of the large gold mines of the Mother Lode lie within a mile or so of the fault, and Highway 49 follows the gold mines.

One hundred and fifty years ago, in the early days of the gold rush, this area was mobbed by thousands of prospectors and miners looking for gold in rivers and creeks. Dozens of gold mining towns were settled, and more towns would be founded in the next few years. There is almost no gold mining now, and most of the mines, miners, and towns have faded and left little trace. However, some towns have lingered on, and some have even prospered, based mainly on tourism and agriculture.

The emphasis in this book will be on the geology and mines of the Mother Lode. Unfortunately, there is little space or time for the other fascinating aspects of the gold rush. Many excellent books have been written about the gold rush, and you should take some of these books with you on your trip. For a very readable account of the history and geology of California gold, get a copy of *Gold, The California Story* by Hill (1999), and for descriptions of the gold rush towns see *The California Gold Country* by Koeppel (1996).

During this trip, you'll visit several famous mining towns of the Mother Lode—Coloma, Placerville, Jackson, Angels Camp, Columbia, and Mariposa—and get a good understanding of life during the gold rush. You'll also examine the rocks along the Melones fault zone, see some caves, and learn how Table Mountain got its flat top.

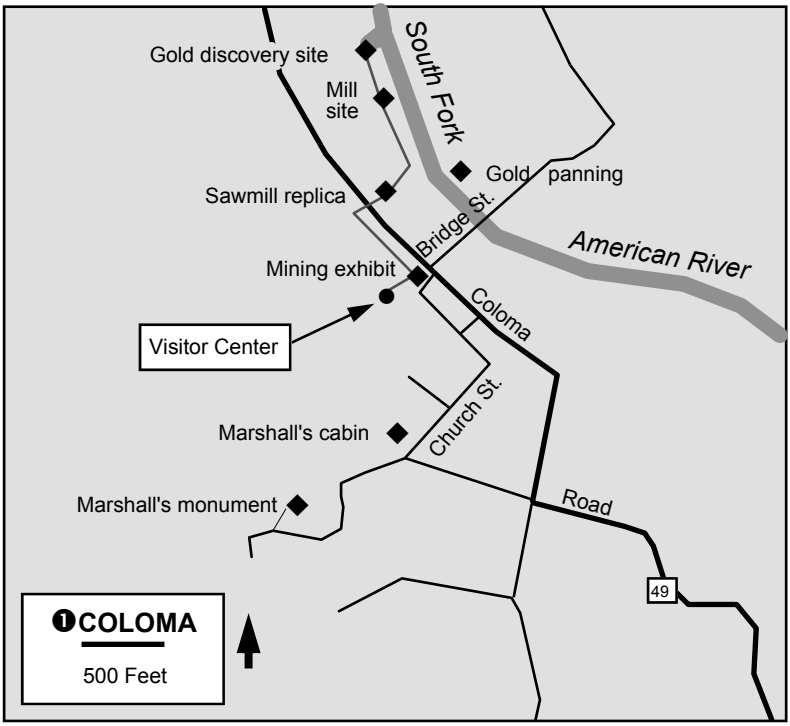
❶ *Coloma*

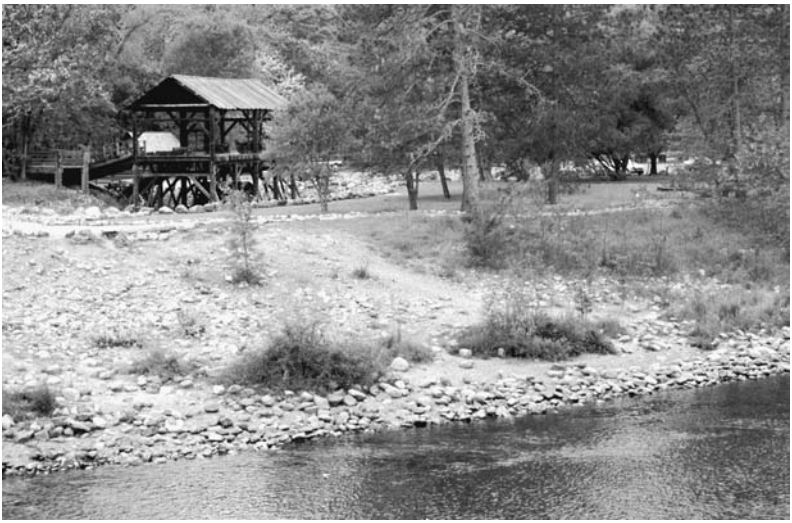
Gold was discovered at Coloma by James Marshall in January of 1848. At the time of discovery, Coloma was a small town on the South Fork of the American River. Within four months of the discovery, nearly the entire population of San Francisco had departed to prospect in the gold fields. Many of these new prospectors first headed for Coloma. Within a few months after the discovery, 2,000 miners had arrived in the town. By the end of 1848, news of the gold had spread throughout the United States and the gold rush was on. By the end of 1849, the population of Coloma was 10,000. Despite the efforts of all of these prospectors, little gold was found at Coloma. By 1852, the population had moved on, and the town declined. The town is now a state park, and 70% of the town is in the park. The park includes a visitor center and many historic exhibits, sites, and buildings from the gold rush era. Several of the buildings in Coloma date from the early and mid 1850's, before the gold rush began.

Considering the many rich gold deposits waiting to be discovered in the Sierra foothills, Coloma was an unlikely place for the first discovery. Coloma is not on the Mother Lode and there are no significant lode mines nearby to provide a source for the placer gold in the river. Ironically, because the prospectors moved on rapidly to better pickings, the town of Coloma is a remarkably well-preserved piece of gold rush history.

It is also somewhat ironic that the gold was discovered while Marshall was correcting a mistake in construction of a sawmill. The foundation for the sawmill had been built too low, and the water was not flowing through the tailrace fast enough to turn the mill wheel. In order to increase the flow of water, Marshall dug a ditch in the gravel under the mill. He had inadvertently created a natural sluice. Some small nuggets of gold were separated from the river gravel along the sluice, and one of these nuggets caught Marshall's eye. You can see a replica of this small nugget at the park visitor center in Coloma.

> ***Visitor Center*** - *From Placerville drive N 8 mi. on Hwy. 49 to Coloma; park at the visitor center for the Marshall Gold Discovery State Historic Park at Bridge St.; for park information phone 530-622-3470.*
>
> Begin at the excellent visitor center and bring yourself up to speed on the history of the gold rush. Then get a copy of the park map and take the self-guided Discovery Tour. This tour includes a mining exhibit, a replica of Sutter's sawmill, the site of the original sawmill, and the gold discovery site along the original tailrace for the sawmill. You can also pan for gold on the American River across the bridge from the visitor center.





This replica of Sutter's Mill lies along the South Fork of the American River in Marshall Gold Discovery State Historic Park. The site of the original mill lies about 500 feet north of the replica.

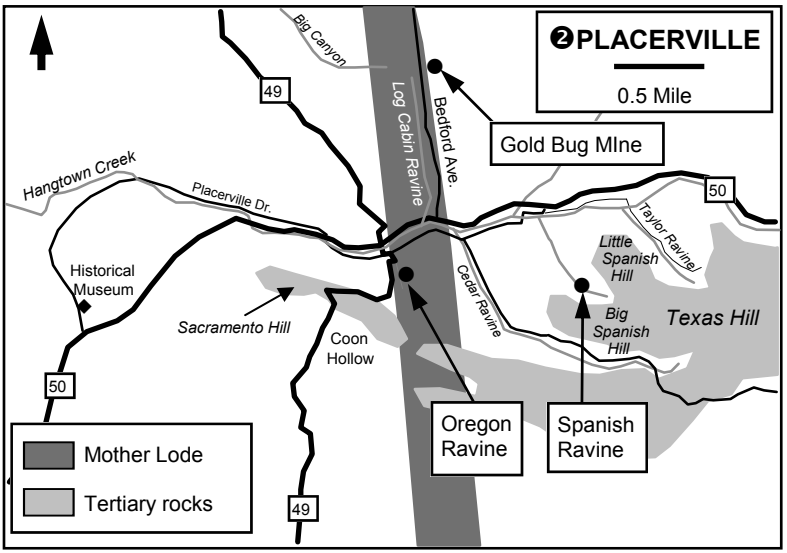
❷ *Placerville*

By the spring and summer of 1848, many of the prospectors at Coloma had given up their search for gold in that area, and began to look elsewhere. Some followed the South Fork of the American River upstream to Big Canyon and then followed Big Canyon upstream to what is now Placerville. The prospectors didn't know it at the time, but Big Canyon and the South Fork of the American River had been incised into the Eocene erosion surface. When they climbed out of this incised drainage, they encountered the more subdued topography of the Eocene erosion surface. For millions of years, great quantities of gold from the Mother Lode had been concentrated on this erosion surface, waiting to be discovered. Placerville is built on this erosion surface.

The first gold in the Placerville area was discovered in July 1848 in stream deposits at Spanish Ravine. Additional discoveries rapidly followed along Hangtown Creek and many of the other ravines that fed into Hangtown Creek. Some of these placer deposits were extremely rich. During the first year, a million dollars in gold came from Cedar Ravine and another million from Log Cabin Ravine, which is now Bedford Road. One pan of gold from Hangtown Creek had 75 ounces of gold dust recovered from white clay. The placer deposits were rapidly depleted in a just a couple of years.

By late 1849, as the placer deposits were being depleted, gold was discovered in the upper parts of Spanish Ravine and several other ravines along Hangtown Creek. This gold came from Eocene river gravels exposed on the sides of Spanish Hill and Texas Hill. The miners dug into the sides of these hills to follow the gold deposits as far as they could. Some of the larger channels were later developed into drift mines, with larger and better tunnels. The river gravels in these mines had been deposited in various channels of the Eocene American River as it flowed across the Eocene erosion surface.

During the early years of the gold rush, water was scarce in the Placerville area. The placer deposits could be worked only in the wet season or by transporting the gold-bearing deposits to flowing streams. However, because the deposits were rich, water flumes were soon built. The gold deposits could then be worked year-round. In 1855, hydraulic mining began. The hydraulic mining was directed mainly at the gold-bearing Eocene river gravels on Spanish Hill, Texas Hill, and at Coon Hollow. Most of the drift and hydraulic mining occurred from the mid-1850's to the 1870's. Hydraulic mining stopped abruptly in 1884 with the Sawyer decision, which is discussed in more detail during the trip to the Malakoff Diggins.



In addition to the placer and hydraulic mines, there were also a large number of lode mines in the Placerville area. Most of the lode mines occur along the Mother Lode. Conveniently, the Mother Lode passes directly under the County Courthouse in downtown Placerville, and the largest of the lode mines, the Pacific Mine, was in the center of Placerville. Mining began at the Pacific Mine in 1852, but the main period of lode mining was from the 1880's to 1915. The gold in these mines mainly occurs in massive quartz veins in slate, and the ore is typically low to moderate grade. Some mines were developed to depths up to 2,000 feet.

The scars of the early mining activity have largely healed. Tunnels, and mine shafts have caved in. The headframe of the Pacific Mine was unceremoniously shoved down its own mineshaft a few years ago and the opening closed. Rotary Park now occupies the site of the large Atlantic Mine. Old roads, trails, and hydraulic mines have become overgrown. The streets of Placerville wind along the old gold-bearing creeks and ravines with little but the street names—Cedar Ravine, Spanish Ravine, Taylor Ravine, Log Cabin Ravine—to recall past mining activity. Houses and buildings now follow the ravines and cling to hillsides where fortunes were once made in gold. You have to look hard to see the work of the early miners.

The El Dorado County Historical Museum at 100 Placerville Drive on the El Dorado County Fairgrounds has historical exhibits of gold rush times and displays of old mining equipment (530-621-5865).

Oregon Ravine - *From Hwy. 49 and Main St. go S on Pacific St. three blocks to Benham St.; City Park is on the E side of Benham St.*

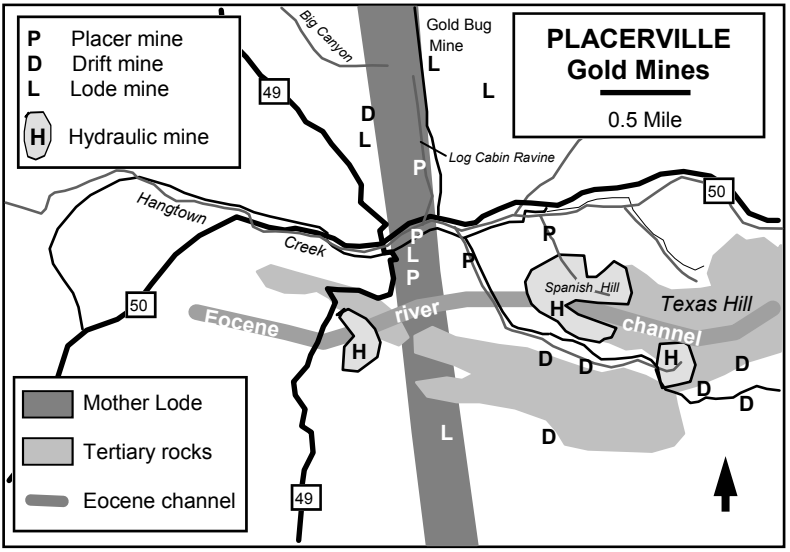
During the early gold rush, Oregon Ravine had the richest placer deposits in Placerville. City Park now lies within the old ravine. The ravine had the good fortune of lying directly on a rich gold-bearing section of the Mother Lode, and a great amount of placer gold was concentrated in this small area. There was little or no water in the ravine, so the gold-bearing dirt was carried to nearby creeks to process. Many large bean-sized nuggets were found.

Spanish Ravine - *From Main St. drive S on Spanish Ravine Rd. to the end of the road.*

Spanish Ravine is one of several ravines on the north side of Texas Hill that had rich placer deposits that were mined in the early days of the gold rush. As the placer gold in Spanish Ravine was depleted, prospectors found gold in the Eocene river gravels that were exposed along the sides of Texas Hill. The Eocene river gravel, which had a distinctive blue color, was especially rich where it rested on bedrock. This same blue stratum was found all the way through the surrounding hills. The miners found that the blue gravel drifted in channels that trended west-southwest under the hill and gave names to these channels, such as "deep blue lead." Miners dug into the hillside and followed these channels. Later, some of the channels were developed into drift mines with horizontal tunnels up to a mile long. By 1854, water flumes had been brought into the area and hydraulic mining began. With hydraulic mining, it was no longer necessary to tunnel into the hillside—the entire hillside could simply be washed down. By 1855, the whole top of Spanish Hill had been washed out to a depth of 60 feet. By 1859, the ridge between Spanish and Taylor Ravines was also gone. None of this mining activity is apparent today, but with some imagination you can appreciate the hectic activity at that time.

Gold Bug Mine - *From Hwy. 50 drive N on Bedford Ave.; follow the signs 1 mi. to Gold Bug Park; opening hours change seasonally; owned by City of Placerville; small entrance charge (530-642-5238).*

The Gold Bug Mine was opened in 1888, and is typical of the small gold mines of that time. It is the only underground mine in California on public property that visitors can enter. The mine has a 352-foot tunnel and provides a self-guided tour where visitors can get a good look at how hardrock mining was done. While at the park, also see the Joshua Hendy Stamp Mill. The mill is on its original site, and has an operating scale model that demonstrates how gold is separated from the ore.



Gold in the Placerville area was found in many different types of deposits. Placer gold was found in Spanish Ravine, Cedar Ravine, Oregon Ravine, Log Cabin Ravine, and Hangtown Creek. Drift mines followed gold-bearing Eocene river channels under Texas Hill. Hydraulic mines were located where the Eocene gravels were exposed on the flanks of Texas Hill. Lode mines occurred in the vicinity of the Mother Lode, which goes through the center of Placerville.

The entrance to the Gold Bug Mine is on the hillside immediately in back of the Hattie Museum at Gold Bug Park. The mine is open for self-guided tours.

❸ *Jackson*

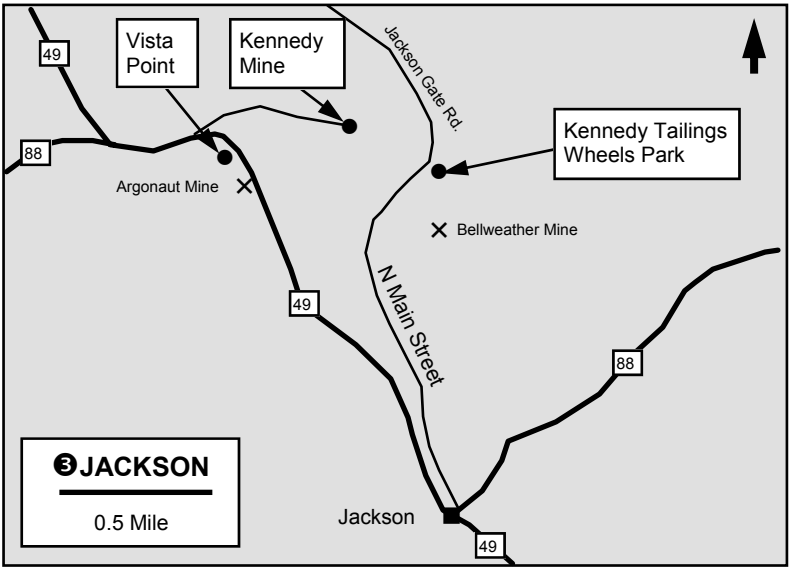
The ten miles of Highway 49 between Jackson and Plymouth goes through the heart of the Mother Lode, and many of the most famous and productive mines of the Mother Lode lie within a mile of this part of the highway. These mines have produced over seven million ounces of gold, valued at over two billion dollars at today's prices. This is more gold than was produced from any other part of the Sierra Nevada gold belt, with the exception of the Grass Valley area.

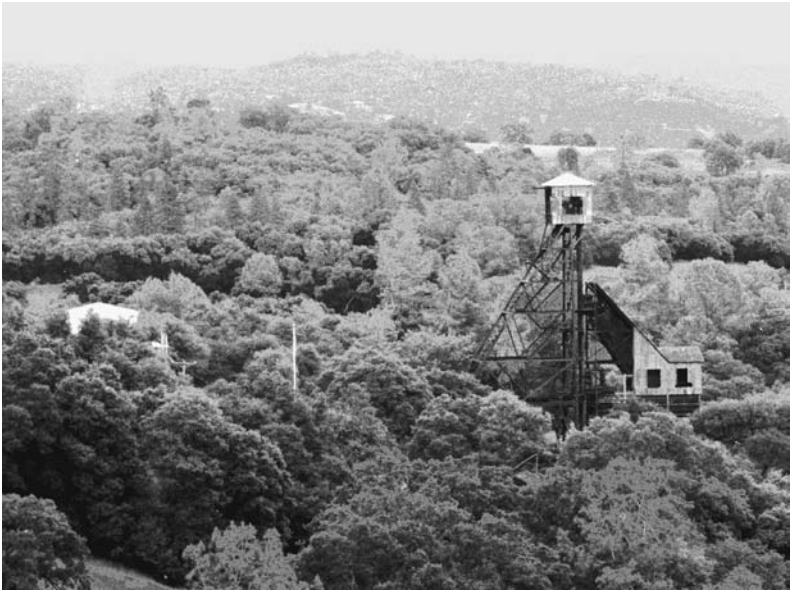
Placer mining began in the Jackson area in 1848. The placer deposits were rapidly depleted, but by that time, rich gold-bearing quartz veins had been found. The first lode mine, the Argonaut, opened in 1850. This was followed by many other lode mines through the 1850's and 60's. Gold mining provided a stable industry for the area for nearly 100 years, until the mines were closed during World War II. Few mines reopened after the war because the mines had deteriorated and filled with water while they were closed. The last major mining operation was the Central Eureka Mine, which reopened in 1945 and then closed again in 1953.

Most of the gold mines are concentrated in a mile-wide zone along a splay of the Melones fault. The main fault lies about a mile to the east. The gold typically occurs as fine-grained native gold in quartz veins that dip steeply east and cut slate and greenstone. Some of the quartz veins are several tens of feet thick. One of the veins at the Keystone Mine was 200 feet thick. The quartz veins generally occur in areas of abundant fault gouge. Although much of the ore was low to moderate grade, some of the mines had rich high-grade pockets with grains, wires, and plates of gold.

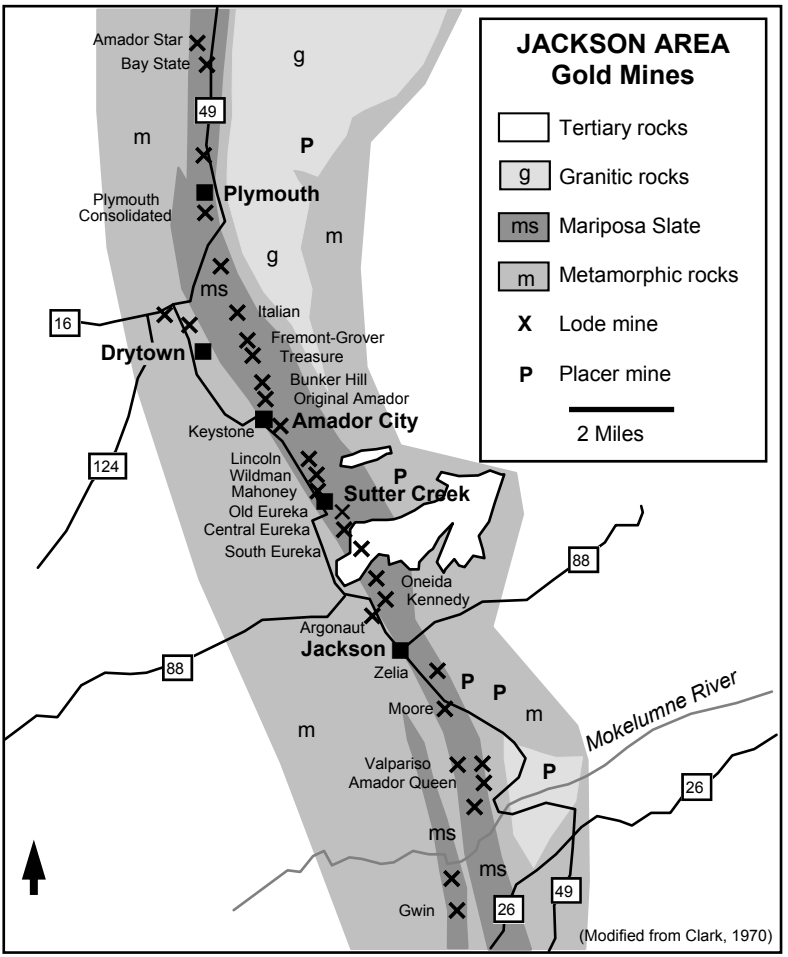
The largest mines in this area were the Kennedy and Argonaut. Other major mines included the Plymouth Consolidated, Original Amador, Lincoln, Wildman, Mahony, Old Eureka, Central Eureka, South Eureka, Oneida, and Zelia. Dozens of other mines also contributed to the production of this gold mining district from time to time.

> ***Vista Point -*** *From Hwy. 49 and N. Main St. in Jackson drive N 1.2 mi. to the Jackson vista point; the best overlook is the one on the W side of the highway.*
> From this vista point, you can get a good view of the Jackson area and also see the headframe to the Kennedy Mine, which lies east of the viewpoint. The Argonaut Mine lies immediately west of the viewpoint, but is difficult to see from the viewpoint. The Argonaut and Kennedy Mines were connected at one time by underground workings.





The headframe of the now quiet Kennedy mine can be seen from the vista point on Highway 49 at the north end of Jackson. This was one of the richest gold mines ever worked along the Mother Lode.



Gold Mines - Jackson Area

(Based on Clark, 1970)

Alma: located next to the Argonaut Mine; active prior to 1900; 1,000-foot shaft.
Alpine: opened in the 1860's, active in the 1890's and from 1910 to l914; 600-foot shaft and a 10-stamp mill.
Amador Gold: active prior to 1900; minor prospecting in the 1960's; 800-foot shaft.
Amador Queen: worked in the early days and in the 30's, 40's and 60's; 1,200-foot adit; 900-foot winze; 20-stamp mill.
Amador Star: active prior to 1900 and from 1917-1935; adit and 900-foot shaft.
Argonaut: first opened in 1850; extensively developed from 1893 to 1942; underground fires in 1919 and again in 1922 in which 47 lives were lost; 5,700-foot inclined shaft with a winze down to 6,300 feet; 60-stamp mill; later ore was treated with ball mills, flotation, and cyanidation; headframe and buildings remain.
Ballard: active in the 1870's and the 1930's; prospected again in the 1940's and 1950's; 285-foot shaft.

Bay State: opened in 1896; active until 1909; minor development during the 1930's; 1,065-foot shaft; 10-stamp mill.
Bellweather: active in the 1890's; purchased by Kennedy Mine; 320-foot shaft.
Bunker Hill: opened in 1853; active until 1888 and again from 1893 to 1922; 2,800-foot shaft with a winze down to 3,440 feet; connected underground to the Treasure Mine; 40-stamp mill; headframe remains.
Central Eureka: opened in 1853; active until 1875; reopened in 1895; combined with the Old Eureka in 1924; active until 1942 and again from 1945 to 1953; 4,855-foot shaft; 30-stamp mill; headframe remains.
Crown: active in the 1930's; 485-foot shaft.
Fremont-Grover: active in the 1860's, from the 1880's to 1918, and in the 1930's; fire in 1910 took 11 lives; 40-stamp mill; 2,950-foot shaft called the Fremont shaft and a 1,500-foot shaft called the Grover shaft; Fremont shaft headframe remains.
Hardenbergh: active during the early days and from the 1890's to 1918; 1,500-foot shaft; 20-stamp mill.
Italian: worked in the 1860's, 1890's, and from 1932 to the 1940's; prospected recently; adit; 5-stamp mill.
Kennedy: first worked in 1850's, active in 1860's and from 1885 to 1942; fires in 1920 and in 1928 and 1929; 4,764-foot vertical shaft with a winze to 5,912 feet; 100-stamp mill; tailings delivered to a reservoir by four 68-foot diameter wheels; headframe, buildings, and wheels remain; wheels preserved as landmarks.
Keystone: discovered in 1851; active until 1919 and from 1933 to 1942; 2,680-foot shaft; old mine office now a motel.
Lincoln: first worked in 1851; active until the early 1900s; combined with the Wildman Mine and the Mahoney Mine to form Lincoln Consolidated Mines; 2,000-foot shaft.
Mahoney: opened in 1861; active from the 1870's to 1906; combined with the Wildman Mine and later the Lincoln Mine; 1,200-foot shaft connected underground to the Wildman Mine; 40-stamp mill.
Moore: active in the 1880's and from 1921 to 1934; 2,290-foot shaft; 20-stamp mill.
New London: active prior to 1894; 1,340-foot shaft; 40-stamp mill.
North Star: opened in the early days; again active in 1890's and from 1917 to 1927; 1,340-foot shaft; 40-stamp mill.
Old Eureka: opened in 1852 and in production until 1881; reopened in 1916; combined with the Central Eureka Mine in 1924; 3,500-foot shaft with winze to 4,150 feet.
Oneida: active in 1860's and again from the 1890's to 1914; 2,280- and 1,350-foot shafts; connected underground to the South Eureka; 60-stamp mill.
Original Amador: opened in 1852; active until the 1870's, from 1898 to 1918, and in the 1930's; 1,240-foot shaft; 20-stamp mill.
Pioneer: active in the 1890's; 550-foot shaft.
Plymouth Consolidated: located in 1852; active until the 1880's and from 1911 to the 1930's; 4 shafts; deepest shaft 4,600 feet; 30-stamp mill.
Pocahontas: active prior to and during the 1890's; 620-foot shaft; 10-stamp mill.
Seaton: active in the 1860's and 1880's; 950- and 500-foot shafts; 40-stamp mill.
South Eureka: active from 1891 to 1917; 2,785-foot shaft with winzes to 2,900 feet; connected to the Oneida Mine; 80-stamp mill.
South Jackson: active from 1912 to 1915; 577-foot shaft.
South Spring Hill: opened in 1851; active until 1902 and again in 1934; 3 shafts; deepest shaft 1,200 feet.
Treasure: active in the 1860's and from 1907 to 1922; 1,600-foot shaft with winzes to 3,030 feet; connected underground to the Bunker Hill Mine; headframe remains.
Valpariso: active in 1850's and 1860's; intermittently active from the 1880's to the 1930's; 1,300-foot adit.
Wildman: opened in 1851; active from 1887 to 1906; combined with the Mahoney Mine and later the Lincoln Mine; 1 ,400-foot shaft; 40-stamp mill.
Zeila: active from the 1860's to 1914; 1,700-foot shaft; old mine office is now a private home.

Kennedy Mine – *From the Jackson vista point drive N on Hwy. 49 0.1 mi. to Kennedy Mine Rd.; turn E and drive 0.5 mi. to the Kennedy Mine; surface tours of the mine are available on weekends seasonally; for information phone 209-223-9542.*
The Kennedy Mine is one of the richest mines ever worked in the Sierra Nevada gold belt. It was discovered in 1856 and was in operation from 1860 to 1942. There were over 150 miles of underground workings in the mine, and these extended to a vertical depth of 5,912 feet. It was the deepest mine in North America when it closed in 1942.

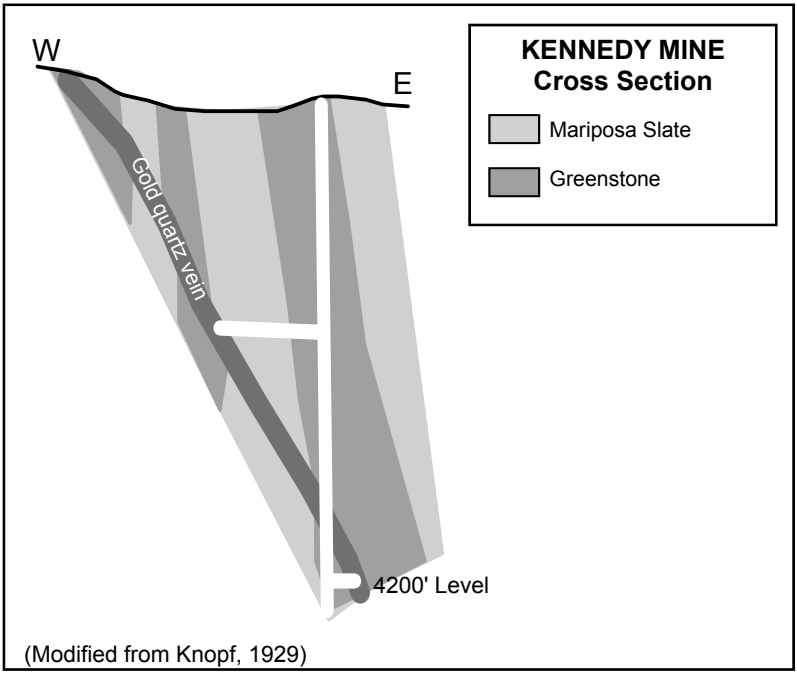
Mining at the Kennedy Mine was difficult because the gold-bearing quartz veins were in fault zones where the rocks were shattered and filled with water. The rocks caved easily so that heavy timbering and backfilling were required. For this reason, shafts and tunnels were mainly cut in hard rock where less timbering was required.

The gold occurs in steeply dipping quartz veins that cut across Mariposa Slate and greenstone. Some of the veins are several tens of feet thick. The gold often occurs in areas with abundant fault gouge. Most of the gold is free and in small grains. Much of the ore was low grade.

The Kennedy Mine had a 100-stamp mill. Ore was processed by crushing in this mill, then passing the finely ground product over amalgamating plates with mercury, shaking tables, and other processes. The final product was a gold-rich concentrate that was shipped to smelters for refining.

In 1922, the nearby Argonaut Mine was the site of one of California's worst mining disasters. Fire broke out at the 4,200 foot level of the mine while work was going on at deeper levels. A shift of 47 men were trapped by the fire and could not be reached through the Argonaut mineshaft. The Kennedy Mine was already connected underground to the Argonaut Mine, but there was no direct access to the trapped men. Tunneling from the Kennedy Mine began as soon as possible, but it was three weeks before the tunnel finally broke through to the lower levels of the Argonaut Mine. Unfortunately, there were no survivors. The miners had perished from poisonous gas about five hours after the fire had started.

The Amador County Museum on 225 Church St. in Jackson is in the historic Brown House, built in 1859. The museum has gold rush artifacts, antique mining equipment, and a detailed working model of the Kennedy Mine, stamp mill, and tailings wheels (209-223-6386).



(Modified from Knopf, 1929)

This mining equipment on display at the Empire Mine at Grass Valley is typical of the equipment that was used in working the lode mines of the Sierra Nevada.

Kennedy Tailings Wheels Park - *From North Main St. and Hwy.49 in Jackson drive N on Main St. 1 mi. to Kennedy Tailings Wheels Park.*

Kennedy Tailings Wheels Park has the remains of four large tailings wheels that were built in 1914 in response to federal anti-debris laws. The wheels were connected by flumes and were used to transport tailings from the Kennedy mill to a dam one-half mile away where the tailings were impounded. The tailings dam was higher than the mill, and the wheels were used to lift the tailings 58 feet on their way to the dam. The wheels are 68 feet in diameter and were driven by electric motors. The wheels were in operation until the Kennedy Mine shut down in 1942. Two of the wheels have been reconstructed, and two lie where they toppled some years ago.

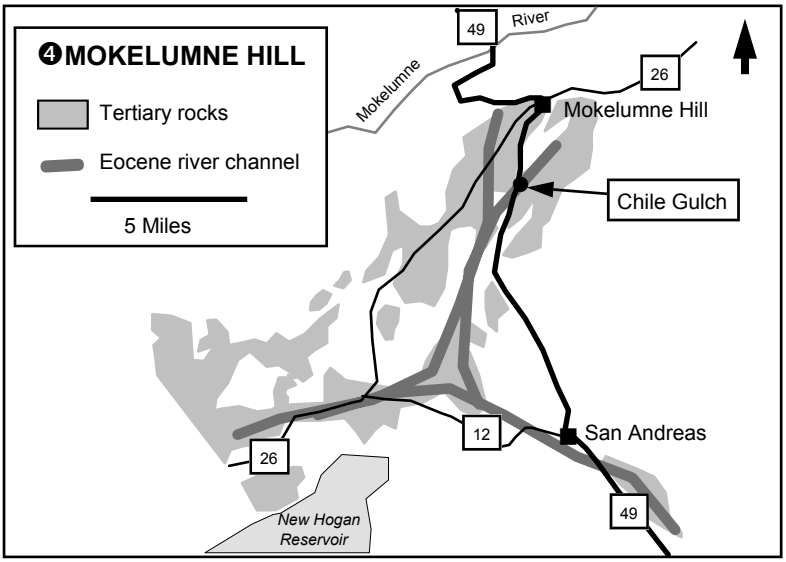
This is one of the four large tailings wheels at Kennedy Tailings Wheels Park. The headframe of the Kennedy Mine can be seen in the distance through the spokes in the wheel.

❹ *Mokelumne Hill*

Mokelumne Hill is one of the few areas south of Placerville where significant gold production has come from Tertiary river gravels. These river gravels were deposited in a complex system of at least eight different channels of the Tertiary Mokelumne River, and occur in an erosional remnant of the Tertiary rocks that once blanketed this area. The gravels were mined extensively in 1850's and 1860's by both drift and hydraulic methods, and production declined in 1870's. The hydraulic pits and drift mines that were used to mine the gravels are not visible from Highway 49. In some places, the Tertiary gravels contain large well-formed quartz crystals of optical grade. These crystals were mined for electronics during World War I and World War II at the nearby Calaveras Crystal Drift Mine, located in Chile Gulch.

Chile Gulch - *From Hwy. 49 and Main St. in Mokelumne Hill drive 1.4 mi. S on Hwy. 49 to the historic marker for Chili Gulch.*

In 1848 and 1849, this part of Chile Gulch was the site of intensive placer mining activity. This placer gold probably was derived from the Tertiary river gravels that were extensively mined in this area. The roadcuts between Mokelumne Hill and this historic marker have large exposures of yellowish gray tuffs of the Valley Springs Formation. The gold-bearing Tertiary gravels lie below these rocks. The Mehrten Formation is exposed in roadcuts along Highway 26 immediately west of Mokelumne Hill.

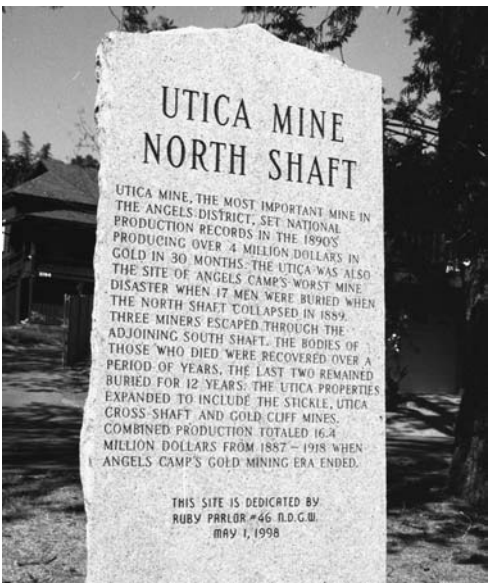


❺ *Angels Camp*

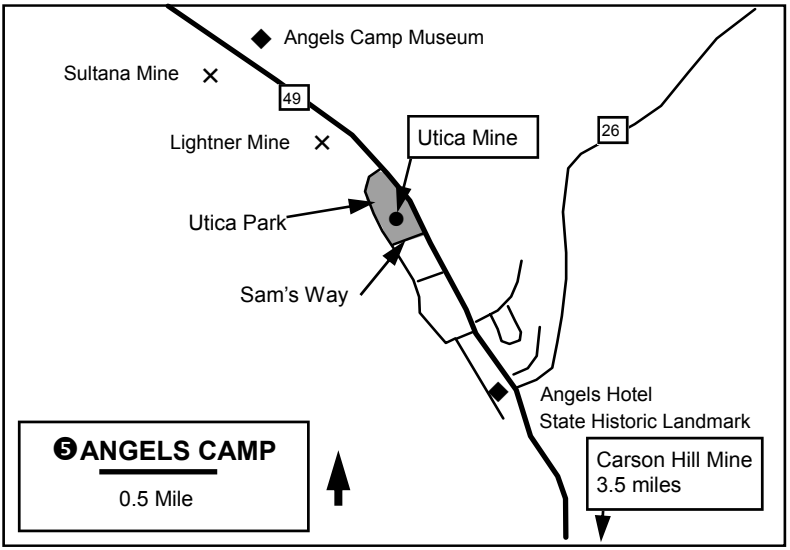
Angels Camp was founded in 1848 as a trading post for nearby placer mines. The placers did not last long. However, gold-bearing quartz veins were soon discovered under the main street of the town. These veins were worked by several mines. The largest of these was the Utica, the most famous mine between Carson Hill and Jackson. Angels Camp also served as the mining center for several of other mines in the vicinity, including the large Carson Hill Mine to the south. Gold mining ended in this area in 1918.

Utica Mine - *From Valecito Rd. and Main St. in Angels Camp, go N on Main St. four blocks to Sams Way; turn left and park at Utica Park.*

The north shaft of the Utica Mine was located in what is now Utica Park. This shaft collapsed in 1889, and 17 men were buried by the collapse. It was 12 years before all of the bodies were recovered. The park is in a depressed area that subsided when the shaft caved in. The Utica Mine is located along a spur of the Melones fault, about a half-mile east of the main fault zone. The gold occurs mainly as finely divided native gold in quartz veins, schist, and greenstone in the fault zone. The veins are nearly vertical, and have been worked to a depth of 3,050 feet below the surface. The ore-bearing veins are faulted off on the south side of town. Many efforts to find their continuation have been in vain. The Utica Mining Company was organized in the 1850's, and peak production was in the1880's and 1890's.



This monument at Utica Park is dedicated to the 17 miners that were lost in the 1889 collapse of the north shaft.



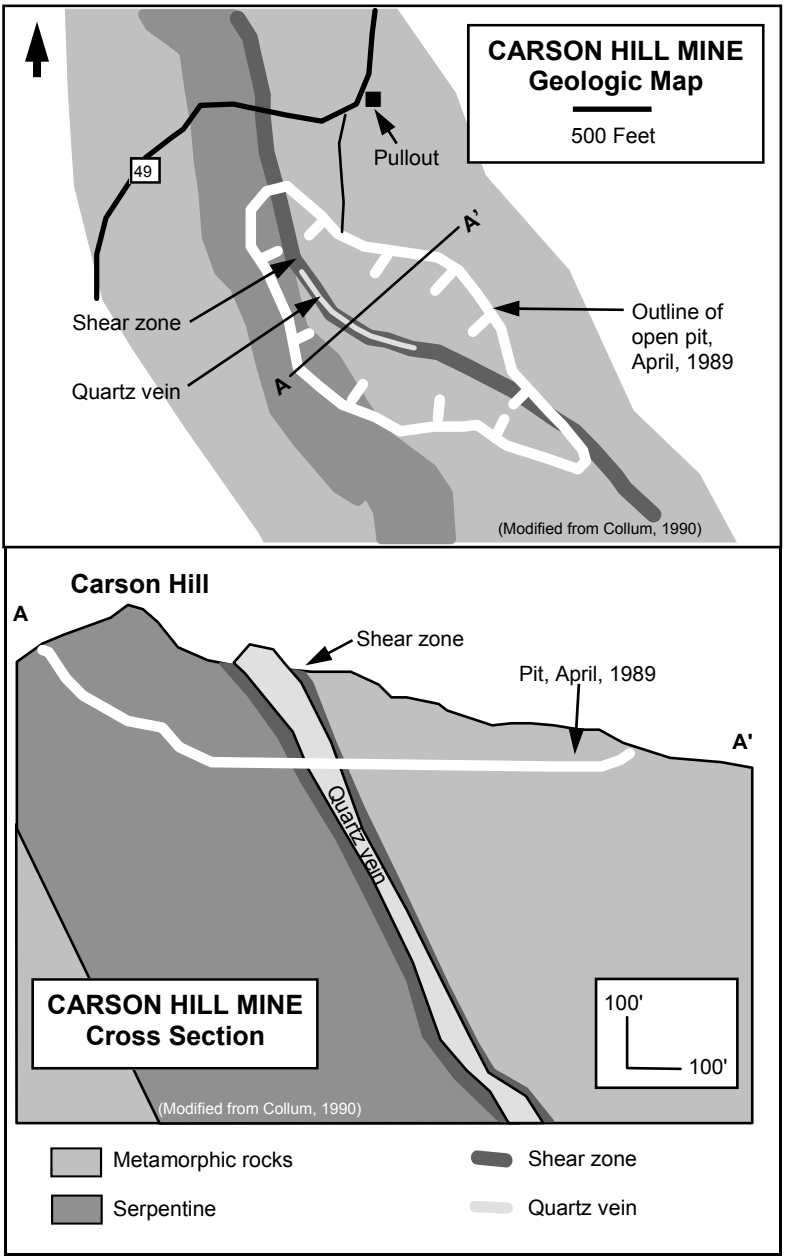
Utica Park in Angels Camp is at the site of the North Shaft of the Utica Mine. The park is in a depressed area that was formed by a major collapse of the underground workings at the North Shaft.

Carson Hill Mine - *From Angels Camp drive 3.5 mi. S on Hwy. 49 to the historical marker for the Carson Hill Mine; park in the pullout at the marker.*
From this pullout on Highway 49, you can see a large open pit that has been carved out of Carson Hill. The pit is the remains of the large Carson Hill Gold Mine, the last of many mines that have intermittently extracted gold from Carson Hill for nearly 150 years. The hill is named for James Carson, a sergeant in the U.S. Artillery. In 1848, Carson and his partners took 180 ounces of gold from a creek on the northwest side of the hill. However, it would be two more years before gold was discovered on Carson Hill. Legend has it that, in 1850, John Hance found a 14-pound lump of gold at the top of Carson Hill while chasing his runaway mule. This may well have been the most significant gold discovery ever made by a mule.

Most of the early gold came from rich surface pockets, where the gold had been concentrated by surface weathering. The gold was produced from a number of different mining claims on the hill. A 195-pound nugget was found in one of these early mines. Gold production declined in the late 1850's as the rich pockets were depleted.

Most of the later mining was of low-grade ore and was carried out by a number of separate underground mines that operated until 1942, when production stopped during World War II. The Carson Hill Gold Mining Corporation began open pit mining and leaching operations in 1986. This activity ended in 1989 as a result of low gold recoveries and low gold prices. In 1991, the Morgan Mine began open pit mining on Carson Hill after consolidating the Carson Hill, Morgan, and many other claims and mines on the hill. After extensive open pit mining, the top of the hill is now gone, and there is a large pit on the side of the hill. Leaching operations of the mine tailing were also carried out at the mine. The gold was recovered by leaching heaps of ore with cyanide. At present, there is no mining, but the mine is being operated for aggregate and decorative rock.

Carson Hill lies east of the Melones fault, along a shear zone that cuts through serpentine and metamorphosed rocks of Jurassic age. The rocks along the shear zone have been intensely altered by hydrothermal solutions, and are cut by numerous quartz veins. The gold occurs in these altered rocks. The shearing, alteration, and gold mineralization are particularly intense in the bend of the shear zone.


CARSON HILL MINE
Geologic Map
500 Feet
Pullout
49
A'
A
Shear zone
Quartz vein
Outline of
open pit,
April, 1989
(Modified from Collum, 1990)
Carson Hill
A
Shear zone
Pit, April, 1989
A'
Quartz vein
CARSON HILL MINE
Cross Section
100'
100'
(Modified from Collum, 1990)
Metamorphic rocks
Serpentine
Shear zone
Quartz vein

❻ *Caves*

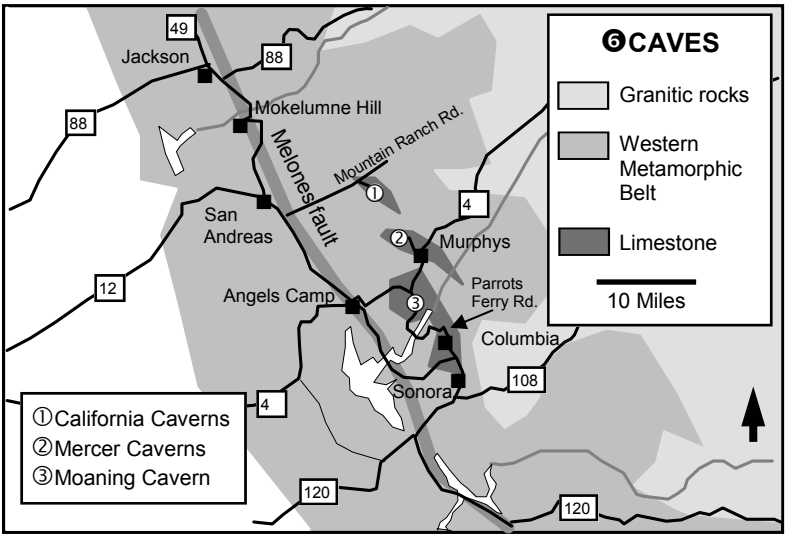
There are dozens of limestone caves scattered along the foothills of the Sierra Nevada. Three of these caves are open to the public and can be easily visited during your trip to the Mother Lode: California Caverns east of San Andreas, the Mercer Caverns near Murphys, and Moaning Caverns east of Angels Camp. Two other caves are open to the public in the southern Sierra Nevada, Crystal Cave in Sequoia National Park, and Boyden Cavern in Kings Canyon National Forest. These caves are described on the trip to Sequoia and Kings Canyon National Parks.

California, Mercer, and Moaning Caverns occur in large outcrops of limestone that lie within the Calaveras Complex of the Western Metamorphic Belt. This limestone was formed in some distant shallow warm sea, probably hundreds of miles southwest of California and probably during Permian time. The limestone was carried to the margin of North America by plate movement, swept into the Nevadan subduction zone, and altered to marble under the high temperatures and pressures in the subduction zone.

When you build a house, first you make the rooms, and then you decorate the rooms. Mother Nature builds a cave in much the same way. The rooms of the cave are made when limestone lies below the water table and weak acidic groundwater moves through the fractures, joints, and bedding surfaces of the limestone. As the water flows along these surfaces, it dissolves the limestone and forms a series of rooms, chambers, and passageways that follow the fractures, joints, and bedding surfaces. This process is interrupted when the water table drops and the limestone is no longer filled with water. When this happens, dissolution of the limestone stops and the rooms are ready to decorate.

The decoration takes place when water from the surface seeps downward along the joints and cracks in the limestone and becomes saturated with $CaCO_3$ as it flows through the limestone. When the $CaCO_3$-rich water reaches the open chambers and passageways of the cave, the water evaporates and calcite is precipitated as stalactites, stalagmites, draperies, and countless other forms of cave decorations.

> ***California Caverns*** - *From Mokelumne Hill go S 8 mi. on Hwy. 49; turn E on Mountain Ranch Rd. and go 7 mi.; turn S on Cave City Rd. and drive 2 mi. to California Caverns (209-736-2708).*
>
> This cavern has been open to the public since 1850. In addition to the one-hour tour along lighted trails, trips are available to other parts of the extensive cavern with professional guides.



Mercer Caverns - *From the junction of Hwy. 49 and Hwy. 4 (Vallecito Rd.) in Angels Camp, go E 8 mi. on Hwy. 4 to Murphys; turn N on Sheep Ranch Rd.; Mercer Caverns is at 1665 Sheep Ranch Rd.; open daily (209-728-2101).*

Mercer Caverns was discovered in 1885 by Walter Mercer while prospecting for gold. The cave consists of a number of rooms and chambers that extend to a depth of nearly 200 feet. The rooms follow steeply-dipping joints and faults in the limestone, and are accessed by a series of staircases that go from room to room down the joint system. Mercer Cavern has been designated as a State Historic Site.

Moaning Cavern - *From the junction of Hwy. 49 and Hwy. 4 (Vallecito Rd.) in Angels Camp go E 4.5 mi. on Vallecito Rd.; turn S on Parrotts Ferry Rd. and drive 1.5 mi. to the turnoff to Moaning Cave; drive 1 mi. to Moaning Cavern; open to the public (209-736-2708).*

Moaning Cavern has California's largest single chamber underground room. The room is reached by an historic 100-foot spiral staircase, and extends for another hundred feet or so below the spiral staircase. Among the many cave decorations are a 14-foot long stalactite, and several huge stalagmites.

Moaning Cavern is located in a large outcrop belt of marble that lies within the Calaveras Complex. This belt of marble extends from Moaning Cavern southeast as far as Columbia. At Columbia, the marble provides the rough karst surface that trapped much of the placer gold that was found in that area.

❼ *Columbia*

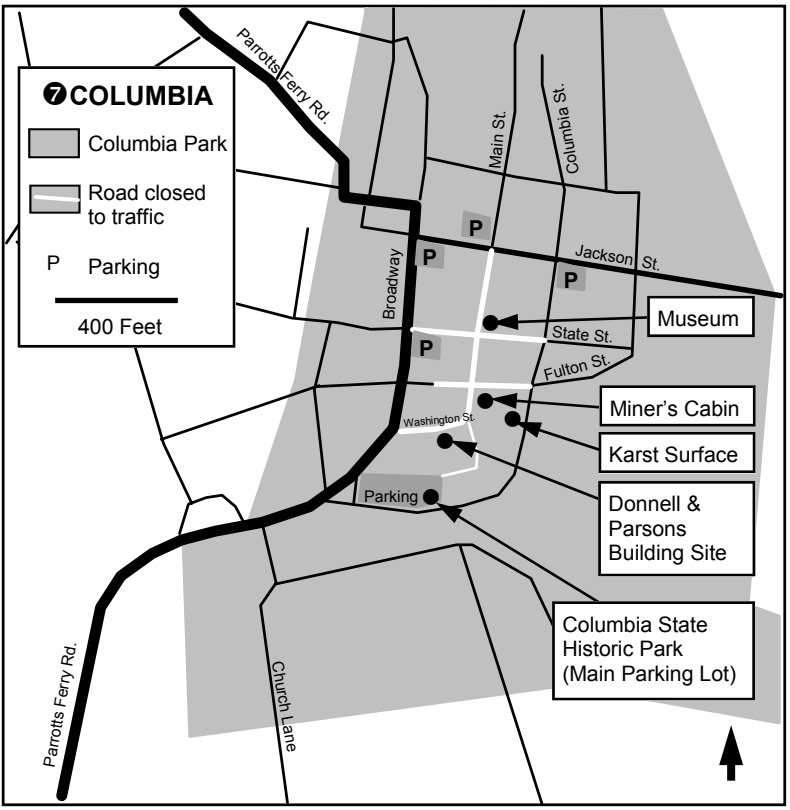
Placer deposits of gold were discovered at Columbia in 1850. Although the deposits were rich, there was little water in the immediate area and the placers were therefore difficult to work. To alleviate this problem, a 60-mile aqueduct was constructed and hydraulic mining began in 1856. During the late 1850's and early 1860's Columbia was one of the largest, richest, and most famous towns in California.

The early town grew rapidly. In 1852, there were over 150 stores, saloons, and other buildings. Many of these early buildings were destroyed by fire in 1854. The town was rebuilt after the fire, including 30 brick buildings. In 1857, there was another fire, and this fire destroyed 13 blocks and several of the new brick buildings. The mines began to play out in the late 1860's, but minor mining activity continued for many years. The central part of the town became a State Park in 1945. Many historic buildings in the town have been restored, and provide good insight into life in an 1850's mining town.

The city lies in a flat valley underlain by a bed of marble that lies within the Calaveras Complex. During the long Eocene erosion period, the marble had weathered to form a highly irregular karst surface, pitted by numerous deep potholes and cavities. At the time of the gold rush, this irregular limestone surface was covered by about ten feet of rich gold-bearing gravel. The gold was concentrated in the potholes and cavities in the marble. The town was built on this gold-bearing gravel, and the buildings and streets of the town were continually under siege by ambitious miners. You can see the results of their efforts to get at the gold-bearing gravel at many places in and around the town, such as at the miner's cabin and the Donnell and Parsons Building site.

It is likely that this placer gold came from quartz veins that occur in slate and schist of the Calaveras Complex east of Columbia. The quartz veins in that area were famous for having small extremely rich pockets of gold. During Eocene time, gold from these veins was transported by streams to the limestone of the Columbia area where the gold was trapped in the potholes on the karst surface. Nature had devised a remarkably efficient way to concentrate the gold.

Some very large nuggets of gold have been recovered from the Columbia area. The largest was a slab-shaped mass that weighed more than 50 pounds. Another nugget weighed 23 pounds. The placer gold production within a one-mile radius of Columbia from 1853-70 has been estimated at $860,000,000, valued at $300 per ounce.



Many of the old buildings along Main Street in Columbia have been restored and the street is closed to traffic. Columbia was one of the most famous placer mining towns along the entire Mother Lode.

Columbia State Historic Park – *The main parking lot for the Columbia State Historic Park is at Broadway (Parrots Ferry Rd.) and Columbia St. For information on the park phone 209-532-0150 or visit the website www.parks.ca.gov.*
The gold discovery site is marked by a plaque in the picnic area at the east end of the parking lot. Here, gold was discovered by the Hildreth party on March 27, 1850. This group consisted of Dr. Thaddeus Hildreth, his brother George, and several other prospectors. Within one month several thousand miners had flocked to this site, first known as Hildreth's Diggins. The town was soon named Columbia, to give the town a sense of permanency.

Museum – *In Columbia at Main St. and State St. (209-532-0150).*
The museum is in a former miner's supply store that was erected in 1854. The museum has many relics of Columbia from the gold rush days and is operated by the Columbia State Historic Park.

Miner's Cabin - *Main and Washington Streets, Columbia (209-532-9693).*
The Matelot Gulch Mine Supply Store occupies an old miner's cabin. The store sells mining supplies, minerals, and pans of sand and gravel that you can pan for gold. It also has tours to an operating gold mine. Just outside the cabin is a long tom, used for separating gold in placer mining. The cabin sits more than ten feet below the original ground surface, and shows how much ground was washed away by hydraulic mining in this area.

Karst Surface - *Main and Washington Streets, Columbia.*
Just east of the miner's cabin, toward Columbia Street, you can see the smooth white marble of the Calaveras Complex. The surface of the marble is very irregular, with a relief of five to ten feet and lots of potholes and crevices. The gold-bearing gravels were trapped in low spots on this irregular *karst* surface. The gravel was removed from the holes and crevices by monitors using high-pressure water.

Donnell & Parsons Building Site - *The site the Donnell & Parsons Building is on S side of Washington St. near Main St.; an historical marker identifies the site.*
This vacant lot is the site of the Donnell & Parsons Building, built in 1853, and Columbia's first brick building. The building was torn down in 1866 and the site was mined in 1867. After the lot was mined, it left Washington St. at the top of the steep ten-foot slope that abruptly descends to the main parking area for Columbia. The parking area is low because the gold-bearing gravel was removed from this area by the hydraulic mining.

Long toms, like these near the miner's cabin in Columbia, were used for recovering gold from placer deposits during the gold rush.

Ten feet of gold-bearing gravel once covered this irregular karst erosion surface near the miner's cabin. The gravel was removed by hydraulic mining, and the gold recovered from the gravel. Most of the rich gold was trapped in the crevasses and pits in the marble.

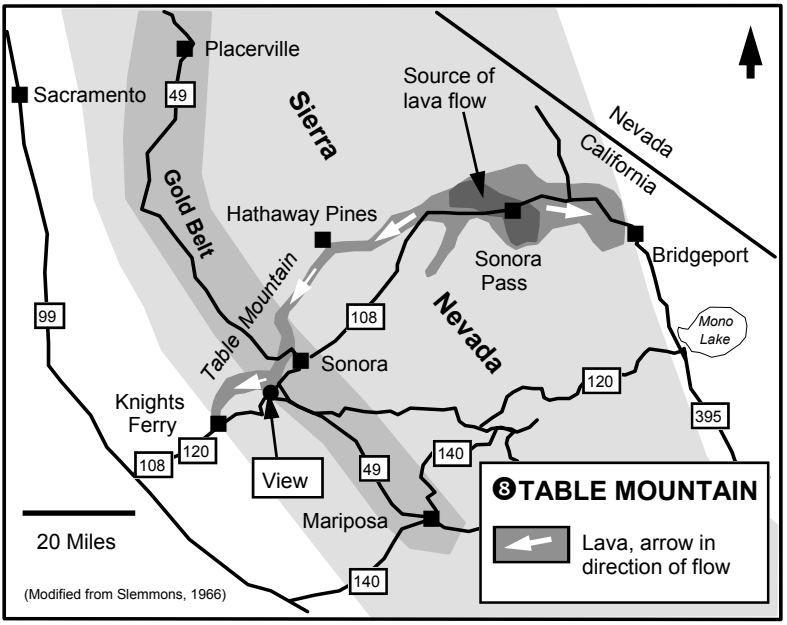
❽ *Table Mountain*

Table Mountain is one of the best examples of inverted topography in the Sierra Nevada. This long, sinuous, flat-topped mountain can be traced for over 50 miles across the Sierra foothills from Hathaway Pines to Knights Ferry. The flat top of the mountain is formed by lava that flowed down a valley of the Miocene Stanislaus River. The bottom of that Miocene river valley now forms the top of the mountain. Let's take a look at how Table Mountain got inverted.

Table Mountain consists entirely of Tertiary sedimentary and volcanic rocks. These rocks lie on top of the hard Eocene erosion surface, and the erosion surface forms most of the low-relief landscape in the vicinity of the mountain. Below the Eocene erosion surface are the basement rocks of the Western Metamorphic Belt. The Tertiary rocks of Table Mountain sit on the Eocene erosion much like a Twinkie on a plate.

At the base of Table Mountain are Eocene river gravels, which lie directly on the Eocene erosion surface. The Eocene gravels are overlain by the Tertiary sedimentary and volcanic rocks of the Valley Springs and Mehrten Formations. At the end of Miocene time, the Tertiary rocks formed a thick blanket that covered most of the Sierra Nevada. About ten million years ago, before uplift of the present-day Sierra, lava erupted from an active volcanic center area near Sonora Pass. The lava was very fluid. Some of the lava flowed east toward Nevada and some flowed west into a channel of the Miocene Stanislaus River that had been cut into the soft Tertiary rocks. The lava filled the river channel to a thickness of about 200 feet and flowed down the channel for 60 miles to Knights Ferry. After the flow, the lava cooled slowly, and columnar joints formed as the lava contracted.

In early Pliocene time, several million years after the Miocene lava flow, the Sierra Nevada began to be uplifted and eroded. The renewed erosion rapidly removed the Tertiary rocks from most of the Sierra foothills and exposed the Eocene erosion surface over much of this area. However, at Table Mountain, the lava that had filled the Miocene Stanislaus river channel was hard and protected the underlying Tertiary rocks from erosion. Because of this protective cap, Table Mountain now traces the course of the Miocene Stanislaus River. The present day Stanislaus River lies nearby, but follows a different course.


Placerville
Sacramento
49
Sierra
Source of
lava flow
Nevada
California
Gold Belt
Hathaway Pines
Sonora
Pass
Bridgeport
Table Mountain
99
108
Nevada
Mono
Lake
Sonora
120
Knights
Ferry
395
108
120
View
49
140
❽TABLE MOUNTAIN
Mariposa
20 Miles
Lava, arrow in
direction of flow
140
(Modified from Slemmons, 1966)

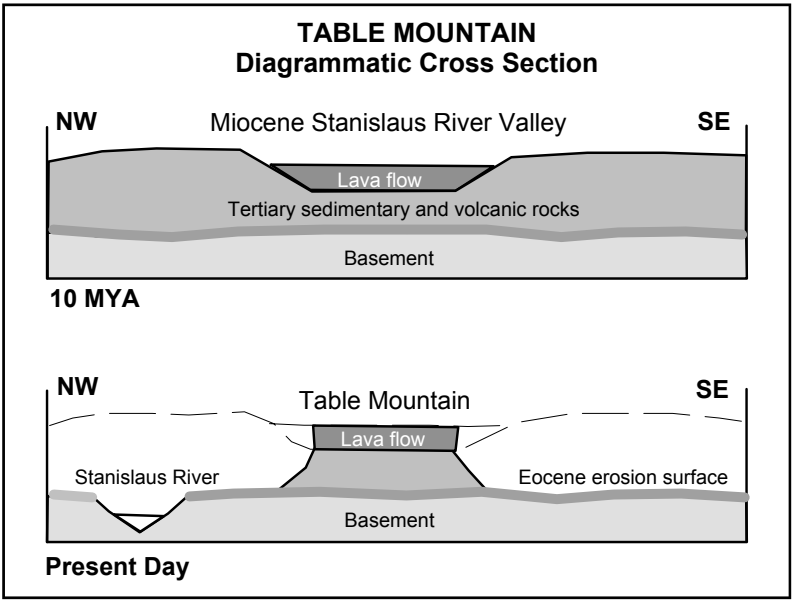


TABLE MOUNTAIN
Diagrammatic Cross Section
NW
Miocene Stanislaus River Valley
SE
Lava flow
Tertiary sedimentary and volcanic rocks
Basement
10 MYA
NW
Table Mountain
SE
Lava flow
Stanislaus River
Eocene erosion surface
Basement
Present Day

View - *Hwy. 108 1 mi. N of Yosemite Junction.*
From Yosemite Junction to Jamestown, Highways 108 and 49 follow along the southeastern flank of Table Mountain and you can get good views of the mountain from a number of places along this part of the highway. However, the best views of the mountain are from Highway 108 between Yosemite Junction and the intersection of Highway 108 and Highway 49. Pull out along the highway where convenient and safe. Note the vertical cliffs of the dark gray columnar-jointed lava that form that cap of Table Mountain. The lava flow is about 200 feet thick in this area and the columns are a foot or so in diameter. The lava consists of latite, which is between andesite and basalt in composition. If you examine a hand specimen, you'll see that the lava has a very fine-grained matrix and phenocrysts of feldspar and augite. The feldspar phenocrysts are white and the augite is dark green.

It is difficult to see the Tertiary sedimentary and volcanic rocks that make up the flanks of Table Mountain, since these rocks are soft and generally covered by vegetation. However, some of these Tertiary rocks are gold-bearing in the portion of Table Mountain that lies northwest of Sonora and Jamestown. This part of Table Mountain crosses the Mother Lode. As the Eocene streams flowed across the bedrock in this area, they followed joints and cracks on the Eocene erosion surface. Gold from the Mother Lode accumulated in these joints and cracks in the deeper parts of the Eocene stream channels. Some of the stream gravels in the Mehrten Formation also contain gold, but only where the Mehrten channels had cut into the underlying gold-bearing Eocene gravels and captured the gold from the Eocene gravels.

Typically, the Eocene gravels and the younger Mehrten stream channels were mined by drift mines that cut into the base and flanks of Table Mountain and followed the channels. Few of the drift mines in the Mehrten Formation were successful because the placer gold deposits were sparse and spotty.

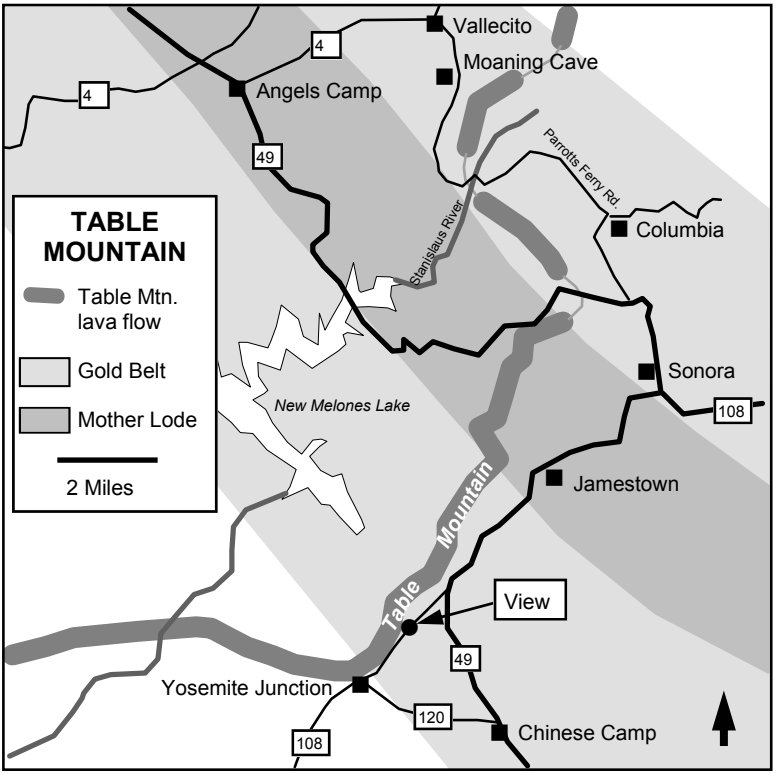


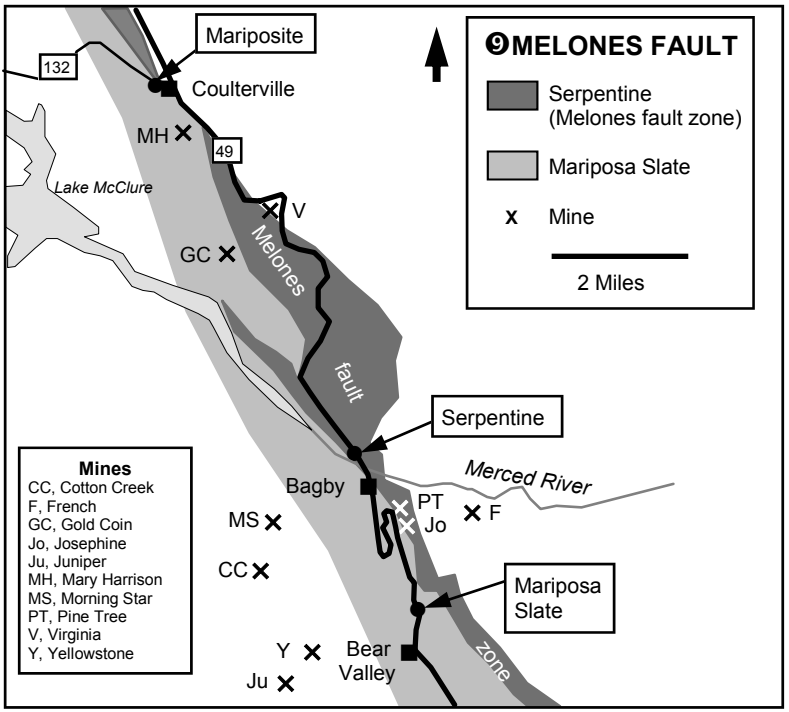
Table Mountain is a classic example of inverted topography. The flat top of the mountain is formed from lava that flowed down the Miocene Stanislaus River. The lava flow now forms the steep cliff at the top of the mountain. The columnar joints that developed in the flow can be seen in the photo.

❾ *Melones Fault*

The Melones fault is one of the best-known faults in the Western Metamorphic Belt. It extends for over 200 miles from Mariposa to north of Sierra City and is closely associated with gold deposits over much of this distance. The fault was formed during Jurassic time, and is one of the main faults along which subduction took place in the Nevadan subduction zone. During this subduction, the Jurassic rocks west of the fault were carried eastward into the subduction zone and thrust under the rocks that were already in the subduction zone. The rocks in the vicinity of the fault were sheared and shattered during this subduction process. In early Cretaceous time, subduction was transferred from the Nevadan subduction zone to the Franciscan subduction zone. When this occurred, there was no more faulting along the Melones fault. However, mineral-rich fluids expelled from the Franciscan subduction zone were forced into the sheared rocks along the Melones fault zone. Gold, copper, zinc, quartz and many other minerals were deposited along the fault zone as temperatures, pressures, and the chemistry of the fluids and wall rocks changed during ascent of the fluids. One of the best places to see the Melones fault is along Highway 49 between Coulterville and Bagby, where the Highway closely follows the fault. This part of the fault zone is marked by extensive bodies of serpentine that can be seen in the roadcuts along the highway.

Mariposite - *From Hwy. 49 in Coulterville turn W on Hwy. 132; drive W 0.2 mi.; park on the S side of Hwy. 132 along old Highway 49; the mariposite roadcut is across the road; cross Hwy. 132 with care.*

This roadcut is one of the best exposures of mariposite rock along the entire Mother Lode. The outcrop marks the trace of the Melones fault zone and the Mother Lode in this area. The rock in the outcrop is green and white and consists of massive white quartz veins that cut green-colored quartz-ankerite-mariposite rock. The green color comes from the mineral mariposite, which is a bright apple-green chromium-rich mica. This mica usually occurs in a groundmass of white fine-grained quartz, and this rock is referred to as mariposite rock. Mariposite is formed from serpentine that has been altered under pressure by mineral-laden hot water. The water, containing potassium, silica, carbon, oxygen, and other elements, reacts with the serpentine and forms deposits of quartz, chromium-rich mica, sulfides, and carbonates such as ankerite (magnesium, iron, manganese carbonate). Mariposite was first described from a specimen collected at the Josephine Mine, just south of Bagby. Most of the workings at the Mary Harrison Mine, two miles south of Coulterville, were in dolomite-ankerite-mariposite-quartz rock. The mine is now closed and not accessible.



The mariposite in this roadcut along highway 132 near Coulterville marks the trace of the Melones fault in this area. The mariposite is cut by veins of white quartz and ankerite. This is one of the best exposures of mariposite along the Mother Lode.

Serpentine - *From Coulterville drive S on Hwy. 49 10 mi. to the vista point on the N side of the bridge across the Merced River; park at the vista point.*

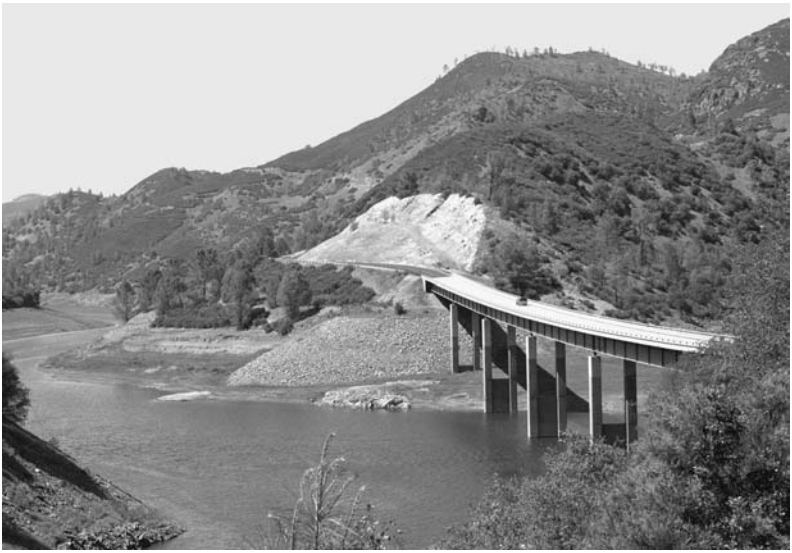
This vista point is at the north end of the bridge where Highway 49 crosses the Merced River. The old town of Bagby lies nearby, but is now flooded, following building of the dam for Lake McClure. Bagby began as a ferry crossing for the Merced River. Later, the town became an important stop on the Yosemite Valley Railroad, which took visitors up the Merced River Canyon to El Portal.

The green rocks in the large roadcut on the north side of the bridge are serpentine. There are also many other exposures of serpentine along Highway 49 from Bagby to Coulterville, where the road closely follows the Melones fault zone. The serpentine outcrops along the fault zone represent chunks of oceanic crust that were broken off in the Nevadan subduction zone and forced upward along the fault zone. The blocks of serpentine traveled upward along the fault zone like watermelon seeds squeezed between fingers. The serpentine is green, breaks into irregular curved fragments, and has a waxy luster and feel. Many pieces have grooves along smooth curved surfaces. The grooves formed as the slippery serpentine mass moved along the Melones fault zone.

Serpentine is formed at spreading centers. As basalt flows onto the sea floor at the spreading center, seawater enters cracks along the spreading center and alters the ultramafic rocks in the upper part of the mantle into hydrated iron-magnesium silicates. The serpentine is then carried away from the spreading center along with the overlying basalt as new rocks are formed at the spreading center.

Mariposa Slate - *From the Merced River bridge go S 2 mi. on Hwy. 49 to the Frémont historic marker.*

The Mariposa Slate is well exposed in the roadcut across the highway from the Frémont historic marker. This slate is one of the best-known rock units of the Foothills Terrane, and was the host rock for many of the gold-quartz veins of the Mother Lode. The slate was formed from shale that was deposited in the Nevadan subduction zone during Jurassic time and then metamorphosed during the late Jurassic Nevadan orogeny. In many parts of the Sierra foothills, the steep-dipping platy black slate sticks out of the ground like a crop of black tombstones growing in a field of grass (see the photo on page 227).



The serpentine in this roadcut on the north side of the Merced River bridge lies within the Melones fault zone. Highway 49 follows the fault zone from here north to Coulterville.

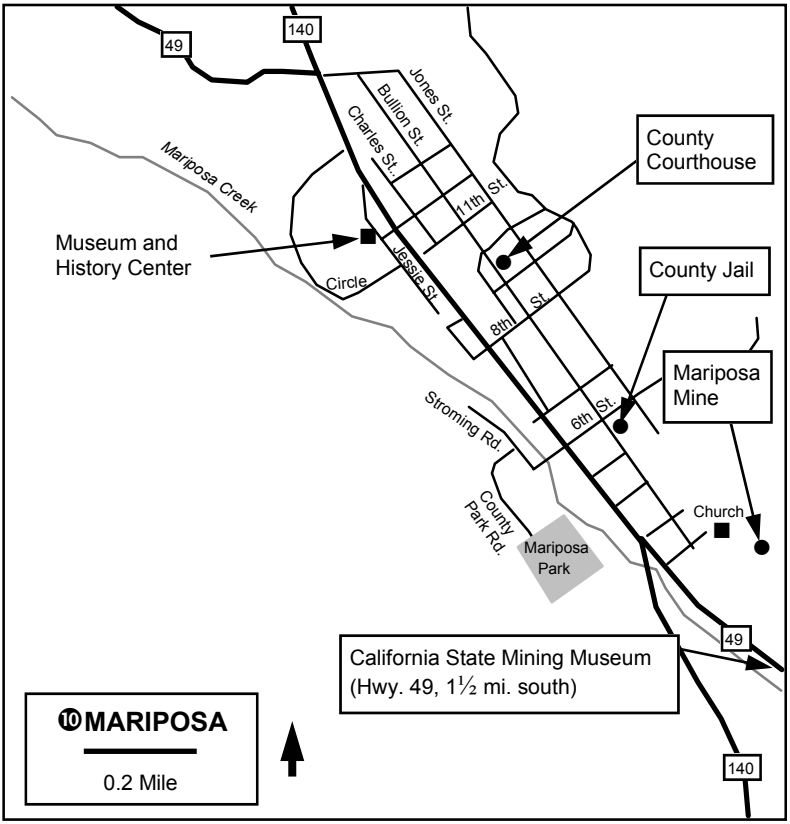
The Mariposa Slate, seen in this roadcut along Highway 49 near the Frémont historic marker, is the host rock for many gold-bearing quartz veins along the Mother Lode.

⑩ *Mariposa*

Although Mariposa is best-known as the gateway to Yosemite, you don't have to scratch the surface hard to find that it was born at the beginning of the gold rush and had a lively and exciting gold mining history. The earliest mining activity was in the spring of 1849 when placer gold was discovered along Mariposa Creek just below the bridge across Highway 140. Later that year, the townsite was laid out.

Mariposa was situated on the large Mariposa Land Grant, which was owned by famed explorer John Frémont. Many of the streets in town are named for members of Frémont's family: Charles Street for himself, Jessie Street for his wife, Bullion Street for his father-in-law, Senator Thomas "Old Bullion" Benton, and Jones Street for his brother-in-law. Despite disastrous fires in 1858 and 1866, the city prospered for many years as a supply center for mines at the south end of the Mother Lode. The city has the Mariposa Mine, one of the oldest gold mines along the Mother Lode, and many historic buildings and artifacts from the gold rush days.

The Mariposa County Courthouse has been in continuous use since 1854, and was the site of many famous mining law court cases.



Mariposa Mine - *The Mariposa Mine is in back of St. Joseph's Catholic Church near the S end of Bullion St., Mariposa.*

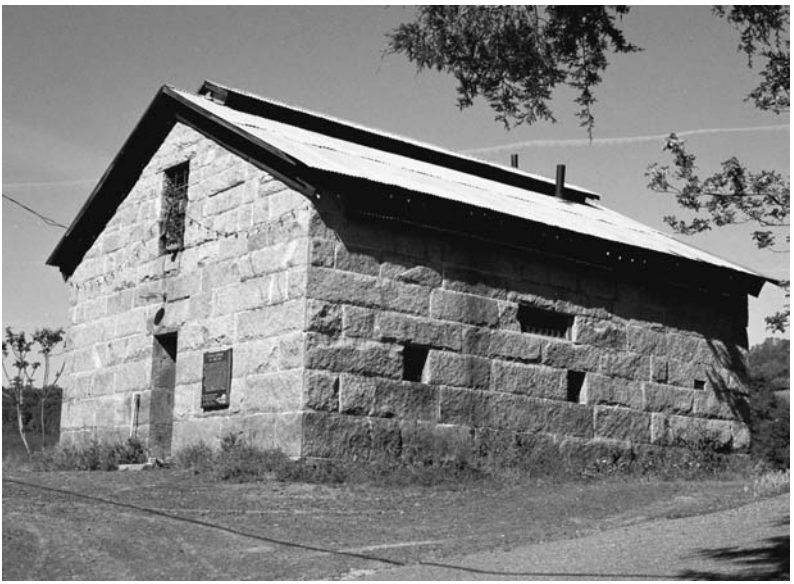
The old Mariposa Mine is not accessible, but the headframe can be seen from Mariposa Park on the west side of Mariposa Creek. The mine was discovered in 1849 by Kit Carson and Alex Goody, and is the first lode mine in California. The discovery was made when gold from Mariposa Creek was followed up the hillside to gold-bearing quartz veins. The gold occurs in veins of milky quartz up to four feet wide. The mineshaft is 1,550 feet deep. Peak production of the mine was from 1900 to 1915, and the mine produced 116,000 oz. of gold. The mine had a 40-stamp mill.

The Mariposa Museum and History Center at 12th and Jessie Streets in Mariposa has Gold Rush memorabilia, mining equipment and mining exhibits (209-966-2924).

County Courthouse – *In Mariposa on Bullion St. between 9th St. and 10th St.*
The Mariposa County Courthouse is the oldest county courthouse in continuous use west of the Rocky Mountains. It was constructed in 1854 at a cost of $9,000 using local timber and pegs. This courthouse was the site of many noted civil and mining cases, including a famous case concerning the title to Frémont's Land Grant.

County Jail – *In Mariposa on Bullion St. between 5th St. and 6th St.*
The old County Jail was built in 1858 for $14,770 and was in use until 1960. It was constructed of large granite blocks from a quarry at Mormon Bar, two miles south of Mariposa. The walls are 2½ feet thick. You can see the quarry marks on the granite blocks.

California State Mining Museum - *The California State Mining and Mineral Museum is on the Mariposa County Fairgrounds on Hwy. 49 2 mi. S of Mariposa (209-742-7625; www.parks.ca.gov).*
The mining museum has a 150-foot long mine tunnel, a stamp mill, a replica of 1890's mining complex, and an excellent collection of California gems, minerals, rocks, and fossils.



The old County Jail in Mariposa, constructed of large blocks of granite, was in use until 1960.

The California State Mining and Mineral Museum at the Mariposa County Fairgrounds near Mariposa.

These “tombstones” are formed from the Mariposa Slate and are characteristic of outcrops of the slate. The layering of the slate dips steeply east, as shown by the eastward tilt of the tombstones.