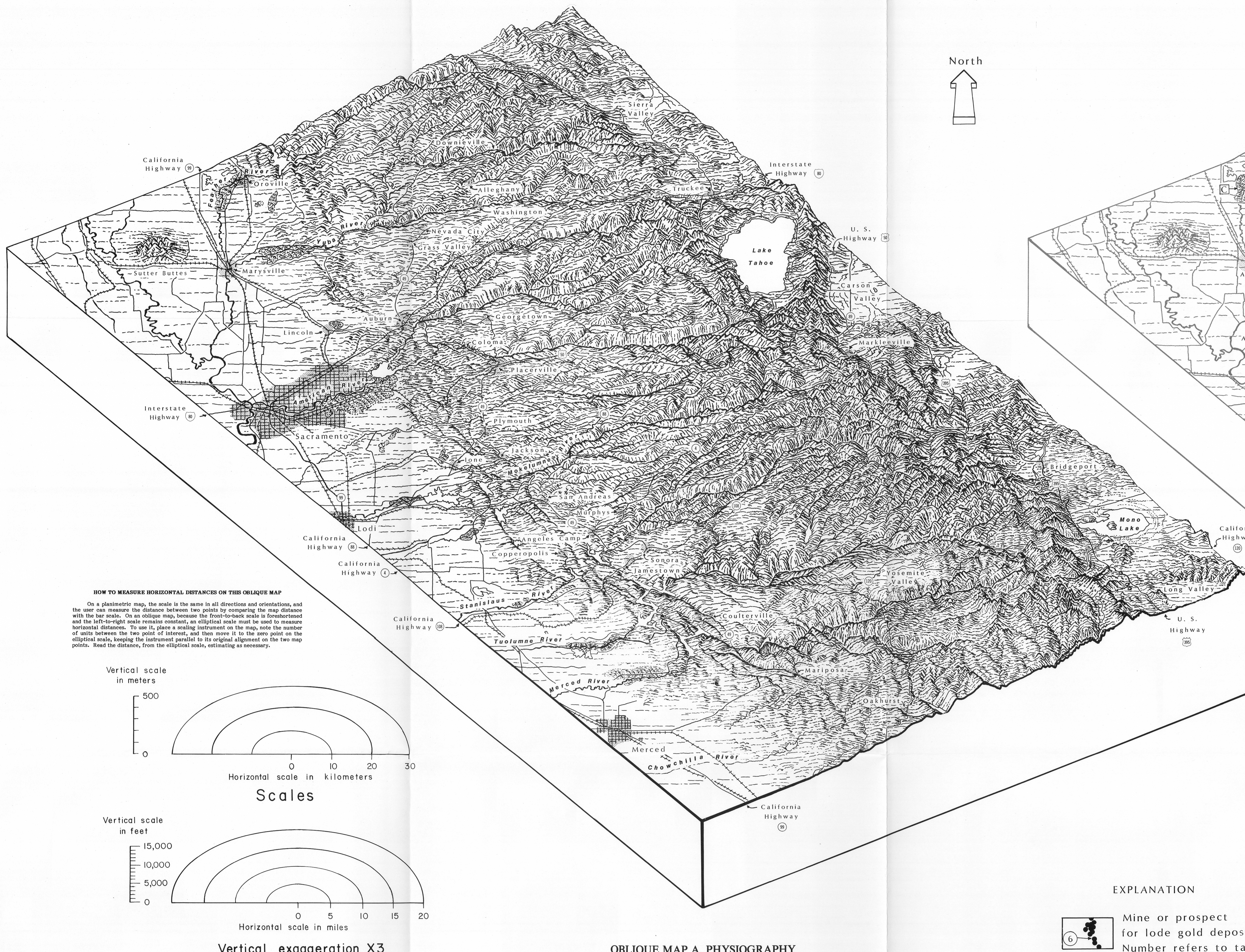
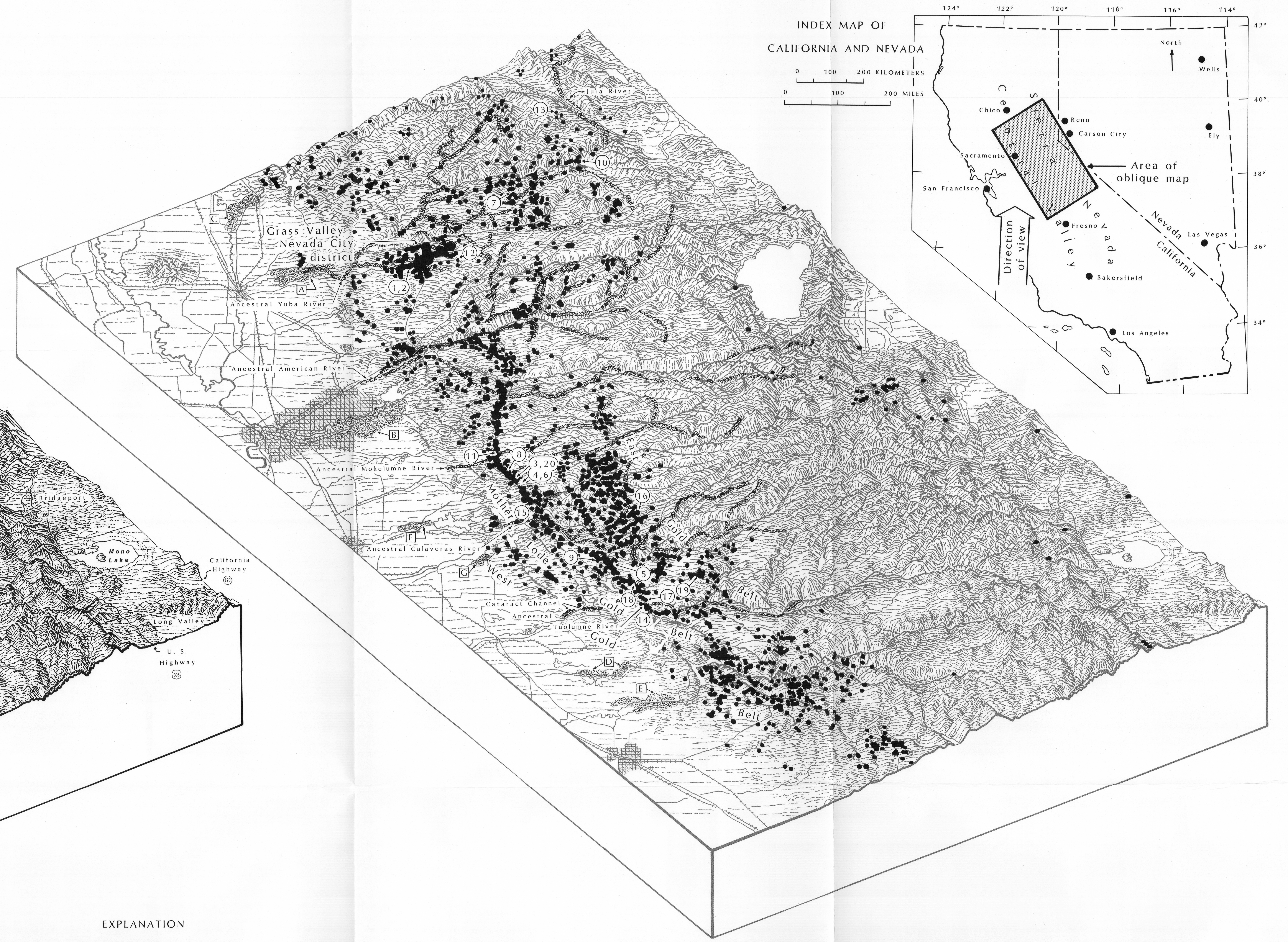


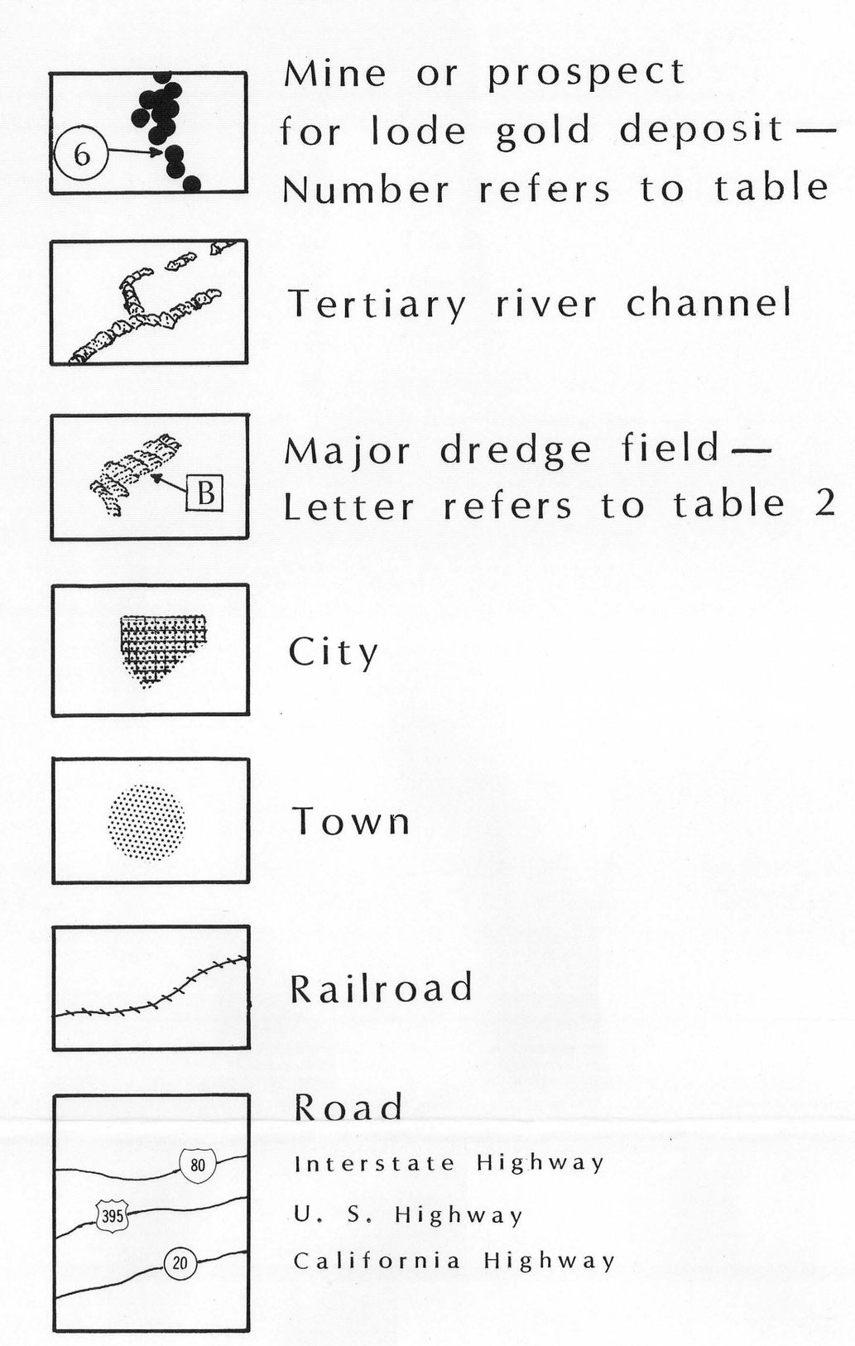
OBLIQUE MAP A, PHYSIOGRAPHY

HOW TO MEASURE HORIZONTAL DISTANCES ON THIS OBLIQUE MAP

On a planimetric map, the scale is the same in all directions and orientations, and the user can measure the distance between two points by comparing the map distance with the bar scale. On an oblique map, because the front-to-back scale is foreshortened and the left-to-right scale remains constant, an elliptical scale must be used to measure horizontal distances. To use it, place a scaling instrument on the map, note the number of units between the two point of interest, and then move it to the zero point on the elliptical scale, keeping the instrument parallel to its original alignment on the two map points. Read the distance, from the elliptical scale, estimating as necessary.



EXPLANATION



OBLIQUE MAP B, LOCATION OF LODE GOLD DEPOSITS, MAJOR DREDGE FIELDS, AND TERTIARY RIVER CHANNELS

INTRODUCTION

More than a third of the gold produced by the United States was mined in California. The bulk of this gold was recovered from the western slope of the northern half of the Sierra Nevada between the Merced River in the south and the Feather River to the north, a distance of about 170 mi. Gold was first discovered, in this region, on the American River at Coloma in 1848, triggering the famed California gold rush. Mining was continuously active, somewhere in the area, from the discovery of gold until World War II when mining was legally prohibited. Dramatic increases in gold prices in the past decade coupled with recent advances in extractive techniques have revitalized prospecting, and major deposits are currently being explored and developed.

Gold has been found in a variety of geologic environments in the region. In addition to production from the complex vein systems of the historically famous Mother Lode and associated East Gold Belt and West Gold Belt, large amounts of gold have also been recovered from the Grass Valley-Nevada City and other isolated lode districts and from Tertiary river channels and Quaternary alluvium.

This oblique map illustrates the relation of the different gold-bearing environments to each other and to the general terrain of the northern Sierra Nevada. The map was derived from the 1970 U.S. Geological Survey 1:500,000-scale topographic map of California and the 1976 U.S. Geological Survey 1:500,000-scale topographic map of Nevada, using an isometrograph, a mechanical instrument that produces an oblique framework by tracing individual contours. Form lines sketched over this framework graphically portray the physiographic configuration of the region. Relief on the oblique map has a 3:1 vertical exaggeration and appears as if viewed from a 30° angle above the horizon.

Locations of lode gold prospects and mines shown on the map were obtained from the U.S. Geological Survey's Mineral Resource Data System (MRDS), a computerized mineral-resource information file, and plotted in their respective locations (D.F. Huber, written commun., 1986). Some locations from two northern counties, missing from the MRDS retrival, were added. The twenty lode mines believed to be the most productive are cited in table 1. A total of nearly 4,000 sites, including both prospects and mines, were initially plotted, but about a third of those were obscured by topography on the oblique map. Locations of Tertiary river channels and gold-dredging fields were taken from published general references modified by examining specific sources and by cursory field examination. Seven of the major dredge fields are identified in table 2.

GEOLOGY

The geology of the western Sierra Nevada has been studied for more than a century, but it still is not well understood and is the subject of considerable controversy. Most believe that the strata of the western metamorphic belt are found 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 an assemblage of tectonically accreted blocks emplaced at various times along the western margin of the North American continent. The eastern flank of this assemblage was then episodically intruded by magmas of the Sierra Nevada batholith during the middle and late Mesozoic; isotopic-age data suggest that most of the gold mineralization took place during this time in the Early Cretaceous.

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 system of northwest-trending mineralized rock 1 to 4 mi wide and en echelon quartz veins extending 120 mi through the western Sierra Nevada. Most of the Mother Lode ore bodies are concentrated in a zone marked by elongate serpentinite bodies, belts of pervasive shearing, and cataclastic deformation. Much of the past gold production was from the quartz veins, but much of the present interest is in mineralized country rock. Productive quartz veins are generally characteristic of the north part 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 part.

The steeply northeast dipping quartz 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 most common in mineralized greenstone and schist. Mineralized greenstone, chiefly altered metavolcanic breccia and tuff, is composed of Fe-Mg carbonate containing lesser amounts of sericite, albite, and quartz and 3 to 4 percent pyrite and arsenopyrite, and is interlaced with veinlets of quartz, carbonate, and albite; it is commonly known as gray ore. Mineralized schist, derived from chlorite schist or amphibolite, also consists chiefly of Fe-Mg carbonate and subordinate sericite, quartz, albite, and pyrite. In both the mineralized greenstone and schist, gold is finely disseminated and associated with the sulfide minerals.

Gold deposits in two zones of mineralization, the East Gold Belt and West Gold Belt, flank the Mother Lode and are found 5 to 15 mi on either side. These 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 are about 30 mi north of the north end 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, and commonly arsenopyrite and chalcopyrite, are present. Gold is found along fractures in the sulfide minerals and in brecciated quartz. At Nevada City, 5 mi northeast of Grass Valley, several vein systems cut a separate granodiorite mass. 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 more coarse gold.

Several isolated lode districts are located in the Sierra Nevada north of the Grass Valley and Nevada City. Most of the gold produced from these districts has been from quartz veins cutting granitic or metamorphic rocks; Alleghany, where gold was produced from several mines in small but spectacularly rich veins, is particularly noteworthy. A small cluster of mines and prospects 25 mi southeast of Lake Tahoe make up the Monitor-Mogul district. Unlike other gold districts of the northern Sierra Nevada, gold chiefly occurs disseminated in altered and silicified zones in Tertiary volcanic rocks.

PLACER DEPOSITS

Gold is present in placer deposits of two different ages in the western Sierra Nevada. The older deposits are chiefly in quartz-rich gravels in relict early Tertiary river channels. The early Tertiary drainage system on the west flank of the Sierra Nevada consisted of five major rivers draining westward. A sixth river flowed northward from near the Sierran crest to beyond the north edge of the map area. Gold has been produced locally from deposits of all these rivers, but the most productive deposits have been those of tributaries of the ancestral Yuba River. Gravel deposited in the beds of these rivers were subsequently covered with volcanic debris late in the Tertiary, and new systems of drainage developed. One such late Tertiary channel, shown on the map, is the Cataract Channel in the Stanislaus drainage. It was later filled by a lava flow that now makes up a series of prominent "table mountains" between Sonora and Knights Ferry, 20 mi to the west. Alluvium deposited during the later Tertiary volcanic episode contains little gold. As a result of late Tertiary and Quaternary erosion, only scattered remnants of the Tertiary river channels remain.

The younger placer deposits are within the present-day drainage system. Latest Tertiary and Quaternary streams have cut deeply through the earlier Tertiary deposits into bedrock, with subsequent accumulation of gold in deposits farther 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 and the Folsom district on the American River flood plain (table 2). However, some placer gold has been produced from alluvial fans of all the major streams and smaller tributaries that flow across gold-bearing areas.

Table 1.--Past production of major historical lode gold mines of the northern Sierra Nevada, Calif.

[Mines are ranked from greatest to least production. Some mines with early production are omitted if records or estimates of past production were not available]

Map No.[1]	Mine name	Estimated or recorded past production in millions of dollars[2]
1	Empire	130
2	Idaho-Maryland	70
3	Central Eureka	36
4	Kennedy	34.2
5	Carson Hill (Morgan-Melones)[3]	26
6	Argonaut	25.1
7	Sixteen-to-One	25(+)
8	Keystone	24
9	Sierra Buttes	17
10	Utica	17(+)
11	Plymouth Consolidated[3]	13.5
12	Lava Cap[3]	12
13	Plumas Eureka	8(+)
14	Eagle-Shawmut	7.4
15	Gwin	7
16	Sheep Ranch	7
17	App-Heslip[3]	6.5
18	Rawhide[3]	6
19	Soulsby	5.5
20	South Eureka	5.3

[1]Some mines are surrounded by many other mines and prospects, which obscure the actual location; in those cases, the number identifies clusters of properties of which the mines are a part. In the case of the Mother Lode belt, number identifies approximate location of mines.
[2]Value of gold production includes both gold at $20.67 (1852-1932) and at $35.00 (1934-1968) per troy ounce; a "(+)" following estimated production value indicates additional gold production but amount is unknown.
[3]Activity, including exploration or development, is recent or ongoing at or adjacent to this mine.

Table 2.--Past production of major dredge fields of the northern Sierra Nevada, Calif.

[Fields are ranked from greatest to least production]

Map No.	Field name	Drainage	Estimated or recorded past production in millions of dollars[1]
A	Hammonton[2]	Yuba River	460
B	Folsom	American River	125
C	Oroville	Feather River	17
D	La Grange	Tuolumne River	13
E	Snelling	Merced River	12
F	Camanche	Mokelumne River	10
G	Jenny Lind	Calaveras River	2.3

[1]Value of gold production includes both gold at $20.67 (1898-1932) and at $35.00 (1935-1968) per troy ounce.
[2]Dredge is currently active in this field.

SELECTED REFERENCES

The following are a few selected general references on gold in the northern 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.
Bohlke, J.K., and Kistler, R.W., 1986, Rb-Sr, K-Ar, and stable isotope evidence for the ages and sources of fluid components of gold-bearing quartz veins in the northern Sierra Nevada foothills metamorphic belt, California: Economic Geology, v. 81, p. 296-322.
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 193, 186 p.
Ferguson, H.G., and Gannet, R.W., 1932, Gold quartz veins of the Alleghany district, Calif.: U.S. Geological Survey Professional Paper 172, 139 p.
Jenkins, O.P., 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, Calif.: 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.
Leicht, Wayne, 1982, California Gold: The Mineralogical Record, v. 13, p. 375-383.
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.
Yeend, W.E., 1974, Gold-bearing gravel of the ancestral Yuba River, Sierra Nevada, California: U.S. Geological Survey Professional Paper 772, 44 p.