DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

TO ACCOMPANY MAP MF-1177-C

MINERAL RESOURCE POTENTIAL OF THE NORTH FORK OF THE AMERICAN RIVER WILDERNESS STUDY AREA, PLACER COUNTY, CALIFORNIA

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STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and the Joint Conference Report on Senate Bill 4, 88th Congress, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the North Fork of the American River Wilderness Study Area, Tahoe National Forest, Placer County, California. The area was classified as a further planning area (5-262) during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

SUMMARY

A mineral resource survey of the North Fork of the American River Wilderness Study Area (RARE II no. 5-262) was conducted intermittently between 1975 and 1979. The mineral resource potential was evaluated by geological, geochemical, and geophysical studies by the U.S. Geological Survey and by detailed examination of mines, prospects, mineralized rock and gravel bars by the U.S. Bureau of Mines.

Gold, silver, and chromium are the principal metals in the proposed wilderness area. Gold occurs in lode and placer deposits; silver and lesser amounts of copper, lead, and zinc are associated with gold in some lode deposits; chromium is disseminated in a belt of serpentinite that crosses the western part of the study area.

Since 1866 approximately 1,100 lode and 900 placer claims and relocations have been recorded in the study area. Most historic gold and silver lode production occurred in the western part of the study area from the Rawhide, Black Hawk, and Southern Cross mines, which yielded about 31,000 troy oz (960,000 grams) of gold, 4,000 troy oz (120,000 grams) of silver and 19,000 lbs (8,600 kg) of copper. More than 85 percent of the gold and silver production was from the Rawhide mine. In addition, the Pioneer mine, which is located within this western mineralized zone but is just outside the proposed wilderness area boundary produced 50,000 troy oz (1,600,000 grams) of gold, and 9,000 troy oz (280,000 grams) of silver between 1889 and 1922.

It is estimated that approximately 1.4 million tons (1.3 million metric tons) of lode resources averaging between 0.04 and 0.22 troy oz of gold per ton (1.4 to 7.5 grams per metric ton) occur at and near the Rawhide, Black Hawk, and Southern Cross mines. It is possible that as much as an additional 6 million tons (5.4 million metric tons) of undiscovered resources averaging 0.10 troy oz of gold per ton (3.4 grams per metric ton) occur in the western mineralized zone between the Rawhide and Pioneer mines.

Since the 1850's, the Lost Emigrant, La Trinidad, and Wubbena mines in the eastern part of the study area have produced about 5,000 troy oz (160,000 grams) of gold, 730 troy oz (22,700 grams) of silver, and 480 lb (220 kg) of copper. The Lost Emigrant and La Trinidad mines have an estimated 270,000 tons (240,000 metric tons) and 150,000 tons (140,000 metric tons) of resources with an average grade of 0.27 troy oz of gold per ton (9.3 grams per metric ton) and 0.17 troy oz of gold (5.8 grams per metric ton), respectively.

Recorded placer gold production equals 3,200 troy oz (100,000 grams) from the Hayden Hill placer mine in the western part of the study area and 340 troy oz (10,600 grams) from Tadpole Creek in the eastern part of the study area. These figures undoubtedly do not reflect the total placer gold produced in the study area. Approximately 7.5 million cubic yards (5.7 million cubic meters) of placer resources occur in gravel bars and terraces in the study area; gold values range from $0.04 to $4.22 per cubic yard ($0.05 to $5.52 per cubic meter), calculated at $500 per troy oz ($16.08 per gram).

Chromite deposits in or near the study area produced about 1,000 tons (900 metric tons) during World War I and II from pods and lenses of ore in the serpentinite belt in the western part of the study area. The potential for chromite concentrations at depth in the serpentinite is unknown, but probably it is low, comparable to surface concentrations.

The potential for one or more lode gold deposits, comparable to historic mines in the belt, is high for the mineralized zone extending between the Rawhide and Pioneer mines in the western part of the study area. It is possible that undiscovered deposits or continuations of known deposits exist at or near Lost Emigrant, La Trinidad, and Wubbena mines, but no anomalous gold concentrations were detected in the geochemical survey around those mines or in the eastern part of the area. Therefore, the resource potential of the eastern part of the area is considered to be moderate.

INTRODUCTION

The North Fork of the American River rises near the crest of the Sierra Nevada about 9 mi (15 km) west of Lake Tahoe and transects the western slope of the range. From an elevation of 5,200 feet (1,575 m), the proposed wilderness area follows the river westward to an elevation of about 2,000 feet (600 m) south of the settlement of Alta. The western two-thirds of the proposed wilderness area is confined to the extremely steep, brush- and tree-covered walls of the river canyon and the slopes of Humbug Canyon, a major tributary. The eastern third of the area, on the other hand, extends irregularly north of the river canyon and incorporates less steep, relatively open glaciated terrane and several small lakes. The proposed wilderness area includes about 80 square miles (200 square km).

Interstate Highway 80, which crosses the Sierra crest at Donner Pass, generally parallels the course of the North Fork of the American River and passes within 0.8 mi (1.2 km) of the northern boundary of the proposed wilderness area near Alta and within 0.9 mi (1.5 km) near Big Bend. Access from Interstate Highway 80 to the northern part of the study area is provided by gravel roads from Blue Canyon, Cisco Grove, and Norden. The southern part of the area is readily

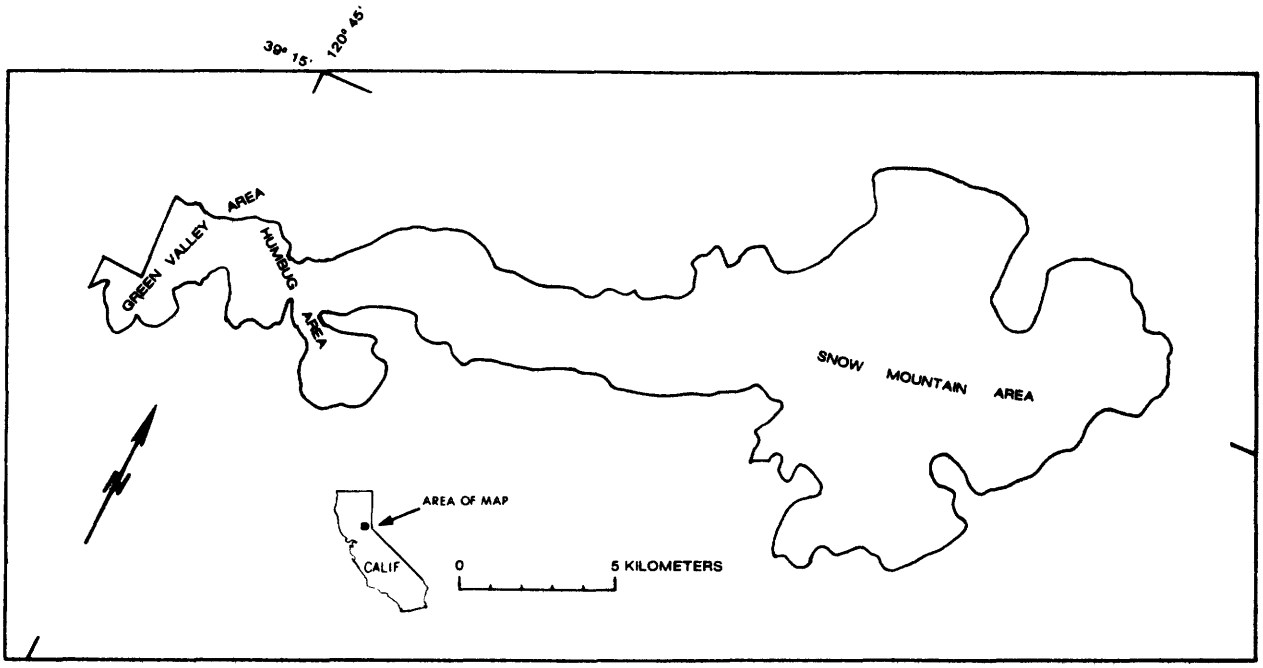

Figure 1.—Index map of the North Fork of the American River Wilderness Study Area.

Table 1.--Lode properties with mineral resources [1/]

Property name	Type of Occurrence	Classification of resource [2/]	Tons [3/]	Average gold content (troy oz per ton [3/])
Rawhide mine	Quartz veins in slate	Indicated and inferred paramarginal	1,400,000	0.04 [4/]
Lost Emigrant mine	Quartz veins in diabse porphyry	Indicated and inferred reserves	270,000	.27
La Trinidad mine	Quartz veins in slate and hornfels	Inferred paramarginal	150,000	.17
Southern Cross mine	Quartz veins in slate	do----------	10,000	.13
Rawhide-Pioneer mineralized zone	Quartz veins in slate	do----------	6,000,000	.10
Marrs mine	do----------	do----------	50,000	.22 [5/]
Black Hawk mine	do----------	do----------	2,000	.22

1/ Samples from the Wubbena mine, Walker and Wildcat Canyon prospects contained high gold values but limited vein exposures preclude resource estimates.

2/ Higher gold prices could move these resources to the reserve category.

3/ Metric conversions: tons x 0.9072 = metric tons; troy oz per ton x 34.285 = grams per metric ton.

4/ Mined ore averaged 0.20 troy oz gold per ton.

5/ Mined ore.

accessible from the secondary road that follows Forest Hill Divide east of the settlement of Foresthill. Several well-maintained trails, shown on the map, extend from the access roads into the canyon of the North Fork and follow the south side of the river from Euchre Bar to Humbug Canyon and from Mumford Bar to Sailor Canyon. Except along these trails, travel within the canyon of the North Fork of the American River is extremely difficult due to thick brush and steep terrane.

GEOLOGY

The North Fork of the American River Wilderness Study Area is located in the northern part of the Sierra Nevada, a faulted and westward-tilted range extending nearly the length of eastern California. The eastern slope of the range is fault controlled and precipitous, whereas the western slope is less steep but deeply incised by major river systems that produce generally parallel, west-trending deep canyons interspersed with relatively flat-topped interfluves capped in the northern Sierra by Tertiary volcanic rocks.

The canyon of the North Fork of the American River exposes a wide variety of metamorphosed sedimentary and volcanic rocks of Paleozoic and Mesozoic age that are intruded by granitic rocks of the Sierra Nevada batholith in the eastern part of the area. These rocks have been described by Harwood (1980). Granitic rocks of the batholith dominate the Sierra Nevada to the south where they extend well into the western foothills of the range. Metamorphic rocks, like those in the study area, dominate the range to the north and form the framework for small, scattered granitic plutons.

Metamorphic Rocks

The belt of serpentinite that passes through the western part of the proposed wilderness area is bounded on the east by a series of steeply dipping faults traditionally mapped as the Melones fault zone, a major tectonic break extending the length of the Sierran foothills. East of the serpentinite the rocks form a complexly folded but generally coherent, east-dipping sequence that gets progressively younger eastward to Snow Mountain. West of the serpentinite the rocks are more strongly sheared and disrupted and may be part of a tectonic melange, as proposed by Schweickert and Cowan (1975). The serpentinite is an important lithotectonic unit in this mineral resource analysis because it contains chromite, some of which was mined during both World Wars at a number of workings in the Green Valley area (see map).

East of the serpentinite the rocks are interbedded quartzite, quartz granule conglomerate, and slate, with scattered lenses of limestone, all assigned to the Shoo Fly Formation. The proportion of quartzite and slate varies considerably over this thick formation, and the western part of the area contains more slate than the eastern part. Within the Humbug area shown on the map, the Shoo Fly is locally faulted and hydrothermally altered to a yellow-tan, pyritic mixture of bleached slate and quartzite injected by numerous quartz veins. The major lode deposits of gold and silver in the proposed wilderness area occur within the altered, western part of the Shoo Fly Formation.

For the purpose of this report, all of the terrain east of Italian Bar and the Marrs mine is grouped into the Snow Mountain area. In that area the upper part of the Shoo Fly is overlain by late Paleozoic chert and pyroclastic rocks that correlate with similar pyroclastic sequences to the north described by McMath (1966) and Durrell and D'Allura (1977). The late Paleozoic pyroclastic sequence is overlain unconformably by a lens of Triassic(?) limestone and interbedded graywacke and slate of the Jurassic Sailor Canyon Formation. On the flanks of Snow Mountain, the Sailor Canyon Formation is gradationally overlain by Jurassic mafic pyroclastic rocks, which are intruded by essentially contemporaneous metadiorite.

The Wubbena mine and the Lost Emigrant mine are located in medium-grained, augite-bearing metadiorite that is locally sheared, fractured, and injected by quartz veins. La Trinidad mine is located in slate and graywacke of the Sailor Canyon Formation that has been intruded by an east-northeast trending dike of granodiorite.

Intrusive Rocks

The eastern part of the proposed wilderness area is underlain by medium-grained, locally prophyritic, hornblende-biotite granodiorite. No significant mineral deposits occur in the granodiorite or related granitic rocks of the Sierra Nevada batholith within the proposed wilderness area.

Tertiary Gravel and Volcanic Rocks

The interfluves north and south of the North Fork of the American River are capped by discontinuous but extensive deposits of gently west-dipping rhyolitic tuff, andesitic lahar, and thin andesitic and basaltic lava flows; the flows are restricted to the eastern part of the area. The Tertiary volcanic rocks range in age from Oligocene to Pliocene (Dalrymple, 1964). Gold-bearing gravels fill sinuous river channels of the ancestral Yuba River beneath the Tertiary volcanic rocks. The volume of gravel in the channels and the amount of gold contained within the gravel deposits increase from east to west across the length of the proposed wilderness area (Lindgren, 1911). Significant amounts of gold were produced from drift and hydraulic mines in the auriferous gravels in the Humbug area during the latter half of the nineteenth century.

Quarternary Gravel

Unconsolidated gravel occurs in the river bed and in solitary or nested terraces as much as 150 ft (50 m) above the river at scattered localities along the canyon of the North Fork. The terrace gravels are remnants of river deposits formed during periods of rapid sedimentation following periods of Quaternary glaciation at higher elevations in the Sierra Nevada. Gold was eroded from lode deposits and from Tertiary gravel deposits and deposited in the Quaternary terrace gravels. The modern river carried the gold-concentrating process one step further by eroding and redepositing the Quaternary gravel.

GEOCHEMICAL STUDIES

The results of a geochemical study of grab samples of stream sediment and panned concentrates of stream sediment are given by Harwood (1981). That geochemical study failed to identify any new ground of potentially favorable mineralized areas. The geochemical survey did show gold anomalies in the Humbug area and chromium anomalies in the streams draining the serpentinite body that underlies the Green Valley area of this report. Gold was detected in most of the samples from the Humbug area in Humbug Canyon and from the eastern part of that area near the Marrs mine. Silver was detected in the stream-sediment samples from drainages that cross the lens of Triassic(?) limestone in the Snow Mountain area.

AEROMAGNETIC INTERPRETATION

Aeromagnetic data, which reflect local variations in intensity of the Earth's magnetic fields, are taken continuously during flights nominally 1,000 ft (300 m) above the terrain. Owing to the steep topography of the study area and the performance limitations of fixed-wing aircraft, however, the actual survey elevation may have been as low as 600 ft (200 m) over ridges and as high as 2,000 ft (700 m) over valley floors. Comparison of topography with the magnetic data indicates that major magnetic anomalies do not correlate with topography, so the irregularity of aircraft altitude does not impair the qualitative value of the aeromagnetic data in this area.

Variations in the Earth's magnetic field are caused, in

general, by variations in the magnetic mineral content of the rock units; magnetite is by far the most common magnetic mineral in the region. The magnetic minerals, where locally concentrated or absent, may cause a magnetic anomaly that is a direct guide to an ore deposit, but no such anomalies have been identified here. In this area, the magnetic data can be used to extend the information on distribution of certain rock units displayed on the geologic map, because the magnetic field of these rock units is measurable even where the rocks are concealed by surficial deposits or by overlying nonmagnetic (or weakly magnetic) rocks. The magnetic data infer the existence of granitic plutons that are totally concealed and also indicate a significant change in the magnetite content of the Shoo Fly formation along a linear mineralized zone in the Humbug area.

The aeromagnetic data indicate boundaries between magnetic and relatively less magnetic rocks units. Such boundaries are, in general, located approximately at the steepest gradient on the flanks of the magnetic anomaly because at these magnetic latitudes the inclination of the Earth's magnetic field is relatively steep. Major linear boundaries, associated with steep magnetic gradients and showing significant changes in magnetic patterns on each side, are interpreted as faults.

Comparision between aeromagnetic data (USGS, 1979) and the geologic map (Harwood, 1980) indicates that three major rock units are strongly magnetic, being associated with major magnetic anomalies ranging from 1,000 to 4,000 gammas in amplitude. These magnetic units include: (1) the serpentinite and serpentinized ultramafic rocks in the western part of the study area, (2) the ultramafic rocks, gabbro, and diorite forming the igneous complex of the Emigrant Gap area, and (3) the granodiorite and associated granitic rocks of the Sierra Nevada batholith in the eastern third of the study area. In addition, two other rock units locally produce magnetic anomalies of lesser amplitudes (50 to 200 gammas), especially in those locations where the particular rock unit forms a topographic high and thus was relatively closer to the airborne magnetometer. The Tertiary volcanic rocks commonly cause anomalies of this sort as do some of the metamorphosed Jurassic mafic igneous rocks of Snow Mountain.

The magnetic expression of the Shoo Fly Formation is generally rather flat and featureless, indicating that the rock unit is essentially nonmagnetic. However, a western belt of these rocks 2 to 3 mi (3 to 5 km) wide is moderately magnetic. This belt of magnetic rocks is bounded on the west by the Melones fault zone (the eastern limit of the serpentinite belt) and on the east by a rather linear magnetic boundary termed the Humbug magnetic lineament. This lineament is subparallel to the Melones fault zone and is tentatively interpreted as a fault within the Shoo Fly Formation that juxtaposed layered rocks of similar lithology but differing magnetic character. Depth analysis of the anomaly indicates that the contact of these differing rock units is located at the surface.

West of the serpentinite belt, with its huge magnetic anomaly, is an area containing discontinuous linear magnetic highs with amplitudes of 300 to 600 gammas. The source rocks of these anomalies have not been positively identified but are probably lenses of serpentinite and greenstone that occur within this tectonic melange (Schweichert and Cowan, 1975). In any case, the rocks are well outside the boundary of the wilderness study area.

In the eastern third of the study area large subcircular magnetic anomalies with wide marginal gradients are associated with known masses of granodiorite and associated granitic rocks of the Sierra Nevada batholith. The forms of these magnetic anomalies are similar to those of anomalies caused by plutonic rocks elsewhere, and the great width of the marginal gradients indicates outward- dipping contacts. Accordingly, similar anomalies on the magnetic map located over older rocks 3 to 6 mi (5 to 10 km) west of the exposed plutonic rocks are believed to be caused by concealed plutonic rocks that did not reach the present surface (see Harwood, 1980, Section B-B'). Several such plutons are indicated by the aeromagnetic data.

Economic implications

Discussion of the economic implications of the aeromagnetic map is divided into three sections corresponding to the three mineralized areas shown on the map: the Humbug area, the Snow Mountain area, and the Green Valley area. Placer deposits are not discussed because they are too thin and weakly magnetic to have aeromagnetic expression.

Humbug area — The Humbug magnetic lineament passes through the Humbug area and is parallel to the Rawhide-Pioneer zone of the quartz veins that has in the past been mined for gold and silver. Thus, the magnetic lineament is closely related to the presence and trend of these known economic deposits. The Rawhide-Pioneer zone contains the Rawhide, Black Hawk, Southern Cross, and Pioneer mines, all of which were major gold producers.

This linear zone of mines is located approximately 0.6 mi (1 km) to the west of the magnetic lineament that is interpreted as a major fault within the Shoo Fly Formation. The zone of mines is associated with hydrothermal alteration and introduced pyrite and is also associated with a local linear magnetic low that extends entirely across the wilderness study area. It seems likely that this alteration associated with the gold deposits has locally destroyed the magnetite in the Shoo Fly Formation, thus causing the magnetic low. The magnetic interpretation supports the conclusion that substantial inferred gold resources may be located along the Rawhide-Pioneer zone within the wilderness study area. The magnetic data also suggest the possibility of additional inferred gold resources extending for 1.2 mi (2 km) north of the Rawhide mine outside the proposed wilderness. Another linear magnetic low parallel to the Rawhide Pioneer magnetic low is located within the study area approximately 0.9 mi (1.4 km) west of the Southern Cross mine. This additional low is outside the Humbug area of mineralization and thus may represent some nonmagnetic stratigraphic unit rather than another zone of alteration.

Snow Mountain area — Three stippled regions on the map show those areas containing gold and silver in quartz veins. The three areas are all located on the sides of prominent subcircular magnetic anomalies, 1 to 2 mi (2 to 3 km) in diameter, that are interpreted as caused by concealed plutonic rocks of the Sierra Nevada batholith. These inferred stocks offer an explanation for the presence of the mineral deposits, which are commonly associated with the top of stocks. As yet undiscovered areas of mineralization may be associated at depth with these subcircular magnetic anomalies.

Green Valley area — The locations of the chromite mines and prospects have been compared with the aeromagnetic data. The data do not appear to provide any information concerning the location or possibility of additional chromite deposits other than to identify the area of serpentinite, even where that area is covered by volcanic rocks or alluvium. Chromite is very weakly magnetic compared to magnetite.

ECONOMIC APPRAISAL OF MINERAL RESOURCES

Mining began in the vicinity of the study area in the 1850's at the onset of the California gold rush. Placer mining was the major activity until the 1880's, then many of the principal lode mines along the North Fork of the American River were developed.

Bureau of Mines production records and Rynearson (1953) indicate that between 1889 and 1963 85,000 troy oz (2,600,000 grams) gold, 14,300 troy oz (445,000 grams) silver, 19,500 lb (8,840 kg) copper, and 1,000 tons (900 metric tons) chromite were produced from mines in or adjacent to the study area. Incomplete production records before 1889 preclude accurate total gold production figures for the study area.

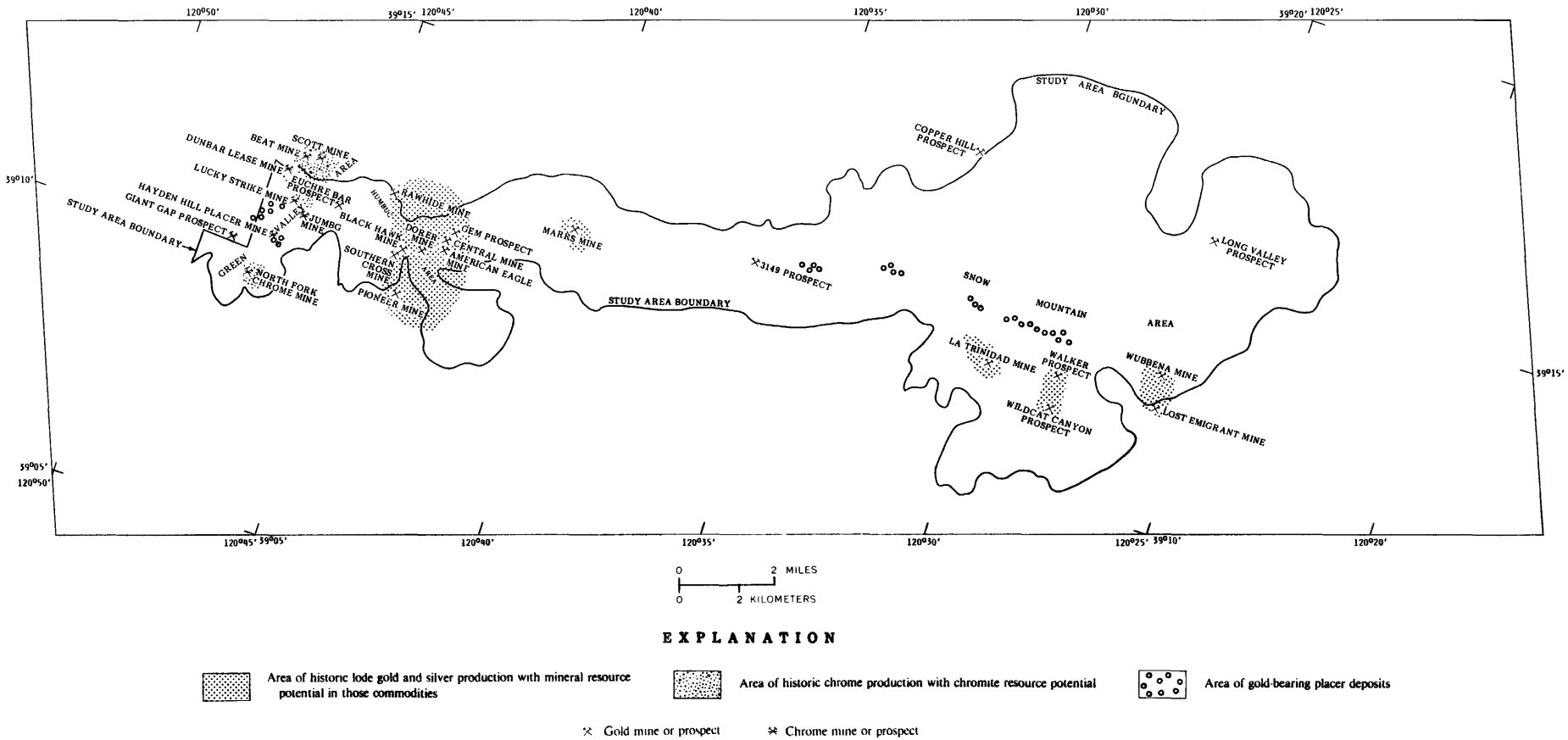

Figure 2.—Mineral resource potential of the North Fork of the American River Wilderness Study Area.

Lode deposits consist of gold-bearing quartz veins and pods and lenses of chromite. The veins, which are localized in shear zones or fracture systems, are commonly a meter thick. These vein systems have been mined for several hundred meters horizontally and several tens of meters vertically. The chromite pods and lenses are widespread in ultramafic rocks of the Green Valley area; these deposits have been mined by open-pit methods.

Most lode development in the Humbug area occurred along a mineral-bearing multiple-fault zone at the Rawhide, Black Hawk, Southern Cross, and Pioneer mines. The Rawhide, Black Hawk, and Southern Cross mines yielded most of the metals recovered in the study area: 31,000 troy oz (960,000 grams) gold, 4,000 troy oz (120,000 grams) silver, and 19,000 lb (8,600 kg) copper. The Pioneer mine, in this zone but outside the study area, yielded about 50,000 troy oz (1,600,000 grams) gold, and 9,000 troy oz (280,000 grams) silver from 1889 to 1922.

Placer deposits in the study area are related to two separate geologic episodes. Major deposits are in Tertiary gravel concentrated in river channels perched on or near ridge crests. Other deposits in Holocene river gravel, or in terrace gravel deposits near present river levels, contain gold that was reconcentrated from eroded Tertiary river gravel deposits or weathered out of local lode deposits.

Many claims currently held, which are primarily placers, give little indication of being actively worked. Since 1866 approximately 1,100 lode and 900 placer claims and relocations have been recorded in the study area. Of the total recordings, 16 claims have been patented: 14 lode claims encompassing 351 acres (142 hectares), and two placers containing 105 acres (43 hectares).

The North Fork of the American River Wilderness Study Area contains all or parts of many mining districts. Because some districts are known by several names or overlap into other districts, the study area was divided into the three geographical subareas shown on the map. The subareas are, in descending order of resource potential, Humbug, Snow Mountain, and Green Valley.

Total estimated resources of the study area (table 1) are about 7.9 million tons (7.2 million metric tons) of gold-bearing material in and near five lode mines, and 7.5 million cubic yd (5.7 million cubic m) in placer deposits. Approximately 1.4 million tons (1.3 million metric tons) of the lode resource range from 0.04 to 0.22 troy oz gold per ton (1.4 to 7.5 grams per metric ton) are at the Rawhide, Southern Cross, and Black Hawk mines in the Humbug area. These mines are part of a more-or-less continuous mineralized zone that has an estimated additional 6.0 million tons (5.4 million metric tons) of resources averaging about 0.10 troy oz gold per ton (3.4 grams per metric ton) in the area between the mines. Approximately 7.5 million cubic yd (5.7 million cubic m) of gold-bearing placer resources are in benches and terraces along the river. Gold values range from \$0.04 to \$4.22 per cubic yard (\$0.05 to \$5.52 per cubic meter) in fifteen bench and terrace deposits, calculated at \$500 per troy oz (\$16.08 per gram).

Humbug Area

The Humbug area extends easterly from Euchre Bar to Italian Bar, and includes the lower part of the North Fork of the American River. It was the most productive area and contains most of the gold resources in the wilderness study area.

The terrain is steep and has a local relief of about 2,500 ft (760 m). Slopes are covered by manzanita, chaparral, pine, and oak. The northern part of the area is accessible by gravel and dirt roads from Interstate 80; the southern portion is reached by unmaintained dirt roads from the Foresthill-Soda Springs road. Many trails cross the area.

Since 1866, about 700 claims (450 lode and 250 placer) and relocations have been located in the Humbug area. Of these, thirteen lode claims totaling approximately 308 acres (125 hectares) have been patented; other lode claims were surveyed for patent. All placer deposits along the North Fork of the American River, in the study area, are on located claims.

Lode and placer mining began in the area about 1850. According to Bureau of Mines mineral production records and other published sources, lode gold mines were active primarily from the late 1800's to 1922, and from 1935 to 1940. Recorded minerals production from lode and placer mines is approximately 39,000 troy oz (1,200,000 grams) gold, 4,000 troy oz (120,000 grams) silver, and 19,000 lb (8,600 kg) copper. More than 85 percent of the gold and silver was produced from the Rawhide mine.

Actual total mineral production was probably higher; records before 1889 are incomplete because gold dust and nuggets were often traded for goods, and this production was not recorded. Recent output has been small, limited to placer gold recovered by weekend miners using small suction dredges to work channel gravel.

Slate and quartzite of the Shoo Fly Formation are the predominant host rocks in the area. Quartz veins containing gold, minor silver, and base metals occur along north-northwest-trending, steeply dipping structures. Veins are generally less than 5 ft (1.5 m) thick and are often associated with narrow dikes. Quartz, pyrite, pyrrhotite, and arsenopyrite are the principal gangue minerals.

Most of the principal mines are along the Rawhide-Pioneer zone of quartz veins that trends north-northwest for at least 2 mi (3.2 km). Mines in this zone (within the study area) are the Rawhide, Black Hawk, and Southern Cross. They contain about 1.4 million tons (1.3 million metric tons) of gold-bearing resources (table 1); the Pioneer mine is outside the study area. An additional 6 million tons (5.4 million metric tons) of resources containing gold and silver in quartz veins are inferred along the Rawhide-Pioneer zone between the mines. The Marrs mine, in the eastern portion of the Humbug area, has 50,000 tons (45,000 metric tons) of gold-bearing resources.

Placer deposits are in benches, some as much as 11 m (35 ft) thick, that are composed of subangular-to-rounded gravel derived from granitic and metasedimentary rocks in the area. Bench gravel contains about 500,000 cubic yd (400,000 cubic m) of gold-bearing material. Gold values at six localities range from \$0.16 to \$4.22 per cubic yd (\$0.21 to \$5.52 per cubic m), calculated at \$500 per troy oz (\$16.08 per gram).

Snow Mountain Area

The Snow Mountain area includes all of the study area east of Italian Bar. Minor gold and silver production has been recorded from this area, and it has a moderate potential for additional resources.

Topographic relief is extreme. In less than 2 mi (3.2 horizontal km), steep canyon walls rise more than 3,000 ft (910 m) from the river to elevations of about 8,000 ft (2,400 m). Dense stands of conifers, patches of manzanita, and chaparral grow in all parts of the area. Deep snowpacks on the canyon rim generally keep roads impassable until June.

Since the 1850's, approximately 950 claims and relocations (450 lode and 500 placer) have been recorded in the Snow Mountain area, with a patent issued for the La Trinidad mine. Millsite claims were staked near major lode deposits, and small-capacity mills were constructed on the Lost Emigrant, La Trinidad, Wubbena, and Walker properties. Only the 10-stamp mill at the La Trinidad mine stands today. Present mining activity is primarily assessment work.

Bureau of Mines production records show about 5,000 troy oz (160,000 grams) gold, 730 troy oz (22,700 grams) silver, and 480 lb (220 kg) copper have been produced from study-area lode mines. This production, in decreasing order of value, has been from the Lost Emigrant, La Trinidad, and Wubbena mines. Recorded placer production is 340 troy oz (10,600 grams) from Tadpole Creek. However, judging from the amount of gravel processed and mining equipment remaining along the river, actual placer production was probably considerably higher.

Principal host rocks for lode deposits are unnamed Jurasic metavolcanic and metaintrusive rocks and Jurassic metasedimentary rocks of the Sailor Canyon Formation. These deposits consist of northwest-trending, lenticular quartz veins that range from 1 to 9 ft (0.03 to 2.7 m) in thickness and contain gold and silver. Pyrite and arsenopyrite are the dominant sulfide minerals, although minor stibnite and chalcopyrite are found in some veins.

The Lost Emigrant and La Trinidad mines in the Snow Mountain area have an estimated 270,000 tons (240,000 metric tons) and 150,000 tons (140,000 metric tons) of resources (table 1) with a grade of 0.27 troy oz gold per ton (9.3 grams per metric ton) and 0.17 troy oz gold per ton (5.8 grams per metric ton), respectively. Neither the Wubbena mine nor the Walker and Wildcat Canyon prospects have been sufficiently explored to determine sizes of associated resources; high assay results indicate that resources do exist.

Placer deposits in six benches and terraces contain about 4 million cubic yd (3 million cubic m) of gold-bearing gravel. Weighted averages of samples from these deposits range in value from \$0.04 to \$4.08 per cubic yd (\$0.05 to \$5.34 per cubic m), calculated at \$500 per troy oz (\$16.08 per gram).

Green Valley Area

At the west end of the study area is the Green Valley area, accessible on the north side from Alta, California (along Interstate 80), and in the south from the Foresthill-Soda Springs road. Steep trails lead from about 1700 ft (520 m) along the North Fork, to 4,000 ft (2,400 m) on the canyon rim. Vegetation is limited to patches of pine trees, fir, oak, and dense low brush.

About 200 lode and 150 placer claims and relocations in the Green Valley area have been registered since 1866. Two placer claims in Green Valley, containing a total of 105 acres (43 hectares) have been patented. Almost all recorded placer gold production from the area, 3,200 troy oz (100,000 grams) was from the Hayden Hill placer mine, near Snakehead Point. The Jumbo claim is the only patented lode claim in the area.

Chromite deposits in or near the area yielded about 1,000 tons (900 metric tons) of ore during the two World Wars. Mines with recorded chromite production are, in decreasing order of quantity, the Beat, North Fork Chrome, Jumbo, Lucky Strike, Dunbar Lease, and Scott.

A belt of serpentinite underlies most of the area; metasedimentary rocks crop out near Euchre Bar. Disseminated and massive chromite occurs in pods and lenses in the serpentinite. Select samples of stockpiled chromite from previously mined deposits contained from 30.7 to 43.8 percent Cr_2O_3. Most near-surface chromite deposits associated with serpentinite in the Green Valley area are probably mined out; others probably occur at depth on either side of the river.

Green Valley area placer resources, in three benches mainly around Snakehead Point, total approximately 3 million cubic yd (2 million cubic m). Value of placer deposits in benches ranges from about \$0.40 to \$0.70 per cubic yd (\$0.52 to \$0.92 per cubic m), calculated at \$500 per troy oz (\$16.08 per gram).

Miscellaneous Properties

Six prospects were examined that have little or no economic potential or are not sufficiently exposed to permit evaluation. Most of these are on northwest-trending, steeply dipping shear zones in slate or metavolcanic rocks.

Samples from the Wildcat Canyon and Copper Hill prospects contained as much as 0.56 troy oz per ton (19.2 grams per metric ton) of gold, 0.34 troy oz per ton (11.7 grams per metric ton) of silver, and 0.07 percent copper. Neither gold nor silver was detected in samples from the Euchre Bar and the "3149" prospect. Samples of finely disseminated chromite in serpentinite were collected from the Giant Gap prospect; one sample contained 0.22 percent Cr_2O_3.

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