DEPARTMENT OF INTERIOR
U.S. GEOLOGICAL SURVEY

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MINERAL RESOURCE POTENTIAL OF THE TUNNEL RIDGE WILDERNESS STUDY AREA, KLAMATH MOUNTAINS, CALIFORNIA

SUMMARY REPORT

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STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Area

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Tunnel Ridge Wilderness Study Area (CA-030-402), Trinity County, California.

SUMMARY

Geological, geochemical, and mining activity surveys in the Tunnel Ridge Wilderness Study Area, Trinity County, California were conducted by the U.S. Geological Survey and the U.S. Bureau of Mines in 1981-1983. Geochemical studies have identified slightly anomalous concentrations of copper in Gwin Gulch, silver in Pennsylvania Gulch, and silver, copper, and nonmagnetic iron in Clear Gulch. These anomalies are due to low level sulfide mineralization that occurred locally throughout the region; they are not indicative of potential resources. Stronger lead and silver geochemical anomalies were identified in two adjacent drainage basins below Little Bally. The anomalies also are attributed to sulfide mineralization, but the areas have only low mineral resource potential. A small area near the southwest corner of the study area is presently yielding crushed stone for use as road material. However, resources here are limited by the small extent of the incompetent schist being mined.

Although lode gold has been mined in areas that are only 1-2 mi north and 1-2 mi east of the wilderness study area, gold was not detected in any of the rock samples that were analyzed for this study. Placer gold in stream sediment in Gwin Gulch, Rarick Gulch, and Clear Gulch occurs in amounts too small to constitute a placer gold resource, but may indicate the presence of lode gold deposits in these drainages. The gold-bearing placers in Canyon Creek are all located west of the study area boundary. Platinum, locally found in the Trinity River placer gravels, is absent from the placers of the Canyon Creek drainage.

INTRODUCTION

Tunnel Ridge Wilderness Study Area is located in the southern Klamath Mountains in Trinity County, northwestern California (fig. 1). The area encompasses 4,623 acres of Bureau of Land Management administered public land about 35 mi west-northwest of Redding and about 5 mi northwest of Weaverville. The wilderness study area is bordered on the northwest, north, and east by Trinity National Forest and the Weaver Bally Roadless Area, and on the south by Clear Gulch. The west side of the area approximately follows the southerly trend of Canyon Creek. Tunnel Ridge, a southerly trending spur of Weaver Bally (mountain), dominates the southern half of the area. The northern half is cut by deep canyons that traverse the area from east to west. The terrain is mountainous with moderate to steep slopes; elevations range from about 1,600 ft in Clear Gulch, to about 5,900 ft on the flank of Weaver Bally. Access to the study area is provided by several light-duty dirt and gravel roads that join the paved Canyon Creek road between Junction City and Dedrick. Most of the study area is accessible only by foot.

The mineral resources of Trinity County and the Klamath Mountains have been summarized by O'Brien (1965) and Albers (1966). Mineral resource assessments of nearby areas, the Trinity Alps Wilderness and adjacent National Forest roadless areas, are given by Hotz and others (1972, 1982), Blake and Peters (1983 1984), and Huber and others (1983a). Assessments of mining activities in the adjacent Weaver Bally and Fisher Gulch Roadless Areas are given by Peters (1983), and Cather and Ritchey (1981).

A mineral resource appraisal of the wilderness study area was conducted by the U.S. Geological Survey and the U.S. Bureau of Mines in 1981-1983. Studies included field checking of previously published geologic mapping and a reconnaissance geochemical survey by the Geological Survey, and a search of mining records and field examination of mines and prospects in the area by the Bureau of Mines.

GEOLOGY

Tunnel Ridge Wilderness Study Area is located in the southeast corner of the Helena 15-minute quadrangle, the geology of which has been mapped by Cox (1956, 1967). Preliminary geologic maps of the adjacent Weaverville and Hayfork 15-minute quadrangles also have been published (Irwin, 1963, 1974). The geology of the Weaver Bally Roadless Area, which borders the study area on the north and east, is discussed by Blake (1985).

The wilderness study area is situated in the central metamorphic belt of the Klamath Mountains geologic province (Irwin, 1960; 1972, fig. 1; 1981). The central metamorphic belt is one of several arcuate (convex westward) lithic belts that are thought to represent eastward-dipping thrust slices of oceanic crust and island arcs that were accreted to the continental margin during the Mesozoic (Irwin, 1972, 1981).

The central metamorphic belt extends for about 100 mi in a north-south direction, and ranges in width from less than a mile in the north to 12 mi in the south. The belt underthrusts the eastern Klamath belt to the east, and in turn is underthrust by the western Paleozoic and Triassic belt (North Fork terrane) on the west. Most of the granitic plutons that intrude the central metamorphic belt are along its eastern margin. The central metamorphic belt consists of two formations, the Salmon Hornblende Schist and the Abrams Mica Schist. The schists are co-extensive and have shared similar metamorphic and tectonic histories (Lanphere and others, 1968). Structurally the Salmon lies below the Abrams, and is a 0.5- to 1-mi-thick mafic metavolcanic unit that underwent amphibolite-facies metamorphism during Devonian time (Irwin, 1981). The Tunnel Ridge area is underlain only by the Salmon Hornblende Schist, which is well foliated and composed primarily of hornblende, oligoclase or albite, and clinozoisite (Cox, 1956, 1967). The texture varies from schistose in the south, to migmatitic in the north (Gaps, 1983). The Abrams Mica Schist is not exposed in the study area.

Andesitic and dacitic dikes intrude the Salmon Hornblende Schist and granitic rocks throughout the region. Dikes within the Salmon are often associated with gold-bearing quartz veins (Cox, 1967; Hotz and others, 1972; Irwin, 1977; Huber and others, 1983a). Alteration of the dikes, mainly by propylitization and the addition of potassium and silica, is greatest within the migmatite (Gaps, 1983).

GEOCHEMISTRY

A reconnaissance sampling program was conducted in the study area by the U.S. Bureau of Mines in 1981 and by the U.S. Geological Survey in 1983. Locations of all sampling sites are shown in Gaps (1983) and Diggles and others (1984 1985), respectively. The Bureau of Mines collected six alluvial panned-concentrate samples from the four major streams that drain the study area, five bulk channel samples of alluvium from perched gravels at the Derby and Alexander claim (fig. 2), and 10 rock samples. Totals of 31 rock samples, 27 stream-sediment samples, and 27 nonmagnetic heavy-mineral-concentrate samples were collected and analyzed by the Geological Survey. Approximate sampling density was one sample per 0.18 mi^2 for rocks, and one sample per 0.23 mi^2 for stream sediments.

Bureau of Mines Sampling and Laboratory Procedures

Alluvial pan samples consisted of several level-full 14-in. pans. These and the bulk channel samples of alluvium were pan concentrated in the field. The heavy-mineral concentrates from all samples were processed on a laboratory-size Wilfley table. Resulting heavy-mineral fractions were scanned with a binocular microscope to identify heavy minerals; larger particles of gold were hand picked and weighed along with fine gold recovered by amalgamation.

Five rock samples were fire assayed for gold and silver and analyzed for 42 elements (Ag, Al, As, Au, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Ga, Hf, In, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Pt, Re, Sb, Sc, Si, Sn, Sr, Ta, Te, Ti, Tl, V, Y, Zn, and Zr) using a semiquantitative emission spectrographic method. Five other rock samples were examined petrographically to determine alteration suites and mineral assemblages. The results of these analyses are on file at the U.S. Bureau of Mines, Western Field Operations Center, Spokane, Washington.

Geological Survey Sampling and Laboratory Procedures

Representative samples of unweathered bedrock were collected at 24 of the 27 stream-sediment sampling sites. Additional samples of bedrock and (or) vein quartz were collected at seven localities. In the laboratory, rock samples were crushed and a small split was ground to minus-60 mesh for analysis.

Bulk stream-sediment samples were collected at first-order (unbranched) and second-order (below the junction of two first order) streams as shown on the map sheet. Samples were screened to remove pebbles and all sediment greater than 8 mesh. The sediment was sieved again in the laboratory and the minus-60 mesh fraction pulverized and saved for analysis.

A second stream-sediment sample was collected for heavy-mineral concentration. Samples were panned, in the field if possible, to remove most of the quartz, feldspar, and clay-sized minerals. In the laboratory, the panned concentrate was sieved again to minus-18 mesh, and magnetic minerals, mainly magnetite, were removed by hand magnet. The less dense minerals were separated and removed by floatation in bromoform (sp. gr. 2.86), and the remaining heavy minerals divided into two fractions on the basis of their magnetic susceptibility by a Frantz Isodynamic Separator[1]. The magnetic fraction was discarded and the nonmagnetic fraction split and analyzed.

All samples were analyzed for 31 elements (Ag, As, Au, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, La, Mg, Mn, Mo, Nb, Ni, Pb, Sb, Sc, Sn, Sr, Th, Ti, V, W, Y, Zn, and Zr) using a six-step semiquantitative emission spectrographic method. In addition, heavy-mineral-concentrate samples were analyzed for mercury by an atomic-absorption method.

Arsenic, antimony, gold, molybdenum, thorium, tungsten, and zinc were not detected in any sample from the study area. Of the elements determined spectrographically, copper and lead were selected in the rock analyses as possibly being indicative of the types of mineralization that might be expected in the study area on the basis of the local geology and history of mining in the region. Likewise, silver, copper, and lead were selected for the stream-sediment samples, and silver, copper, nonmagnetic (ferrous) iron, and lead were selected for the nonmagnetic heavy-mineral concentrates. Nonmagnetic iron characteristically is derived from pyrite and (or) chalcopyrite and is often associated with other sulfide minerals. Mercury was not detected in anomalous concentrations in any sample. Analytical data for samples collected by the U.S. Geological Survey are given in Diggles and others (1984 1985).

Geochemical Anomalies

For sediment samples, an anomalous concentration of any element was assigned an anomaly rating of 1 if it were weakly anomalous, and an anomaly rating of 2 if it were moderately anomalous. Samples analyzed for this study did not contain highly anomalous concentrations of any element. Anomaly ratings for each element are summed for each sample type (rock, stream sediment, heavy-mineral concentrate) and sampling site. Sampling sites with an anomaly rating sum of one are based on the presence of a single weakly anomalous element and do not reliably indicate mineral resource potential.

Five drainage basins in the study area yielded samples that contained anomalous concentrations of one to three elements, and corresponding anomaly rating sums of 2 to 6. Three drainage basins with rating sums of less than 4 are considered geochemically anomalous, but are not likely to indicate the presence of mineral resources. The areas and their commodities are: Rarick Gulch, with weakly anomalous copper in both stream sediment and heavy-mineral concentrate; Pennsylvania Gulch, with moderately anomalous silver in stream sediment; and Clear Gulch, with weakly anomalous silver, copper, and nonmagnetic (ferrous) iron in heavy-mineral concentrate. These anomalies are probably due to low level sulfide mineralization that occurred in the region.

Geochemical anomalies are of greater significance when they occur in more than one sample type, are accompanied by a suite of pathfinder elements that typically are

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[1] Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey

found together, or consist of a suite of elements characteristic of a particular type of mineralization.

Two adjacent drainage basins on the southwest side of Little Bally yielded stronger geochemical anomalies than found elsewhere in the study area. In the northern of the two, lead was moderately anomalous in the bedrock sample and silver and lead were moderately anomalous in the heavy-mineral concentrate. The southern basin yielded weakly anomalous lead in the bedrock sample, weakly anomalous lead in stream sediment, and weakly anomalous silver, lead, and nonmagnetic iron in the heavy-mineral concentrate. Because these elements are indicative of sulfide mineralization, which has occurred sporadically in the Salmon Hornblende Schist and dike rocks throughout this region of the Klamath Mountains, the two drainage basins are assigned a low resource potential for metallic sulfides of lead and silver. Other chalcophile elements were not detected in our samples.

MINING ACTIVITY AND KNOWN MINERAL OCCURRENCES

The majority of mining claims located adjacent to the wilderness study area have been gold placer claims along Canyon Creek and its tributaries. All known auriferous gravel deposits are located outside the study area. The Derby and Alexander claim (fig. 2, no. 3) is located outside, but adjacent to the study area. No lode mines or claims are known within the wilderness study area.

Lode Gold

Lode mining for gold began in 1889 in the nearby Dedrick mining district, centered about 3 mi north of the study area. Mines in the district yielded a substantial amount of gold in the latter part of the 19th century and remained active until the 1930s (Clark, 1970; Peters, 1983). The principal producers, the Alaska mine and the Globe Consolidated group (which includes the Bailey and Chloride mines) (fig. 1) have yielded at least $1,300,000 in gold and lesser amounts of silver. Total production from the Globe Consolidated Group was 113,970 oz gold and 26,650 oz silver (Hotz and others, 1972). Other mines in the district include the Ralston, Maple, Silver Gray, and Mason and Thayer (fig. 2) mines (O'Brien, 1965). Production from these mines, and the few (including Meckel-Fields mine, fig. 2) on the east side of Weaver Bally, has been minor (Peters, 1983).

Lode deposits in this region consist of quartz veins containing fine free gold with some sulfides; country rock consists of the Salmon Hornblende Schist that has been intruded by dikes originating from granodiorite stocks that lie to the north and east (Clark, 1970; Blake, 1985).

Placer Gold

Placer gold was first discovered in Trinity County at Reading Bar on the Trinity River in 1848 (O'Brien, 1965). Within a few years, all of the tributaries of the Trinity River, including Canyon Creek, had been explored and hydraulic mining was underway in many places. The bench placers along Canyon Creek, encompassed by the Canyon Creek mining district, were once extensive and apparently quite rich. Large scale hydraulic mining continued for nearly 40 years throughout its more than 12 mi length (Clark, 1970), but production figures for this period are not available (Peters, 1983). All placer deposits along Canyon Creek are located west of the wilderness study area boundary. A fair amount of placer mining is presently being done here and none of the river or terrace gravels lie unclaimed. Some suction dredging is done along Canyon Creek, but it is mainly recreational.

One of the claims along Canyon Creek is the Derby and Alexander claim. The placer deposit is a small segment of perched terrace gravel about 75 ft above the current stream. Gravel is 40 to 50 ft thick and gold, some of which is coarse, is concentrated mostly in the lower few feet of the deposit. Of five bulk samples (from 0.1 to 0.2 yd^3 each) taken here, three contained $0.04 to $1.01 in gold per yd^3, and one, from a drift adit, contained $21.60 in gold per yd^3 (assuming a gold price of $400 per troy oz).

The placer prospects in Gwin Gulch (fig. 2, no. 1) and Rarick Gulch (fig. 2, no. 2) have been worked intermittently over the past 100 years (Peters, 1983). Six pan samples (three each) from these prospects yielded less than one cent in gold per yd^3 of gravel apiece (Peters, 1983). Alluvial pan samples taken for this study from Gwin Gulch, Rarick Gulch, and Clear Gulch all yielded small amounts of placer gold (Gaps, 1983).

Mercury

Mercury production in Trinity County was at its height from 1875 to 1879, and from 1895 to 1901 (Averill, 1941, p. 70). Most of the mercury produced in the county came from the Altoona mining district, located about 35 mi northeast of the study area. A few additional prospects, however, are located elsewhere in the county, including two that are within a mile or two of the northwest corner of the study area.

Cinnabar was found in the mid 1870s in the hydraulic gold claim of the Wolff Brothers on Mogul Gulch (not shown on present day topographic maps) about one-half mile below Canyon City and within one mile of the northwest corner of the wilderness study area (Miller, 1890). Small seams of very rich ore were discovered in the slates upon uncovering the bedrock; considerable prospecting was carried on by tunneling the formation, but the results were unsatisfactory (Miller, 1890). Further references to this deposit were not found by O'Brien (1965).

The Anna Bell cinnabar mine comprised 40 acres of unpatented land about 2.5 mi south of Dedrick in the vicinity of Canyon City (Logan, 1926). Apparently only assessment work was done; further references to this claim were not found by O'Brien (1965).

Platinum and Platinum Group Elements

Platinum, as fine flakes and in native alloys of crystalline, sharp-edged pieces and nuggets of osmiridium (osmium and iridium) and platinum up to an ounce in weight, has been produced as a by-product of placer gold operations on the Trinity River for several miles west and south of Junction City (Logan, 1926). The Valdor dredge, working west of Junction City, produced one dollar in platinum for every 80 dollars in gold (Logan, 1926). Typical analyses of platinum-group elements from the dredge were 40-43 percent platinum and 47-58 percent osmiridium. Production in the area essentially ceased when the Valdor dredge was dismantled and moved in 1922.

Although the source of the platinum in the Trinity River has not been discovered, it is probably derived from the serpentinized ultramafic rocks of the North Fork terrane that crop out sporadically along a narrow north-northwesterly trending zone in the Helena, Hayfork, and Weaverville 15-minute quadrangles (Cox, 1956, 1967; Irwin, 1963, 1974). The ultramafic rocks occur in drainage basins that lie to the west of the Trinity River. Platinum first shows up in the Trinity River near the mouth of Dutch Creek (and presumably Maxwell Creek, fig. 1), but it was not found in the rich placers farther upstream, nor in the Tertiary channel gravels in Oregon Gulch at the La Grange mine (fig. 2), whose sources are all to the east (Logan, 1926). Earlier claims that platinum was found in veins in prospects in the vicinity of Soldier Creek, 3 mi south of Junction City, could not be substantiated by Logan (1918 1919 ; 1926), nor by subsequent workers, although the creek drains areas that contain exposures of the ultramafic rocks. Platinum recently has been found in ultramafic rocks that lie near the southern extent of the ultramafic belt in the Chanchelulla Roadless Area (fig. 1) (Huber and others, 1983b).

Crushed Rock

Crushed rock that is used for road material is being removed from a small pit (no. 4 on map sheet) near the southwestern corner of the study area. The schist here is incompetent and easily broken up and loaded into dump trucks for local use. The extent of the exposure is small.

MINERAL RESOURCE POTENTIAL

The mineral resource potential of the Tunnel Ridge Wilderness Study Aea has been determined on the basis of several criteria: (1) magnitude and location of geochemical anomalies in rocks, stream sediments, and heavy-mineral concentrates: (2) geology favorable to the occurrence of mineral deposits; (3) similarity of geologic setting to those of nearby areas with known resources; and (4) history of mining in the region.

Lode Gold

Although free gold has been mined from quartz veins and felsic dikes in Salmon Hornblende Schist less than 2 mi from the study area, evidence of lode mining was not encountered during the reconnaissance of the Tunnel Ridge area, nor is there any record of such mining. In addition, gold was not detected in any of the rock samples analyzed for this study. An area on Weaver Bally with moderate resource potential for gold (Blake and Peters, 1983 1984) does not extend into the Tunnel Ridge area, although it may be the source of the placer gold found in Gwin and Rarick Gulches. One sample of iron-oxide-stained migmatite from the southwestern flank of Weaver Bally closest to this region contained a slightly anomalous amount of copper, but no gold (Gaps, 1983). Because of the proximity of the lode gold mining to the north and east of the study area, subsurface occurrences of gold associated with quartz veins cannot be ruled out.

The presence in Gwin and Rarick Gulches of placer gold in concentrations compatible with that found in well mineralized areas (Fischer and Fisher, 1968) suggests a lode source within these drainages. The source of the gold has not been determined. It could have been derived from an area on Weaver Bally that has been assigned a moderate resource potential for gold (Blake and Peters, 1983 1984) on the basis of geology and geochemical analyses. Only a small part of the Gwin Gulch drainage and about one third of the Rarick Gulch drainage lie within the wilderness study area.

Placer Gold

Small amounts of gold were detected in three stream-sediment samples collected by the Bureau of Mines in Gwin, Rarick, and Clear Gulches. However, the lack of gravel accumulations in these streams due to the steep terrain and V-shaped nature of the drainages precludes consideration of placer gold as a potential resource. The stream gradient in Conrad Gulch is less extreme and some gravel accumulation is present at lower elevations, but gold was not detected in any samples from there. Placer gold is not considered a potential resource of the study area.

Mercury

Although two mercury prospects are reported to occur within two miles of the northwest corner of the study area (Miller, 1890; Logan, 1926), mercury (in cinnabar) was not present in heavy-mineral-concentrate samples in amounts that are considered above normal background levels for this element. Mercury is not considered a potential resource of the wilderness study area.

Platinum and Platinum Group Elements

Although the Trinity River placer gravels in the vicinity of Junction City were once the primary source of platinum in Trinity County, platinum has not been reported in the placers of Canyon Creek, which enters the Trinity River at Junction City. Because the probable source rocks for platinum and platinum group elements (serpentinized ultramafic rocks of the North Fork terrane) are not present in the wilderness study area or in the drainage system of Canyon Creek, these metals are not considered a potential resource of this area.

Metallic Sulfides

On the basis of geochemical analyses, two short, steep drainage basins on the southwest side of Little Bally have low resource potential for lead and silver (fig. 2). The multiple element (lead, silver) and multiple sample type geochemical anomalies in the adjacent drainages are due to low level sulfide mineralization. Additional geochemical anomalies in Rarick Gulch, Pennsylvania Gulch, and Clear Gulch are weak and are not indicative of potential mineral resources.

Crushed Rock

Crushed rock that is used for road metal is presently (1983) being produced by bulldozer from a small pit (No. 4 on map sheet) near the southwest corner of the study area. The schist here is incompetent and easily broken up. The extent of the incompetent schist is not known, but field investigations indicate that it is fairly limited. No other areas that contained schist of this nature were observed in the study area.

Other Commodities

No indications of coal, oil, gas, or geothermal energy resources were found in the wilderness study area during this study.

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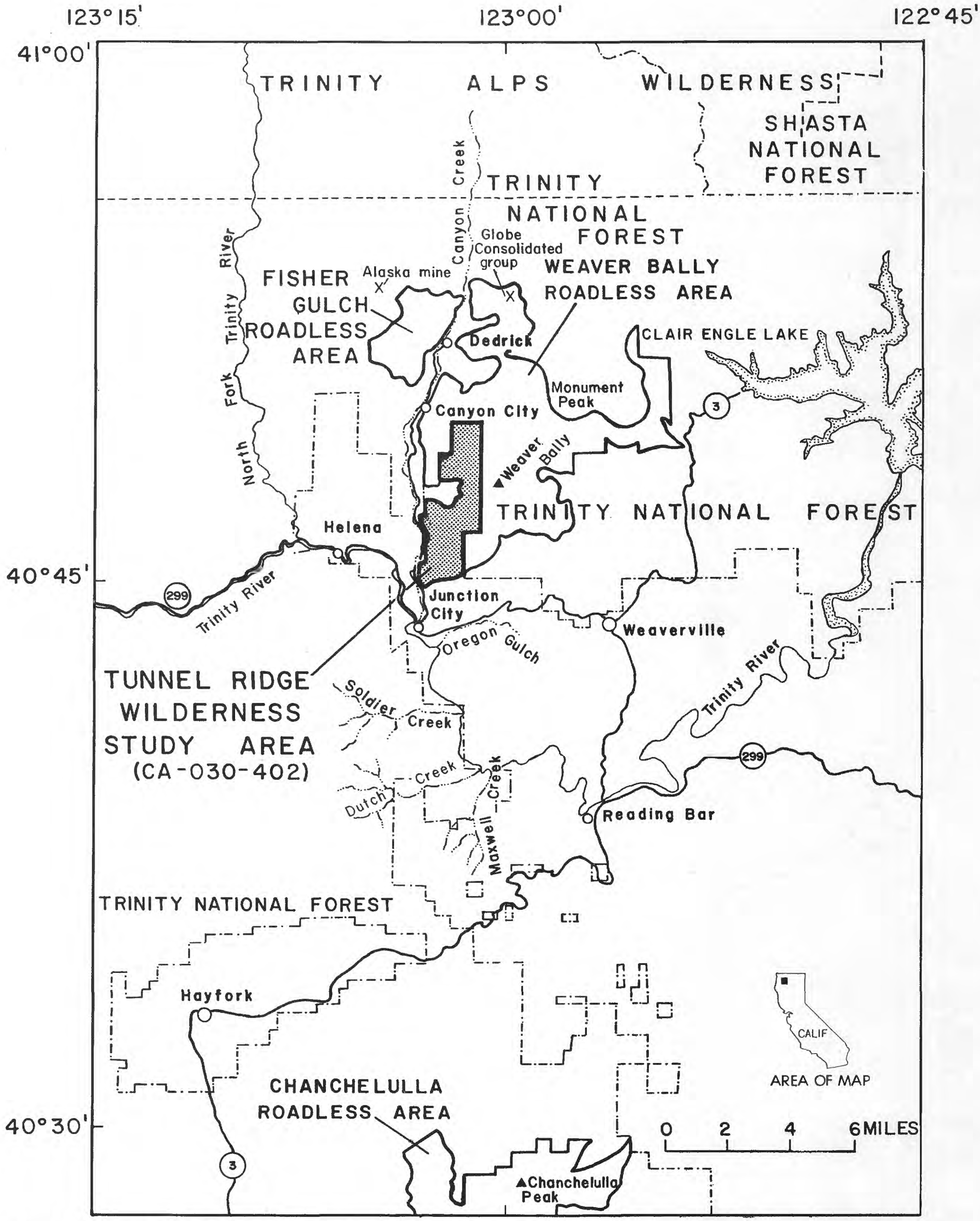

Figure 1.--Index map showing location of Tunnel Ridge Wilderness Study Area, Klamath Mountains, northern California.

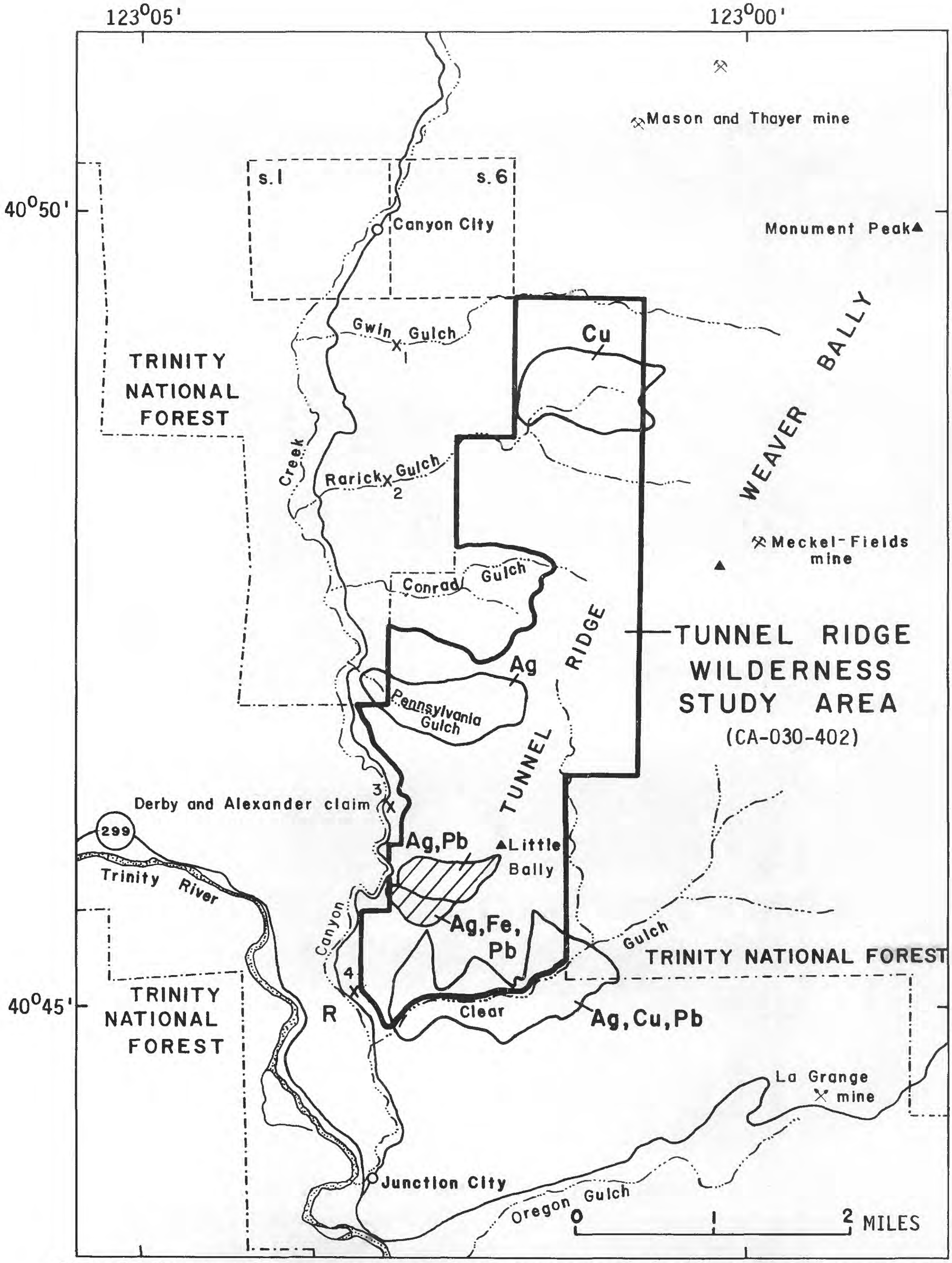

Figure 2.--Map showing geochemically anomalous drainage basins (outlined) and area of mineral resource potential (diagonally ruled area) in the Tunnel Ridge Wilderness Study Area. Ag, silver; Cu, copper; Fe, nonmagnetic iron; Pb, lead; R, rock; X, location of local workings (number referred to in text).