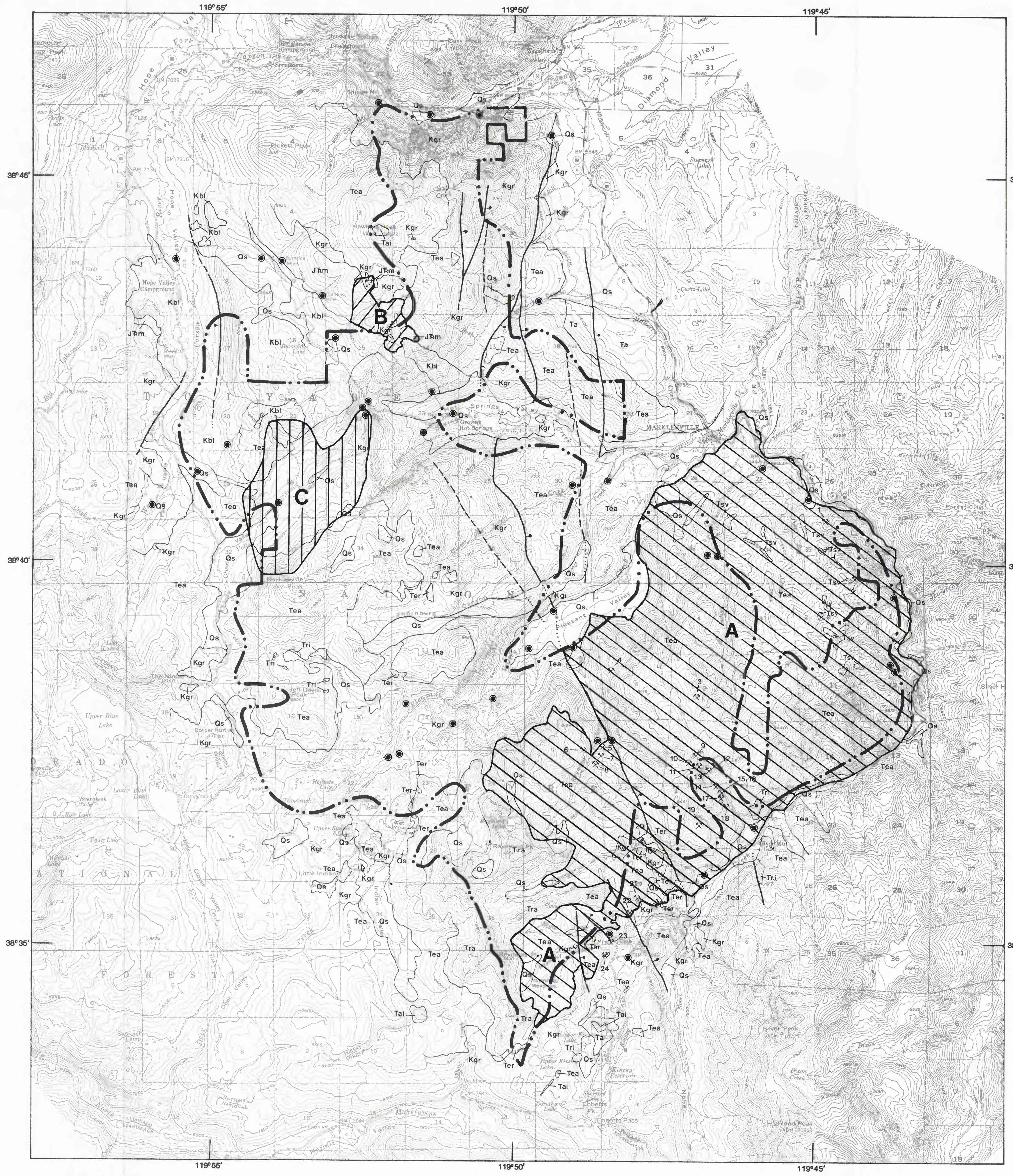
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1365-C




Base from U.S. Geological Survey Freel Peak, Markleeville, Topaz Lake, 1956

SCALE 1:62500

CONTOUR INTERVAL 80 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

TRUE NORTH — MAGNETIC NORTH 16½°
APPROXIMATE MEAN DECLINATION, 1983

AREA OF MAP

Geology after Armin and others (1982); simplified by D. A. John, 1982

# MINERAL RESOURCE POTENTIAL MAP OF THE EAST PART OF THE RAYMOND PEAK ROADLESS AREA, ALPINE COUNTY, CALIFORNIA

By

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U.S. Bureau of Mines

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## EXPLANATION

A — AREA OF HIGH POTENTIAL FOR PRECIOUS METAL DEPOSITS; LOW POTENTIAL FOR URANIUM RESOURCES

B — AREA OF MODERATE POTENTIAL FOR SKARN-TYPE TUNGSTEN DEPOSITS

C — AREA OF LOW POTENTIAL FOR VEIN-TYPE MOLYBDENUM AND TUNGSTEN DEPOSITS

● GEOCHEMICAL SAMPLE LOCATION

## CORRELATION OF MAP UNITS

Qs — Holocene and Pleistocene — QUATERNARY — CENOZOIC
Unconformity
Tsv — Pliocene(?)
Tri — Pliocene, Miocene(?)
Tra, Ta, Tai, Tea — Miocene — TERTIARY
Unconformity
Ter
Unconformity
Kgr, Kbl — CRETACEOUS — MESOZOIC
Unconformity
JTRm — JURASSIC(?) AND TRIASSIC(?)

## DESCRIPTION OF MAP UNITS

Qs — SURFICIAL DEPOSITS (QUATERNARY)--Consists of glacial, alluvial, and landslide deposits

Tsv — SILICIFIED VOLCANIC ROCKS (PLIOCENE?)--Mostly quartz-pyrite jasperoid

Tri — INTRUSIVE RHYOLITE (PLIOCENE AND UPPER MIOCENE?)--Flow banded, platy-weathering porphyritic rhyolite

Ta — ANDESITE, UNDIVIDED (MIOCENE)--Includes flows and autobrecciated flows

Tra — RAYMOND PEAK ANDESITES OF WILSHIRE (1957) (MIOCENE)--Generally unaltered, thick-bedded andesite lahars and minor andesite flows and tuffs

Tai — INTRUSIVE ANDESITE (MIOCENE)--Columnar-jointed pyroxene andesite

Tea — EARLY ANDESITE (MIOCENE)--Andesite lahars, interbedded with massive flows and andesitic sandstone and conglomerate. Locally strongly propylitized

Ter — EARLY RHYOLITE (LOWER MIOCENE)--Air-fall and ash-flow rhyolite tuff

Kgr — GRANITIC ROCKS (CRETACEOUS)--Includes fine- to coarse-grained, equigranular to porphyritic granite and granodiorite

Kbl — BURNSIDE LAKE ADAMELLITE OF PARKER (1961) (CRETACEOUS)--Coarse-grained, porphyritic granite with potassium feldspar phenocrysts as long as 1.2 in. (3 cm)

JTRm — METAMORPHIC ROCKS (JURASSIC? AND TRIASSIC?)--Mostly calcareous siltstone and sandstone with minor limestone and mafic volcanic rocks metamorphosed to amphibolite facies

CONTACT--Approximately located

FAULT--Dashed where approximately located; dotted where concealed; bar and ball on down throne side

MINES AND PROSPECTS

APPROXIMATE BOUNDARY OF EAST PART OF RAYMOND PEAK ROADLESS AREA

## MINES AND PROSPECTS SHOWN ON MAP

1. Good Hope prospect
2. Easy Nos. 1-9 claims
3. St. Helena prospect
4. Silver Cloud claim
5. California-Illinois prospect
6. Unnamed prospect
7. Unnamed prospect
8. Unnamed prospect
9. Exchequer mine
10. Lady Franklin claim
11. Acacia claim
12. Adlphus Canyon prospect
13. IXL mine
14. Pine Tree prospect
15. Big Sandy prospect
16. Little Sandy prospect
17. Pittsburgh prospect
18. Gould and Curry prospect
19. Knox prospect
20. Pennsylvania claim
21. Sa Sha prospect
22. Bolin claims
23. Columbine claim
24. Cindy and Deer claims

## STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral resource potential. 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 resource potential survey of the east part of the Raymond Peak Roadless Area (4985) in the Toiyabe National Forest, Alpine County, California. Raymond Peak Roadless Area was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

## SUMMARY

The east part of the Raymond Peak Roadless Area has mineral resource potential in base and precious metals and uranium. Three areas have been identified as having potential for undiscovered precious-metal and skarn-type tungsten deposits. Area A in the southeastern part of the roadless area has geochemically anomalous elements, hydrothermal alteration, favorable rock types, and known mineralization in mines and prospects in the immediate area suggesting a high potential for undiscovered precious- and base-metal deposits. Area B, near Burnside Lake, has geochemically anomalous elements, favorable rock types, and mines and prospects in and near the area suggesting a moderate potential for undiscovered tungsten deposits. Area C, near Charity Valley, has geochemically anomalous elements, suggesting a low potential for undiscovered molybdenum and tungsten deposits. Uranium mineralization is known in one prospect just south of the roadless area, but the potential for undiscovered uranium deposits in the study area is low.

An estimated 1,826,000 tons (1,657,000 t) of resources averaging from a trace to 0.04 oz gold per ton (1.37 g/ t), and a trace to 23.5 oz silver per ton (805.7 g/ t) occur within the roadless area on three properties (table 1 and map Nos. 3, 5, 9). About 1,500,000 tons (1,360,000 t) of inferred subeconomic resources are on the St. Helena prospect, and the California-Illinois property contains about 270,000 tons (245,000 t) of inferred subeconomic resources. At the Exchequer mine, an estimated 56,000 tons (50,800 t) of inferred marginal reserves averaging 0.04 oz gold per ton (1.37 g/ t) and 23.5 oz silver per ton (805.7 g/ t) occur in ore shoots. Other prospects adjacent to the southeastern boundary contain gold, silver, and uranium resources along structures which probably extend into the study area. Energy resource potential in the area is study low. A low geothermal potential exists near Grovers Hot Springs just east of the study area.

## INTRODUCTION

### Location and Access

The Raymond Peak Roadless Area consists of two separate units. The west part (5985), about 12 mi (19 km) southwest of Markleeville in Stanislaus National Forest, has been studied separately as part of the Mokelumne Wilderness Area and vicinity (McKee and others, 1982) (fig. 1). The east part (4985) is the subject of this report (fig. 2).

The east part of the Raymond Peak Roadless Area (4985) encompasses about 57.8 mi² (153 km²) along the crest and eastern slope of the Sierra Nevada, approximately 13 mi (21 km) south-southeast of Lake Tahoe. Principal access is provided by California State Highways 89, 4, and 88. Secondary roads lead to the main mines south of the area, and a U.S. Forest Service road passes within 0.25 mi of the west side of the area.

### Geologic Setting

The Raymond Peak Roadless Area straddles the crest of the Sierra Nevada and consists of upper Tertiary volcanic rocks overlying a complex of Mesozoic granitic and metamorphic rocks. The volcanic section thickens to the southeast, and the remains of a large composite volcano may be present near the southern margin of the area (Curtis, 1951). Glacial and alluvial deposits of Quaternary age cover most of the valley floors in the area. The eastern part of the area is cut by numerous north-south-trending normal faults, and the area is undergoing continued uplift and westward tilting.

## GEOLOGY

The oldest rocks in the study area are metamorphic rocks of Triassic(?) and Jurassic(?) age, exposed in the northwest part of the area. These rocks consist mainly of calcareous siltstone and sandstone, with minor amounts of volcanic rocks, and were regionally metamorphosed to amphibolite grade. Garnet-pyroxene skarns have locally formed along contacts with granitic rocks.

About half of the area is underlain by granitic rocks of the Sierra Nevada batholith. Parts of 13 plutons, probably emplaced during a relatively short span of time during the late Cretaceous, are exposed in the area. They are composed mostly of fine- to coarse-grained equigranular to porphyritic granite and granodiorite. The only mineralization known to be related to the granitic rocks is tungsten-gold skarn mineralization in metamorphic rocks along contacts with the Burnside Lake Adamellite of Parker (1961).

Volcanic rocks of early Miocene through early Pliocene age cover about half of the area. They range in composition from rhyolite to basalt, although andesitic compositions are more prevalent. The composite thickness of these volcanic rocks is as much as 7,000 ft (2,150 m) and decreases toward the northwest.

Volcanic activity concluded during the latest Miocene and early Pliocene with the intrusion of several small rhyolite plugs exposed mostly outside the southeast border of the area. Silver and gold mineralization in the Silver Mountain district, and the nearby Monitor district (Zaca mine, 1.5 mi east of the area) apparently is associated with this younger silicic volcanism. The numerous silicified (jasperoid) zones in andesitic rocks at the east side of the area also probably formed as a result of these intrusions.

The major fault system along the east margin of the Sierra Nevada passes through this area. The present topography is a result of uplift and westward tilting that is occurring along this fault system and of Pleistocene glaciation that cut deep canyons and valleys.

## GEOCHEMICAL STUDIES

A total of 38 rock samples, 41 -60-mesh (-0.25-mm) stream-sediment samples, and 41 nonmagnetic heavy-mineral-concentrate samples were analyzed for the geochemical investigation of the east part of the Raymond Peak Roadless Area.

The rock samples were collected primarily to provide information on the background chemical abundances of the rock units in the study area and are not discussed below.

For the stream-sediment samples, 11 elements were selected as possibly being related to mineralization; for the concentrate samples, 15 elements were selected. Because of the small number of samples collected for study of this area, the analyses were compared to those collected from other areas in this part of the Sierra Nevada. Based on analytical distributions of elements in all of these areas, threshold values (highest background values) were selected for the Raymond Peak samples.

The selected elements in the concentrate samples have been divided into three separate suites of elements. Suite 1 includes those elements most closely associated with base- and precious-metal deposits. Suite 2 includes those elements most closely associated with molybdenum and tungsten deposits, particularly contact metasomatic-type deposits. Suite 3 includes those elements most closely associated with hydrothermal alteration but not necessarily mineralization. This last element suite identifies the minerals pyrite and barite and seems to indicate areas of pyritization, argillization, silicification, and bleaching, particularly in the Tertiary volcanic rock units.

### Geochemical anomalies

Significant anomalies are present in three areas of the east part of the Raymond Peak Roadless Area and are described below.

Area A.--This area is bounded by the drainage divide between Raymond and Reynolds Peaks on the southwest, by Pleasant Valley Creek on the north, by the East Fork of the Carson River on the east, and by Silver Creek on the southeast. Geochemically, the area is characterized by generally low-level anomalies in stream-sediment samples, with the strongest anomalies in the drainages of IXL Canyon, Raymond Canyon Creek, and an unnamed north-flowing fork of Pleasant Valley Creek immediately to the west of Raymond Canyon Creek. Anomalies in the concentrate samples include most of the elements in suite 1 (base- and precious-metal suite) and suite 3 (hydrothermal-alteration suite). Anomalies for suite 3 are very strong throughout area A. The anomalies for suite 1 are strongest in the IXL Canyon, Raymond Canyon Creek, Indian Creek, and Poor Boy Creek drainage basins. Geologically, area A is characterized by locally intensely altered Tertiary andesitic rocks that are known to be favorable host rocks for base- and precious-metal deposits. Some, but probably not all, of the geochemical anomalies may have resulted from contamination from past mining activity. On the basis of the above information, area A is considered to have a high potential for precious- and base-metal deposits.

Areas B and C.--These areas include basins that represent: (1) most of the tributaries flowing westward into the West Fork of the Carson River in Hope, Faith, and Charity Valleys; (2) the north-flowing tributaries that flow into this same river in West Carson Canyon on the north side of the study area; and (3) the upper part of Hot Springs Creek. Areas B and C are represented by generally low-level anomalies in stream-sediment samples and generally low to moderate anomalies in the concentrate samples for elements in suite 1 (base- and precious-metal suite) and suite 2 (molybdenum-tungsten suite). The strongest anomalies from concentrates are in those basins draining the areas of the Burnside and Cal-Pine mines and in the basin draining upper Hot Springs Creek. Geologically, area B with the strongest anomalies for both types of sample has outcrops of highly altered metasedimentary rocks known to contain contact-metasomatic-type tungsten deposits in other areas. Some of the anomalies seem to be related to contamination from past mining activity. Area B is considered to have a moderate potential for tungsten deposits that may also contain other base and precious metals. Other less significant anomalies generally contain low concentrations of one or more of the molybdenum-tungsten suite of elements. The geology of these areas, particularly in the Faith and Charity Valleys (Area C) suggests the possibility of molybdenum-rich veins in the granitic plutons within these drainage basins. Area C is considered to have a relatively low potential for molybdenum and tungsten.

## GEOPHYSICAL STUDIES

Gravity and aeromagnetic surveys were used to aid geologic mapping and mineral appraisal in the Raymond Peak Roadless Area (Plouff, 1983). The gravity anomaly map is dominated by closely spaced north-trending contours that reflect thickening of the crust beneath the Sierra Nevada (Oliver and others, 1982). A gravity high 3 mi (4.8 km) in diameter that is located east of Poor Boy Creek at the eastern edge of the area may outline a relatively dense underlying pluton.

The second geophysical mapping method was an aeromagnetic survey flown at about 1,000 ft (300 m) above the ground along northeast-trending flight lines spaced at intervals of 0.5 mi (0.8 km) (U.S. Geol. Survey, 1981).

The Burnside and Cal-Pine mines northwest of the roadless area boundary are located along the contact between metamorphic rocks and the Burnside Lake Adamellite. This contact appears to parallel fairly linear northwest-trending magnetic contours. These mines occur at the northeast edge of a 1-mi-diameter magnetic low that is located in the northern part of a broader low. This trend is interrupted near Grovers Hot Springs by a magnetic high associated with relatively mafic granitic rock. Northeast of this high, the granitic rock underlying a magnetic low apparently has relatively low magnetization, possibly caused by alteration associated with the hydrothermal system that feeds Grovers Hot Springs. Elsewhere the effects of topography and the variations in magnetization of the surrounding and deeper lying rocks tend to conceal possible aeromagnetic lows associated with occurrences of altered rock.

## MINING DISTRICTS AND MINERALIZATION

### Mining History and Mining District

Principal mining districts in the county including the Monitor, Silver Mountain, Raymond, and Hope Valley, were established in the early 1860's. Most county mineral production, estimated to be about $20 million since 1880 (Clark, 1977, p. 13) has been from the Leviathan mine (sulfur) and Zaca mine (silver and gold); both are in the Monitor district, 1.5 to 5 mi (2-8 km) east of the Raymond Peak Roadless Area. These mines were initially developed in the 1860's and have yielded ore periodically.

Mining properties in and adjacent to the southeastern part of the area are in the Silver Mountain district. Production records are incomplete, but Clark (1977, p. 28) reports district mines had an output of less than $300,000. Principal silver and gold deposits in this district are on the Exchequer, St. Helena, IXL, Acacia, Columbine, Bolin, and Pennsylvania properties (map Nos. 9, 3, 13, 11, 23, 22, and 20, respectively). These deposits, except for the Columbine, are in quartz veins in silicified shear zones in Tertiary andesite breccia; deposits at the Columbine claim (No. 23) are in shear zones in Cretaceous granitic rocks. These claims have been developed since the 1860's; currently small-scale prospecting is being done in IXL Canyon. The Cindy and Deer claims (No. 24), located in 1969, were explored for uranium by the Utah Construction and Mining Company (presently Pathfinder Mines, Inc.) until 1973.

The Raymond district, organized in the late 1860's along Raymond Canyon Creek, has been dissolved since the 1920's. Gold and silver deposits in this district were extensively developed at the California-Illinois prospect (No. 5), but only minor development was done on the Silver Cloud claim (No. 4). These deposits are similar to those in the Silver Mountain district. The California-Illinois prospect probably yielded small quantities of ore before 1900, but production records are not available.

The Hope Valley and Summit City districts lie north and west, respectively, of the roadless area. Hope Valley district mines, including the Burnside, Brewer, and Cal-Pine, are in tungsten-bearing tactite deposits which were developed in the 1940's and 1950's; gold-bearing quartz veins were also mined at the Cal-Pine mine.

Prospecting in the Summit City district about 5 mi west of the area commenced in the late 1860's with the discovery of gold-bearing quartz veins. Numerous small veins in granitic and volcanic rocks were explored; no metal production was recorded for the district.

### Mining Claims

Since 1850, approximately 300 lode claims have been recorded in the roadless area; no placer claims were recorded. Some of the patented claims comprising the Exchequer mine and Lady Franklin claim (map, Nos. 9, 10) extend into the roadless area, and are currently being developed by a small mining company.

No oil and gas, geothermal, or other mineral leases exist in the study area.

### Geologic Factors Related to Deposits

Silver and gold deposits occur in shear zones which cut Miocene andesite breccia, mainly in the southeast part of the area. These zones are hydrothermally altered and contain limonite-stained silicified country rock and quartz veins and stringers with disseminated pyrite and pyrargyrite; galena and stibnite also occur locally in the quartz veins.

Uranium occurs in a podiform-type deposit in a buried Tertiary stream channel along a contact between granitic and volcanic rocks.

## ASSESSMENT OF MINERAL RESOURCE POTENTIAL

The potential for resources of silver and gold is high in the east part of the Raymond Peak Roadless Area; the potential for tungsten resources is moderate to low; and the potential for uranium, lead, zinc, copper, molybdenum, and antimony resources is low. Most of the mineral resource potential is in andesite breccia and granitic rocks in the southeastern part of the area. These rocks have been broken by numerous northwest- and northeast-trending shear zones and faults and have been extensively altered.

The St. Helena, California-Illinois, and Exchequer properties contain approximately 1,826,000 tons (1,657,000 mt) of silver and gold resources in north-trending, steeply dipping shear zones that range from 1 to 34 ft (0.3-10.4 m) thick. These properties and others with mineral resources in similar geologic settings adjacent to the study area are shown on table 1.

Potential resources for gold and silver occur in structures on five properties, mainly near the southeast area boundary. Other properties, shown on the map and summarized in table 1 of the pamphlet, have structures similar to those with resources in the study area; however, they are not sufficiently exposed to enable tonnage and grade estimates.

Area A.--A high potential exists for additional undiscovered resources of gold and silver in area A. This area contains older andesitic rocks and younger silicic intrusive rocks that are similar both in age and composition to rocks in the nearby Monitor district, which contain large silver deposits. Extensive hydrothermal alteration (propylitization and silicification), similar to alteration in the Monitor district, is present throughout area A. Area A has geochemically anomalous concentrations of elements in the base- and precious-metal suite that may indicate deposits. The area also contains most of the mines and prospects described above and summarized in table 1. The geologic and geochemical features suggests that there is a high probability for the occurrence of additional deposits of gold and silver in this area. Copper resources, similar to mineralization in the Monitor district (Clark, 1977), may also be associated with precious-metal resources in this area.

Area B.--A moderate potential exists for undiscovered tungsten resources in area B near Burnside Lake. This area includes the southern end of a pendant of metamorphic rocks, consisting largely of calcareous sedimentary rocks, which includes two tungsten skarn deposits (Burnside and Cal-Pine mines) outside of the roadless area. The pendant may also be covered in part by Tertiary volcanic rocks. It was intruded on the west by the Burnside Lake Adamellite, which was apparently the source of metal-bearing fluids that formed all the tungsten deposits in the Hope Valley district.

Area C.--A low potential exists for molybdenum and tungsten-bearing quartz vein or pegmatite deposits in area C. Anomalous concentrations of molybdenum and tungsten are present, but no alteration or extensive veining was observed in any of the four granitic plutons there.

Uranium.--A low potential exists for undiscovered uranium resources in area A. Uranium mineralization is locally present in the lower part of the Relief Peak Formation at the Cindy and Deer claims (No. 24) on the southern edge of the area and about 20 mi (32 km) farther south near Sonora Pass at the Juniper mine (Rapp and Short, 1980). The lack of suitable host rocks, the lack of known uranium mineralization (except at the Cindy and Deer claims) and the lack of a uranium source suggest a low potential for undiscovered uranium resources in area A.

Placer resources.--Alluvial deposits consisting of silt, sand, and gravel occur along all drainages in the study area. Nine samples were collected from Blue, Deer, and Pleasant Valley Creeks; no gold was detected, but two pan concentrates from Pleasant Valley Creek had 0.016 percent $eU_3O_8$ (uranium oxide equivalent).

Energy resources.--A small potential for geothermal energy is present near Grovers Hot Springs near the eastern part of the area. The reservoir is estimated to have a volume of 3.3±0.9 $km^3$ and a mean temperature of 126±46°C (Muffler, 1979, p. 64), but not enough for steam-fire power generation. There is no evidence of oil or gas potential in the roadless area.

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Table 1.--Estimated mineral resources in the east part of the Raymond Peak Roadless Area and vicinity (Underlined numbers refer to properties with mineralized structures which probably extend into the study area)

| Map number | Property | Type | Tonnage[1] (tons) | Resource[2] classification | Product | Grade |
|---|---|---|---|---|---|---|
| 3 | St. Helena | Shear zone | 1,500,000 | Inferred subeconomic | Gold<br>Silver | 0.01 oz/ton<br>2.5 oz/ton |
| 5 | California-Illinois | Shear zone | 270,000 | Inferred subeconomic | Gold<br>Silver | 0.03 oz/ton |
| 9 | Exchequer | Shear zone | 56,000 (in shoots) | Inferred marginal reserve | Gold<br>Silver | 0.04 oz/ton<br>23.5 oz/ton |
| 13 | IXL | Shear zone | 150,000 | Inferred subeconomic | Gold<br>Silver | 0.01 oz/ton<br>0.93 oz/ton |
| | | | 15,000 (in shoots) | Marginal reserve | Gold<br>Silver | 0.56 oz/ton<br>48.47 oz/ton |
| 23 | Columbine (Sawmill) | Shear zone | 94,000 | Inferred subeconomic | Gold<br>Silver | 0.005 oz/ton<br>0.5 oz/ton |
| 24 | Cindy and Deer | Stream channel | 8,000 | Inferred subeconomic | Uranium | 0.05% $eU_3O_8$[3] |

[1]Metric conversions: tons x 0.9072 = metric tons ( t); oz per ton x 34.285 = grams per metric ton ( t).
[2]Resource classification terminology from U.S. Bureau of Mines and U.S. Geological Survey (1980).
[3]Equivalent percent uranium oxide assuming uranium is in equilibrium with daughter products which emit gamma radiation.

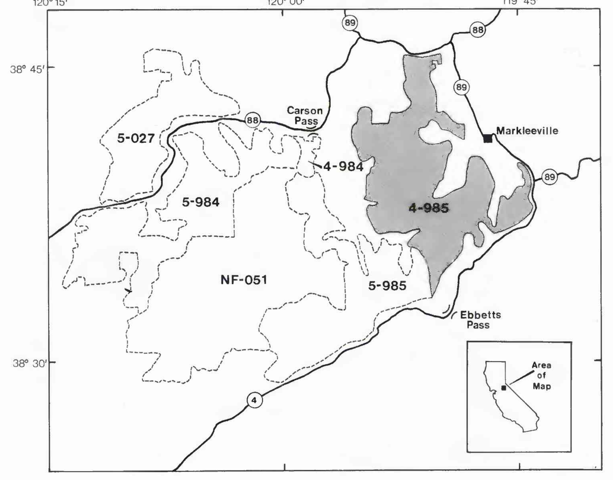


Figure 1.--Index of wilderness and roadless areas in the vicinity of the east part of the Raymond Peak Roadless Area.

4-985 East part of the Raymond Peak Roadless Area
NF-051 Mokelumne Wilderness
5-027 Caples Creek Roadless Area
4-984 Tragedy-Elephants Back Roadless Area; part in Toiyabe National Forest
5-984 Tragedy-Elephants Back Roadless Area; part in El Dorado National Forest
5-985 Raymond Peak Roadless Area

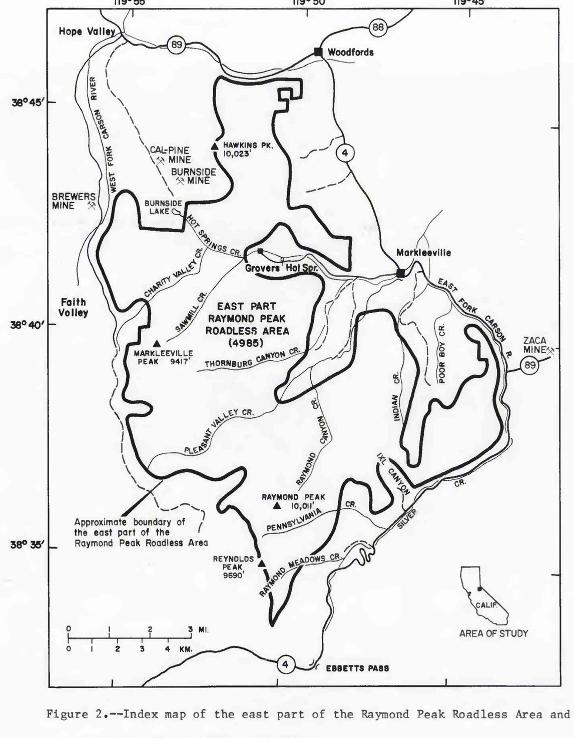


Figure 2.--Index map of the east part of the Raymond Peak Roadless Area and vicinity, Alpine County, California.

Explanatory pamphlet accompanies map

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