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UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
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PAMPHLET

# MINERAL RESOURCE POTENTIAL, GEOLOGY, AND GEOCHEMISTRY OF PART OF THE WHITE CLOUD-BOULDER ROADLESS AREA, CUSTER COUNTY, IDAHO

By

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## STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts, 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 consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys consitute 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 geologic, geochemical, and mineral survey of part of the White Cloud-Boulder Roadless Area (04551), Sawtooth and Challis National Forests, Custer County, Idaho. The 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.

## MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

Geological and geochemical investigations were conducted to evaluate the mineral resource potential of the White Cloud-Boulder Roadless Area, Custer County, Idaho. The area is on the eastern and southern sides of the White Cloud-Boulder Mountains and is within the Sawtooth and Challis National Forests. Complexly folded and faulted Paleozoic sedimentary rocks underlie the area. These rocks were uplifted and eroded to form a rugged terrain and then were buried by a thick sequence of Tertiary volcanic rocks. Both the sedimentary and volcanic rocks have been intruded by plutons of intermediate and felsic composition. Hydrothermal activity and contact metamorphism associated with the emplacement of the intrusive bodies formed vein and skarn deposits in the area.

A moderate resource potential for tungsten is assigned to the southern part of the area where metalliferous calc-silicate skarns have formed in carbonate-rich sedimentary rocks adjacent to intrusive rocks. A moderate resource potential for gold is assigned to an area northwest of Sheep Mountain in the northern part of the study area where anomalous concentrations of gold occur in quartz-carbonate veins. A moderate resource potential for arsenic, copper, gold, lead, molybdenum, silver, tin, and zinc is assigned to the Sheep Mountain-Bowery Peak area because of the widespread geochemical anomalies in that area and the inferred presence of a large buried intrusive body. The entire study area has a low resource potential for sand, gravel, stone, oil, and gas.

## INTRODUCTION

The White Cloud-Boulder Roadless area is located approximately 32 mi south of Challis, Idaho (fig. 1). Access is via U.S. Highway 93 and by county roads along the East Fork of the Salmon River. The study area comprises 50,324 acres in the Sawtooth and Challis National Forests, Custer County, Idaho. The study area is on the eastern and southern sides of the White Cloud-Boulder Mountains and is characterized by very rugged topography with relief in excess of 4,000 ft. Major drainages are the Big Lost River, the East Fork of the Salmon River, East Pass Creek, and West Pass Creek.

Previous geologic work is limited to the northern one-third of the study area, which was mapped by Ross (1937) at a scale of 1:125,000. The region immediately to the west was mapped as part of the mineral resource appraisal of the Sawtooth National Recreation Area (Tschanz and others, 1974) and the northern half of the study area is presently being mapped by the U.S. Geological Survey at a scale of 1:250,000 as part of the Challis $1^{\circ} \times 2^{\circ}$ quadrangle mineral resource assessment. Dover and others (1980), Dover (1981), Simons (1981), Tucheck and Ridenour (1981), and Spoelhof (1972) did detailed stratigraphic, structural, and mineral resource assessments in the region directly south of the White Cloud-Boulder area.

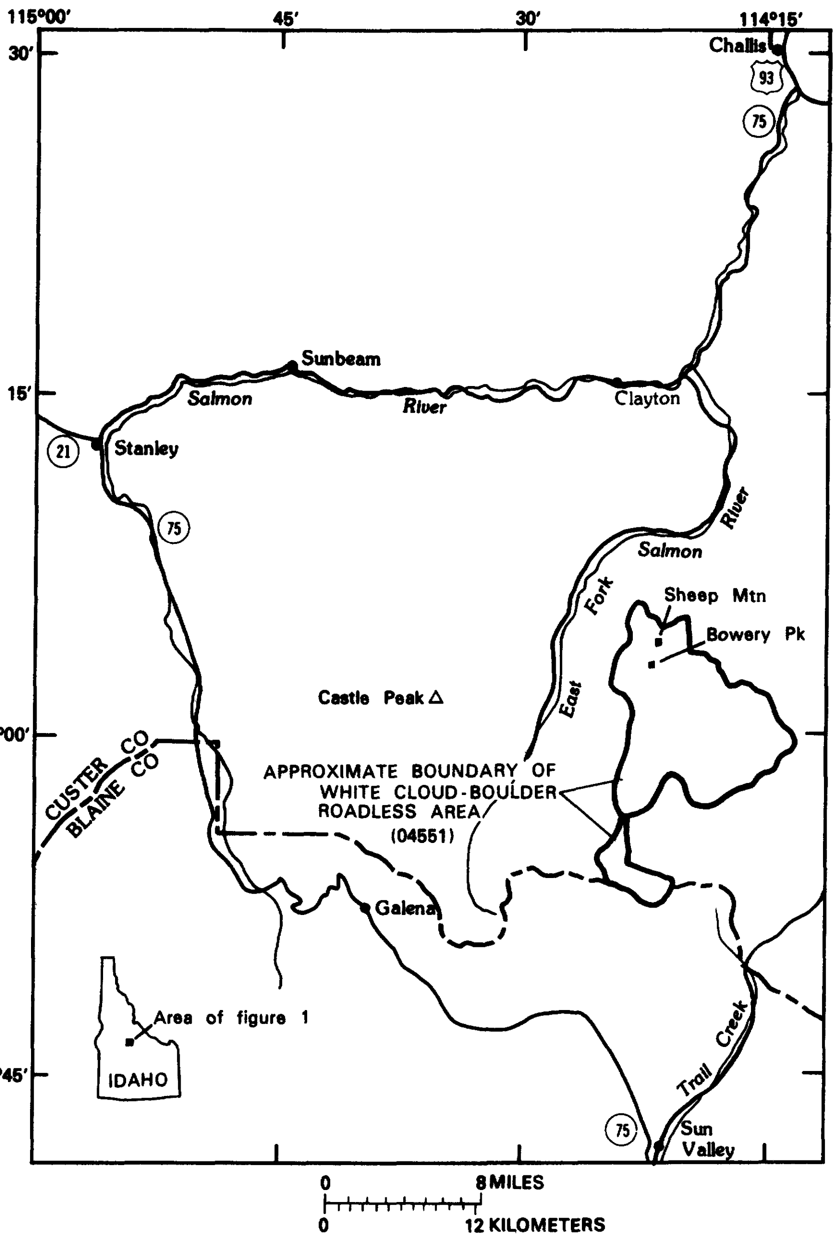



Figure 1.--Index map showing location of the White Cloud-Boulder Roadless Area, Custer County, Idaho.

The study area has been prospected and sampled sporadically in the past and a few prospect pits have been dug.

## GEOLOGY

The White Cloud-Boulder Roadless Area includes two principal groups of rocks (fig. 2): sedimentary rocks of Paleozoic age, and volcanic rocks, together with associated intrusive rocks, of Eocene age. The Paleozoic sedimentary rocks were faulted, chiefly along low-angle thrust faults, complexly folded, and eroded to form a rugged terrain prior to deposition of the volcanic rocks. Locally, especially in the southern part of the roadless area, the sedimentary rocks were metamorphosed near the contacts of intrusive masses that were emplaced during volcanism. The volcanic rocks that blanket most of the roadless area were erupted during two episodes; rocks of the younger episode rest unconformably on those of the older. The older rocks include pyroclastic rocks, porphyritic lava and breccia of intermediate composition, and porphyritic intrusive rocks, all of which crop out only in the area surrounding Sheep Mountain. Lavas of intermediate composition that also are part of the older sequence crop out over a broad area in the region south of Sheep Mountain. The younger volcanic rocks include relatively thin (less than 300 ft) volcaniclastic rocks, and thick, widespread potassium-rich andesite and latite.

The structure within the northern part of the roadless area is closely related to two major, regional structural features: the northeast-trending East Fork fault zone to the west and the northwest-trending Herd Creek fault zone to the east (McIntyre and others, in press). These two fault zones converge about 4 mi north of the roadless area. The zones are conjugate shears that have lateral components of movement that are small relative to the vertical components (left lateral on the East Fork fault zone and right lateral on the Herd Creek fault zone). The northeast- and northwest-trending faults within the northern part of the roadless area are subsidiary features related to these two zones.

Northeast- and northwest-trending faults bound the uplifted block that is centered on the Sheep Mountain-Bowery Peak ridge. Uplift of the block most likely is due to buoyancy of an intrusive mass still concealed beneath the ridge. The presence of such an intrusive body is suggested by the swarm of porphyry dikes on the ridge, the pervasive alteration of all rocks exposed on the ridge, and a strong positive aeromagnetic anomaly centered on the ridge (U.S. Geological Survey, 1978).

The volcanic rocks south of Sheep Mountain dip toward the northeast at moderate angles and are cut by a few faults similar to those noted farther north.

East- and northeast-directed thrust faults of considerable displacement characterize the structural geology of the Paleozoic rocks in the southern part of the study area. The allochthonous plates were emplaced during Paleozoic and Mesozoic deformation that affected wide areas of the Western United States (Dover, 1981). The thrust plates have been broken by high-angle faults at various times and were intruded by numerous quartz porphyry plutons during Tertiary time.

## GEOCHEMISTRY

One hundred seventy-two rock, 101 stream-sediment, and 73 panned-concentrate samples were analyzed by semiquantitative spectrographic methods for 30 elements. In addition, 33 samples were analyzed by atomic absorption techniques for zinc, cadmium, bismuth, antimony, arsenic, and gold. Selected sample were scanned by radiometric and fluorometric methods for radioactive minerals and for tungsten. All of the geochemical data and sample locality maps are given in Fisher and others (1983).

For the purposes of this report, anomalous values for the following elements are defined as: antimony $\geq$10 ppm, arsenic $\geq$10 ppm, copper $\geq$100 ppm, gold $\geq$0.05 ppm, lead $\geq$100 ppm, molybdenum $\geq$10 ppm, silver $\geq$1.0 ppm, tin $\geq$10 ppm, tungsten $\geq$10 ppm, and zinc $\geq$100 ppm. The concentrations of other elements that were analyzed are within the normal range for the various rocks, stream sediments, and panned concentrates collected from the study area.

## MINING DISTRICTS AND MINERALIZED AREAS

### Types of deposits

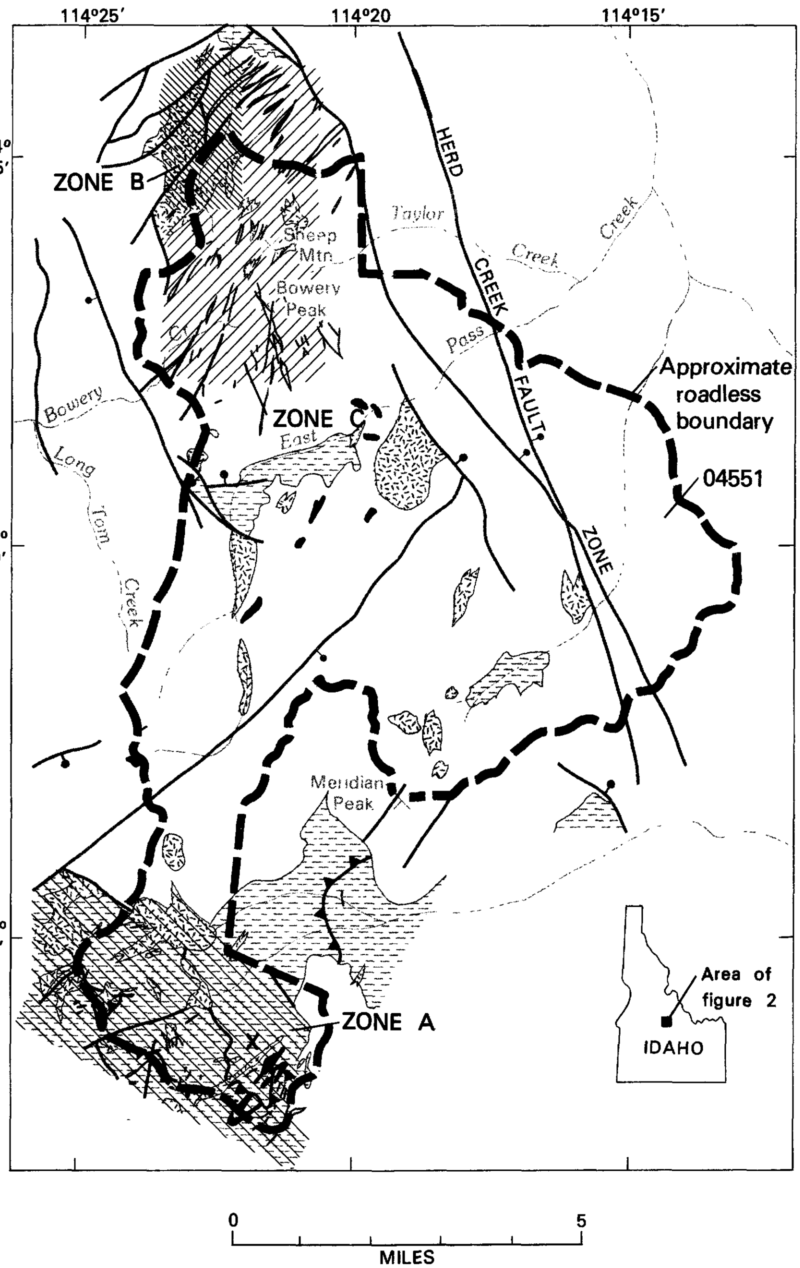
In the northern part of the roadless area, ore minerals and metals occur in quartz-carbonate fissure veins and in an ill-defined area of hydrothermally altered volcanic rocks (table 1). In the southern part of the area, the Paleozoic sedimentary rocks are extensively altered and iron-stained adjacent to their contacts with the Tertiary plutons; these skarn zones locally are metalliferous.

### Quartz-carbonate fissure veins

In the northern part of the study area, near the headwaters of Pine Creek, a series of quartz-carbonate veins with predominant northeast trends cut intermediate-composition intrusive rocks, pyroclastic rocks, and lava flows. Most of these veins are narrow (less than 1 ft wide) and have exposed strike lengths of only a few tens to a few hundred feet. One vein, first described by Ross (1937), has a known strike length of 1 mi and could be as long as 2 mi; the vein locally ranges up to 300 ft in width (fig. 3). The veins parallel the regional structural grain, which also is expressed by a northeast-trending dike swarm (fig. 2) and by high-angle normal faults (figs. 2, 3). Faulting both preceded and followed vein development. The veins and breccia zones strike N. 15°-20° E. and commonly dip approximately 50° west. Slickensided surfaces within these zones show mainly dip-slip movement, although a few show strike-slip movement. Total displacements on the faults are unknown.

Vein rocks are mostly breccias consisting mainly of subangular, altered rock fragments about 1-2 in. in diameter in a matrix of dense, white, fine-grained silica. Matrix material commonly is crustiform, vuggy, and banded. Some clay, chiefly kaolinite, occurs in small (less than 1 in.) pods, and carbonates are present both in thin veinlets and as vug fillings. The veins usually are iron-stained, probably from the weathering of pyrite. Sulfides are sparse in the vein material.

The wallrocks a few inches away from the veins are argillically altered, bleached, somewhat iron-




## EXPLANATION

**Mineral resource potential**

- ZONE A--Area of moderate potential for tungsten-bearing skarn deposits
- ZONE B--Area of moderate potential for precious-metal vein deposits
- ZONE C--Area of moderate potential for porphyry, vein, or replacement deposits of copper, gold, molybdenum, silver, tin, and zinc

- Intrusive rocks (Tertiary)
- Dikes (Tertiary)
- Volcanic rocks (Tertiary)
- Sedimentary rocks (Paleozoic)
- Contact
- Fault--Bar and ball on downthrown side
- Thrust fault-- Sawteeth on upper plate
- X Prospect

Figure 2.--Mineral resource potential and geologic map of the White Cloud- Boulder Roadless Area.

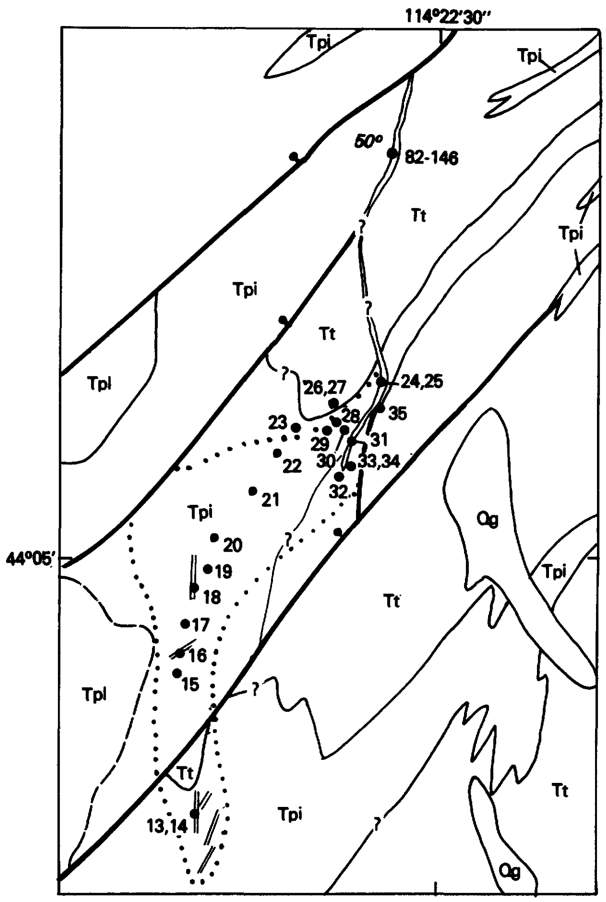



Figure 3.--Geologic and sample location map of Pine Creek vein zone.

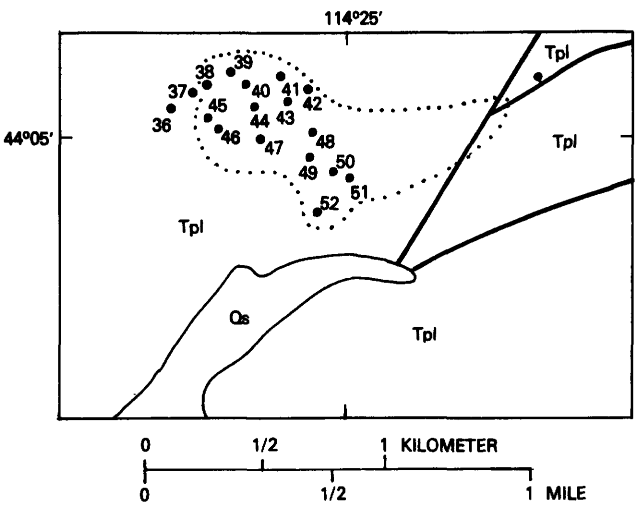



Figure 4.--Geologic and sample location map of zone of pervasive alteration.

**EXPLANATION**
**(FOR FIGURES 3 AND 4)**

**Qs** SURFICIAL DEPOSITS (QUATERNARY) --Chiefly floodplain and terrace deposits of gravel, sand, and silt

**Qg** GLACIAL DEPOSITS (QUATERNARY)--Chiefly moraines deposited by valley glaciers; locally includes some landslide deposits

**Tpi** PORPHYRITIC INTRUSIVE ROCKS (TERTIARY)--Mostly porphyritic latite, andesite, and dacite. Phenocrysts of plagioclase and biotite

**Tpl** PORPHYRITIC INTERMEDIATE LAVA AND BRECCIA (TERTIARY)--Porphyritic lava and breccia of intermediate composition. Phenocrysts of plagioclase, biotite and amphibole

**Tt** PYROCLASTIC ROCKS (TERTIARY)--Crystal-poor pyroclastic rocks with abundant uncollapsed pumice and lithic fragments. Brownish gray to dark green

CONTACT--Dashed where approximate, queried where uncertain

AREA OF ALTERED ROCK

VEIN--Queried where uncertain

FAULT--Bar and ball on downthrown side

•24 SAMPLE LOCALITY--Numbers refer to table 1 stained, and contain fine-grained clay minerals. Propylitically altered rocks are widespread and are characterized by chlorite, epidote, and carbonate that replace biotite, hornblende, and plagioclase.

Twenty-four rock samples were collected from the veins and nearby altered rocks (fig. 3). Twelve of these samples contain anomalous concentrations of zinc, arsenic, antimony, gold, molybdenum, and silver (table 1); 9 were of veins and 3 were of silicified, altered intrusive rocks.

### Pervasively altered rocks

A small zone of pervasively altered rocks is present on the north side of Sheep Creek approximately 2 mi west of the northernmost boundary of the study area. These rocks are mostly bleached and silicified porphyritic lavas. Some clay minerals are present in these rocks, and iron staining is widespread. Seventeen rock samples collected from this area (fig. 4) were analyzed, but no anomalous concentrations of elements were found in any of them.

Two additional small areas of hydrothermally altered volcanic rocks do not contain anomalous concentrations of elements; one is located where the fault crosses the ridge in the NW1/4 sec. 21, T. 9 N., R. 18 E. (sample GM82-147A of Fisher and others, 1983), and the other on the northwest-trending spur southeast of the big bend in East Pass Creek at an elevation of about 8,800 ft (sample GM82-147B of Fisher and others, 1983).

### Skarn zones

Skarns commonly are developed in carbonate-rich rocks adjacent to Tertiary plutons in the southern part of the study area. Scheelite has been observed in some of these skarns, and pan concentrates collected from streams draining these areas contain visible scheelite grains. The skarn zones commonly are iron stained and contain garnet, epidote, and in places, pyrrhotite. Although no skarn deposits have been developed in the study area, these types of ore bodies have been mined near the western and southern boundaries of the White Cloud-Boulder Roadless Area (Tschanz and others, 1974; Simons, 1981). Tungsten, molybdenum, and lead all are present in anomalous concentrations in panned concentrates collected from streams draining the Paleozoic rocks.

### Sheep Mountain-Bowery Peak area

Arsenic, copper, gold, lead, molybdenum, silver, tin, and zinc are present in anomalous concentrations in rock and stream-sediment samples taken from the Sheep Mountain-Bowery Peak area. With the exception of the auriferous quartz-carbonate veins described earlier, no recognizable ore deposits were observed in the Sheep Mountain-Bowery Peak area. The best explanation for the widespread geochemical anomalies in this region is the presence of a buried intrusive mass beneath Sheep Mountain-Bowery Peak ridge, as suggested earlier. Several types of ore deposits, not now exposed at the surface, could be associated with such an intrusive, and the observed geochemical anomalies would be explained as a result of the hydrothermal events associated with the emplacement of the intrusion.

### Mines and prospects

Only a few mining claims have been located, and only one mine working found within the roadless area (Johnson, 1983). Numerous claims, workings, and mines are present within a few miles of the southwestern part of the roadless area in the headwaters of Summit Creek and also west of Ryan Peak in the headwaters of West Pass Creek. The one working within the roadless area (fig. 2) consists of a 7-ft-long trench on an unnamed prospect in which a 2-ft-wide shear zone in argillite is exposed. The argillite contains traces of pyrite, but a chip sample across the shear zone contained no significant concentrations of metallic minerals.

The deposits outside of the roadless area west of Ryan Peak and in the headwaters of Summit Creek, are mostly vein and replacement deposits containing lead, zinc, silver, and tungsten (Simons, 1981; Tschanz and others, 1974).

## ASSESSMENT OF MINERAL RESOURCE POTENTIAL

### Areas of moderate resource potential

A moderate potential for tungsten resources is assigned to the southern part of the White Cloud-Boulder Roadless Area where Paleozoic sedimentary rocks have been intruded by Tertiary plutons (fig. 2, zone A) because:

1. Highly anomalous concentrations of tungsten were found in panned concentrates from all of the streams draining the area.
2. Sheelite has been observed both in the panned concentrates and within skarn zones.
3. Geological relationships favorable for the formation of skarn deposits occur in the area.

A moderate potential for gold resources is assigned to the vein zone northwest of Sheep Mountain (fig. 3) because:

1. Metalliferous quartz-carbonate veins are quite common in the area.
2. Gold was detected in approximately 25 percent of the rock samples from the area.
3. Fifty percent of the rocks collected from the area contained anomalous concentrations of one or more metals (table 1).

A moderate potential is assigned to the Sheep Mountain-Bowery Peak area (fig. 2) for arsenic, copper, gold, lead, molybdenum, silver, tin, and zinc because:

1. Occurrences of these elements are of widespread occurrence in all types of samples from the area.
2. A variety of ore deposit types containing these elements could be associated with the intrusive mass that probably lies buried beneath the area.

### Areas of low resource potential

Sand, gravel, and stone could be produced from numerous localities within the study area. However, a low potential is assigned to these commodities because of the lack of good transportation and routes and the distance to markets. Marine sedimentary rocks are present in the study area, but have been severely folded, faulted, metamorphosed, and intruded by igneous plutons. Thus, the resource potential for oil and gas is low.

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Table 1.--Geochemistry of selected rock samples from vein zone northwest of Sheep Mountain
[Values in parts per million. Analyses by semiquantitative spectrographic methods except where indicated by an asterisk which were analyzed by atomic absorption methods; < indicates less than the lower limit of detection; L indicates limit of detection; leaders (--) indicate no data. Sample localities identified in figure 3. All analyses done by the U.S. Geological Survey laboratories]

| Sample No. | Description | Zn | As | Sb | Au | Ag | Mo | Cu | Pb |
|---|---|---|---|---|---|---|---|---|---|
| 13 | Quartz-kaolinite vein------- | 15 | 40 | 11 | 0.1 | 20 | 5 | 10 | 20 |
| 14 | Quartz-biotite porphyry (Qb) argillically altered. | -- | -- | -- | -- | <0.5 | <5 | 30 | 50 |
| 15 | Breccia; abundant carbonate | 25 | 400 | 13 | <.05 | 1.5 | <5 | 20 | 20 |
| 16 | Silicified breccia; 1 percent disseminated pyrite. | 30 | 140 | 5 | .05 | 1.5 | 5 | 30 | 20 |
| 17 | Silicified breccia---------- | 60 | 20 | 6 | <.05 | 1.5 | 5 | 30 | 20 |
| 18 | QB porphyry; bleached numerous quartz veins. | -- | -- | -- | -- | <.5 | <5 | 20 | 30 |
| 19 | Do. | -- | -- | -- | -- | <.5 | <5 | 20 | 30 |
| 20 | QB porphyry; argillically altered; limonite casts; 2 percent disseminated pyrite. | -- | -- | -- | -- | <.5 | <5 | 20 | 50 |
| 21 | Do. | 40 | 15 | <.1 | <.05 | .5 | <5 | 20 | 100 |
| 22 | Breccia; bleached; quartz veinlets. | -- | -- | -- | -- | <.5 | <5 | 10 | 50 |
| 23 | QB porphyry; propylitized--- | -- | -- | -- | -- | <.5 | <5 | 20 | 50 |
| 24 | Breccia; silicified--------- | 15 | 20 | 1 | .1 | 2 | 10 | 15 | 10 |
| 25 | Do. | 15 | 20 | 2 | .15 | .5 | <5 | 5 | 10 |
| 26 | Volcanic breccia; quartz veins. | -- | -- | -- | -- | <.5 | <5 | 30 | 50 |
| 27 | Volcanic breccia; quartz veins; limonite stain. | -- | -- | -- | -- | <.5 | <5 | 10 | 20 |
| 28 | QB porphyry; bleached------- | 10 | 30 | 3 | <.05 | 1 | <5 | 20 | 50 |
| 29 | Do. | 50 | 40 | <.1 | <.05 | 1 | <5 | 30 | 20 |
| 30 | QB porphyry; bleached; quartz veinlets. | 35 | 80 | 3 | .05 | 3 | 50 | 10 | 20 |
| 31 | Breccia; silicified; vugs with sulfide boxworks. | 420 | 20 | 3 | L(.05) | 3 | 50 | 10 | 10 |
| 32 | Breccia; silicified--------- | 5 | 10 | 2 | L(.05) | 1.5 | <5 | <5 | <10 |
| 33 | Volcanic breccia; porphylitized; quartz veins. | -- | -- | -- | -- | <.5 | <5 | 10 | 70 |
| 34 | QB porphyry; porphylitized; quartz veins. | -- | -- | -- | -- | <.5 | <5 | 10 | 50 |
| 35 | Do. | -- | -- | -- | -- | <.5 | <5 | 20 | 50 |
| 82-146 | Quartz vein; 2 percent disseminated pyrite; limonite stained. | 10 | 150 | 2 | .10 | 5 | 10 | 15 | 10 |