MINERAL RESOURCE POTENTIAL OF THE WHEELER PEAK AND HIGHLAND RIDGE FURTHER PLANNING AREAS, WHITE PINE COUNTY, NEVADA

SUMMARY REPORT

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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 suitability 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 Wheeler Peak (4359) and Highland Ridge (4391) Further Planning Areas, Humboldt National Forest, White Pine County, Nevada. The areas were classified as further planning areas during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

SUMMARY

The Wheeler Peak Further Planning Area contains areas of low to moderate potential for tungsten, beryllium, lead, zinc, placer gold, and possibly thorium and rare earth elements. Several mines within the area have produced tungsten, and placer diggings have yielded a small amount of gold. Samples from prospects contain anomalous tungsten, lead, silver, and zinc. Panned concentrates of stream sediments from several drainages show anomalously high values of tungsten, beryllium, lead, zinc, and thorium. Mines in a similar geologic setting outside the study area have yielded tungsten, beryllium, gold, silver, and lead.

The Highland Ridge Further Planning Area includes one area of moderate to high potential for tungsten and several areas of low to moderate potential for tungsten, lead, zinc, and silver. Most of the area has a low potential because of its structural setting, in which favorable host rocks underlie barren strata in the upper plate of the Snake Range decollement. Panned concentrates of some stream sediments show anomalously high values of tungsten, lead, zinc, silver, beryllium, and barium.

Both areas contain large resources of limestone, and scattered sites contain rock suitable for building stone or flagstone. These materials have a low potential because of their inaccessibility and distance from markets. The potential for sand and gravel is low because these materials are readily available at more accessible sites. Several square miles along the east and west borders of the Wheeler Peak and Highland Ridge areas have been leased for oil and gas exploration, but the potential for oil and gas within the areas is believed to be low.

INTRODUCTION

During the summers of 1980 and 1981, the U.S. Geological Survey and the U.S. Bureau of Mines conducted field investigations to evaluate the mineral resource potential of the Wheeler Peak and Highland Ridge Further Planning Areas. Field studies included geologic mapping, geochemical sampling, and geophysical surveys by the U.S. Geological Survey, and a survey of mines and prospects by the U.S. Bureau of Mines. This report summarizes the findings and includes a mineral resource potential map of the areas.

Location, size, and geographic setting

The Wheeler Peak and Highland Ridge Further Planning Areas include a major part of the southern Snake Range in eastern White Pine County, Nevada (fig. 1). The Wheeler Peak area encompasses 61,919 acres (25,059 ha), and the Highland Ridge area covers 76,017 acres (30,764 ha). The rugged northerly trending Snake Range is bounded on the west by Spring Valley and on the east by Snake Valley. Wheeler Peak (13,063 ft), the highest point in the Wheeler Peak area, is the second highest peak in Nevada. Lincoln Peak (11,597 ft) is the highest point in the Highland Ridge area. The altitude along the base of the Snake Range is from 6,200 to 7,400 ft.

The Utah state boundary is about 4 mi (6.5 km) east of the study areas. Baker, Nev. and Garrison, Utah, are the only permanent communities in the immediate area. Ely, Nevada, about 35 mi (56 km) northwest, and Delta, Utah, about 85 mi (137 km) northeast, are the nearest main population centers. U.S. Highway 50 crosses the Snake Range at Sacramento Pass about 4 mi (6.5 km) north of the Wheeler Peak Further Planning Area, and U.S. Highway 93 is about 8 mi (13 km) west of it. Nevada Highway 487 and Utah Highway 21 are about 5 mi (8 km) east of the range. Nevada Highway 488 extends from Baker to Lehman Caves National Monument, which is on the northeast border of the Wheeler Peak area.

Geologic setting

The southern Snake Range is underlain mainly by sedimentary rocks of Proterozoic Z to Permian age. The total thickness of exposed strata is about 30,000 ft (9,100 m) (Whitebread, 1982). Granitic rocks that intrude Middle Cambrian and older rocks yield radiometric ages (Lee and others, 1970) that suggest intrusive episodes in Jurassic, Cretaceous, and Oligocene time. Tertiary conglomerate and ash-flow tuff locally overlie the upper Paleozoic rocks, and Quaternary deposits consist of alluvial material, glacial debris, and landslides.

The Snake Range is separated into two distinct structural elements by the Snake Range decollement, a low-angle fault that emplaced younger rocks over older rocks. Relatively undeformed, weakly metamorphosed lower-plate rocks, ranging in age from Proterozoic Z to Middle Cambrian, are intruded by granitic rocks that in places are truncated by the decollement. Upper-plate rocks, ranging in age from Middle Cambrian to Permian, are broken by high-angle faults and some low-angle faults. These faults are confined to the upper plate and terminate at the decollement. Field relations indicate that movement on the decollement and associated faults occurred after emplacement of at least part of the granitic rocks and prior to deposition of conglomerate and ash-flow tuff of early and middle Tertiary age. Some low-angle faults, along which highly fractured and brecciated masses of Paleozoic rocks slid onto Tertiary conglomerate, developed during the basin-and-range uplift that began in late Tertiary time.

Wheeler Peak Further Planning Area

The Wheeler Peak Further Planning Area is underlain mainly by clastic and carbonate rocks of Proterozoic Z to Middle Cambrian age and granitic rocks of Jurassic to Tertiary age that lie in the lower plate of the Snake Range decollement. In the southeast part of the area, complexly faulted rocks ranging in age from Middle Cambrian to Devonian are exposed in the upper plate of the decollement. Formations below the decollement include, in ascending order, the McCoy Creek Group of Misch and Hazzard (1962), Prospect Mountain Quartzite, Pioche Shale, and Pole Canyon Limestone. The Proterozoic Z McCoy Creek Group is composed of alternating units of quartzite and argillite, phyllite, and schist. The thick section of the Lower Cambrian Prospect Mountain Quartzite that conformably overlies the McCoy Creek Group consists of fine- to coarse-grained, thin- to thick-bedded, locally conglomeratic quartzite. The Prospect Mountain Quartzite grades upward into the Pioche Shale, which consists of siltstone, shale, quartzite, and limestone of Early and Middle Cambrian age. Alternating units of light-gray massive limestone and dark-gray thin-bedded to massive limestone of the overlying Pole Canyon Limestone are prominent along the west side of the range. Rocks exposed in the upper plate of the decollement include all the formations from the Cambrian Lincoln Peak Formation to the Devonian Guilmette Formation, but the section is highly attenuated by normal faults and a few low-angle faults.

Highland Ridge Further Planning Area

Rocks exposed in the Highland Ridge Further Planning Area are mainly in the upper plate of the Snake Range decollement; lower-plate rocks are exposed only along the north and west borders of the area and in a few places in the northeast part. The lower-plate rocks include the Prospect Mountain Quartzite, Pioche Shale, Pole Canyon Limestone and Lincoln Peak Formation, of Early to Late Cambrian age, and porphyritic quartz monzonite presumably of Cretaceous age. Upper-plate rocks consist mainly of Middle Cambrian to Devonian formations composed largely of limestone and dolomite, with relatively minor shale and quartzite. Limestone, shale, and minor sandstone constitute the Late Devonian to Permian upper-plate rocks exposed in the southwest part of the area. The Paleozoic formations in the upper plate are broken by northerly trending normal faults, a few northeasterly trending normal faults with a strike-slip component, and several low-angle faults. Relatively undeformed Tertiary conglomerate and ash-flow tuff lie on the complexly faulted upper Paleozoic rocks in the southwest part of the area.

GEOLOGY, GEOCHEMISTRY, AND GEOPHYSICS PERTAINING TO MINERAL RESOURCE ASSESSMENT

Cambrian sedimentary rocks and Mesozoic granitic rocks contain deposits of tungsten, beryllium, gold, silver, and lead within or adjacent to the Wheeler Peak and Highland Ridge Further Planning Areas. The favorable host rocks are in the lower plate of the Snake Range decollement. The Wheeler Peak area, which is underlain mainly by lower-plate rocks, includes several tungsten mines, scattered prospects that contain small amounts of tungsten, lead, and zinc minerals, and a placer gold deposit. The Highland Ridge area is underlain mainly by upper-plate rocks. Several prospects in lower-plate rocks contain small amounts of tungsten, lead, zinc, silver, and copper, and the easternmost workings of a tungsten mine extend into the western edge of the area.

A geochemical survey was conducted by sampling stream sediments at 138 sites within and adjacent to the Wheeler Peak and Highland Ridge Further Planning Areas. A bulk sample was collected at each site and a comparable sample was panned to concentrate the heavy minerals. Many of the panned concentrates contain anomalously high values of tungsten, beryllium, silver, lead, zinc, thorium, or barium.

Mines and prospects in and adjacent to the study areas also were sampled. Within the areas, the mines and nearly all prospects containing visible ore minerals are in veins in the Pioche Shale, Pole Canyon Limestone, or granitic rocks, and most of the high values for metals in panned concentrates are in samples from drainages that contain these rocks. Areas considered favorable for small deposits of tungsten, beryllium, silver, or lead are underlain by these units, although tungsten also is found in the Lincoln Peak Formation near the northeastern border of the Highland Ridge area. Quartz veins in the Prospect Mountain Quartzite and the Pioche Shale are probably the source of placer gold in the gravels at the north end of the Wheeler Peak area.

The Pioche Shale is the host rock for tungsten deposits in quartz veins at the Bonita mine in the southeast part of the Wheeler Peak area, but elsewhere in the study areas the formation has only a few prospect pits. Outside of the study areas, the formation is the host rock for tungsten and beryllium minerals at the Mt. Wheeler mine and other properties near the southwest corner of the Wheeler Peak area, and for gold, silver, and tungsten at mines in the Osceola district near the northwest corner of the area. Most of the deposits except those in the Osceola district are in a limestone unit, locally known as the "Wheeler limestone", in the lower part of the formation. Veins in the Pioche Shale are locally the source of anomalous tungsten, beryllium, silver, lead, and zinc in concentrates of stream-sediment samples.

The Pole Canyon Limestone is the host rock for the tungsten deposits in the Shoshone district (fig. 2) along the west border of the Highland Ridge area and for the tungsten deposits at the Chapman-Taylor (Big Wash) claims on the southern border of the Wheeler Peak area. Lead-silver deposits at the St. Lawrence mine and at the Mortenson mine both just outside the western border of the Highland Ridge area, are also in the Pole Canyon Limestone. In the northeast part of the Highland Ridge area, prospects in the Pole Canyon Limestone contain sparse tungsten minerals and anomalous amounts of silver, lead, zinc, and copper. Geochemical samples from drainages that cross the Pole Canyon Limestone locally contain anomalously high values of tungsten, silver, lead, and zinc.

Tungsten deposits at the Bonanzy mine and Hope mine, outside the northeast border of the Highland Ridge area, are in the Lincoln Peak Formation. The quartz and calcite veins that contain the tungsten are in the basal part of the formation, which structurally is more closely related to the rocks in the lower plate of the decollement. Tungsten and silver were mined from a zone of highly brecciated limestone of the Pole Canyon and Lincoln Peak Formations near the decollement at the Poljack mine northeast of the Wheeler Peak area.

Granitic rocks are cut by quartz veins that contain tungsten minerals in the vicinity of the Hub and Johnson mines in the southwest part of the Wheeler Peak area, and in the Osceola district northwest of the area. In these mining areas the granitic rocks are composed of medium- to coarse-grained quartz monzonite of Mesozoic age. Numerous aplite dikes cut the quartz monzonite in the Hub mine area. Near the borders of the granitic rocks, sparse skarn minerals are developed locally in the Pole Canyon Limestone and in sandy limestone beds in the upper part of the Pioche Shale. Stream sediment samples from drainages in the granitic rocks locally contain anomalously high values of tungsten, beryllium, lead, and thorium. The thorium occurs in allanite and monazite, which are accessory minerals in the granitic rocks (Lee and Bastron, 1967).

No mineral deposits are known in the rocks in the upper plate of the Snake Range decollement in the areas, and areas underlain by upper-plate rocks have been little explored.

Anomalously high values of barium reported in concentrates of stream-sediment samples from many of the drainages in the areas with carbonate rocks of Cambrian to Pennsylvanian age probably are derived from small veinlets or beds of barite.

Aeromagnetic and gravity data show a correlation with the geology in the area, but no geophysical anomalies can be directly related to known ore deposits. Many of the magnetic anomalies are associated with granitic rocks, but the lack of magnetic highs in some of the granitic rocks indicates local variations in susceptibility within the pluton. A broad magnetic high east of the Wheeler Peak area indicates that the pluton extends beneath the alluvium into Snake Valley. A basin-and-range fault along the west side of the Snake Range is suggested by the linear outline of the range front, but the gravity data do not indicate a great thickness of alluvial deposits immediately west of the range front.

MINING DISTRICTS, MINES, AND PROSPECTS

Wheeler Peak Further Planning Area

The Wheeler Peak Further Planning Area includes parts of the Osceola, Tungsten, Snake, Mount Washington, and Lexington mining districts (fig. 2).

The Osceola district, which extends into the northwest corner of the area, is mainly a lode and placer gold district, but silver, tungsten, and minor lead, zinc, copper, and bat guano have also been mined (Smith, 1976). No mines or prospects are in the part of the Osceola district that lies within the Wheeler Peak study area. Immediately east of the district, however, alluvial deposits extending into the north end of the study area contain placer gold. During 1981, a small amount of placer gold was recovered from these gravels (Kluender, 1983).

The Tungsten district lies mainly in the western part of the Wheeler Peak area. The district was organized in 1900, after huebnerite-bearing quartz veins were discovered in the granitic rocks. The Hub mine, which lies partly within the study area, is the only deposit known to have been productive. The mine was operated intermittently from 1900 to 1911, and was most active in 1915 and 1916. In 1952 and 1953 ore shipped from the dump averaged 0.5 percent WO_3. Total production was about 14,000 units of WO_3, valued at \$704,000 (Smith, 1976). The Hub vein, which trends northeast and dips 60° NW. to vertical, ranges in width from a few inches to 5 ft (few centimeters to 1.5 m). Fluorite is more widespread and abundant than huebnerite in the vein, and scheelite and pyrite are local minor constituents. Numerous other smaller quartz veins crop out in the vicinity of the mine.

The Snake district covers most of the central and southern parts of the Wheeler Peak Further Planning Area, and includes the Johnson and Bonita mines. The district was organized in 1869, after silver ore was found. The scheelite-bearing quartz veins at the Bonita mine were discovered in 1913 and the mine was operated mainly between 1913 and 1916 (Lincoln, 1923). Scheelite and local galena and pyrite occur with quartz in a thin marble bed that strikes about N. 70° E. and dips 20°-30° NW. Scheelite from quartz veins in the granitic rocks at the Johnson mine was mined sporadically from about 1913 to 1943. The quartz veins are 0.5 to 4 ft (0.2 to 1.2 m) wide, strike N. 35°-80° E., and dip 70° SE. to vertical. Production figures for the Bonita and Johnson mines are not available. Prospects in the southwestern part of the district that are near the southern border of the study area contain anomalous amounts of lead and tungsten.

The Chapman-Taylor (Big Wash) mine, a short distance south of the Snake district, was discovered in 1915 and was operated until 1917. Scheelite occurs with quartz mainly in narrow fractures of diverse strike and locally is sporadically disseminated in the limestone country rock. A small amount of scheelite was shipped, but production records are not available.

The Mount Washington district includes a segment of the southwest part of the Wheeler Peak area. No mines are within the study area, but lead and silver were produced from the St. Lawrence mine about 1 mi (1.6 km) south, and tungsten and beryllium were mined at the Mount Wheeler mine about 1.5 mi (2.4 km) south of the area. The ore bodies are in narrow veins of quartz or calcite along small north- and east-trending faults and as replacement deposits near the faults. At the Mount Wheeler mine, scheelite, phenakite, and bertrandite occur with fluorite, pyrite, sericite, and manganoan siderite (Smith, 1976). Ore shoots as much as 10 ft (3 m) wide and 20 ft (6 m) high have an average BeO content of 1.0 percent and a WO_3 content ranging from a trace to 25 percent but averaging less than 0.5 percent (Stager, 1960; Smith, 1976).

The Lexington district includes a strip along the southeast border of the study area, but no mines are within the area. A small amount of lode and placer scheelite was produced from mines in the district.

Highland Ridge Futher Planning Area

The Highland Ridge Further Planning Area includes parts of the Mount Washington, Shoshone, and Lexington mining districts (fig. 2). The Mount Washington and Shoshone districts were organized in 1869, and the Lexington district was organized about 1883.

The Mount Washington district includes the northwest corner of the Highland Ridge study area, but no mines or prospects are in the study area. Elsewhere in the district, mines have produced tungsten, beryllium, lead, and silver.

The Shoshone district includes most of the west side of the study area. Mines just west of the study area are the largest producers of tungsten in the southern Snake Range, and a small amount of lead and silver has also been mined in the district. Smith (1976) states that total production from the district probably exceeds \$2 million. The largest mines are the Scheelite Chief, Silver Bell, and East Everit. Scheelite occurs in quartz veins along normal faults that strike east and dip 45°-70° N. (Lemmon, 1944). The quartz veins range in width from a few inches (centimeters) to 30 ft (9 m), and are as much as 4,000 ft (1219 m) long. The veins are offset by many faults with displacements as much as 400 ft (122 m). The faults disrupt ore shoots that were formerly continuous for 900 ft (274 m) or more (Lemmon, 1944) The easternmost workings of the Silver Bell mine extend into the study area, and the vein of the Canary Yellow mine crops out in the study area (Brown, 1983).

The Lexington mining district includes the northeastern part of the Highland Ridge area, but all the mines and most of the prospects in the district are excluded from the area. Scheelite worth about \$100,000 was mined at the Bonanzy mine in 1918 and 1941-42 (Smith, 1976), and a small amount of scheelite also was produced at the Hope mine. The mines are less than 0.5 mi (0.8 m) outside the boundaries of the study area. At both mines the scheelite is in calcite veins commonly less than 1 ft (0.3 m) wide, and in colluvium overlying the bedrock. The area of scheelite-bearing veins at the Hope mine may extend into the study area, although analyses of samples from pits and trenches near the border show little promise. One mile (1.6 km) southeast of the Bonanzy mine, an adit and several cuts explore a quartz vein as much as 7 ft (2 m) thick that has sparsely disseminated sulfide minerals containing copper, lead, silver, and zinc.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

The mineral resource potential of the Wheeler Peak and Highland Ridge Further Planning Areas was appraised on the basis of geological, geochemical, and geophysical surveys by the U.S. Geological Survey and examination and sampling of mines and prospects by the U.S. Bureau of Mines. A classification of high, moderate, or low potential for mineral resources was based on observed mineral occurrences in mines and prospects, proximity to known mineral occurrences, geochemical data from rock and stream-sediment samples, and the stratigraphic and structural setting. A high mineral resource potential indicates high probability of the presence of mineral deposits. A moderate mineral resource potential indicates a reasonable chance for the occurrence of mineral deposits. A low mineral resource potential indicates little or no evidence to suggest the presence of mineral deposits.

The Wheeler Peak Further Planning Area contains areas of low to moderate potential for tungsten, beryllium, lead, zinc, and placer gold, and anomalously high thorium values noted in analyses of panned concentrates of stream sediments suggest a low to moderate potential for thorium and rare earth oxides in placer deposits. The Highland Ridge Further Planning Area contains one area of moderate to high potential for tungsten, and several areas of low to moderate potential for tungsten, lead, zinc, and silver. In addition, anomalously high barium values have been noted in analyses of panned concentrates of stream sediments, but the potential for mineral resources is considered to be low. Specific areas considered to have mineral resource potential are delineated on figure 2 and the accompanying mineral resource potential map, and the criteria upon which the classifications are based are discussed below. The areas of favorable potential for mineral resources are underlain mainly by the Pioche Shale, Pole Canyon Limestone, and granitic rocks, all of which are in the lower plate of the Snake Range decollement. Most areas underlain by rocks in the upper plate of the decollement are considered to have low potential for mineral resources, but favorable host rocks concealed beneath the decollement possibly have low to moderate potential for deposits of tungsten, beryllium, silver, and lead.

Tungsten

Several tungsten mines are within or adjacent to the Wheeler Peak and Highland Ridge Further Study Areas. Areas B through K are all considered to have a low to moderate potential for tungsten, and area L has a moderate to high potential. In the Wheeler Peak area, scheelite and huebnerite deposits of the Johnson and Hub mines are in area C, the Bonita scheelite mine lies on the north border of area G, and the Chapman-Taylor (Big Wash) scheelite mine is on the south border of area F. The resource potential of these mines was not classified higher than the remaining part of each area, however, because it seems doubtful that reserves of tungsten in unmined portions of the veins are of sufficient tonnage and grade to be economic. The low to moderate classification for Areas D and E is based mainly on the presence of the Pioche Shale and the Pole Canyon Limestone, which are favorable host rocks for mineral deposits in other areas, although concentrates of stream sediments in a drainage from area D contain only 500 ppm tungsten, and those from a main drainage in area E contain <100 ppm tungsten. Area F also contains exposures of the Pioche Shale, and one prospect pit in the lower part of the formation contains visible sphalerite and 150 ppm tungsten.

Concentrates of stream sediments from drainages of areas F and G of the Wheeler Peak study area and areas H and I of the Highland Ridge study area contain 2,000-5,000 ppm tungsten. The source of the tungsten in these areas probably is scheelite in quartz veins in the Pole Canyon Limestone. In the Highland Ridge area, area L is immediately adjacent to the scheelite mines of the Shoshone district and includes the easternmost workings of the Silver Bell mine. The area in the vicinity of the mine has a high potential for tungsten; more than 1,000 units of WO_3 are inferred to be present on the basis of exposures in the mine workings (Brown, 1983) The remaining part of area L has a moderate potential for tungsten. The vein of the Canary Yellow mine crops out in area L, and other east-trending quartz veins may extend into the area, although they are not exposed at the surface. A prospect pit in area J contains scheelite in quartz veins, and concentrates of a stream-sediment sample from the northern part of area J contain 2,000 ppm tungsten.

Beryllium

Beryllium values range from 100 to 1,000 ppm in panned concentrates of samples from drainages on the west side of the Wheeler Peak area. Phenakite and bertrandite have been mined at the Mt. Wheeler mine, southwest of area F (Stager, 1960), and phenakite, bertrandite, and beryl occur in the Pioche Shale at several other properties in the vicinity. High beryllium values in drainages near the southwest corner of the Wheeler Peak area are related to mineralization in the Pioche Shale. In drainages farther north the source of the beryllium in the stream sediments is unknown, but probably is beryllium minerals from veins in the granitic rocks. Areas B and C, which contain mainly granitic rocks, have a low to moderate potential for beryllium. Areas E and F are considered to have low to moderate potential for beryllium because of the presence of the Pioche Shale.

Beryllium values range from 100 to 150 ppm in panned concentrates of samples in stream sediments near area J in the northeast part of the Highland Ridge area. The source of the anomalous beryllium values is not known, and the drainage basin extends considerably beyond the boundary of the study area.

Lead, zinc, and silver

Those areas considered to have low to moderate potential for lead, zinc, or silver were classified mainly on the basis of high values of these metals in geochemical samples. A low to moderate potential for lead, zinc, or silver in areas F, H, and I is based on the proximity of lead-silver mines outside of the study areas and on analyses of panned concentrates of stream sediments that contain 300-10,000 ppm lead, 1,000-5,000 ppm zinc, and <3-100 ppm silver. The fault that contains lead-silver ore at the St. Lawrence mine projects southward into area I, but it is concealed beneath rocks in the upper plate of the Snake Range decollement. The anomalous values of lead and silver in panned concentrates of stream sediments in area K probably are related to the mineralized area explored by an adit and prospects from which samples yielded 1,500 ppm lead, 1,000 ppm zinc, 50 ppm silver, and 1,000 ppm copper. Although silver ore was mined west of area L, production was very meager, and the potential for silver in area L is considered to be low.

Gold

Area A is considered to have moderate potential for gold on the basis of placer workings that have yielded a small amount of placer gold. No other localities within the study areas are considered favorable for gold, but both placer and lode deposits of gold were mined in the Osceola district a few miles northwest of the Wheeler Peak area.

Thorium

Thorium values ranging from 200 ppm to $>2,000$ ppm were noted in panned concentrates of stream sediments in drainages that include granitic rocks. Sample sites with high thorium values are shown on the accompanying map. The thorium is contained in allanite and monazite, which are accessory minerals in the granitic rocks.

In the southern part of the Wheeler Peak area, allanite and monazite are present in the granitic rocks in amounts from 0.04 to 0.12 weight percent (Garside, 1973). The ThO_2 content of the allanite ranges from 0.9 to 2.5 percent, and from 5.9 to 14.8 percent in the monazite (Lee and Bastron, 1967). Total rare earth oxides in the allanite range from 15.5 to 25.3 percent, and from 36.3 to 75.5 percent in the monazite. The allanite and monazite are locally concentrated as placer deposits in alluvium.

Additional studies are needed to determine the size and grade of these placer concentrates. Many of the favorable sites, however, are in canyons excluded from the study area.

Barium

Anomalous barium values ranging from 700 ppm to >5,000 ppm in panned concentrates of stream sediments are apparently related to small veinlets or beds of barite in Paleozoic carbonate rocks mainly in the Highland Ridge area. Sample sites with high barium values are shown on the accompanying map, but the potential for barite resources is considered to be low.

Other commodities

The Paleozoic carbonate units in the southern Snake Range are a major resource of limestone, but they have low potential because of the distance from markets. A small quantity of rock from the Lincoln Peak Formation, Prospect Mountain Quartzite, and McCoy Creek Group has been used for building stone or flagstone, but the potential for these localities also is restricted by their inaccessibility. The potential for sand and gravel is low because these materials are readily available at more accessible sites. Tracts east and west of the Wheeler Peak and Highland Ridge areas have been leased for oil and gas exploration, and several square miles of land along the borders of the study areas were under lease in June, 1981, or lease applications were pending. The potential for oil and gas within the study areas is believed to be low.

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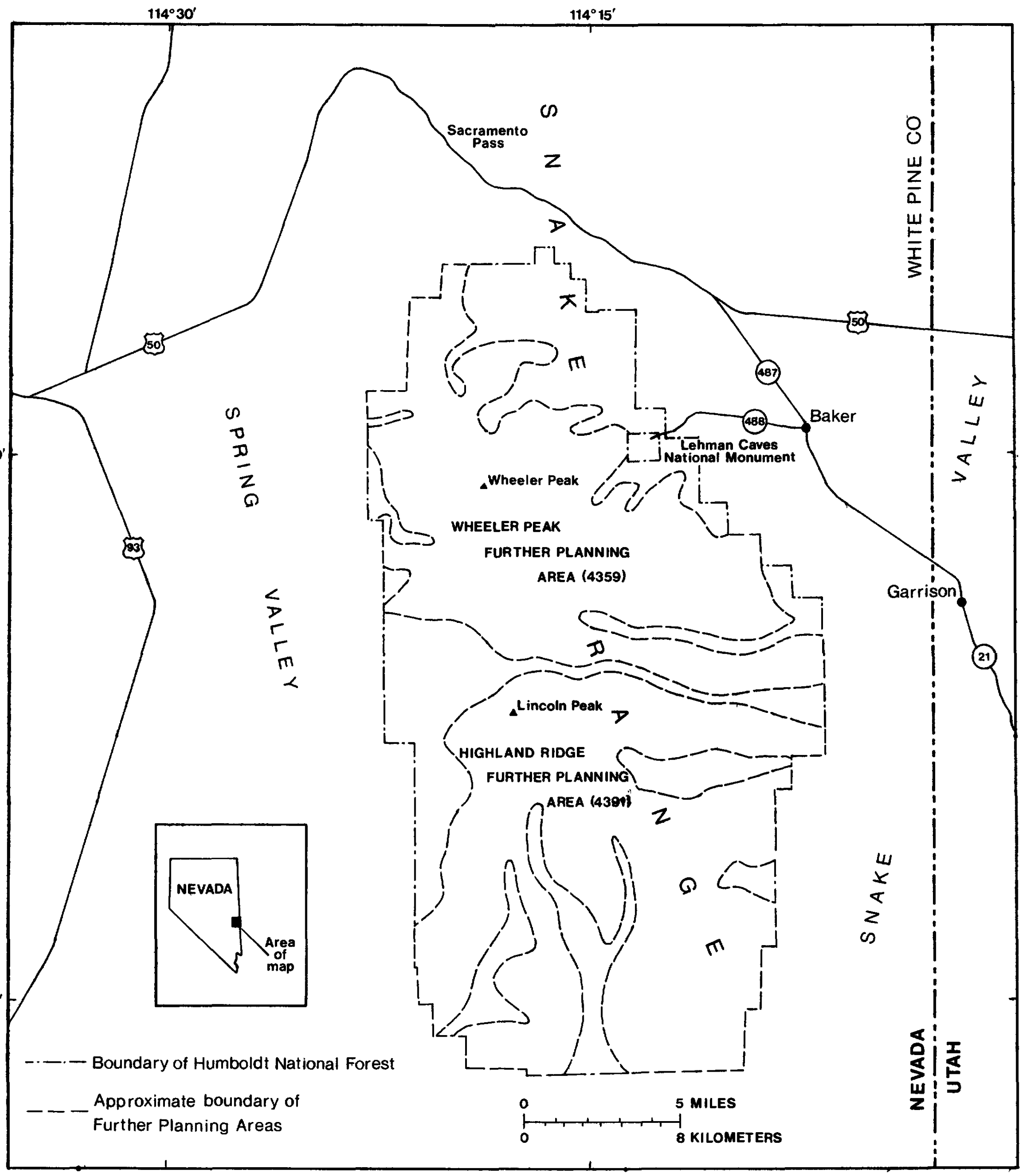
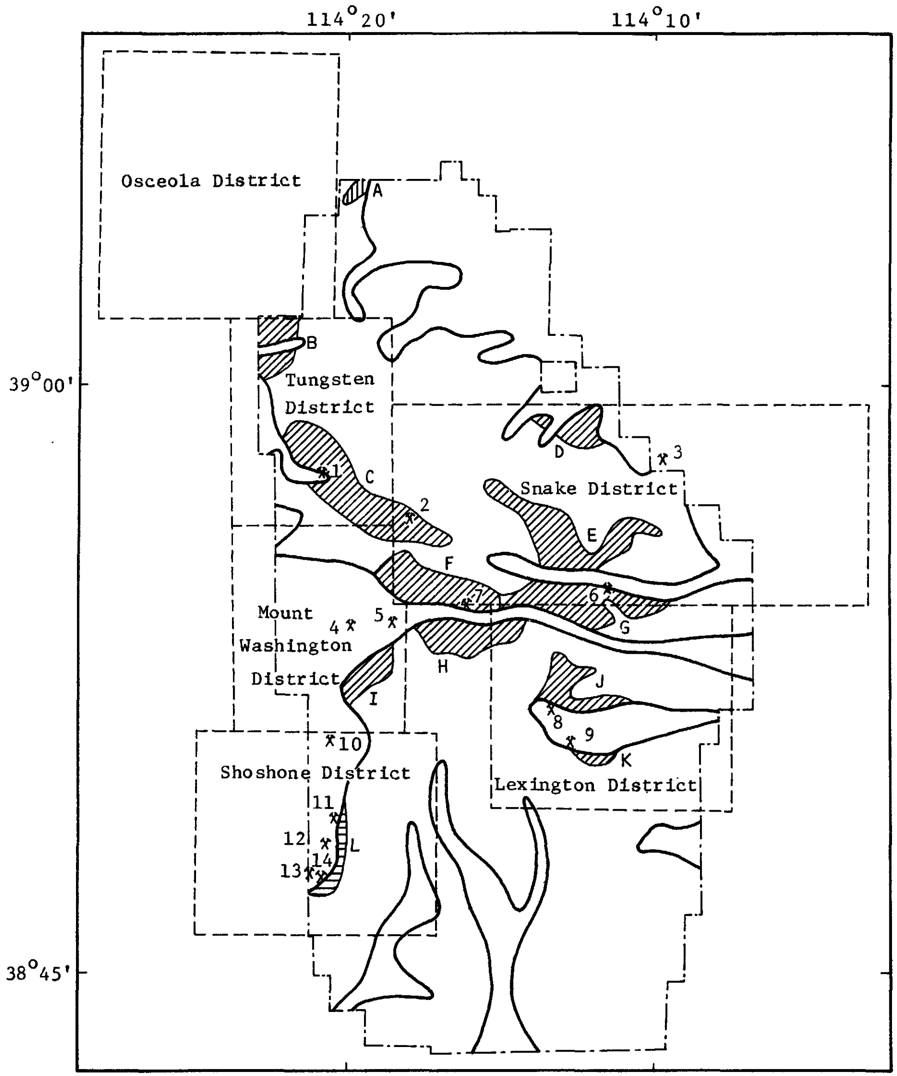


Figure 1.--Index map showing location of the Wheeler Peak and Highland Ridge Further Planning Areas, Nevada.



EXPLANATION

Areas of mineral potential. Letters identify areas discussed in text.

Moderate to high potential

L tungsten

Moderate potential

A gold

Low to moderate potential

D, G, J tungsten

B, C tungsten, beryllium

E, F tungsten, beryllium, lead, zinc, silver

H, I, K tungsten, lead, zinc, silver

Approximate boundary of further planning area

Boundary of Humboldt National Forest

Approximate boundary of mining district

Mine

1 Hub mine
2 Johnson mine
3 Poljack mine
4 Mt. Wheeler mine
5 St. Lawrence mine
6 Bonita mine
7 Chapman-Taylor (Big Wash) mine
8 Hope mine
9 Bonanzy mine
10 Mortenson mine
11 Canary Yellow mine
12 East Everit mine
13 Scheelite Chief mine
14 Silver Bell mine

0 5 Miles

8 Kilometers

Figure 2.--Areas of mineral resource potential in the Wheeler Peak and Highland Ridge Further Planning Areas, Nevada.