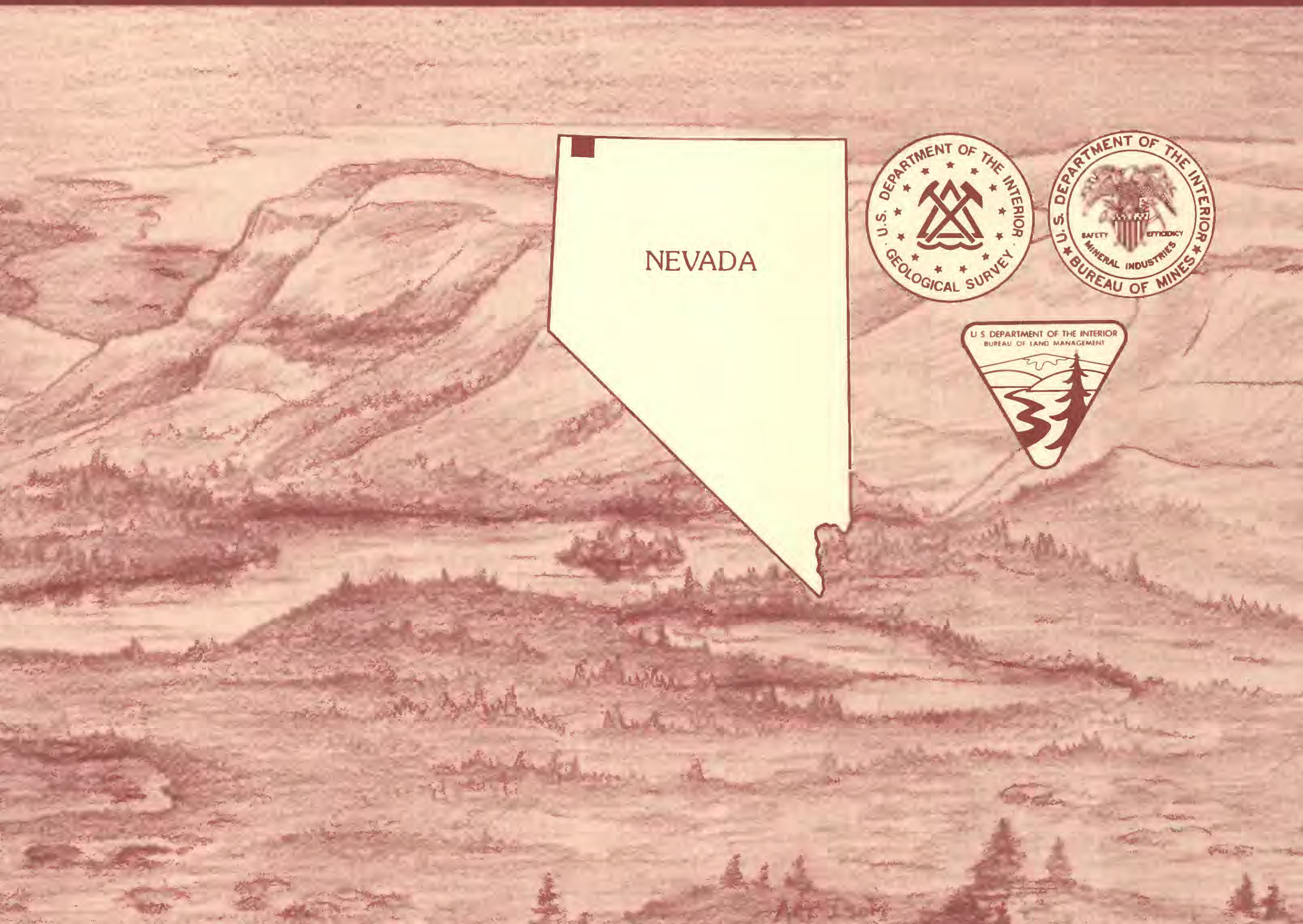
Mineral Resources of the Blue Lakes Wilderness Study Area, Humboldt County, Nevada

U.S. GEOLOGICAL SURVEY BULLETIN 1726–D



Chapter D

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MINERAL RESOURCES OF WILDERNESS STUDY AREAS:
HUMBOLDT AND PERSHING COUNTIES, NEVADA

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

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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 the 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 part of the Blue Lakes Wilderness Study Area (NV-020-600), Humboldt County, Nevada.

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Mineral Resources of the Blue Lakes Wilderness Study Area, Humboldt County, Nevada

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SUMMARY

Abstract

The part of the Blue Lakes Wilderness Study Area (NV-020-600) requested for mineral surveys encompasses 16,400 acres in the southern part of the Pine Forest Range, Humboldt County, Nev. Field work for this report was done in 1984. No resources were identified within the wilderness study area. There is low potential for undiscovered gold and silver resources and associated antimony, copper, lead, mercury, molybdenum, zinc, and uranium throughout the study area. A low potential exists for undiscovered tungsten resources in skarn in three small areas of limestone in the northern part of the study area. In this report, references to the Blue Lakes Wilderness Study Area refer only to that part of the wilderness study area requested by the U.S. Bureau of Land Management for mineral surveys.

Character and Setting

The Blue Lakes Wilderness Study Area is in the southern part of the Pine Forest Range in northwest Nevada near the Oregon border (fig. 1). These mountains are in the Basin and Range physiographic province, which is characterized by north-trending fault-bounded ranges separated by broad alluviated valleys. Relief in the area is rugged; elevations range from about 5,100 ft in the Big Creek drainage on the east side of the study area to 9,397 ft at Duffer Peak in the center. From Nevada Highway 140 west of Denio Junction, access to the study area is provided by gravel roads from the north, west, and south. The eastern part of the area is accessible by roads leading from Nevada Highway 140, south of Denio Junction.

The study area is underlain mostly by granitic rocks of Jurassic and Cretaceous age (205 to 66 million years before present (Ma); see appendix for geologic time chart). The northeastern part of the study area is underlain by folded and faulted marine metasedimentary rocks of Permian(?) and Triassic age that are intruded by the younger granitic rocks.

No mines have been developed within the study area. Mining in the Pine Forest Range outside the study area began in the latter half of the nineteenth century and has continued intermittently. The Ashdown mine, about 7 mi north of the study area (fig. 1), is the largest mine in the region and has produced gold, silver, lead, molybdenum(?), and copper. The mine was again being developed in 1985 for gold in quartz veins and byproduct molybdenum. The Adams gold mine (Homer Verne mine) is less than 0.5 mi northeast of the study area (fig. 2). The Nevada King mine, about 1 mi southeast of the study area (fig. 2), produced small amounts of gold, silver, and antimony.

Identified Resources

No resources were identified within the Blue Lakes Wilderness Study Area. Field observations and analyses of samples from sites within the study area indicate the presence of small amounts of gold, silver,

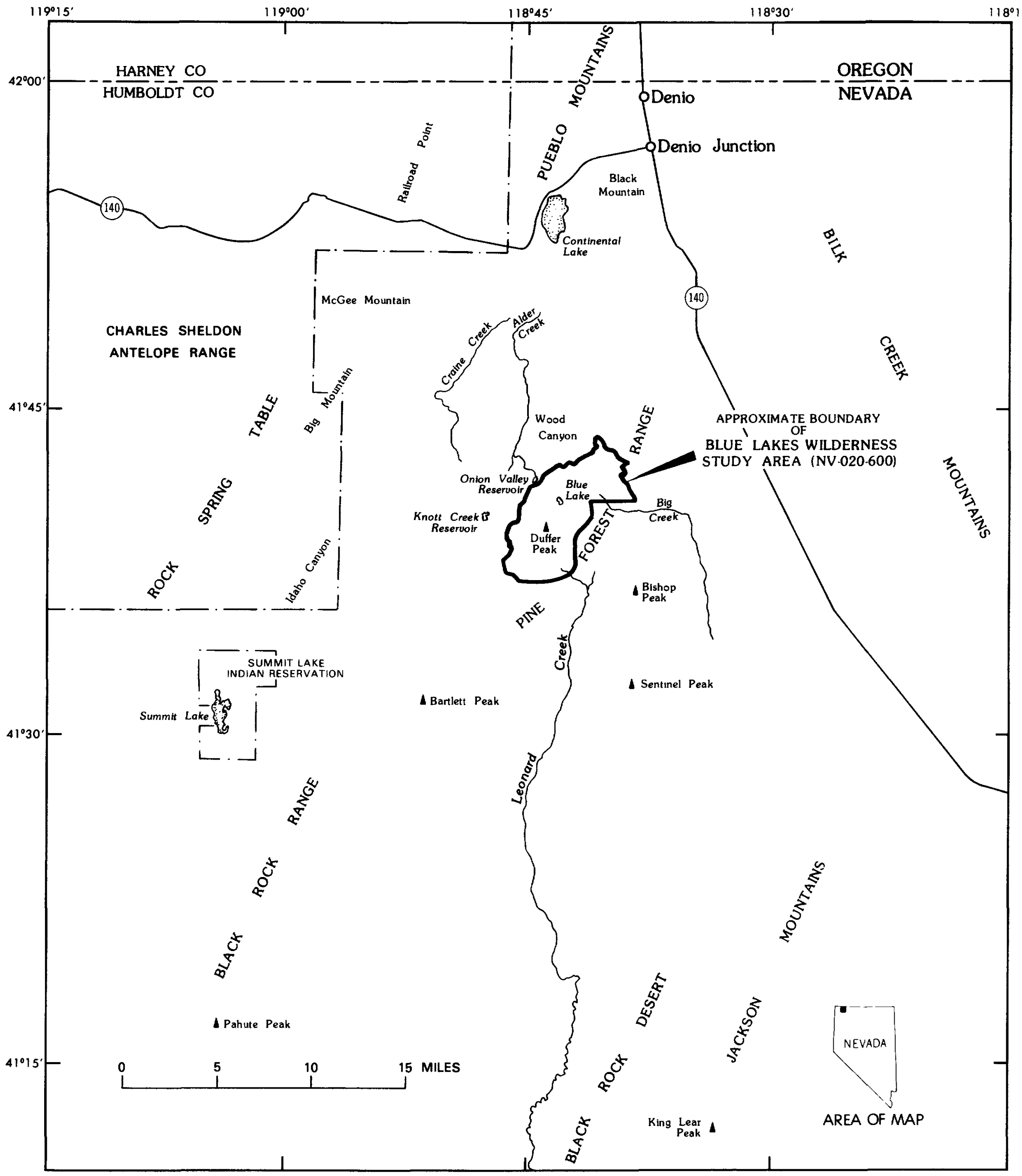

Figure 1. Index map showing location of Blue Lakes Wilderness Study Area, Humboldt County, Nevada.

copper, antimony, lead, zinc, molybdenum, and uranium in discontinuous quartz veins and associated altered zones. Very fine grained gold is present at the Arriba No. 1 placer claim 0.5 mi southwest of the study area but in quantities too small to be considered a resource (table 1). No promising exploration targets are recognized.

Mineral Resource Potential

There is low potential in the study area for undiscovered gold and silver resources with associated antimony, copper, lead, mercury, molybdenum, zinc, and uranium in small epithermal-vein deposits (fig. 2). Mines were developed elsewhere in the Pine Forest

Range primarily for gold and silver (table 1). The quartz veins that contain the ore typically have minor amounts of base metals (for example, copper, lead, and zinc) and uranium. The vein systems are believed to be related to the granitic plutons in the area. Veins are found in both the granitic rocks and the older metamorphic rocks. The Tertiary volcanic rocks in the area are younger that the granitic and metamorphic rocks, and hence have no potential for vein deposits of this type.

There is a low potential for undiscovered tungsten resources in skarn in the areas of carbonate rock that are intruded by granitic rocks (fig. 2). A small area of limestone (part of the sedimentary rocks of Bishop Canyon) is present on the ridge between the upper parts of Wood and Big Creek Canyons (fig. 2). This is the only sizeable area of carbonate rock in the study area.

INTRODUCTION

Area Description

The part of the Blue Lakes Wilderness Study Area (NV-020-600) requested for mineral surveys covers 16,400 acres on the crest of the Pine Forest Range, south of Denio in Humboldt County, Nev. (fig. 1). The rugged terrain is characterized by cirques, ridges, steep slopes, and boulder-strewn basins. Partially eroded moraines are common in the higher parts of the study area. Elevations range from about 5,100 ft on the east side of the study area near Big Creek to 9,397 ft at Duffer Peak, the highest point in the Pine Forest Range. Blue Lake, a small cirque lake, is about 1 mi northeast of Duffer Peak; other small cirque lakes are also present in the study area. Three reservoirs are close to the west boundary outside the study area. More than 16 in. of precipitation fall annually in the Pine Forest Range (Houghton and others, 1975), and several perennial streams drain the study area. Vegetation at the lower elevations consists mostly of grasses, sagebrush, pinyon, and juniper. Higher elevations support scattered thick stands of pine, and aspen trees grow in the drainages. Other plants of the higher elevations include willow, snowberry, serviceberry, and mountain mahogany. The area also supports a rich fauna including antelope, mule deer, sage grouse, chukars, and raptorial birds.

Previous Investigations

The Blue Lakes Wilderness Study Area includes parts of the Duffer Peak, and Idaho Canyon 15-minute quadrangles. The geologic map of the Duffer Peak quadrangle by Smith (1973) served as the basis for most of the geologic map for this study. Smith (1966) discussed the geology of the area in detail and mapped an area that includes most of the study area. The geology of the northern part of the Pine Forest Range is discussed by Bryant (1970) and Graichen (1972). Willden (1964) reported on the geology and mineral deposits of Humboldt County, Nev. The west side of the Pine Forest Range and parts of the Idaho Canyon quadrangle were mapped by Donald C. Noble (unpub. data, 1985). Bergquist and others (1987) compiled a geologic map of the Blue Lakes Wilderness Study Area.

The mining districts and mineral production in Nevada, including information on the Pine Forest Range, are discussed in Raymond (1875), Hill (1912), Lincoln (1923), Couch and Carpenter (1943), Koschman and Bergandahl (1968), and Johnson (1973). Information on the mining districts and mineral resources of Humboldt County is given in Vanderberg (1938). Barringer Resources, Inc. (1982), published a report on their geochemical and geostatistical evaluations of the U.S. Bureau of Land Management (BLM) Winnemucca District. The U.S. Bureau of Land Management (1983) published a wilderness technical report that includes a section on the Blue Lakes Wilderness Study Area. The mineral resources, mines, and prospects in and around the Blue Lakes Wilderness Study Area are discussed in Willett (1985).

Present Investigations

This mineral resource study is a joint effort by the U.S. Geological Survey (USGS) and the U.S. Bureau of Mines (USBM). Mineral assessment methodology and terminology are discussed by Goudarzi (1984). Studies by the USGS are designed to provide a reasonable scientific basis for assessing the potential for undiscovered mineral resources by determining geologic units and structures, possible environments of mineral deposition, and presence of geochemical and geophysical anomalies. The USBM evaluates identified resources at individual mines and known mineralized areas by collecting data on current and past mining activities and through field examination of mines, prospects, and mineralized areas.

The U.S. Geological Survey conducted field investigations in 1984. Work consisted of geologic mapping in the western part of the area, field checking existing mapping, geochemical sampling, and taking gravity measurements. Geochemical samples were analyzed by semiquantitative spectrographic methods to reveal areas having anomalous concentrations of elements.

The U.S. Bureau of Mines collected information relating to current and past mining activities within and adjacent to the study area. Geological libraries, U.S. Bureau of Mines production records, and the Mineral Industry Location System (MILS) were searched for data pertaining to the area. Bureau of Land Management records of mining claims, land status records, and county claim records were examined. Claim owners and lessees were contacted, when possible, for permission to examine properties and publish the results.

Field work by the U.S. Bureau of Mines was completed during 1984 and involved searches for all prospects and claims indicated by preliminary studies to be within the study area. Those found were examined and, if warranted, mapped and sampled. Properties and claims within 1 mi of the study area boundary were also studied to determine whether mineralized zones extend into the study area. In addition, areas of obvious rock alteration were

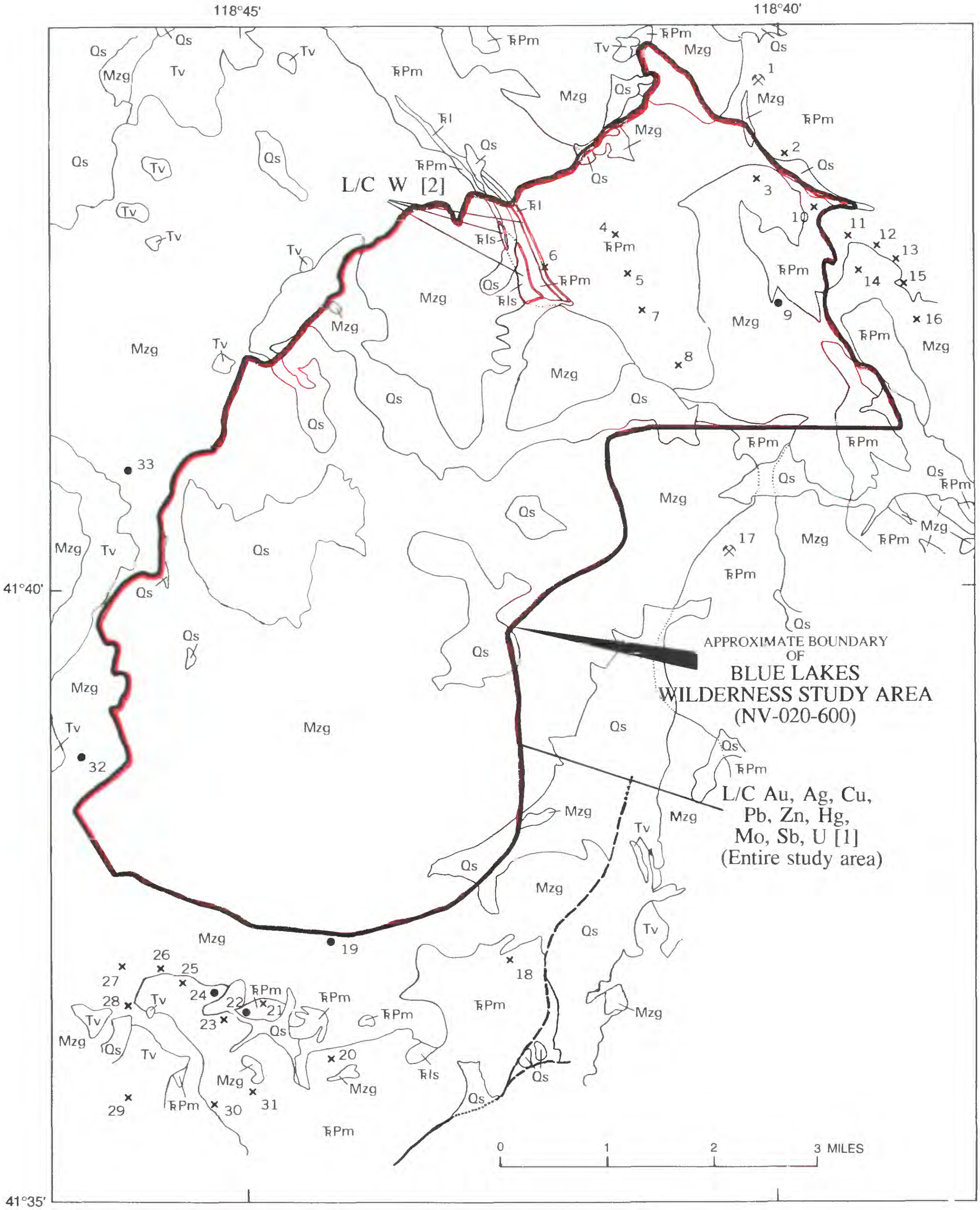

Figure 2. Mineral resource potential and generalized geology of the Blue Lakes Wilderness Study Area, Humboldt County, Nevada.

checked for mining-related activities that may not have been recorded.

The U.S. Bureau of Mines collected samples from mines, prospects, claims, and mineralized sites within or adjacent to the Blue Lakes Wilderness Study Area. Chip samples were taken across mineralized structures, and grab samples were collected from dumps at prospect sites where no outcrops were present or where underground workings were inaccessible. Samples were analyzed using a variety of

EXPLANATION

Area with low mineral resource potential—See appendix for definition of levels of mineral resource potential and certainty of assessment

Commodities

Ag	Silver	Pb	Lead
Au	Gold	Sb	Antimony
Cu	Copper	U	Uranium
Hg	Mercury	W	Tungsten
Mo	Molybdenum	Zn	Zinc

[ ] Types of deposits

1 Hydrothermal veins in granitic and metamorphic rocks

2 Skarn deposits in carbonate rocks near contact with granitic rocks

Description of Map Units

Qs **Surficial deposits (Quaternary)**—Includes moraines, alluvium, and landslide deposits

Tv **Volcanic rocks (Tertiary)**—Consists of andesite flows, basalt flows, and tuff

Mzg **Granitic rocks (Mesozoic)**—Consists of Theodore Quartz Diorite (Jurassic), Duffer Peak Granodiorite (Cretaceous), and dikes and plugs of alaskite and aplite

Ŧl **Massive limestone (Triassic)**—Consists of massive white to buff pure limestone at the base grading upward into quartz-sand-bearing limestone, limy sandstone, pebble conglomerate, carbonaceous limestone, and fine-grained metapelite beds. Part of the sedimentary rocks of Bishop Canyon (Smith, 1973)

Ŧls **Limestone (Triassic)**—Consists of white to gray, quartz-sand-bearing to pure limestone, with a white limestone-pebble conglomerate at the base. Part of the sedimentary rocks of Bishop Canyon (Smith, 1973)

ŦPm **Metasedimentary rocks (Triassic and Permian?)**—Consists of quartzite and biotite-hornblende schist (unit Ŧq of Smith, 1973), phyllite, sandy hornfels, and chert-pebble conglomerate (unit Ŧp of Smith, 1973), and chert, phyllite, and sandy hornfels (unit Ŧc, a part of the Sedimentary Rocks of Bishop Canyon of Smith, 1973)

Contact—Dotted where concealed

Fault—Dashed where approximately located; dotted where concealed

1 Mine—See table 1 for description

22 Prospect

9 Mineralized outcrop—See table 1 for description

Figure 2. Continued.

laboratory techniques including fire assay, inductively coupled plasma, atomic absorption, colorimetic, and X-ray fluorescence. Descriptions of methods and analytical limits are given in Willett (1985).

APPRAISAL OF IDENTIFIED RESOURCES

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Mining History and Production

The earliest mining in the Pine Forest Range began in 1863 at the Ashdown mine (fig. 1) in the Warm Springs mining district, 7 mi north of the study area (Graichen, 1972). A small mill was constructed at the mine in 1864 but was subsequently burned by hostile Bannock Indians (Vanderburg, 1938). The Ashdown mine, the largest in the Warm Springs mining district, eventually produced 10,287 oz (troy ounces) of gold (Couch and Carpenter, 1943, p. 68). Total production from the district was approximately 22,870 oz of gold and silver between 1888 and 1981 (Couch and Carpenter, 1943; U.S. Bureau of Mines unpub. data, 1985).

The Varyville mining district, in the Pine Forest Range approximately 6 mi south of the study area, was first prospected in the 1870's. Couch and Carpenter (1943) recorded gold production on 184 oz in 1875 and 926 oz in 1936. U.S. Bureau of Mines records indicate 1,704 oz of lode and placer gold were produced from 1935 through 1956.

Placer gold was first discovered about 1914 in the Leonard Creek mining district, 3 mi south-southeast of the study area (Vanderburg, 1938). Lode gold was also mined in this district. U.S. Bureau of Mines records indicate total placer production of 175 oz of gold from 9,200 yd^3 of gravel from 1933 to 1941, and lode production of 1,176 oz of gold from 1936 through 1939.

Earliest recorded production in the Pine Forest (Boyd Basin) mining district was from the Adams mine (fig. 2) in 1933. The district abuts the study area on the northeast (fig. 2). The mine produced approximately 324 oz of gold between 1933 and 1935 and 469 oz of gold and 223 oz of silver in 1936. U.S. Bureau of Mines records show 1,305 oz of gold and 418 oz of silver were produced from the mine between 1939 and 1941.

U.S. Bureau of Mines records indicate the Nevada King mine (Pass Creek mine, American antimony mine), located about 1 mi east of the study area (fig. 2), produced 22 oz of gold and 1 oz of silver in 1910 and 1911.

In 1979, Exxon Minerals Company staked 551 claims for uranium adjacent to and near the southern part of the Blue Lakes Wilderness Study Area. Subsequently several holes were drilled to evaluate uranium potential. Conoco also staked 21 claims for uranium in 1979 within a mile of the south boundary of the study area. According to Humboldt County records, both companies performed final assessment work in 1980 and dropped their claims, presumably because of the depressed uranium market, low uranium values, or both.

Humboldt County claim records show the earliest placer and lode activity within or adjacent to the Blue Lakes Wilderness Study Area as having occurred in the Snow Creek drainage (fig. 2) in 1916 and 1924 respectively. U.S. Bureau of Mines records indicate a total production of 7.28 oz of gold from the Snow Creek area in 1935 and 1936. Approximately 351 lode claims and 5 placer claims were located between 1916 and 1980 inside or adjacent to the study area according to Humboldt County records. As of March 1985, there were 49 lode and 2 placer claims in and near the study area.

Mines, Prospects, Claims, and Mineralized Sites

Mineral deposits and occurrences in the Big Creek area (fig. 2) are mostly related to discontinuous quartz veins that cut Triassic metasedimentary rocks. The veins are typically in or near contacts between different metasedimentary units (amphibolite, quartzite, and phyllite) or are near the contact between metasedimentary rocks and Jurassic or Cretaceous granitic intrusive rocks (Smith, 1973).

Willden (1964) described the Adams mine (fig. 2, table 1) as consisting of quartz veins that cut hornfels, schistose sedimentary rocks, quartzite, and slate. The quartz veins generally trend northwest and appear to be controlled by fault zones. Most veins contain gold, silver, copper, lead, zinc, or molybdenum. Silicification is the predominant type of alteration observed around the mine. The deposits do not extend into the study area.

The Nevada King mine (fig. 2, table 1) is about 1 mi east of the study area. According to U.S. Bureau of Mines files, antimony is found there in discontinuous veins along fault zones that parallel the bedding and foliation of phyllite and interbedded quartzite. High-grade pockets are rare. The Triassic metasedimentary host rocks appear to constitute a large roof pendant surrounded by plutonic rock (Smith, 1973).

Prospects and mineralized sites in the northeastern part of the study area consist mainly of small quartz veins (fig. 2, table 1) that contain minor amounts of gold, silver, copper, lead, zinc, and molybdenum. No mineral resources were identified.

Mineralized and altered zones in the vicinity of Snow Creek southwest of the study area are on or near the contact between the Cretaceous Duffer Peak Granodiorite and Triassic(?) and Jurassic rocks of the Happy Creek Volcanic Complex (formerly Happy Creek Volcanic Series), which are not found in the study area (Olander, 1980). The Happy Creek Volcanic Complex (Sorensen, 1986) is now considered to be Triassic(?) and Jurassic on the basis of rubidium-strontium radiometric dating by Russell (1981) and stratigraphic relations. Smith (1973) showed the Happy Creek as older than the sedimentary rocks of Bishop Canyon, which contain Triassic fossils (N.J. Silberling, oral commun., 1986), but newer evidence indicates reverse stratigraphic relations (Silberling and others, 1984). However, to be consistent with Smith's (1973) geologic map, this paper continues to use his descriptions of units. Molybdenum, uranium, and precious-metal minerals are present along this contact in and around altered alaskite and aplite dikes that cut rocks of the Happy Creek Volcanic Complex, and in quartz veins within the granodiorite (Olander, 1980, p. 42). Olander (1980) proposed that the altered zones and mineralized areas were formed from late stage hydrothermal solutions from the Duffer Peak Granodiorite. Molybdenite is present locally in the Snow Creek area as rosettes, but is more commonly disseminated in quartz veins and locally accompanied by hematite, chalcocite, chalcopyrite, malachite, and azurite. Several altered aplite dikes in the volcanic rocks about 650 to 1500 ft from the contact with the granodiorite also contain anomalous concentrations of molybdenum (Olander, 1980, p. 44).

The presence of uranium and zones of anomalous radioactivity are associated with altered aplite dikes exposed in the Happy Creek Volcanic Complex immediately adjacent to Duffer Peak Granodiorite (Olander, 1980). Both the dikes and the surrounding host rocks have undergone moderate to intense alteration, which varies from incipient development of clay minerals to total replacement of aplite and alaskite by secondary silica (Olander, 1980). Thirteen lode prospects, claims, and mineralized sites in the Snow Creek area (fig. 2; table 1), all outside the study area, are vein-type deposits that contain anomalous amounts of gold, silver, copper, molybdenum, and uranium. No mineral resources were identified at any of the prospects or at a mineralized site near the study area.

Very fine grained placer gold in alluvium is found at the Arriba No. 1 placer claim (table 1). Prospect pits and trenches cover approximately 14 acres, and alluvium ranges from 2.0 ft to 6.5 ft deep. Quartz float in the prospect area suggests the gold was probably derived from vein deposits. Gold content of alluvial samples averages $3.58/yd^3 at a gold price of $350/oz (0.01 oz/yd). Due to the small size of the deposits, limited water supply, poor access, and randomly distributed gold values, the deposit is not considered a resource.

Two lode samples were collected from a quartz vein and an aplite dike in granitic rock west of the study area near Knott Creek Reservoir (fig. 2; table 1). The samples contain only minor amounts of silver, molybdenum, and uranium.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

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Geology

Rocks of the Blue Lakes Wilderness Study Area consist of an older group of metamorphic and granitic rocks overlain by younger volcanic flows and welded tuffs. Sedimentary rocks of late Paleozoic(?) and early Mesozoic age were metamorphosed, folded, and faulted prior to emplacement of the granitic plutons during the Mesozoic. A long period of erosion followed before Tertiary lavas and tuffs were deposited on erosion surfaces of both the granitic and metamorphic rocks.

The Triassic sedimentary rocks of Bishop Canyon (Smith, 1973), which crop out in the northern part of the area, are the oldest rocks exposed within the study area. Older metamorphic rocks found elsewhere in the Pine Forest Range are absent in the study area. The sedimentary rocks of Bishop Canyon were divided by Smith (1973) into four units—a lowermost limestone, graywacke, and pebble conglomerate unit, a lower limestone unit, a chert, phyllite, and sandy hornfels unit, and an upper limestone unit. Three of the units are exposed in the study area. The lower limestone unit is about 450 ft thick and consists of a white to gray, quartz-sand-bearing to pure limestone, with a basal, white limestone-pebble conglomerate. The chert, phyllite, and sandy hornfels unit is about 300 ft thick. The upper limestone unit is about 1,000 ft thick and consists of massive, white to buff limestone that grades upward into quartz-sand-bearing limestone, limy sandstone, sandstone, pebble conglomerate, carbonaceous limestone, and fine-grained metapelite beds.

About 1,000 ft of Triassic phyllite and sandy hornfels gradationally overlie the sedimentary rocks of Bishop Canyon. Beds of chert-pebble conglomerate are found throughout the section, but are especially common near the bottom.

A sequence of Triassic rocks overlies the phyllite, and upwardly comprises: amphibolite and schist, white massive crystalline marble (not present within the study area), and quartzite.

The Mesozoic and Paleozoic rocks in northwestern Nevada, including those in the Pine Forest Range, were deformed and regionally metamorphosed before emplacement of the Mesozoic plutons (Smith and others, 1971).

Granitic rocks of Jurassic and Cretaceous age intruded the older metamorphic rocks. The Jurassic Theodore Quartz Diorite, the oldest granitic rock in the study area, is exposed in the northern part of the study area. The quartz diorite is typically dark, massive, medium grained, and equigranular. Within the quartz diorite are small bodies of hornblendite that probably represent a mafic phase of the pluton (Smith, 1973). The Cretaceous Duffer Peak Granodiorite underlies most of the study area. The granodiorite is typically light colored, massive, medium grained, and equigranular to inequigranular porphyritic.

Dikes and plugs of Cretaceous alaskite and aplite intrude the Duffer Peak Granodiorite and older rocks. The alaskite is light colored and fine to medium grained; the aplite is light colored and everywhere fine grained.

Tertiary volcanic rocks are present only in small, isolated patches within the study area, although they crop out extensively elsewhere in the range. Small outcrops of black, platy andesite and the vesicular Steens Basalt, both of Miocene age, are present adjacent to the study area on the northwest side.

The Pine Forest Range was uplifted and tilted along north-trending high-angle normal faults on either side of the range after intrusion of the granitic rocks. Uplift and tilting of the range has continued through the late Tertiary, as seen by the successively greater tilting of the bedded volcanic rocks downward in the section.

The surficial deposits in the study area include Pleistocene moraines and Holocene alluvium. The moraines, which are partly eroded, are present in the higher parts of the range and consist of unconsolidated, unsorted debris ranging from silt to boulders. The youngest surficial deposits are small patches of alluvium along drainages and around lakes and marshes.

Geochemical Studies

The U.S. Geological Survey collected and analyzed rock samples. Previously, Barringer Resources, Inc., of Golden, Colo., was contracted by the BLM to collect and analyze stream-sediment samples.

Fifty-three rock samples were taken, representing all of the major rock types within the study area. Analysis of unaltered rock samples establishes background levels of elements. No anomalous concentrations of metals were detected in the rock samples.

Stream-sediment samples were taken at 48 sites along the range front at elevations high enough to avoid being contaminated with material from older alluvium or other drainage basins. The sizes of drainage basins that were sampled range from about 0.5 to 3 mi^2, and the sampling density was approximately one/mi^2. Descriptions of the sampling and analytical techniques used for stream-sediment samples are given in Barringer Resources, Inc. (1982).

Relatively low uranium anomalies were found in stream sediments at 22 sites, with values ranging from 3 to 76 part per million (ppm) (Barringer Resources, Inc., 1982). The anomalies were found at sites around the perimeter of the study area and appear to correlate with the Jurassic and Cretaceous granitic rocks. These rocks are not particularly favorable for concentrations of uranium, although minor amounts are present in veins.

Low-level anomalies were also found for copper (5 sites) and arsenic (5 sites). Other low-level anomalies were found for cadmium, lithium, nickel, and mercury. However, none of these anomalies are high enough to indicate a mineral deposit.

Considered as a suite, anomalous arsenic, mercury, copper, and uranium in stream-sediment samples may be derived from epithermal base- and precious- metal veins (Rose and others, 1979; Berger, 1983). Gold was mined from quartz veins at several locations close to the study area, and placer gold was recovered near the southern parts of the area (Willden, 1964). Outside the study area, on the flank of New York Peak (fig. 1), a small prospect pit dug along a small fault zone contains chrysocolla. The observed anomalies are interpreted to reflect local epithermal base- and precious-metal (gold, silver, copper, lead, zinc, molybdenum) vein-type mineralization similar to other known vein-type deposits that have been prospected and mined in the Pine Forest Range. The anomalies, however, are not high enough to indicate mineral deposits.

Geophysical Studies

Radioelement concentrations of potassium, equivalent uranium, and equivalent thorium were estimated by J.S. Duval (written commun., 1985) by examining unpublished composite-color maps of gamma-ray spectrometric data. The maps were prepared at a scale of 1:1,000,000 from radiometric data acquired in regional surveys contracted by the U.S. Department of Energy as part of the National Uranium Resource Evaluation (NURE) program. East-west flightlines were flown at altitudes of about 400 ft above mean terrain at spacings of about 3 mi (Geodata International, Inc., 1979). The following estimates of radioelement concentrations were based on criteria discussed by Duval (1983). The area has low radioactivity with values of 1.0 to 1.5 percent potassium, 0 to 2 ppm equivalent uranium, and 4 to 7 ppm equivalant thorium. There is no indication of anomalous concentrations of radioelements.

An aeromagnetic survey of the region was flown at a constant barometric elevation of 9,000 ft above sea level with east-west flightlines spaced at 2-mi intervals (U.S. Geological Survey, 1972). Blue Lake and Duffer Peak lie along the axis of a narrow magnetic high, which follows the trend of the Pine Forest Range for about 20 mi. The width of the magnetic high is about 4 mi in the study area, and its amplitude is about 200 nanoTeslas. Two smaller closed magnetic highs within the elongated magnetic high overlie outcrops of Theodore Quartz Diorite. The Duffer Peak Granodiorite apparently has low magnetization, because magnetic intensities over that unit do not correlate with topography. Neither Tertiary volcanic rocks nor the older metamorphic rocks correlate with the magnetic high. Therefore, the elongated magnetic high may reflect large unexposed masses of Theodore Quartz Diorite at shallow depths beneath the study area.

The gravity map of Plouff (1984) supplemented by gravity data from Plouff (1977) shows a north-trending gravity high with an amplitude greater than 10 milligal (mGal), which nearly coincides with the elongated magnetic high. The crest of the gravity high also is correlated with exposures of the Theodore Quartz Diorite. Both gravity and magnetic studies suggest that the Theodore Quartz Diorite or a basement ridge with similar physical properties underlies the Pine Forest Range. Steep gravity gradients, near the longitude of Duffer Peak along the west flank of the anomalies, indicate that the edge of the basement ridge is steep and perhaps fault controlled. These gradients were interpreted by Plouff (1984) as a reflection of a major boundary between a core of pre-Tertiary rocks beneath the Pine Forest Range and a thick section of Tertiary rocks to the west.

CONCLUSIONS

The evaluation of mineral resource potential is based on a variety of data that include the geologic, geochemical, and geophysical features, a survey of mines and prospects, and the mineral resources present in the surrounding regions. Mineral resource potential was classified using the system of Goudarzi (1984) (appendix this report).

There is potential for two types of mineral deposits in the Blue Lakes Wilderness Study Area as revealed by the geology, geochemistry, geophysics, an examination of mines and prospects, and the production records of mines.

The first type of mineral deposit with potential in the study area is epithermal-vein deposits that contain precious metals (gold and silver), base metals (copper, lead, zinc, and associated metals), and uranium (fig. 2). The granitic and metamorphic rocks have a low potential, certainty level C, for gold, silver, copper, lead, zinc, mercury, molybdenum, antimony, and uranium in veins (see Appendix for definition of certainty levels). This type of deposit is the more important in terms of past production in the Pine Forest Range; however, total production has been small. Locally, gold-quartz veins have been mined, as for example at the Adams mine, northeast of the study area.

The geologic setting of the study area is typical of that with precious-metal vein-type mineralization. The mineralizing fluids were probably derived from the magma that formed the Jurassic and Cretaceous granitic rocks that are now the core of the Pine Forest Range. These fluids migrated along fractures of zones of weakness and deposited elements including some metals to form the present vein system in the granitic and surrounding metamorphic rocks. The potential for vein-type deposits exists in all of the Mesozoic granitic rocks and the older metamorphic rocks. The Tertiary volcanic rocks do not have potential for these vein-type deposits. There is no evidence of mineral resource potential in the surficial deposits.

If vein-type deposits are found within the study area, they are likely to be small and to contain only small quantities of mineral resources. This conclusion is based on the size and character of known veins in the area.

The second type of deposit with potential in the area is tungsten-bearing skarns. These deposits can form where felsic plutonic rocks intrude limestones that become metasomatically altered and enriched in a variety of elements. The geologic setting of the Pine Forest Range is favorable for the existence of tungsten-bearing skarns, because Triassic carbonate rocks are locally in contact with intrusive granitic rocks. However, no tungsten mineralization is known in the vicinity, and there is no evident geochemical signature of tungsten skarns. The nearest known tungsten prospect is about 6.5 mi southeast of Duffer Peak (Willden, 1964). However, because of the favorable geologic environment, the contacts between limestone and granitic rock within the study area have a low potential, certainty level C, for tungsten in skarn (fig. 2).

The alluvial and glacial deposits within the study area contain sand and gravel, but other sources are closer to existing markets.

A large area a few miles southeast of the study area that is favorable for local sources of low-temperature (less than 194°F) geothermal water was outlined by Muffler (1979). Bliss (1983) lists a number of geothermal springs in the valleys outside the study area. However, there are no known hot springs within the study area and the geologic setting is not conducive for deep circulation of ground water. There is no evidence of geothermal resources within the study area.

There is no potential for oil and gas within the study area. The core of the area consists of granitic rocks, and any hydrocarbons in the older sedimentary rocks would have been driven of during metamorphism.

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APPENDIXES

DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

Definitions of Mineral Resource Potential

LOW mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources is permissive. This broad category embraces areas with dispersed but insignificantly mineralized rock as well as areas with few or no indications of having been mineralized.

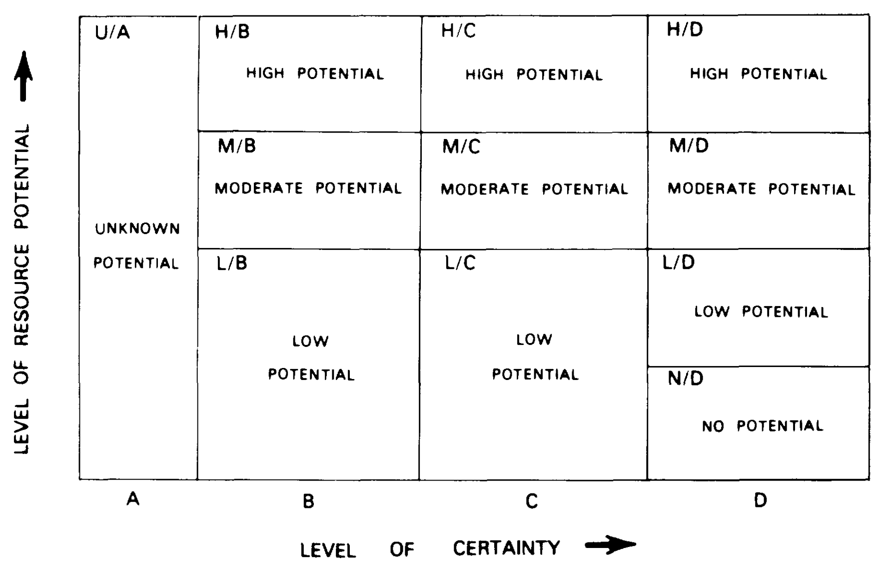
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate reasonable likelihood of resource accumulation, and (or) where an application of mineral-deposit models indicates favorable ground for the specified type(s) of deposits.

HIGH mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data supports mineral-deposit models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

UNKNOWN mineral resource potential is assigned to areas where information is inadequate to assign low, moderate, or high levels of resource potential.

NO mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

Levels of Certainty



A. Available information is not adequate for determination of the level of mineral resource potential.
B. Available information suggests the level of mineral resource potential.
C. Available information gives a good indication of the level of mineral resource potential.
D. Available information clearly defines the level of mineral resource potential.

Abstracted with minor modifications from:

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RESOURCE/RESERVE CLASSIFICATION

	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUB-ECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		

Major elements of mineral resource classification, excluding reserve base and inferred reserve base. Modified from U.S. Bureau of Mines and U.S. Geological Survey, 1980, Principles of a resource/reserve classification for minerals: U.S. Geological Survey Circular 831, p. 5.

GEOLOGIC TIME CHART

Terms and boundary ages used by the U.S. Geological Survey in this report

EON	ERA	PERIOD		EPOCH	AGE ESTIMATES OF BOUNDARIES (in Ma)
Phanerozoic	Cenozoic	Quaternary		Holocene	0.010
				Pleistocene	1.7
		Tertiary	Neogene Subperiod	Pliocene	5
				Miocene	24
			Paleogene Subperiod	Oligocene	38
				Eocene	55
				Paleocene	66
	Mesozoic	Cretaceous		Late	96
				Early	138
		Jurassic		Late Middle Early	205
		Triassic		Late Middle Early	~240
	Paleozoic	Permian		Late Early	290
		Carboniferous Periods	Pennsylvanian	Late Middle Early	~330
			Mississippian	Late Early	360
		Devonian		Late Middle Early	410
		Silurian		Late Middle Early	435
		Ordovician		Late Middle Early	500
		Cambrian		Late Middle Early	~570[1]
Proterozoic	Late Proterozoic				900
	Middle Proterozoic				1600
	Early Proterozoic				2500
Archean	Late Archean				3000
	Middle Archean				3400
	Early Archean				
		- (3800?) -			
pre-Archean[2]					4550

[1]Rocks older than 570 Ma also called Precambrian, a time term without specific rank.

[2]Informal time term without specific rank.

TABLE 1. *Mines, prospects, claims, and mineralized sites in and adjacent to the Blue Lakes Wilderness Study Area*
[*, outside the study area; ppm, parts per million]

Map No. (fig. 2)	Name	Geology	Workings and production	Sample and resource data
*1	Adams mine (Homer Verne mine)	Discontinuous quartz-filled fissures and shear zones, which contain pervasive limonite, specular hematite, and some pyrolusite; strike N. 23° E. to N. 55° W., dip steeply to east or west, and cut Triassic metasedimentary rocks that were intruded by Jurassic quartz diorite.	Two main adits and several small caved adits, trenches, and pits. Recorded production from 1935 to 1940 for Pine Forest mining district (Boyd basin) was 5,075 tons of ore valued at $27,488 at $35/oz gold, or 0.15 oz/ton (Couch and Carpenter, 1943).	Of 26 samples collected of quartz vein and shear zone material and altered host rock, 19 chip samples contained from 0.02 to 11.32 ppm gold; 9 had 0.95 to 61.75 ppm silver; 6 yielded 8.2 to 340 ppm copper and 230 to 3,700 ppm lead; 8 had 12 to 870 ppm zinc; 10 yielded 1.4 to 23 ppm molybdenum; 1 had 6 ppm tungsten. Seven grab samples contained from 0.71 to 10.29 ppm silver; 6 had 0.04 to 11.96 ppm gold; 4 yielded 34 to 4,200 ppm lead and 6.1 to 19 ppm molybdenum; 3 had 22, 200, and 320 ppm zinc; 1 sample contained 6 ppm tungsten.
*2	Prospect	Siliceously altered quartzite and amphibolite schist cut by discontinuous milky quartz veinlets measuring 0.25 to 3 in. in shear zones that strike N. 22°-45° W. and dip vertically.	Two caved adits and three shallow pits.	Three chip samples across silicified zones contained a trace to 0.47 ppm gold, 100 to 300 ppm copper, 140 to 1,900 ppm lead, and 140 to 700 ppm zinc; two contained 1.7 and 2.6 ppm silver and 9.1 and 16 ppm molybdenum. Three grab samples contained 0.37 to 5.99 ppm silver, 19.2 to 49 ppm copper, and 29.6 to 87 ppm zinc.
3	Prospect	Hydrothermally altered and fractured amphibolite schist containing discontinuous milky quartz veins that have moderate limonite stains and a trace of pyrite.	Four shallow pits	Two chip samples contained 0.03 and 0.04 ppm gold and 34 and 49 ppm zinc; 0.50 ppm silver in one and 5.4 ppm molybdenum in the other. Two grab samples contained 0.02 and 0.05 ppm gold, 25.9 and 49 ppm copper, and 35 and 64 ppm zinc; one contained 12 ppm molybdenum and 6 ppm tungsten.
4	Prospect	Siliceously and sericitically altered quartz-mica schist moderatley bleached and limonite stained.	Three shallow pits	Three grab samples contained 0.02 to 0.12 ppm gold, 110 to 400 ppm copper, 58 to 96 ppm zinc, and 8.3 to 16 ppm molybdenum; two assayed 0.40 and 5.2 ppm silver; one contained 150 ppm lead and another had 280 ppm tungsten.
5	Prospect	Clay-rich and siliceously altered lensoid-shaped zone with moderate limonite content strikes N. 70° E., dips 60° W., and is hosted in amphibolite schist.	One shallow pit	One chip sample contained 0.03 ppm gold, 150 ppm copper, and 2.7 ppm molybdenum.
6	Prospect	Discontinuous, limonite-stained, bull quartz veinlets in fracture zone that strikes N. 30° W. and dip 67° NE.	Five shallow pits	One chip sample contained 0.02 ppm gold, 62 ppm copper, 140 ppm lead, 310 ppm zinc, and 40 ppm molybdenum. One grab sample had 0.01 ppm gold and 16 ppm molybdenum.
7	Prospect	Bull quartz boulders as much as 3 ft in diameter in float surrounded by bleached, limonite-stained, sericitically and siliceously altered biotite schist.	One shallow pit	One chip sample contained 0.07 ppm gold, 7.76 ppm silver, 1,300 ppm copper, 94 ppm lead, 340 ppm zinc, and 190 ppm molybdenum. One grab sample yielded 0.07 ppm gold, 1.71 ppm silver, 380 ppm copper, and 8.8 ppm molybdenum.
8	Prospect	Moderately limonite-stained, translucent to white quartz veins strike N. 10° E. and dip 50° W. to vertically and cut biotite schist, which is altered to clay around veins.	Two pits	Of three chip samples, two contained 0.04 and 0.05 ppm gold, 42 and 47 ppm copper, 100 and 340 ppm zinc, and 11 and 43 ppm molybdenum; one has 120 ppm lead. Three grab samples contained 0.02 to 0.22 ppm gold and 15 to 20 ppm molybdenum; two had 71 and 700 ppm copper; one contained 3.78 ppm silver and 130 ppm zinc.
9	Mineralized outcrop	Quartz diorite with minor chloritic alteration locally cut by aplite dikes as thick as 2 in. that strike N. 80° E. and dip 47° NW.	None	One random-chip sample collected across 4 ft contained 0.05 ppm gold, 55 ppm copper, 69 ppm lead, 95 ppm zinc, and 21 ppm molybdenum.
10	Prospect	Moderately limonite-stained, clear to white quartz veins are hosted by amphibolite and biotite schist that show siliceous and sericitic alteration.	Five shallow pits	One chip sample contained 0.06 ppm gold, 96 ppm copper, 100 ppm zinc, and 13 ppm molybdenum. Of four grab samples, one had 0.02 ppm gold and another had 1.22 ppm silver; one contained 390 copper; three had 4.1 to 37 ppm zinc and four contained 2.6 to 23 ppm molybdenum.

TABLE 1. *Mines, prospects, claims, and mineralized sites in and adjacent to the Blue Lakes Wilderness Study Area*—Continued

Map No. (fig. 2)	Name	Geology	Workings and production	Sample and resource data
*11	Prospect	Bull quartz vein material with slight limonite stains, chloritized amphibolite, and biotite schist on dumps.	One shallow bulldozer cut 90 ft long and one shallow pit.	Two grab samples yielded 0.06 and 0.01 ppm gold, 0.70 and 1.20 ppm silver, and 11 and 14 ppm molybdenum; one also contained 47 ppm copper and 56 ppm zinc.
*12	Prospect	White quartz with minor limonite stains present as float in area underlain by quartz diorite.	One pit	One grab sample contained 0.15 ppm gold, 0.74 ppm silver, and 18 ppm molybdenum.
*13	Prospect	Fractured bull quartz and moderately altered, iron-stained quartz diorite found as float.	One shallow pit	One grab sample had 0.05 ppm gold, 0.94 ppm silver, 50 ppm copper, and 19 ppm molybdenum.
*14	Prospect	Quartz-rich zone with abundant limonite measures 2.5 ft wide and 4 ft long, and is hosted by quartz diorite.	Two shallow pits	One chip sample contained 0.02 ppm gold and 7.8 ppm molybdenum. One grab sample yielded 0.02 ppm gold, 83 ppm copper, 47 ppm lead, 140 ppm zinc, and 13 ppm molybdenum.
*15	Prospect	Weakly to moderately iron-stained white quartz veins 2 to 4 ft thick, strike N. 45°-60° W., dip vertically, and hosted by quartz diorite.	Two shallow pits	Two chip samples contained 0.03 and 0.03 ppm gold, 75 and 100 ppm copper, and 22 and 23 ppm molybdenum.
*16	Prospect	Moderately limonite-stained fractured quartz veins in quartz diorite strike N. 62° W., dip 36° NE., and range in width from 10 in. to 3.5 ft within a distance of 10 ft.	One shallow pit	One chip sample contained 0.05 ppm gold, 1.17 ppm silver, 49 ppm copper, and 13 ppm molybdenum.
*17	Nevada King mine (Pass Creek mine, American antimony mine, Stybo claims)	Sparsely scattered pockets of antimony ore in hydrothermally altered, discontinuous, brecciated shear zones that strike N. 23° E. to N. 71° W., dip steeply to the NE, and lie near contact between Triassic quartzite and phyllite.	Two caved adits, one shaft, and 14 shallow pits and trenches. U.S. Bureau of Mines production records show 22 oz of gold and 1 oz silver produced in 1910 and 1911. In 1927, 30 tons of 50 percent grade antimony ore were produced and in 1941 and 1942, 13 tons averaging 50 percent grade antimony ore were produced.	Of 19 chip samples collected, 11 yielded 0.003 to 0.72 ppm gold and 4 contained 0.36 to 8.3 ppm silver; 17 had 10.6 to 9,800 ppm antimony; two contained 2.0 and 3.1 ppm uranium; one yielded 6.8 ppm zinc and 50 ppm molybdenum. Seven grab samples yielded 0.06 to 0.12 ppm gold; three contained 3.0, 16.7, and 2,500 ppm antimony, and two had 1.5 to 50 ppm molybdenum.
*18	Prospect	Contact zone between phyllite and granodiorite, cut by garnet-bearing pegmatite, shows siliceous and argillic alteration.	One shallow pit	Of three chip samples, two contained 6.9 ppm silver and one had 10.3 ppm silver; two yielded 1.3 and 7.4 ppm molybdenum; one had 4.4 ppm uranium. One grab sample contained 6.9 ppm silver, 43 ppm copper, and 12 ppm molybdenum.
*19	Mineralized outcrop	Three moderately iron oxide-stained, parallel quartz veins range from 3 to 12 in. thick, strike N. 70° W. and dip 40° N., and are hosted by slightly altered granodiorite.	None	One chip sample across quartz veins yielded 52 ppm zinc, 59 ppm molybdenum, and 0.70 ppm uranium.
*20	Big Dipper group	Discontinuous quartz veins in grandiorite range in thickness from 1 to 6 in., strike N. 10° E. to N. 85° E., and dip vertically or steeply to east and west. Discontinuous, podiform, and lensoid aplite and alaskite dikes cut Happy Creek Volcanic Series in contact with Duffer Peak Granodiorite. Molybdenum, uranium, and tungsten minerals associated with quartz veins and aplite and alaskite dikes.	Five shallow pits and four shallow trenches.	Ten chip samples of contact zone material, discontinuous quartz veins, and aplite and alaskite dikes: two yielded 0.01 and 0.02 ppm gold and eight yielded 0.53 to 20.57 ppm silver; four contained 150 to 1,500 copper; eight had 5.5 ppm to 270 ppm molybdenum; one contained 6.8 ppm zinc, five had 6.1 to 58 ppm uranium, and two contained 6 ppm tungsten. Of six grab samples collected from dumps and high grade piles, two yielded 0.03 and 0.08 ppm gold; three contained 0.77, 6.73, and 20.57 ppm silver; five had 9.5 to 400 ppm molybdenum; one yielded 24 ppm lead and another had 1.4 ppm uranium.
*21	Prospect	Discontinuous, 3.5-ft-thick quartz vein strikes N. 45° E., dips 25 ° NW. and cuts granodiorite host rock.	Two shallow pits	Two chip samples contained 0.05 ppm gold, 0.10 and 2.96 ppm silver, 46 and 81 ppm lead, 1 and 70 ppm zinc. 16 and 43 ppm molybdenum, and 2.3 and 14 ppm uranium. One grab sample had 0.02 ppm gold, 2.58 ppm silver, 93 ppm lead, 79 ppm zinc, 66 ppm molybdenum, and 8 ppm arsenic and 26 ppm uranium.

TABLE 1. *Mines, prospects, claims, and mineralized sites in and adjacent to the Blue Lakes Wilderness Study Area*—Continued

Map No. (fig. 2)	Name	Geology	Workings and production	Sample and resource data
*22	Mineralized outcrop	Discontinuous, 1.0-ft-thick limonite-stained quartz vein cuts chloritized granodiorite.	None	One chip sample contained 1.1 ppm uranium and 8 ppm tungsten; no gold or silver detected.
*23	Prospect	Fine- to medium-grained granodiorite float contains quartz veinlets.	One shallow pit	One grab sample contained 0.78 ppm silver and 3.0 ppm uranium.
*24	Mineralized outcrop	Siliceously altered contact zone between volcanic rocks and granodiorite intruded by aplite dikes.	None	Two chip samples contained 10.29 ppm silver and 4.9 and 6.3 ppm molybdenum, and 2.7 and 5.0 ppm uranium.
*25	Prospect	Contact zone between volcanic rocks and granodiorite cut by aplite dikes and local smokey quartz veins.	One shallow pit	Of two chip samples, one contained 2.33 ppm silver and the other had 3.8 ppm uranium and 8.4 ppm molybdenum.
*26	Prospect	Near their contact, Happy Creek Volcanic Series and Duffer Creek Granodiorite are cut by quartz veinlets.	One shallow prospect pit	One grab sample yielded 20.57 ppm silver.
*27	Prospect	Bull quartz vein in quartz monzonite locally cut by small pegmatite veinlets.	One L-shaped pit	One chip sample had 6.98 ppm silver. Two grab samples contained 0.52 and 0.65 ppm silver and 7.8 and 12 ppm uranium.
*28	Arriba No. 1 placer claim	Localized alluvium predominantly composed of quartz monzonite and basalt. According to Olander (1980), most pits and trenches are in alluvium that overlies Cretaceous New York Peak Quartz Monzonite (not found in study area) and several situated over Happy Creek Volcanic Complex and some near contact between Tertiary basalt and other two units.	Fourteen trenches ranging from 22 to 570 ft long, from 3 to 6 ft wide, and from 1.0 to 6.5 ft deep. Approximately 35 shallow pits ranging in diameter from 3 to 20 ft. Collectively, workings cover approximately 14 acres, and depth of alluvium ranges from 2.0 to 6.5 ft.	Nine channel samples, collected from four trenches and two pits, contained between 0.3 cents and $13.47/yd^3 with an average value of $3.58/yd^3 at a gold price of $350/oz. Due to small size of deposit, limited water availability, poor access, and randomly distributed gold values, deposit is not considered a resource.
*29	Sky View, Dyke Claim	Felsite breccia with interstitial and vug fillings of azurite, malachite, and limonite is surrounded by Tertiary basalt.	Four shallow pits and one trench.	Of three chip samples, two contained 0.02 and 0.04 ppm gold; three yielded 30, 5500, and 41,000 ppm copper; one had 5.58 ppm silver and another contained 36 ppm zinc. Of three high-grade grab samples, two contained 0.02 and 0.07 ppm gold and 0.42 and 7.29 ppm silver; three yielded 1.04, 4100, and 35,000 ppm copper; one contained 150 ppm zinc. Five samples yielded 1.8 to 3.9 ppm uranium.
*30	Prospect	Quartz vein material and phyllite float is weakly to moderately sericitically and argillically altered.	Three shallow pits	Three grab samples had 0.03, 0.04, and 0.05 ppm gold and 21 ppm molybdenum; two contained 47 and 62 ppm zinc and 1.6 and 1.8 ppm uranium; one had 41 ppm copper.
*31	Prospect	Discontinuous bull quartz veinlets and limonite-filled fractures in phyllite and quartzite.	Four shallow pits	Of five grab samples, four contained 0.02 to 0.07 ppm gold; two had 0.65 and 1.62 ppm silver; five yielded 0.85 to 2.3 ppm uranium.
*32	Mineralized outcrop	Moderately limonite-stained quartz float near contact between granodiorite and basalt.	None	One grab sample yielded 13.71 ppm silver.
*33	Mineralized outcrop	Several small aplite dikes near contact between granodiorite and basalt.	None	One chip sample taken across an aplite dike contained 10.29 ppm silver, 14 ppm molybdenum, and 2.8 ppm uranium.

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U.S. DEPARTMENT OF THE INTERIOR

March 3, 1849