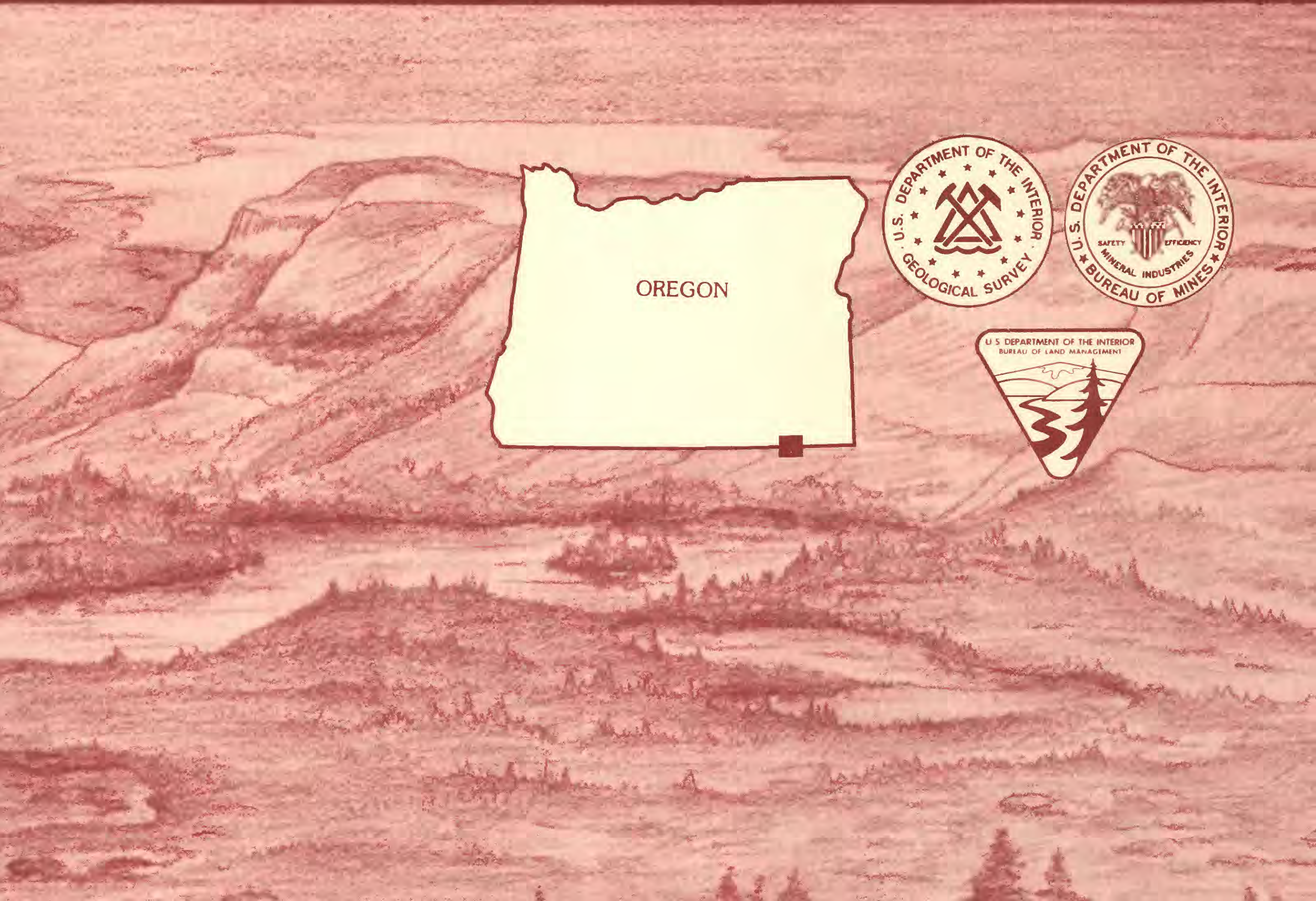
Mineral Resources of the Disaster Peak Wilderness Study Area, Harney and Malheur Counties, Oregon, and Humboldt County, Nevada

U.S. GEOLOGICAL SURVEY BULLETIN 1742-A



AVAILABILITY OF BOOKS AND MAPS OF THE U.S. GEOLOGICAL SURVEY

Instructions on ordering publications of the U.S. Geological Survey, along with prices of the last offerings, are given in the current-year issues of the monthly catalog "New Publications of the U.S. Geological Survey." Prices of available U.S. Geological Survey publications released prior to the current year are listed in the most recent annual "Price and Availability List." Publications that are listed in various U.S. Geological Survey catalogs (**see back inside cover**) but not listed in the most recent annual "Price and Availability List" are no longer available.

Prices of reports released to the open files are given in the listing "U.S. Geological Survey Open-File Reports," updated monthly, which is for sale in microfiche from the U.S. Geological Survey, Books and Open-File Reports Section, Federal Center, Box 25425, Denver, CO 80225. Reports released through the NTIS may be obtained by writing to the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161; please include NTIS report number with inquiry.

Order U.S. Geological Survey publications **by mail** or **over the counter** from the offices given below.

BY MAIL

Books

Professional Papers, Bulletins, Water-Supply Papers, Techniques of Water-Resources Investigations, Circulars, publications of general interest (such as leaflets, pamphlets, booklets), single copies of Earthquakes & Volcanoes, Preliminary Determination of Epicenters, and some miscellaneous reports, including some of the foregoing series that have gone out of print at the Superintendent of Documents, are obtainable by mail from

U.S. Geological Survey, Books and Open-File Reports
Federal Center, Box 25425
Denver, CO 80225

Subscriptions to periodicals (Earthquakes & Volcanoes and Preliminary Determination of Epicenters) can be obtained ONLY from the

Superintendent of Documents
Government Printing Office
Washington, D.C. 20402

(Check or money order must be payable to Superintendent of Documents.)

Maps

For maps, address mail orders to

U.S. Geological Survey, Map Distribution
Federal Center, Box 25286
Denver, CO 80225

Residents of Alaska may order maps from

Alaska Distribution Section, U.S. Geological Survey,
New Federal Building - Box 12
101 Twelfth Ave., Fairbanks, AK 99701

OVER THE COUNTER

Books

Books of the U.S. Geological Survey are available over the counter at the following Geological Survey Public Inquiries Offices, all of which are authorized agents of the Superintendent of Documents:

- **WASHINGTON, D.C.**--Main Interior Bldg., 2600 corridor, 18th and C Sts., NW.
- **DENVER, Colorado**--Federal Bldg., Rm. 169, 1961 Stout St.
- **LOS ANGELES, California**--Federal Bldg., Rm. 7638, 300 N. Los Angeles St.
- **MENLO PARK, California**--Bldg. 3 (Stop 533), Rm. 3128, 345 Middlefield Rd.
- **RESTON, Virginia**--503 National Center, Rm. 1C402, 12201 Sunrise Valley Dr.
- **SALT LAKE CITY, Utah**--Federal Bldg., Rm. 8105, 125 South State St.
- **SAN FRANCISCO, California**--Customhouse, Rm. 504, 555 Battery St.
- **SPOKANE, Washington**--U.S. Courthouse, Rm. 678, West 920 Riverside Ave..
- **ANCHORAGE, Alaska**--Rm. 101, 4230 University Dr.
- **ANCHORAGE, Alaska**--Federal Bldg, Rm. E-146, 701 C St.

Maps

Maps may be purchased over the counter at the U.S. Geological Survey offices where books are sold (all addresses in above list) and at the following Geological Survey offices:

- **ROLLA, Missouri**--1400 Independence Rd.
- **DENVER, Colorado**--Map Distribution, Bldg. 810, Federal Center
- **FAIRBANKS, Alaska**--New Federal Bldg., 101 Twelfth Ave.

Chapter A

Mineral Resources of the Disaster Peak Wilderness Study Area, Harney and Malheur Counties, Oregon, and Humboldt County, Nevada

By SCOTT A. MINOR, ROBERT L. TURNER,
and DONALD PLOUFF
U.S. Geological Survey

ANDREW M. LESZCYKOWSKI
U.S. Bureau of Mines

U.S. GEOLOGICAL SURVEY BULLETIN 1742

MINERAL RESOURCES OF WILDERNESS STUDY AREAS:
TROUT CREEK MOUNTAINS REGION, OREGON

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

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

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1988

For sale by the
Books and Open-File Reports Section
U.S. Geological Survey
Federal Center, Box 25425
Denver, CO 80225

Library of Congress Cataloging-in-Publication Data

Mineral resources of the Disaster Peak Wilderness Study
Area, Harney and Malheur Counties, Oregon, and
Humboldt County, Nevada.

(Mineral resources of wilderness study areas—
Trout Creek Mountains Region, Oregon ; ch. A) (U.S.
Geological Survey Bulletin ; 1742A)
Bibliography: p.
Supt. of Docs. no. : I 19.3:1742-A
1. Mines and mineral resources—Disaster Peak
Wilderness (Or. and Nev.) 2. Disaster Peak Wilderness
(Or. and Nev.) I. Minor, Scott A. II. Series.
III. Series: U.S. Geological Survey bulletin ; 1742A.
QE75.B9 no. 1742-A 557.3 s 88-600128
[TN25.D57] [553'.09795'95]

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 submitted to the President and the Congress. This report presents the results of a mineral survey of the Disaster Peak Wilderness Study Area (OR-003-153/NV-020-859), Harney and Malheur Counties, Oregon, and Humboldt County, Nevada.

CONTENTS

FIGURES

TABLE

MINERAL RESOURCES OF WILDERNESS STUDY AREAS:
TROUT CREEK MOUNTAINS REGION, OREGON

Mineral Resources of the Disaster Peak Wilderness Study Area, Harney and Malheur Counties, Oregon,and Humboldt County, Nevada

By Scott A. Minor, Robert L. Turner, *and* Donald Plouff
U.S. Geological Survey

Andrew M. Leszcykowski
U.S. Bureau of Mines

SUMMARY

Abstract

The Disaster Peak Wilderness Study Area (OR-003-153/NV-020-859) is located in the south Trout Creek Mountains in southeastern Oregon and northern Nevada. At the request of the U.S. Bureau of Land Management, 30,195 acres of the Disaster Peak Wilderness Study Area were evaluated for mineral resources (known) and mineral resource potential (undiscovered). In this report, the area studied is referred to as the "Disaster Peak Wilderness Study Area" or the "study area." Field work for this report was done in 1986. No resources were identified within the study area. There is high and low potential for gold resources in quartz veins in the southern part and low potential for epithermal gold, silver, mercury, and uranium resources in the northeastern part of the study area. The study area has no potential for sand and gravel, oil and gas, or geothermal energy resources.

Character and Setting

The Disaster Peak Wilderness Study Area (OR-003-153/NV-020-859) is located in the south Trout Creek Mountains in Harney and Malheur Counties, Oreg., and Humboldt County, Nev., about 23 mi west of McDermitt, Nev. (fig. 1). The study area contains the 7,000- to 8,500-ft-high crestline of the north-tilted plateau that forms the Trout Creek Mountains and caps the escarpments in the southern and eastern parts of the study area. The rugged and steep southern escarpment, which crests at Orevada View (8,506 ft) and Disaster Peak (7,781 ft), has more than 3,000 ft of relief to the Kings River Valley south of the study area. The southern part of the study area is underlain by Cretaceous (see appendixes for geologic time chart) granitic rocks (fig. 2). An approximately flat-lying sequence of Tertiary volcanic and pyroclastic flows unconformably onlaps the granitic rocks and is exposed within most of the remainder of the study area. The Long Ridge caldera, located just east of the study area, is a collapse structure resulting from the eruption of an ash-flow tuff that forms the top of the flow sequence. The caldera is filled largely by tuffaceous sedimentary rocks. Numerous arcuate, north- to northeast-striking caldera ring faults displace rocks in and near the northeastern part of the study area. Younger, north-northwest-striking normal faults that have large displacements cut rocks west of the caldera in the study area.

County mining records show that more than 100 mining claims have been located in or near the study area since 1892 when the first claims were recorded. Current mineral exploration in and adjacent to the study area is primarily for gold and is centered in two areas containing claims and a prospect. Five mercury mines, including the producing McDermitt mine, are located in the Opalite mining district 10 to 20 mi east of the study area (fig. 1). The Opalite district also contains a uranium mine and several prospects. Two mines just southeast of the study area are active for clay minerals.

Publication authorized by the Director, U.S. Geological Survey, Mar. 15, 1988.

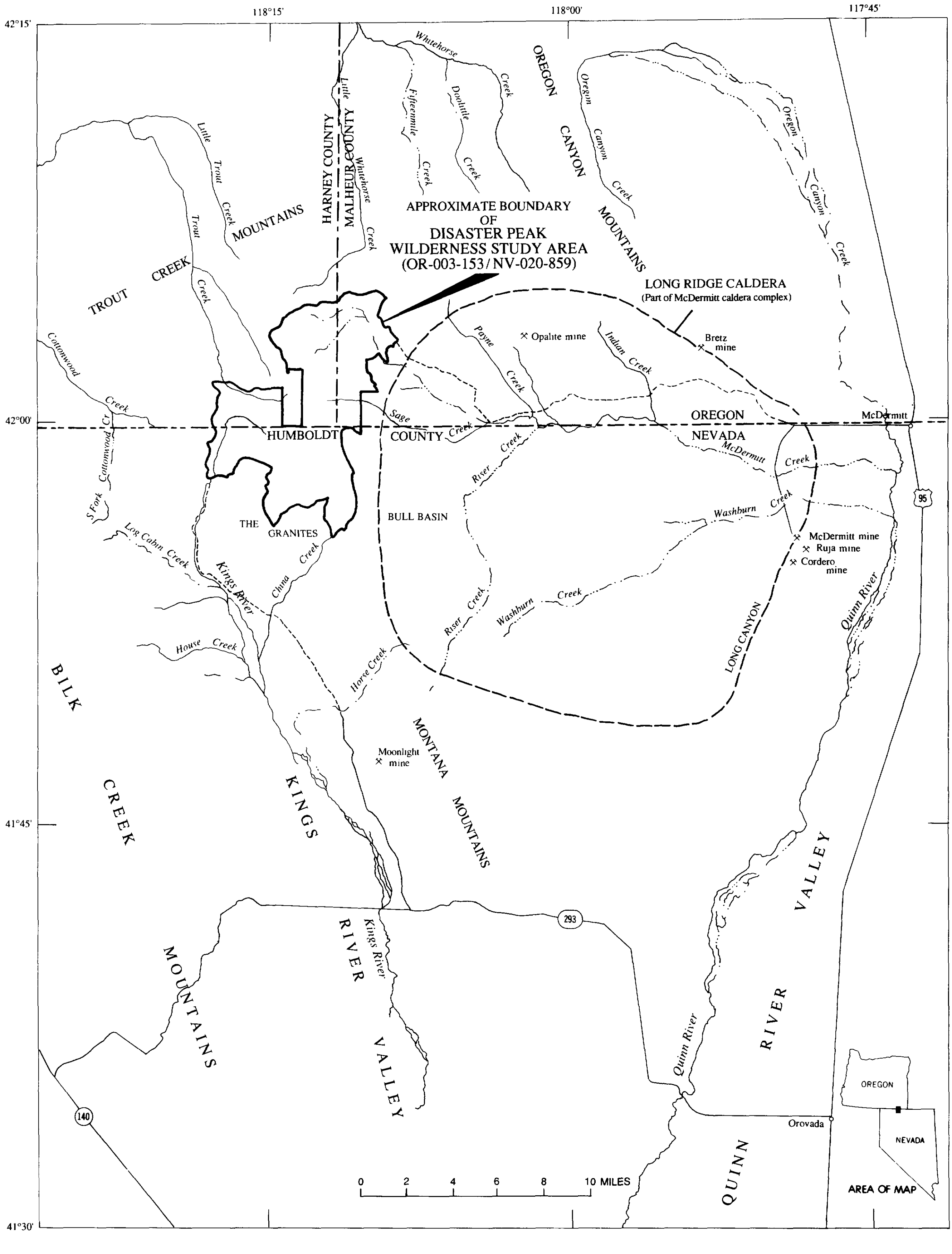


Figure 1. Index map showing location of Disaster Peak Wilderness Study Area, Harney and Malheur Counties, Oregon, and Humboldt County, Nevada.

Identified Resources

The Disaster Peak Wilderness Study Area has no identified mineral resources. However, the study area contains occurrences of gold of unknown extent for which identified resource amounts could not be estimated.

Mineral Resource Potential

Areas having high potential for gold resources and low potential for gold, silver, mercury, and uranium resources have been delineated in the Disaster Peak Wilderness Study Area (fig. 2).

Quartz veins mineralized with gold crosscut granitic rocks in an area of about 1 mi^2 in the southern part of the study area. The gold is accompanied by minor silver and associated sulfide minerals. The mineralized veins yield geochemical anomalies of gold, antimony, arsenic, molybdenum, silver, tellurium, and tungsten. The geometry and extent of the gold-bearing veins are poorly known, but weak geochemical anomalies elsewhere within the granitic rocks suggest that other undiscovered auriferous veins may be present. The quartz, gold, and associated minerals may have precipitated from residual magmatic fluids along faults and joints soon after intrusion of the granitic rocks or may have formed from hydrothermal fluids at some later time prior to eruption of the Steens Basalt. The mineralized area in the southern part of the study area has high potential for gold resources in quartz veins, and the surrounding area of granitic rock, having weak geochemical anomalies, has low resource potential for gold in quartz veins (fig. 2).

Epithermal gold, mercury, and uranium mineralization that affected a zone about 1 mi east of the study area may have also affected the northeastern part of the study area. The mineralized zone outside the study area contains strong geochemical anomalies of gold, antimony, arsenic, mercury, and uranium and weaker anomalies of silver. Visible metalliferous minerals, however, are sparse. The mineralized zone, which locally contains highly fractured and brecciated rock, is cut by numerous north- to northeast-striking, arcuate ring faults that border the Long Ridge caldera (fig. 2). The zone has characteristics similar to those of reported epithermal mercury and uranium occurrences and ore deposits within other parts of the caldera, including hydrothermally altered rock and sulfide minerals. Those more distant mineral occurrences and deposits were formed by hydrothermal systems during late stages of caldera development. Although the geochemical signatures of those occurrences and deposits are similar to those of the mineralized zone adjacent to the study area, they differ in that they lack anomalous concentrations of gold. Nevertheless, the timing, style, and causes of mineralization are believed to be nearly identical. The northeastern part of the study area resembles the adjacent mineralized zone in that it contains north- to northeast-striking caldera ring faults and similar, although weak, geochemical anomalies However, this part of the study area generally lacks epithermal alteration or mineralization. Thus, the northeastern part of the study area has low potential for resources of gold, silver, mercury, and uranium in epithermal deposits.

The study area has no potential for oil and gas and geothermal energy resources because the geologic environment is not conducive for such resources. Sand and gravel deposits along intermittent streams are too small to constitute a potential resource.

INTRODUCTION

This mineral survey was requested by the U.S. Bureau of Land Management and is the result of a cooperative effort by the U.S. Geological Survey and the U.S. Bureau of Mines. An introduction to the wilderness review process, mineral survey methods, and agency responsibilities was provided by Beikman and others (1983). The U.S. Bureau of Mines 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, claims, and mineralized areas. Identified resources are classified according to a system that is a modification of that described by McKelvey (1972) and U.S. Bureau of Mines and U.S. Geological Survey (1980). Studies by the U.S. Geological Survey 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, presence of geochemical and geophysical anomalies, and applicable ore-deposit models. Goudarzi (1984) discussed mineral assessment methodology and terminology as they apply to these surveys. See appendixes for the definition of levels of mineral resource potential and certainty of assessment and for the resource/reserve classification.

Location and Physiography

The Disaster Peak Wilderness Study Area (OR-003-153/NV-020-859) is located in Harney and Malheur Counties, Oreg., and Humboldt County, Nev., about 23 mi west of McDermitt, Nev. (fig. 1). The study area, which encompasses 30,195 acres, is situated in the southern part of the Trout Creek Mountains (fig. 1), a broad, gently north-tilted, moderately dissected plateau. The study area is somewhat V-shaped, with the west and north segments coinciding with northwest- and north-trending escarpments, respectively, that converge southward at 7,781-ft Disaster Peak. The escarpments bound the highest (7,000 to 8,500 ft) part of the Trout Creek Mountains plateau, which forms the central and northwesternmost parts of the study area.

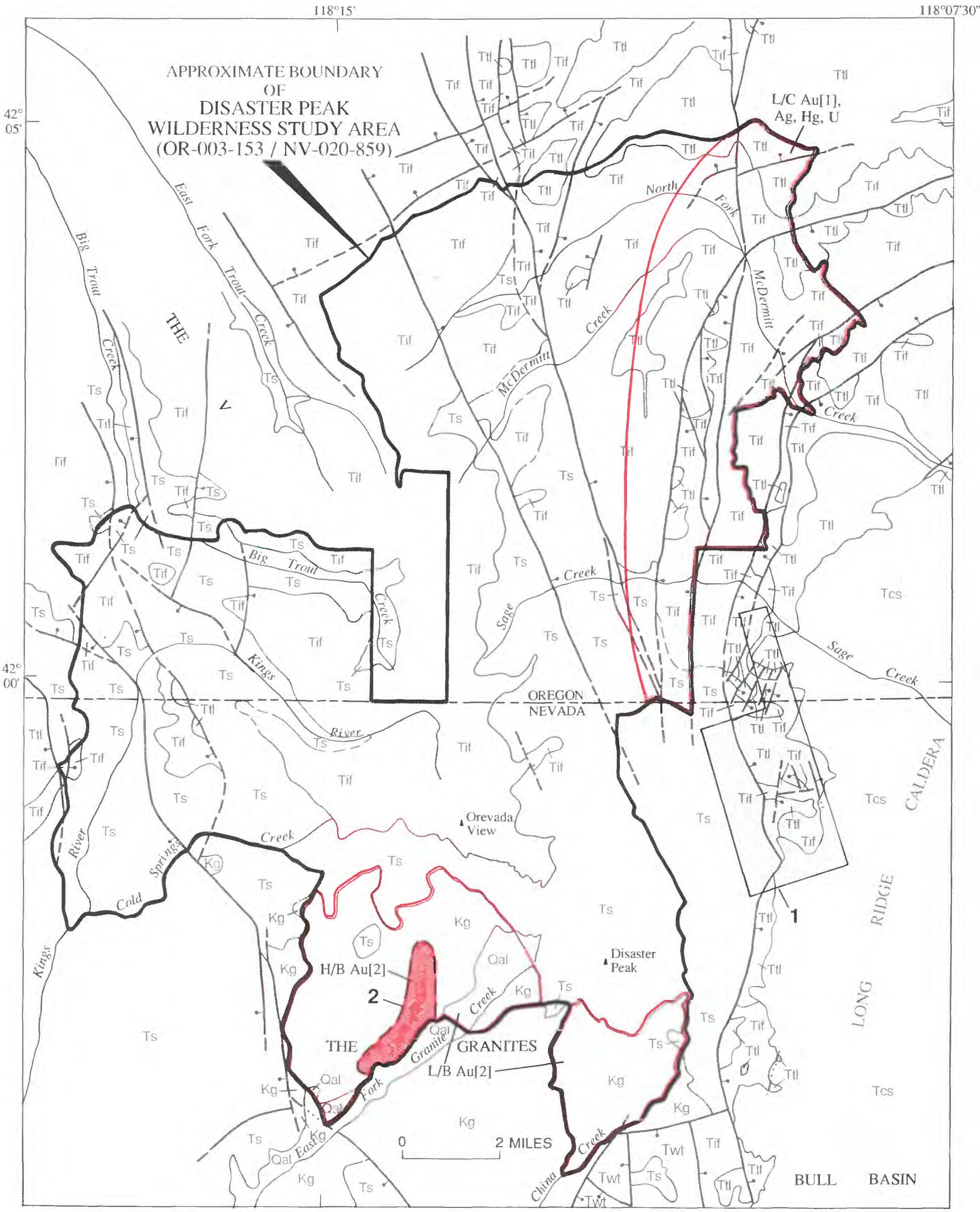


Figure 2. Generalized geology and mineral resource potential of Disaster Peak Wilderness Study Area, Harney and Malheur Counties, Oregon, and Humboldt County, Nevada.

EXPLANATION

[pink stippled box]	Area having high mineral resource potential (H)
[pink outlined box]	Area having low mineral resource potential (L)

Level of certainty of assessment

B	Data only suggest level of potential
C	Data give good indication of level of potential

Commodities

Au	Gold
Ag	Silver
Hg	Mercury
U	Uranium

[ ] Type of deposit or occurrence

1	Epithermal
2	Quartz veins

Prospects and claims—See table for description

1	Albisu prospect
2	Au claim group

Geologic map units

Qal	Alluvium (Quaternary)
Tcs	Caldera-fill sedimentary rocks (Miocene)
Ttl	Tuff of Long Ridge and, locally, tuff of Trout Creek Mountains (Miocene)
Tif	Intermediate lava flows (Miocene)
Ts	Steens Basalt (Miocene)
Twt	Dacitic welded tuff (Eocene)
Kg	Granitic rocks (Cretaceous)

——-- Contact—Dashed where approximately located

——-- Fault—Dashed where approximately located; dotted where concealed. Bar and ball on downthrown side

Figure 2. Continued.

The escarpment extending northwest from Disaster Peak is precipitous, having more than 3,000 ft of relief from Orevada View (8,506 ft), the highest point in the study area, to the Kings River Valley to the south. Major intermittent streams draining this escarpment include the Kings River in the southwestern part of the study area and China Creek in the southeasternmost part (fig. 1). The lowest point in the study area, at about 5,300 ft, is located where China Creek crosses the south boundary. In contrast to the escarpment described above, the one crossing the eastern part of the study area is less steep; it descends eastward to the gently rolling lower McDermitt Creek drainage basin adjacent to the east edge of the study area (fig. 1). The intermittent Sage Creek and North Fork and main fork of McDermitt Creek, having incised canyons as deep as about 800 ft into the east-facing escarpment, are the most prominent drainages in the northern part of the study area (fig. 2). Vegetation of the study area is similar to that growing elsewhere in mountain ranges of the northern Great Basin. Sage and seasonal desert grasses are common throughout the study area, and mountain mahogany and aspen only grow in the more elevated parts.

The most direct access to the northern and eastern parts of the study area consists of a maintained unpaved road west of the paved Cordero mine road about 5 mi west of the town of McDermitt (fig. 1). This unpaved road, which roughly follows McDermitt Creek, forms the northern boundary of the study area and is intersected by several jeep trails that extend into the central part of the study area. Access to the southern and southwestern parts of the study area is by way of a partly maintained, unpaved county and ranch road that follows the northeast side of the Kings River valley from the south (fig. 1). Several jeep trails extend northeast into the study area from this road, including a road following China Creek that forms part of the southeast boundary.

Previous Investigations

Yates (1942) mapped and described the geology and quicksilver deposits of the Opalite district east of the study area. The geology of mercury deposits in Nevada and in Malheur County, Oreg., was examined by Benson (1956). Willden (1964) investigated the geology and mineral deposits of Humboldt County, Nev., and prepared a reconnaissance geologic map of the county. A reconnaissance geologic map of the Adel 1° by 2° quadrangle, which includes the Oregon part of the study area, was published by Walker and Repenning (1965). Greene (1976) described the general geology of the feature initially named McDermitt caldera (now known as Long Ridge caldera) and included a generalized geologic map of an area that includes most of the study area. Revised and more detailed descriptions and interpretations of the geology of the McDermitt caldera complex were presented by Rytuba (1976), Rytuba and Conrad (1981), and Rytuba and McKee (1984). Rytuba and Glanzman (1978), Glanzman and others (1978), Rytuba and others (1979), and Rytuba and Conrad (1981) investigated mineral deposits associated with the McDermitt caldera complex. The geology of an area adjacent to the west side of the study area was mapped and described in detail by Minor (1986). The geology of the southern Trout Creek Mountains, including the eastern and western parts of the study area, were mapped by J.J. Rytuba (written commun., 1980) and S.A. Minor (unpub. data, 1985), respectively.

Geochemical and geophysical reconnaissance surveys were conducted for the U.S. Department of Energy's National Uranium Resource Evaluation (NURE) program to assess the radioactive mineral potential of the region (Erikson and Curry, 1977; Geodata International, Inc., 1979, 1980). Preliminary geochemical and mineral evaluations of several wilderness study areas in southeast Oregon, including the Oregon part of the Disaster Peak Wilderness Study Area, were conducted by the Oregon Department of Geology and Mineral Industries (DOGAMI) (Gray and others, 1983). Barringer Resources, Inc., conducted supplementary geochemical evaluations of the Oregon study areas in conjunction with the DOGAMI study (Bukofski and others, 1984) and conducted a similar geochemical study as part of an evaluation of the U.S. Bureau of Land Management Winnemucca District (Conners and others, 1982) in the part of the study area in Nevada.

Present Investigations

In 1986 the U.S. Geological Survey (USGS) conducted field investigations in the study area, which consisted of checking, refining, and completing earlier geologic mapping, searching for altered or mineralized areas, taking gravity measurements, and collecting geochemical samples. All of the 49 rock samples and 37 stream-sediment and heavy-mineral-concentrate samples collected were analyzed geochemically to reveal areas having anomalous concentrations of elements of interest. Linear features that appear in Landsat multispectral-scanner images of the region were mapped by photogeologic interpretation (D.L. Sawatzky, written commun., 1987).

Work by the U.S. Bureau of Mines (USBM) included perusal of all literature on the geology, mines, and prospects in the vicinity of the study area. Federal, state, and county records were examined to ascertain the location of mines or mineral claims in the study area. Field studies, conducted in 1986, included the examination, mapping, and geochemical sampling of prospects and claims in and adjacent to the study area; 4 alluvial and 41 rock samples were collected primarily from a prospect and a group of claims. The alluvial samples were concentrated and examined for economic minerals, and the rock samples were geochemically analyzed. Sampling procedures and results of the USBM investigations of the study area are described by Leszcykowski (1987). Sample data are available at Western Field Operations Center, E. 360 Third Ave., Spokane, WA 99202.

Acknowledgments

The assistance of John Muntean during the USGS field investigation was invaluable. James Rytuba of the USGS supplied useful information on the geology and mineral deposits in the region. The assistance and information provided by Tom Whittle and Ken Holtz of McDermitt Mine and Jim LeBret was greatly appreciated.

APPRAISAL OF IDENTIFIED RESOURCES

By Andrew M. Leszcykowski
U.S. Bureau of Mines

Mining History

The study area is partly within the unorganized Disaster Peak mining district. County mining records indicate that more than 100 mining claims have been located in or near the study area. The earliest recorded claims were in 1892, with most of the activity in the 1900's and minor activity from the 1920's to the 1940's. There was an increase in claims in the 1950's and during the past decade; the impetus for the latter was due to uranium, mercury, and gold exploration.

The unorganized Opalite mining district, located 10 to 20 mi east of the study area, includes the past-producing Opalite, Bretz, Ruja, and Cordero mercury mines and the currently (1988) producing McDermitt mercury mine (fig. 1). The McDermitt mine was on standby in 1987 until the mercury market improved.

Several uranium deposits have been explored in the region, including the deposit at the Moonlight mine south of the study area (fig. 1). A lithium occurrence was discovered within the Opalite district directly east of the study area during the past decade (Glanzman and others, 1978). Beneficiation tests on lithium-bearing clay from the deposit were run in 1980 by the USBM (May and others, 1980).

Clay minerals are being mined by J.M. Huber Co. and American Colloid Co. on the east side of the Montana Mountains.

Current mineral exploration in and near the study area is focused on two sites, the Albisu prospect and the Au claim group (fig. 2). The McDermitt Mine company has leased the Albisu prospect, which is located less than 1 mi east of the study area, for the purpose of evaluating gold-bearing structures at the site. The prospect consists of three claim blocks composed of 69 claims (table 1, No. 1). Claim notices and workings at the prospect indicate that the first mineral exploration was in about 1907. McDermitt Mine leased the Albisu prospect in 1985 and conducted an extensive soil sampling program followed by drilling in 1986. Extensive evaluation work was planned (1987), including additional drill holes.

The Au claim group, located in the southern part of the study area (table 1 and fig. 2, No. 2), was recently staked for gold. Humboldt County records indicate that about 50 claims were staked in this general area from 1906 to 1910 and that additional claims were staked in 1938 and 1948. No production is known from these claims, although the remains of two small mills indicate that some ore was processed.

Prospects, Claims, and Mineralized Areas

No resources were identified in the Disaster Peak Wilderness Study Area. Mineralized areas in and adjacent to the study area are limited to the Albisu prospect and the Au claim group. These areas contain gold-mineralized structures that need further study before resources, if any, can be calculated.

The Albisu prospect (table 1 and fig. 2, No. 1) contains gold-bearing sulfides along a north-northwest-trending fault zone that cuts rhyolite ash-flow tuff. The mineralized part of the fault zone, which lies partly within the study area, consists of brecciated and hydrothermally altered rock bearing sulfides as disseminated grains and veinlets. The mineralized fault zone is on the perimeter of the Long Ridge caldera (figs. 1 and 2), a regional Miocene collapse structure (Rytuba and McKee, 1984), and is probably a ring-fracture zone associated with the caldera. Proprietary assay data from McDermitt Mine indicating the presence of gold in the mineralized area was confirmed by the results of the USBM sampling (see table 1); USBM gold values from the mineralized zone range from 14 to 380 parts per billion (ppb). Calculation of gold resources awaits further evaluation by McDermitt Mine.

Gold occuring in quartz veins in Cretaceous granitic rocks is also the principal metal at the Au claim group (table 1 and fig. 2, No. 1). Smaller concentrations of silver, galena, copper sulfides, and carbonate minerals accompany the gold. The discontinuous quartz veins, which occur sporadically over about 1 mi^2, strike approximately north-northeast and dip at low angles toward the northwest. The vuggy, coarsely crystalline quartz appears to fill fissures. Gold assay values of quartz-vein samples range from 0.107 to 1.120 troy ounces per ton (oz/ton). No gold-resource calculations can be made because no continuous quartz veins are exposed.

Tuffaceous sedimentary rocks that fill the Long Ridge caldera east of the study area contain large amounts of lithium within the clay mineral hectorite (Rytuba and Glanzman, 1978; Glanzman and others, 1978; May and others, 1980). Clay beds within these rocks commonly contain from 0.01 to 0.1 percent and as much as 0.65 percent lithium. Total estimated marginal reserves of 1 million tons of lithium equivalent (Singleton, 1979) make the Long Ridge caldera deposit the world's largest identified lithium resource.

Quaternary sand and gravel deposits along intermittent streams in the study area are too small to be considered a resource.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

By Scott A. Minor, Robert L. Turner, *and* Donald Plouff
U.S. Geological Survey

Geology

The Disaster Peak Wilderness Study Area lies within the northwestern part of the Basin and Range province, an area characterized by north-trending, normal-fault-bounded ranges and intervening basins. The Kings River Valley just south of the study area is a basin that terminates to the north against the southwestern edge of the broad, uplifted Trout Creek Mountains plateau (fig. 1). In the vicinity of the study area, a sequence of Tertiary volcanic and pyroclastic flows unconformably overlies a basement of Cretaceous granitic rocks. A caldera collapse structure, which formed as a result of the eruption of the uppermost rocks of the sequence, lies adjacent to the study area and is filled by younger tuffaceous sedimentary rocks. The volcanic and pyroclastic rocks are cut by numerous normal faults associated with the caldera and basin-and-range extensional deformation.

The oldest rocks consist of Cretaceous granodiorite and subordinate amounts of other granitic rocks that are exposed in the southern part of the study area in the area known as The Granites (fig. 2). These light-colored, coarsely crystalline rocks contain, in order of decreasing abundance, plagioclase, quartz, potassium feldspar, hornblende, biotite, and sphene. Pegmatite and aplite dikes and quartz veins locally intrude the granitic rocks. These rocks are typically cut by several intersecting joint sets that have greatly influenced weathering of the rock, resulting in the conspicuous pinnacles and spires of The Granites.

Unconformably overlying the granitic basement rocks is a sequence of Tertiary volcanic and pyroclastic rocks

Table 1. Prospect and claims in and adjacent to the Disaster Peak Wilderness Study Area, Harney and Malheur Counties, Oregon, and Humboldt County, Nevada

Map No. (fig. 2)	Name (commodity)	Geology	Workings and production	Sample data
1	Albisu prospect (Lost Bucket, Sagehen, and Capulio claim groups) (gold)	Rocks in area include rhyolitic welded ash-flow tuff, intermediate lava flows, minor basalt flows, and tuffaceous sedimentary rocks. Primary mineral-bearing zone trends northwesterly and is traceable for about 2 mi on the surface. Faults and fractures within the zone typically strike subparallel to the zone trend. Hydrothermal alteration is most intense in an 80-ft-wide segment exposed in a road cut. Sulfides, including marcasite, pyrite, and arsenopyrite, occur as disseminated grains and veinlets less than 1/16 in. thick. Two stages of mineral deposition indicated by (1) rhyolite fragments in a breccia containing sulfides as discrete grains and masses and (2) a siliceous breccia matrix containing sulfides as discrete grains, masses, and thin veinlets. McDermitt Mine leased the prospect in 1985 and was evaluating it in 1987.	Numerous widely scattered trenches and pits in secs. 20 and 21, T. 41 S., R. 39 E., secs. 33 and 34, T. 48 N., R. 34 E., and secs. 3 and 4, T. 47 N., R. 34 E. Two old workings: a 130-ft-long adit in NE1/4SE1/4 sec. 4, T. 47 N., R. 34 E., and a 16-ft-long decline in SW1/4NE1/4 sec. 4, T. 47 N., R. 34 E. In 1986, McDermitt Mine drilled four rotary holes to depths of 450 to 480 ft to test for mineral-bearing zones (McDermitt Mine, proprietary data, 1976). No recorded production.	Of 18 samples from the prospect, 2 are of drill cuttings; 7 samples from bulldozer cuts and drill pads contain the only gold (14 to 380 ppb) and anomalous concentrations of antimony (up to 78 ppm), arsenic (up to 2,270 ppm) and uranium (up to 53 ppm).
2	Au claim group (gold)	Rocks in area of claims consist primarily of granodiorite cut by several discontinuous quartz veins. Although poorly exposed, veins appear to be as much as 1.5 ft thick, strike N. 20°-40° E., and dip 20°-30° NW. They are estimated to have a strike length of less than 100 ft and extend downdip less than 50 ft. Quartz within veins is vuggy, coarsely crystalline, and appears to fill fissures. Gold occurs in the veins and is accompanied by minor silver, galena, chalcopyrite, bornite, malachite, and azurite. Gold-bearing quartz veins are scattered over about 1 mi^2.	Approximately 24 pits and trenches on claims. Trenches are as long as 80 ft, but most are less than 20 ft. All trenches are less than 5 ft deep. Pits are less than 10 ft long and 4 ft deep. Remains of two small mills are present: one in NE1/4SE1/4SE1/4 sec. 14 and the other in NE1/4NE1/4 sec. 14, T. 47 N., R. 33 E. No recorded production, but mill remains indicate small amount of ore was processed.	Sixteen samples from claims consist mostly of grab samples of stockpiled quartz near workings. Seven samples contain from 0.11 to 1.12 oz/ton (3.7 to 38.4 ppm) gold. Other anomalous elements are antimony (up to 230 ppm), molybdenum (up to 36 ppm), silver (up to 94 ppm), tellurium (up to 400 ppm or more), and tungsten (up to 130 ppm).

(fig. 2). This sequence was apparently deposited upon a relatively flat paleotopographic surface formed on the basement rocks.

The oldest part of the sequence consists of brown biotite- and hornblende-bearing dacitic welded tuff and associated rocks of Eocene age that are exposed a few hundred feet south of the southeast corner of the study area near China Creek (Greene, 1976) (fig. 2). Within the study area, the dacitic welded tuff is not present, and the younger (Miocene) Steens Basalt (Fuller, 1931; Piper and others, 1939) rests directly on the basement rocks. The Steens Basalt consists of a thick (as much as 1,800 ft) flow-on-flow flood-basalt sequence that is regionally extensive (Mankinen and others, 1987). The gray basalt flows, which average about 20 ft in thickness, commonly contain distinctive large (as long as 2 in.) plagioclase phenocrysts that make up as much as 50 percent of the rock. Other mineral constituents include olivine, augite, and iron-titanium oxides. The Steens Basalt flows tend to form prominent ledges and steep cliffs, such as the spectacular escarpment just south of Orevada View.

A series of predominantly intermediate-composition flows exposed in the northern part of the study area conformably overlies the Steens Basalt (fig. 2). Included in this series, in order of decreasing age, are porphyritic rhyolite flows, porphyritic dacitic flows, latite flows, more porphyritic dacitic flows, and andesitic flows (J.J. Rytuba, written commun., 1980).

Two Miocene ash-flow tuff sheets cap the Tertiary eruptive sequence within the study area. The lower sheet, informally named the tuff of Trout Creek Mountains (Rytuba and McKee, 1984), consists of minor basal air-fall tuff and overlying peralkaline, comenditic, non- to densely welded ash-flow tuff. This bluish-green ash-flow tuff, which is markedly crystal rich (as much as 35 percent), is only present in the northern part of the study area where it has a maximum thickness of about 60 ft. The more extensive upper tuff sheet, informally named the tuff of Long Ridge (Rytuba and McKee, 1984), consists of subordinate basal air-fall tuff and overlying non- to densely welded ash-flow tuff. This compositionally zoned ash-flow tuff consists of a bluish-green, platy, aphyric, peralkaline comenditic lower part and a brown, crystal-rich (as much as 10 percent) rhyolitic upper part. Secondary flow folds and lineations are common in the tuff of Long Ridge, which has a maximum thickness of about 250 ft in the study area.

Eruption of the tuff of Long Ridge about 15.6 million years ago resulted in the formation of the Long Ridge caldera, a large collapse feature located directly east of the study area, which forms part of the McDermitt caldera complex (Rytuba and McKee, 1984) (fig. 1). A north-striking feeder dike of the tuff of Long Ridge in the northern part of the study area (fig. 2) probably was a vent for the tuff (J.J. Rytuba, oral commun., 1987). Numerous north- to northeast-striking arcuate normal faults within and outside the easternmost part of the study area (fig. 2) are ring faults associated with the caldera. Tuffaceous fluvial and lacustrine sedimentary rocks fill much of the basin resulting from caldera subsidence and lap onto the older wall rocks near the eastern edge of the study area (fig. 2). These sedimentary rocks consist primarily of tan to light-gray, well-bedded, fine- to medium-grained tuffaceous sandstone, siltstone, shale, and water-laid tuff.

Several large-displacement, north-northwest-striking normal faults cut rocks in the northern and western parts of the study area (fig. 2). These faults form the east edge of a broad, north-northwest-trending, complexly faulted zone that extends for more than 30 mi north and south of the study area (Walker and Repenning, 1965; Minor, 1986). Most of these faults formed soon after caldera collapse, probably during regional basin-and-range extension.

The aforementioned hydrothermally altered area within the Albisu prospect follows north- to northeast-striking ring faults and fractures bordering the Long Ridge caldera from an area about 2.5 mi northeast of Disaster Peak to as far north as Sage Creek (fig. 2). The alteration has affected both caldera-wall and caldera-fill rocks. All of the altered rocks are highly silicified and bleached light gray to white such that original textures are rarely identified. Numerous fractures and areas of brecciated rock within the prospect are stained with reddish iron oxides and typically contain limonite and (or) secondary clays. Less commonly, the rocks show signs of argillic alteration, in particular feldspar phenocrysts replaced by kaolinite.

Minor amounts of stream sand and gravel are present along larger drainages in the study area.

Geochemical Studies

A reconnaissance geochemical study conducted by the USGS in and near the study area consisted of the collection, analysis, and evaluation of rock, stream-sediment, and heavy-mineral-concentrate samples.

Forty-nine fresh, mineralized, and altered rocks were sampled from outcrop and, rarely, from stream float. Samples that appeared fresh and unaltered were collected to provide information on geochemical background values, and those that seemed altered or mineralized were collected to determine the suite of elements associated with the alteration or mineralization.

Thirty-seven sites along stream channels containing recent alluvium were sampled for stream sediments and heavy-mineral concentrates. Stream sediments represent a composite of rock and soil exposed upstream from the sample site. In contrast, heavy-mineral concentrates include ore-bearing and ore-related minerals, and they permit determination of some elements that are not easily detected in bulk stream sediments.

The rock, stream-sediment, and heavy-mineral-concentrate samples were analyzed for 31 elements by semiquantitative emission spectroscopy, using the methods of Grimes and Marranzino (1968). Elements of special interest or which have high lower limits of determination by emission spectrography were also analyzed by other means. Gold and mercury contents were determined by atomic absorption, and antimony, arsenic, bismuth, cadmium, and zinc contents were determined by inductively coupled, argon plasma-atomic emission spectroscopy, using methods described by Crock and others (1987). Anomalous values were determined by considering the range and distribution of the elemental concentrations as well as by comparison with published average elemental abundances associated with certain rock types. Analytical data and a detailed description of the sampling and analytical techniques are provided by M.S. Erickson (unpub. data, 1987).

An anomalous north-northeast-trending zone about 1 mi east of the study area was delineated by analyses of geochemical samples. This zone is defined by stream sediments anomalous in arsenic (10 to 25 parts per million, ppm) and mercury (0.16 to 0.69 ppm), nonmagnetic fraction of the heavy-mineral concentrates enriched in bismuth (as much as 50 ppm) and copper (as much as 7,000 ppm), and rocks anomalous in silver (as much as 1 ppm), antimony (4 to 28 ppm), arsenic (19 to 320 ppm), and mercury (0.28 to 24 ppm). Gray and others (1983) and Conners and others (1982) reported weakly anomalous concentrations of gold (as much as 20 parts per billion, ppb), arsenic, mercury, and uranium oxide (as much as 6.1 ppm) in rock and stream-sediment samples from this part of the study area. This geochemically anomalous zone coincides with the zone of caldera-related ring faults and fractures (fig. 2). The highest antimony, arsenic, and mercury concentrations are in rocks from the area of hydrothermal alteration in the Albisu prospect northeast of Disaster Peak. The ring-fracture zone of the Long Ridge caldera was the controlling structure for reported mercury and uranium mineralization less than 20 mi to the east and south (Rytuba and Glanzman, 1978; Rytuba and others, 1979) and was probably the controlling structure for the mineralization that occurred near the study area. Many of the anomalous elements (antimony, arsenic, mercury, silver and uranium) found in and near the eastern part of the study area are part of the suite of elements associated with hydrothermally altered and mineralized areas in the McDermitt caldera complex (Rytuba and others, 1979). Anomalous antimony, arsenic, bismuth, copper, and mercury, all present in the study area, also characterize gold-silver-base-metal (arsenic, antimony, mercury, tellurium, thallium, uranium, lead, zinc, and copper) epithermal deposits (Berger, 1982).

Scattered low-level gold (up to 6 ppb) and arsenic (up to 8 ppm) anomalies were detected by Conners and others (1982) in stream sediments from the southwestern part of the study area. In the present study, only anomalous mercury (0.55 ppm) was observed in stream sediments collected from this area. These stream sediments were derived in part or entirely from granitic rocks exposed in the area (fig. 2), and, thus, the anomalies may reflect gold-mineralized quartz veins in the granitic rock such as those at the Au claim group. The fact that veins were only observed in the granitic rock suggests that vein emplacement and gold mineralization occurred prior to the inception of Miocene volcanism in the region and perhaps during the waning stages of plutonism.

Geophysical Studies

Geophysical evaluation of the mineral resources of the study area was based on interpretations of three kinds of geophysical surveys. These were aerial gamma-ray, aeromagnetic, and gravity surveys.

Radiometric data were compiled by Geodata International, Inc. (1979, 1980) for the NURE program of the Department of Energy. The coverage in Oregon consists of two east-west flightlines spaced 3 mi apart and totalling about 8 mi in length. Flight altitudes ranged from 300 to 600 ft above the ground. One east-west flightline in Nevada was flown at an unacceptably high elevation and was unusable. Recordings were made of spectra that are associated with gamma-ray flux from radioactive isotopes of uranium, thorium, and potassium. Count rates exceeded background levels for all three isotopes over the eastern half of the study area in Oregon. Radiometric data also were collected at a spacing of 0.33 mi and a flight altitude of 400 to 600 ft above the ground (U.S. Geological Survey, 1982). The data, however, only include about 30 line-miles (23 east-west lines) in the eastern part of the study area. Radioelement count rates recorded in the latter survey markedly correlate with surface geology. The count rates—especially for equivalent uranium—are low over the Steens Basalt and intermediate-composition flows, somewhat higher and more variable over Cretaceous granitic rocks, and high over rhyolitic ash-flow tuff sheets exposed to the east of the study area. A concentration of equivalent uranium (greater than 12 ppm) is indicated about 1.5 mi outside the study area in a location that coincides with the most geochemically anomalous part of the Albisu prospect (fig. 2).

Regional aeromagnetic surveys were flown over the study area at a constant barometric elevation of 9,000 ft above sea level with east-west flightline spacings of 2 mi (U.S. Geological Survey, 1972a, b). Conspicuous magnetic lows, especially intense over topographic highs such as Disaster Peak, occur in most of the study area. The magnetic lows reflect exposed, reversely magnetized rocks of Steens Basalt (Mankinen and others, 1987)

The USGS established 23 gravity stations in and within 3 mi of the study area in 1986 (Plouff, 1987). These data supplemented a larger set of previously established stations located mostly to the east of the study area (Plouff, 1977). A preliminary gravity map prepared from these data shows a north-trending gravity high centered along the east edge of the study area (Donald Plouff, unpub. data). Gravity values rather uniformly decrease westward about 20 milligals in 8 mi across the study area and eastward about 15 milligals in 8 mi. Within and to the south of the southeastern part of the study area, the gravity high is centered near the eastern edge of exposed Cretaceous granitic rocks mapped by J.J. Rytuba (written commun., 1980) (fig. 2). The gravity high apparently reflects the contrast in density between Cretaceous basement rocks and surrounding Tertiary rocks near the surface and at depth. The gravity gradient to the east of the gravity high overlies the margin of the Long Ridge caldera and may reflect the west edge of Miocene pluton(s) under the caldera. Concealed Cenozoic pluton(s) of low density also may exist at progressively shallower depths to the west of the gravity high.

Mineral and Energy Resource Potential

The mineral resource potential of the Disaster Peak Wilderness Study Area was assessed on the basis of geologic investigations, geochemical and geophysical studies, a study of prospects and claims, and reported mineral occurrences and deposits in the region. The study area has resource potential for gold (in two types of deposits), silver, mercury, and uranium. Data suggest lack of resource potential for geothermal energy, oil, and gas.

A study of the Au claim group in the southern part of the study area (table 1 and fig. 2, No. 2) indicates that quartz veins crosscutting the granitic basement rocks have been mineralized with gold. Gold within the veins occurs in concentrations of at least 1.120 oz/ton and is accompanied by minor native silver, galena, copper sulfides, and carbonate minerals. Although poorly exposed, the veins are subparallel, occupy faults or other fissures, and are limited to the area of the Au claim group. However, weakly anomalous concentrations of gold and arsenic within stream sediments derived partly from other areas of granitic rock suggest that similar undiscovered mineralized veins may be present elsewhere. The quartz veins have some attributes of low-sulfide gold-quartz veins described in the ore-deposit model of Berger (1986a). The Mother Lode veins in California are perhaps the best known example of this type of deposit. In this model, quartz, gold, and accessory minerals crystallize from fluids migrating along fault and joint systems along continental-margin orogenic belts following regional metamorphism and emplacement of granitic batholiths. In the study area, the mineralized quartz veins may have formed during the Late Cretaceous, soon after intrusion of the granitic rocks. Alternatively, the veins may have formed during some later magmatic hydrothermal event but prior to the inception of Miocene volcanism in the area. The area of the Au claim group in the southern part of the study area has high potential, certainty level B, for gold resources in quartz veins (fig 2). Although economically significant concentrations of gold have been detected in the claim area in a geologic environment favorable for ore deposition, the geometry, extent, and quality of the mineralized veins are not well defined. The surrounding area of granitic rock that lacks known quartz veins, in which weak but significant geochemical anomalies are present, has low resource potential, certainty level B, for gold in quartz veins.

Results of the present study, and reported near-by mining activity, indicate that epithermal gold, mercury, and uranium mineralization occurred in an area adjacent to, and possibly within, the northeastern part of the study area. Adjacent to the study area, the area of hydrothermally altered and mineralized rock within the Albisu prospect is controlled by north- to northeast-striking arcuate faults and fractures associated with the Long Ridge caldera (fig. 2). The hydrothermally affected area contains highly anomalous concentrations of gold, antimony, arsenic, mercury, and uranium as well as weakly anomalous amounts of silver. A pronounced radiometric anomaly over the area (see geophysical studies, above) also indicates anomalous concentrations of uranium. Surrounding this area, but still within the zone of caldera ring faults and including the northeastern part of the study area (fig. 2), are scattered, weak geochemical and radiometric anomalies of these elements. Epithermal occurrences and ore deposits of mercury and uranium formed by hydrothermal activity during late stages of caldera development are present elsewhere within the McDermitt caldera complex (Rytuba and Glanzman, 1978; Rytuba and others, 1979; Rytuba and Conrad, 1981). Some of the uranium, such as at the Moonlight mine about 10 mi south of the study area (fig. 1), was hosted by rhyolite domes and ring intrusions. Both mercury and uranium were deposited in caldera-fill sedimentary and volcanic rocks, typically near the caldera margin. Rhyolite that erupted within the caldera complex, including the tuff of Long Ridge that is present in the study area, contains high background concentrations of uranium and mercury (Rytuba and others, 1979). Thus, the rhyolite is inferred to be the main source of the mercury and uranium in the occurrences. Although most of the anomalous elements in the Albisu mineralized area adjacent to the study area are also associated with the other mercury and uranium occurrences in the caldera complex, no significant gold concentrations have been reported in other parts of the caldera complex.

The Albisu mineralized area has many attributes of hot-spring gold-silver (Berger, 1986b) and hot-spring mercury (Rytuba, 1986) deposit models, including geochemical signatures, geologic environment, and types of alteration. The area also resembles the distal part of the volcanogenic uranium model described by Bagby (1986), although the model requires a shallow rhyolite intrusive host rock—a rock type not exposed in the study area. Mineralization in the Albisu area probably was caused by the circulation of gold-, silver-, mercury-, and uranium-enriched hydrothermal fluids through ring faults and fractures during the waning stages of the caldera cycle. The driving heat source may have been slowly cooling rhyolitic magma emplaced at shallow depth along the ring-fracture zone. Gold, silver, mercury, and uranium ore-forming minerals have not been identified at the surface near the Albisu prospect, suggesting that any undiscovered ore deposits of these metals are present at shallow depth.

The northeastern part of the study area resembles the adjacent Albisu mineralized area in that it contains caldera ring faults and similar, although weak, geochemical anomalies. Unlike the Albisu area, however, this part of the study area has no claims or prospects and generally lacks evidence of epithermal alteration or mineralization. The northeastern part of the study area has low potential, certainty level C, for resources of gold, silver, mercury, and uranium in epithermal deposits (fig. 2).

Sand and gravel suitable for construction use are present in the study area, but deposits are too small to constitute a resource. No undiscovered sand and gravel resources are expected beyond known occurrences, with a certainty level of D.

Bliss (1983a, b) compiled lists of thermal springs and wells in Oregon and Nevada which include several low-temperature (less than 90 °C) hot springs located in surrounding basins 10 or more miles from the study area. However, there is no evidence of recent geothermal activity in the study area, such as hot springs, recent volcanism, and geothermal wells. Furthermore, it is unlikely that faults in the area penetrate to great enough depths to allow for deep circulation of ground water. There is no potential for geothermal resources, certainty level D, in the study area.

Geologic data indicate the absence of oil and gas resources in or near the study area. The Tertiary volcanic and pyroclastic sequence that underlies most of the study area contains only local, thin, and discontinuous layers of sedimentary rock and lacks evidence of hydrocarbons. Cretaceous granitic rocks exposed in The Granites area and presumably forming the basement rock throughout the study area are not a source or reservoir for hydrocarbons, nor are the underlying Cenozoic intrusive rocks inferred from the gravity data (see geophysical studies, above). There are no active oil and gas leases or producing wells in or near the study area. The Disaster Peak Wilderness Study Area has no potential, certainty level D, for oil and gas resources.

REFERENCES CITED

Bagby, W.C., 1986, Descriptive model of volcanogenic U, model 25f, *in* Cox, D.P., and Singer, D.A., eds., Mineral deposit models: U.S. Geological Survey Bulletin 1693, p. 162-164.

Beikman, H.M., Hinkle, M.E., Frieders, Twila, Marcus, S.M., and Edward, J.R., 1983, Mineral surveys by the Geological Survey and the Bureau of Mines of Bureau of Land Management Wilderness Study Areas: U.S. Geological Survey Circular 901, 28 p.

Benson, W.T., 1956, Investigation of mercury deposits in Nevada and Malheur County, Oregon: U.S. Bureau of Mines Report of Investigation 5285, 54 p.

Berger, B.R., 1982, The geological attributes of Au-Ag-base metal epithermal deposits, *in* Erickson, R.L., ed., Characteristics of mineral deposit occurrences: U.S. Geological Survey Open-File Report 82-795.

_____ 1986a, Descriptive model of low-sulfide Au-quartz veins, model 36a, *in* Cox, D.P., and Singer, D.A., eds., Mineral deposit models: U.S. Geological Survey Bulletin 1693, p. 239-243.

_____ 1986b, Descriptive model of hot-spring Au-Ag, model 25a, *in* Cox, D.P., and Singer, D.A., eds., Mineral deposit models: U.S. Geological Survey Bulletin 1693, p. 143-144.

Bliss, J.D., 1983a, Oregon basic data for thermal springs and wells as recorded in Geotherm: U.S. Geological Survey Open-File Report 83-435, 242 p.

_____ 1983b, Nevada basic data for thermal springs and wells as recorded in Geotherm: U.S. Geological Survey Open-File Report 83-433A, 101 p.

Bukofski, J.F., Lovell, J.S., and Meyer, W.T., 1984, Mineral resource assessment through geochemical studies of heavy mineral concentrates from wilderness study areas in the Burns, Prineville, and Vale Districts, southeastern Oregon: Golden, Colo., Barringer Resources, Inc., 94 p.

Conners, R.A., Robinson, M.L., Bukofski, J.F., Meyer, W.T., and Howarth, R.J., 1982, Geochemical and geostatistical evaluation of wilderness study areas, Winnemucca District, northwest Nevada: Golden, Colo., Barringer Resources, Inc., 5 v., 24 pl.

Crock, J.G., Briggs, P.H., Jackson, L.L, and.Lichte, F.E., 1987, Analytical methods for the analysis of stream sediments and rocks from wilderness study areas: U.S. Geological Survey Open-File Report 87-84, 35 p.

Erikson, E.H., and Curry, W.E., 1977, Preliminary study of the uranium favorability of Tertiary rocks, southeastern Oregon: eastern Klamath, southern Lake, Harney, and western Malheur Counties: U.S. Energy Research and Development Administration Open-File Report GJBX-92(77), 23 p.; available through U.S. Geological Survey, Books and Open-File Reports Section, P.O. Box 25425, Federal Center, Denver, CO 80225.

Fuller, R.E., 1931, The geomorphology and volcanic sequence of Steens Mountain in southeastern Oregon: University of Washington Publications in Geology, v. 3, no. 1, p. 1-130.

Geodata International, Inc., 1979, Aerial radiometric and magnetic survey, National Topographic Map, Vya, Nevada: U.S. Department of Energy Open-File Report GJBX-136 (79), v. 2, 73 p.

_____1980, Aerial radiometric and magnetic survey, National Topographic Map, Adel, Oregon: U.S. Department of Energy Open-File Report GJBX-104 (80), v. 2, 145 p.

Glanzman, R.K., Rytuba, J.J., and McCarthy, J.H., Jr., 1978, Lithium in the McDermitt Caldera, Nevada and Oregon: Energy, v. 3, no. 3, p. 347-353.

Goudarzi, G.H., 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report 84-787, 51 p.

Gray, J.J., Peterson, J.C., Clayton, Janine, and Baxter, Gary, 1983, Geology and mineral resources of 18 BLM wilderness study areas, Harney and Malheur Counties, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report 0-83-2, 106 p.

Greene, R.C., 1976, Volcanic rocks of the McDermitt caldera, Nevada-Oregon: U.S. Geological Survey Open-File Report 76-753, 80 p.

Grimes, D.J., and Marranzino, A.P., 1968, Direct-current arc and alternating-current spark emission spectrographic field methods for the semiquantitative analysis of geologic materials: U.S. Geological Survey Circular 591, 6 p.

Leszcykowski, A.M., 1987., Mineral resources of the Disaster Peak study area, Harney and Malheur Counties, Oregon, and Humboldt County, Nevada: U.S. Bureau of Mines Open-File Report MLA 65-87, 16 p.

Mankinen, E.A., Larson, E.E., Gromme, C.S., Prevot, Michel, and Coe, R.S., 1987, The Steens Mountain (Oregon) geomagnetic polarity transition—3. Its regional significance: Journal of Geophysical Research, v. 92, no. B8, p. 8057-8076.

McKelvey, V.E., 1972, Mineral resource estimates and public policy: American Scientist, v. 60, p. 32-40.

May, J.T., Witkowski, D.S., and Seidel, D.G., 1980, Extracting lithium from clays by roast-leach treatment: U.S. Bureau of Mines Report of Investigation 8432, 16 p.

Minor, S.A., 1986, Stratigraphy and structure of the western Trout Creek and northern Bilk Creek Mountains, Harney County, Oregon, and Humboldt County, Nevada: Boulder, Colo., University of Colorado, M.S. thesis, 189 p.

Piper, A.M., Robinson, T.W., Jr., and Park, C.F., Jr., 1939, Geology and ground-water resources of the Harney Basin, Oregon: U.S. Geological Survey Water-Supply Paper 841, 189 p.

Plouff, Donald, 1977, List of principal facts and gravity anomalies for an area between Orovada, Nevada, and Adel, Oregon: U.S. Geological Survey Open-File Report 77-683, 40 p.

_____1987, Gravity observations by the U.S. Geological Survey in northwest Nevada, southeast Oregon, and northeast California, 1984-1986: U.S. Geological Survey Open-File Report 87-639, 33 p.

Rytuba, J.J., 1976, Geology and ore deposits of the McDermitt Caldera, Nevada-Oregon: U.S. Geological Survey Open-File Report 76-535, 9 p.

_____ 1986, Descriptive model of hot-spring Hg, model 27a, *in* Cox, D.P., and Singer, D.A., eds., Mineral deposit models: U.S. Geological Survey Bulletin 1693, p. 178-179.

Rytuba, J.J., and Conrad, W.K., 1981, Petrochemical characteristics of volcanic rocks associated with uranium deposits in the McDermitt caldera complex, *in* Goodell, P.C., and Waters, A.C., eds., Uranium in volcanic and volcaniclastic rocks: American Association of Petroleum Geologists Studies in Geology, no. 13, p. 63-72.

Rytuba, J.J., and Glanzman, R.K., 1978, Relation of mercury, uranium, and lithium deposits to the McDermitt caldera complex, Nevada-Oregon: U.S. Geological Survey Open-File Report 78-926, 28 p.

Rytuba, J.J., Glanzman, R.K., and Conrad, W.K., 1979, Uranium, thorium, and mercury distribution through the evolution of the McDermitt caldera complex, *in* Newman, G.W., and Goode, H.D., eds., Rocky Mountain Association of Geologists Basin and Range Symposium and Great Basin Field Conference: Rocky Mountain Association of Geologists Meeting, Las Vegas, 1979, Guidebook, p. 405-412.

Rytuba, J.J., and McKee, E.H., 1984, Peralkaline ash-flow tuffs and calderas of the McDermitt volcanic field, southeast Oregon and north central Nevada: Journal of Geophysical Research, v. 89, no. B10, p. 8616-8628.

Singleton, R.H., 1979, Lithium: U.S. Bureau of Mines Mineral Commodity Profiles, 24 p., available from Publications Distribution Branch, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, PA 15213.

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, 5 p.

U.S. Geological Survey, 1972a, Aeromagnetic map of the Adel and parts of the Burns, Boise, and Jordan Valley 1o by 2o quadrangles, Oregon: U.S. Geological Survey open-file report, scale 1:250,000.

_____1972b, Aeromagnetic map of the Vya and part of the McDermitt 1^{o} by 2^{o} quadrangle, Nevada: U.S. Geological Survey open-file report, scale 1:250,000.

_____1982, Spectral radiometric and total-field magnetic survey of the McDermitt calderas, NV-OR: U.S. Geological Survey Open-File Report 82-323, 41 p., 96 sheets, scale 1:62,500.

Walker, G.W., and Repenning, C.A., 1965, Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon: U.S. Geological Survey Miscellaneous Geological Investigations Map I-446, scale 1:250,000.

Willden, Ronald, 1964, Geology and mineral deposits of Humboldt County, Nevada: Nevada Bureau of Mines and Geology Bulletin 59, 145 p.

Yates, R.G., 1942, Quicksilver deposits of the Opalite district, Malheur County, Oregon, and Humboldt County, Nevada: U.S. Geological Survey Bulletin 931-N, p. 319-348.

APPENDIXES

DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

LEVELS OF RESOURCE POTENTIAL

H **HIGH** 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 a high degree of likelihood for resource accumulation, where data support 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.

M **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 for resource accumulation, and (or) where an application of mineral-deposit models indicates favorable ground for the specified type(s) of deposits.

L **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 little or no indication of having been mineralized.

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

U **UNKNOWN** mineral resource potential is assigned to areas where information is inadequate to assign a low, moderate, or high level of resource potential.

LEVELS OF CERTAINTY

A Available information is not adequate for determination of the level of mineral resource potential.
B Available information only 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.

LEVEL OF RESOURCE POTENTIAL →

A	B	C	D
U/A	H/B HIGH POTENTIAL	H/C HIGH POTENTIAL	H/D HIGH POTENTIAL
UNKNOWN POTENTIAL	M/B MODERATE POTENTIAL	M/C MODERATE POTENTIAL	M/D MODERATE POTENTIAL
	L/B LOW POTENTIAL	L/C LOW POTENTIAL	L/D LOW POTENTIAL
			N/D NO POTENTIAL

LEVEL OF CERTAINTY →

Abstracted with minor modifications from:

Taylor, R.B., and Steven, T.A., 1983, Definition of mineral resource potential: Economic Geology, v. 78, no. 6, p. 1268-1270.
Taylor, R.B., Stoneman, R.J., and Marsh, S.P., 1984, An assessment of the mineral resource potential of the San Isabel National Forest, south-central Colorado: U.S. Geological Survey Bulletin 1638, p. 40-42.
Goudarzi, G.H., compiler, 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report 84-0787, p. 7, 8.

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 McKelvey, V.E., 1972, Mineral resource estimates and public policy: American Scientist, v. 60, p. 32-40; and 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	[1]~570
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.

SELECTED SERIES OF U.S. GEOLOGICAL SURVEY PUBLICATIONS

Periodicals

Earthquakes & Volcanoes (issued bimonthly).
Preliminary Determination of Epicenters (issued monthly).

Technical Books and Reports

Professional Papers are mainly comprehensive scientific reports of wide and lasting interest and importance to professional scientists and engineers. Included are reports on the results of resource studies and of topographic, hydrologic, and geologic investigations. They also include collections of related papers addressing different aspects of a single scientific topic.

Bulletins contain significant data and interpretations that are of lasting scientific interest but are generally more limited in scope or geographic coverage than Professional Papers. They include the results of resource studies and of geologic and topographic investigations; as well as collections of short papers related to a specific topic.

Water-Supply Papers are comprehensive reports that present significant interpretive results of hydrologic investigations of wide interest to professional geologists, hydrologists, and engineers. The series covers investigations in all phases of hydrology, including hydrogeology, availability of water, quality of water, and use of water.

Circulars present administrative information or important scientific information of wide popular interest in a format designed for distribution at no cost to the public. Information is usually of short-term interest.

Water-Resources Investigations Reports are papers of an interpretive nature made available to the public outside the formal USGS publications series. Copies are reproduced on request unlike formal USGS publications, and they are also available for public inspection at depositories indicated in USGS catalogs.

Open-File Reports include unpublished manuscript reports, maps, and other material that are made available for public consultation at depositories. They are a nonpermanent form of publication that may be cited in other publications as sources of information.

Maps

Geologic Quadrangle Maps are multicolor geologic maps on topographic bases in 7 1/2- or 15-minute quadrangle formats (scales mainly 1:24,000 or 1:62,500) showing bedrock, surficial, or engineering geology. Maps generally include brief texts; some maps include structure and columnar sections only.

Geophysical Investigations Maps are on topographic or planimetric bases at various scales; they show results of surveys using geophysical techniques, such as gravity, magnetic, seismic, or radioactivity, which reflect subsurface structures that are of economic or geologic significance. Many maps include correlations with the geology.

Miscellaneous Investigations Series Maps are on planimetric or topographic bases of regular and irregular areas at various scales; they present a wide variety of format and subject matter. The series also includes 7 1/2-minute quadrangle photogeologic maps on planimetric bases which show geology as interpreted from aerial photographs. Series also includes maps of Mars and the Moon.

Coal Investigations Maps are geologic maps on topographic or planimetric bases at various scales showing bedrock or surficial geology, stratigraphy, and structural relations in certain coal-resource areas.

Oil and Gas Investigations Charts show stratigraphic information for certain oil and gas fields and other areas having petroleum potential.

Miscellaneous Field Studies Maps are multicolor or black-and-white maps on topographic or planimetric bases on quadrangle or irregular areas at various scales. Pre-1971 maps show bedrock geology in relation to specific mining or mineral-deposit problems; post-1971 maps are primarily black-and-white maps on various subjects such as environmental studies or wilderness mineral investigations.

Hydrologic Investigations Atlases are multicolored or black-and-white maps on topographic or planimetric bases presenting a wide range of geohydrologic data of both regular and irregular areas; principal scale is 1:24,000 and regional studies are at 1:250,000 scale or smaller.

Catalogs

Permanent catalogs, as well as some others, giving comprehensive listings of U.S. Geological Survey publications are available under the conditions indicated below from the U.S. Geological Survey, Books and Open-File Reports Section, Federal Center, Box 25425, Denver, CO 80225. (See latest Price and Availability List.)

"Publications of the Geological Survey, 1879-1961" may be purchased by mail and over the counter in paperback book form and as a set of microfiche.

"Publications of the Geological Survey, 1962-1970" may be purchased by mail and over the counter in paperback book form and as a set of microfiche.

"Publications of the U.S. Geological Survey, 1971-1981" may be purchased by mail and over the counter in paperback book form (two volumes, publications listing and index) and as a set of microfiche.

Supplements for 1982, 1983, 1984, 1985, 1986, and for subsequent years since the last permanent catalog may be purchased by mail and over the counter in paperback book form.

State catalogs, "List of U.S. Geological Survey Geologic and Water-Supply Reports and Maps For (State)," may be purchased by mail and over the counter in paperback booklet form only.

"Price and Availability List of U.S. Geological Survey Publications," issued annually, is available free of charge in paperback booklet form only.

Selected copies of a monthly catalog "New Publications of the U.S. Geological Survey" available free of charge by mail or may be obtained over the counter in paperback booklet form only. Those wishing a free subscription to the monthly catalog "New Publications of the U.S. Geological Survey" should write to the U.S. Geological Survey, 582 National Center, Reston, VA 22092.

Note.--Prices of Government publications listed in older catalogs, announcements, and publications may be incorrect. Therefore, the prices charged may differ from the prices in catalogs, announcements, and publications.

U.S. DEPARTMENT OF THE INTERIOR

March 3, 1849