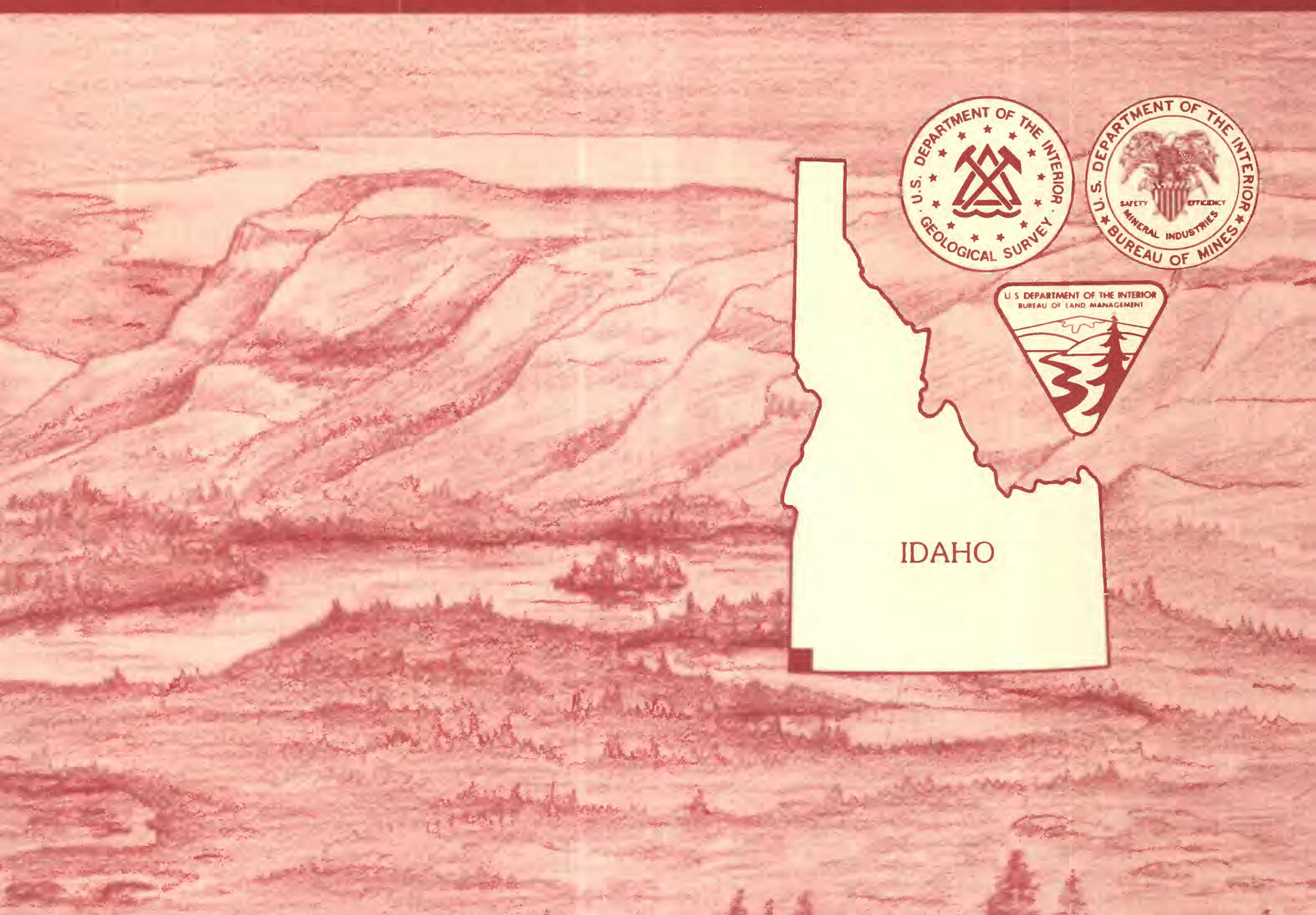
Mineral Resources of the Owyhee River Canyon and Deep Creek–Owyhee River Wilderness Study Areas, Owyhee County, Idaho

U.S. GEOLOGICAL SURVEY BULLETIN 1719–D



Chapter D

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By MICHAEL G. SAWLIN, HARLEY D. KING, JAMES D. HOFFMAN, and DOLORES M. KULIK

U.S. Geological Survey

PETER N. GABBY, DONALD O. CAPSTICK, and ALAN R. BUEHLER

U.S. Bureau of Mines

U.S. GEOLOGICAL SURVEY BULLETIN 1719

MINERAL RESOURCES OF WILDERNESS STUDY AREAS: OWYHEE RIVER REGION, IDAHO AND 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 Areas

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 of 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 Congress. This report presents the results of a mineral survey of the Owyhee River Canyon Wilderness Study Area (ID-16-48B) and of the Deep Creek-Owyhee River Wilderness Study Area (ID-16-49A), Owyhee County, Idaho.

CONTENTS

FIGURES

Mineral Resources of the Owyhee River Canyon and Deep Creek–Owyhee River Wilderness Study Areas, Owyhee County, Idaho

By Michael G. Sawlan, Harley D. King, James D. Hoffman, *and* Dolores M. Kulik
U.S. Geological Survey

and Peter N. Gabby, Donald O. Capstick, *and* Alan R. Buehler
U.S. Bureau of Mines

SUMMARY

Abstract

The Owyhee River Canyon Wilderness Study Area (ID-16-48B) and the Deep Creek-Owyhee River Wilderness Study Area (ID-16-49A) are contiguous areas located in the southwest corner of Idaho. At the request of the Bureau of Land Management, 33,700 acres of the Owyhee River Canyon Wilderness Study Area and 67,400 acres of the Deep Creek-Owyhee River Wilderness Study Area were studied. In this report, the areas studied are refered to as the "wilderness study areas," or simply "the study areas." The Owyhee River Canyon Wilderness Study Area extends along the Owyhee River and the South Fork Owyhee River canyons. The Deep Creek-Owyhee River Wilderness Study Area extends along the Owyhee River, and Deep and Dickshooter Creeks. Fieldwork for this report was conducted during 1984 and 1985. Two prospects for lapidary jasper, chalcedony, and common opal are located adjacent to the study areas, and one of these extends into both study areas. These prospects have yielded materials that are mainly of interest to hobbyists. There are no active mines located inside either study area and no mineral resources were identified. A small area in the southwest part of the Deep Creek-Owyhee River Wilderness Study Area has low resource potential for silver. There is no evidence of mineral resources within the Owyhee River Canyon Wilderness Study Area. A diatomite deposit is located within a mile of the northeast margin of the Deep Creek-Owyhee River Wilderness Study Area but has not been mined for over 50 years. Oil and natural gas leases cover parts of both study areas, but no exploration has occurred. Geologic and geophysical evidence for hydrocarbon source beds or structural traps is lacking in both study areas.

Character and Setting

The Owyhee River Canyon Wilderness Study Area and the Deep Creek-Owyhee River Wilderness Study Area are both located in the Owyhee Plateau region in the extreme southwest corner of Idaho (fig. 1). The terrain consists of a flat to rolling plateau into which deep, narrow canyons have been cut by the Owyhee River and its tributaries, Deep Creek and Dickshooter Creek. Canyon depths range from 300 ft in upper Dickshooter Creek to more than 1,000 ft along the Owyhee River at the Oregon-Idaho border. The plateau is underlain by more than 1,000 ft of middle and late Miocene (9-14 million years before present (Ma); see geologic time chart, fig. 3) rhyolite rheoignimbrite (material originally deposited as an ash flow but which flowed in the manner of lava before coming to rest). These volcanic rocks are locally overlain by fluvio-lacustrine sedimentary rocks that may include minor intercalated basalt flows. Basalt flows that have a composite thickness of 20-100 ft form a discontinuous, thin, widespread veneer upon the rhyolites and sedimentary rocks south of the Owyhee River and in the Lambert Table area. Locally abundant, northwest to northeast-trending high-angle faults are most common in the Owyhee River Canyon Wilderness Study Area and the Deep Creek-Owyhee River Wilderness Study Area west of Lambert Table. These faults displace rhyolite and overlying sedimentary rocks but, in most instances, do not displace the mesa-forming basalts.

Mineral Resource Potential of the Owyhee River Canyon Wilderness Study Area

The Owyhee River Canyon Wilderness Study Area exhibits no evidence of the existence of metallic or nonmetallic mineral resources. Available geologic and geophysical data do not suggest the occurrence of hydrocarbon source rocks or structural traps within the

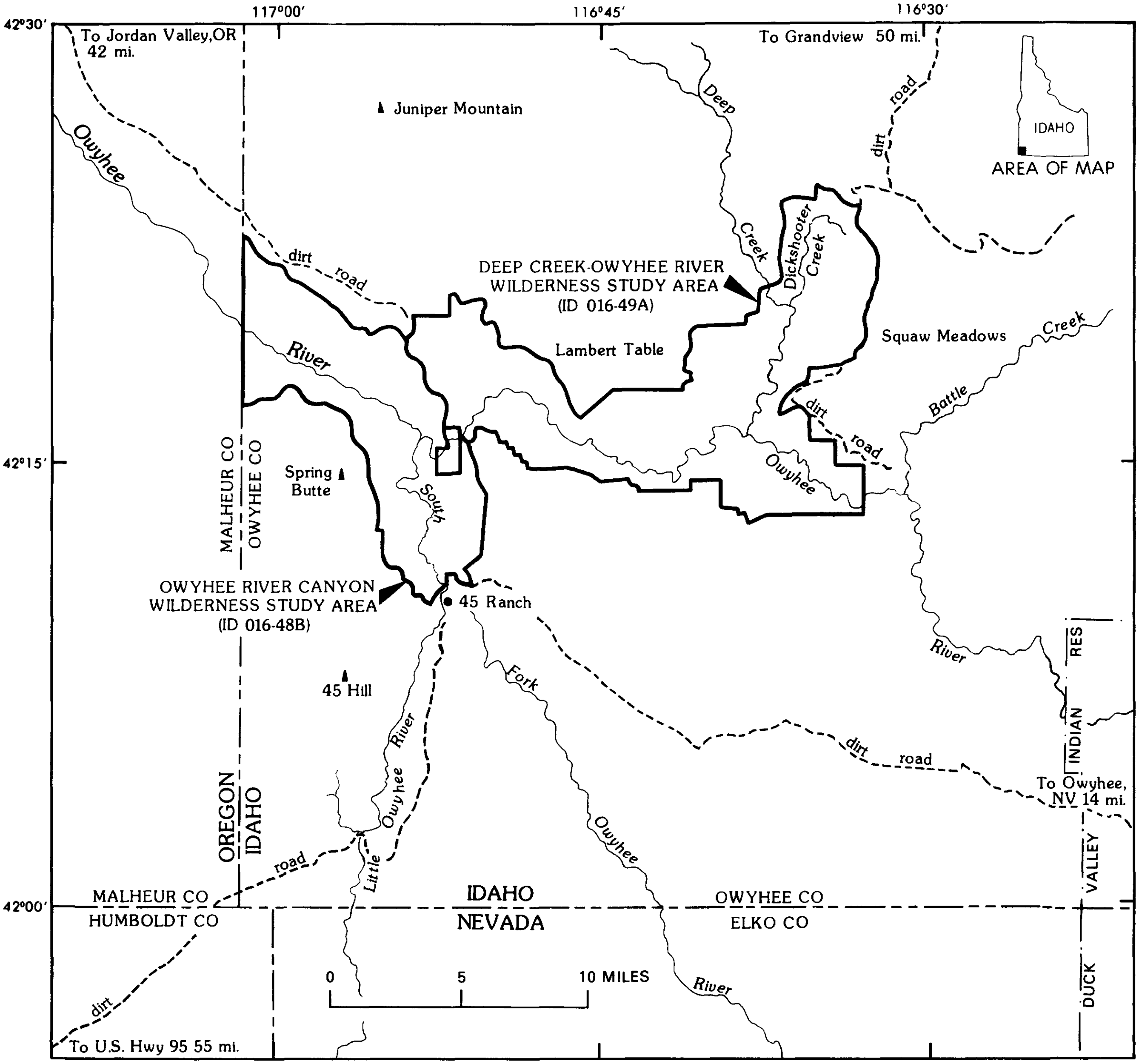


Figure 1. Index map showing location of Owyhee River Canyon and Deep Creek-Owyhee River Wilderness Study Areas, Owyhee County, Idaho.

study area. Geochemical analyses of stream sediments indicate widespread anomalous concentrations of tin and local anomalous concentrations of bismuth for areas underlain by rhyolite, but geologic field study does not indicate the presence of favorable structures, such as caldera ring fractures or vent systems within the study area. Widespread anomalies of tin and associated elements in stream sediment samples are attributed to generally higher tin concentrations in the rhyolites and do not indicate regional tin mineralization. These anomalies are best regarded as high background levels. Construction-grade sand and gravel occurrences are small and scattered. Available geologic and geophysical data give no indication of the occurrence of favorable source rocks or structural traps for oil and gas. There are no producing oil or gas wells in Idaho, and exploratory drilling in geologically more favorable areas 50 mi to the north and south has yielded only dry holes. Hence, this area is considered to have no resource potential for oil and gas.

Mineral Resource Potential of the Deep Creek-Owyhee River Wilderness Study Area

The Deep Creek-Owyhee River Study Area has low mineral resource potential for epithermal silver that may be associated with faults in the western part of the study area. Geochemical analyses indicate anomalous concentrations of tin, and slightly anomalous concentrations of cadmium and zinc in areas underlain by rhyolite. Favorable structures for mineralization of tin and associated elements are lacking, however, and the anomalous values most likely reflect the generally higher concentrations of these elements in the rhyolite. Although a diatomite deposit occurs adjacent to the study area, diatomite occurrences within the study area are small and impure; hence, this study area is considered to have no potential for diatomite. Construction-grade sand and gravel occurrences are small, scattered, and poorly accessible. Available geologic and geophysical data give no indication of the occurrence of favorable source rocks or structural traps for oil and gas. There are no producing oil or gas wells in Idaho, and drilling in geologically more favorable areas 50 mi to the north and south has yielded only dry holes. Hence, this area is considered to have no resource potential for oil and gas.

INTRODUCTION

Area Description

The Owyhee River Canyon Wilderness Study Area (ID-16-48B) includes 33,700 acres, and the Deep Creek-Owyhee River Wilderness Study Area (ID-16-49A) includes 67,400 acres. Both study areas are in the flat to gently rolling Owyhee Plateau of southwestern Idaho and have average elevations of about 5,000 ft. In the study areas, spectacular canyons as much as 1,000 ft deep have been cut into the plateau by the Owyhee River and its tributaries, Deep Creek and Dickshooter Creek. The climate is arid to semiarid; vegetation is sparse and consists predominantly of sagebrush and grasses.

The study areas are located at least 40 mi from the nearest paved roads. Areas north of the Owyhee River can be reached by gravel and dirt roads either southeast from Jordan Valley, Oregon, or southwest from Grandview, Idaho (fig. 1). Access to areas located south of the Owyhee River is provided by gravel and dirt roads that lead west from Idaho State Highway 51 through the Duck Valley Indian Reservation. Jeep trails provide limited vehicle access after entering the Owyhee region via the main dirt roads shown in figure 1.

Previous and Present Investigations

Previous geologic studies related to the wilderness study areas have focused on the regional stratigraphy (Ekren and others, 1984) and the emplacement mechanism of the rhyolites (Ekren and others, 1982). The geologic map of western Owyhee County (Ekren and others, 1981; 1:125,000 scale) includes both study areas. Geologic mapping for the present study was done at 1:24,000 scale and compiled at 1:62,500 scale. Lithologic units were based on unit assignments made by Ekren and others (1981).

Regional evaluations of uranium resource potential in parts of the study areas and (or) adjacent areas were prepared by Geodata International, Inc. (1980), Berry and others (1982), and the Union Carbide Corporation (1982) as part of the National Uranium Resource Evaluation (NURE) program administered by the U.S. Department of Energy. Previous nonspecific mineral-resource or exploration geochemical studies in or adjacent to the study areas include those of Matthews and Blackburn (1983), R. W. Morris (1976, unpub. report; available at U.S. Bureau of Mines, Western Field Operations Center, Spokane, Wash.), and Gloria Derby (1981, unpub. report; available at U.S. Bureau of Land Management, Boise District Office, Boise, Idaho).

The U.S. Geological Survey conducted field investigations in the study areas in 1984 and 1985. The work included field checking of existing geologic maps, new mapping where necessary, and geochemical sampling. Analytical data were obtained for 45 stream-sediment samples and 39 nonmagnetic, heavy-mineral panned concentrates from the Owyhee River Canyon area, and 70 stream-sediment samples and 59 nonmagnetic, heavy-mineral, panned concentrates from the Deep Creek-Owyhee River area.

The U.S. Bureau of Mines conducted a library search for information on mines and prospects within the wilderness study areas. These data were supplemented by information from Owyhee County and U.S. Bureau of Land Management mining and mineral-lease records and by U.S. Bureau of Mines and State production records. Field studies were conducted in 1984 for both the Owyhee Canyon Wilderness Study Area (Gabby, 1985) and the Deep Creek-Owyhee River Wilderness Study Area (Capstick and Buehler, 1985). Prospects and claims near the study areas were studied to determine if mineralized zones extend into the study areas and to establish guides to mineral deposits in the region. Reconnaissance panned-concentrate sampling was done along the Owyhee River and along Deep and Dickshooter Creeks to test for gold and other heavy minerals. Areas of obvious rock alteration were examined for evidence of prospecting activity that may not have been recorded.

Twenty-one rock and 11 placer samples were collected at prospects and mineralized sites in or near the Owyhee River Canyon Wilderness Study Area. Sixty rock and 19 placer samples, and 10 samples of possible diatomaceous material were collected in or near the Deep Creek-Owyhee River Wilderness Study Area. Samples were analyzed by fire-assay, atomic absorption, and semiquantitative methods, examined under a petrographic microscope, scanned with a binocular microscope to characterize the heavy-mineral content, and checked for radioactivity and fluorescence. Complete analyses are on file at the U.S. Bureau of Mines, Western Field Operations Center, Spokane, Wash.

Acknowledgments

The staff of the Boise area office of the U.S. Bureau of Land Management provided logistical support, information, maps, and the use of the U.S. Bureau of Land Management camp at Mud Flat, Idaho.

APPRAISAL OF IDENTIFIED RESOURCES

By Peter N. Gabby, Donald O. Capstick, and Alan R. Buehler U.S. Bureau of Mines

The two study areas contain no known mines, mining claims, or prospects and do not lie in or adjacent to an established mining district. Lode claims for lapidary jasper, chalcedony and common opal straddle the study area boundaries at the White Point prospect (fig. 2). Oil and gas leases or lease applications cover the approximately 25 percent of the Deep Creek-Owyhee River Wilderness Study Area in its northeast part, and approximately 7 percent of the Owyhee River Canyon Wilderness Study Area in its southeast part, east of the South Fork of the Owyhee River. There are no identified mineral or oil and gas resources within either of the study areas.

Jasper and Opal

Jasper, chalcedony, and common opal occur within silicified rhyolite throughout the study areas; most occurrences are small, scattered, and poor in quality. In some localities, these materials form colorful massive specimens or hollow spheroidal masses (commonly known as geoids or "thundereggs"). Lapidary specimens have been intermittently extracted from the White Point and Lu Lew prospects (fig. 2), but the informal production at these sites has not been recorded. Most production apparently has been from the White Point prospect. The larger occurrences of jasper, chalcedony, and common opal (which are various forms of silica), as at the two prospects cited here, have formed as replacements of rhyolite and porous tuffaceous rocks along faults. The White Point prospect includes about 10 acres of silicified rock, but lapidary material is found only locally; part of this prospect extends into both study areas along a common boundary. The Lu Lew prospect consists of small, isolated occurrences of jasper and associated silicified rock. These commodities are mainly of interest to hobbyists.

Diatomite

The diatomite located north of the northeast tip of the Deep Creek-Owyhee River Wilderness Study Area is one of Idaho's largest diatomite deposits (Staley, 1964), but apparently there has not been any production since the 1930's when a "few" tons were extracted (Powers, 1947). The diatomaceous earth, also reported as fuller's earth or clay deposit (Derby, 1981, unpub. report; available at U.S. Bureau of Land Management, Boise District Office, Boise, Idaho), occurs in a basin cut in the Little Jacks Rhyolite and is overlain by 10-20 ft of basalt. This deposit covers an area of about 0.07 mi^2, approximately 1,000 ft north-south by 2,000 ft east-west, and has a maximum thickness of 150 ft. It contains an estimated 4.2 million tons of material (Staley, 1964) and has been regarded as Idaho's best "reserve" because of its purity and grain size appropriate for industrial use (Powers, 1947). Production from this deposit has apparently been used as cement admixture, polishing agent, insulation, and filter media (Powers, 1947; Elevatorski, 1975). Minor amounts of diatomite were found within the wilderness study areas but the diatomite here is impure and volumetrically insignificant in terms of consideration as a resource.

Gold

Trace amounts of gold were detected in heavy-mineral panned concentrates of stream sediments from both study areas, but the gold concentrations in all samples are neither anomalous nor economic. These stream sediments contain gold valued at less than $0.02/$yd^3$ (calculated at a gold value of $400 per troy ounce) whereas $0.10-0.15/$yd^3$ is considered anomalous, and $8-10/$yd^3$ is marginally economic.

Sand and Gravel

Construction-grade sand and gravel occur in the study area in small bars in the narrow canyons but are not considered to be significant resources because deposits are small and scattered.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

By Michael G. Sawlan, Harley King, James D. Hoffman, and Dolores M. Kulik
U.S. Geological Survey

Geology

The Owyhee River Canyon and Deep Creek-

Owyhee River Wilderness Study Areas are underlain by laterally extensive, flat-lying, middle Miocene rhyolite rheoignimbrites. These are locally overlain by fluvio-lacustrine sedimentary strata deposited in shallow north-trending grabens. Upper Miocene and (or) Pliocene basalt locally form thin caps of low-lying mesas. Pre-Miocene basement rocks are not exposed within the study areas, but may include Cretaceous granitoid rocks and associated metamorphic country rock of the Idaho batholith, and perhaps Eocene and (or) Oligocene volcanic rocks. These pre-Miocene rocks are exposed in the Owyhee Mountains 25 to 30 mi north of the study areas and may extend beneath the volcanic rocks of the study areas.

The rhyolitic rocks in the study areas are rheoignimbrites: that is, they were emplaced as ash flows that continued to flow in the manner of lava after collapse of the dense ash cloud. Ekren and others (1984) applied the descriptive term "tuff" in naming each of these rock-units on the basis of their inferred emplacement mechanism. However, in most localities within the study areas, the rhyolite forms flow-banded devitrified lava. Vitroclastic textures are recognizable in parts of some outcrops, most commonly at the tops and bottoms of flow units, but these have been largely destroyed by annealing and shear deformation of glass shards during flow. Sigmoidal flow foliations, folds, and diapiric structures are common in the lava-like parts of the flows. The amplitude (A) of these structures ranges from a few centimeters to more than 100 m. Partially welded tuff occurs in parts of the rhyolite of upper Juniper Mountain. At transitions between lava and partially welded tuff in this unit, the tuff is strongly folded (A = 50-150 m) and strata are inclined as much as 55°.

Five rhyolite units were distinguished within the study areas on the basis of the stratigraphy of Ekren and others (1984). The stratigraphically lowest four rhyolite units range in age from about 14 to 12 Ma (Neill, 1975; Armstrong and others, 1980). In ascending stratigraphic order, these are the Swisher Mountain Rhyolite (= the Swisher Mountain Tuff of Ekren and others, 1984), the lower rhyolite of Juniper Mountain (= the lower-lobes unit of Ekren and others, 1984), the upper rhyolite of Juniper Mountain (= the upper-lobes unit of Ekren and others, 1984), and the rhyolite of The Badlands (= the tuff of The Badlands of Ekren and others, 1984). These rhyolite units are overlain by the Little Jacks Rhyolite (= the Little Jacks Tuff of Ekren and others, 1984), which is about 9-10 Ma in age (Neill, 1975; Armstrong and others, 1980).

The name "Swisher Mountain Tuff" is herein redefined only in its outcrop area south of Juniper Mountain (located in southwestern Idaho) as the Swisher Mountain Rhyolite to more adequately reflect its lithlogic character. In this area, the Swisher Mountain Rhyolite is a dense, flow-foliated rhyolite lava having a maximum thickness in excess of 200 m. It comprises a single cooling unit in which the uppermost 10-15 m consist of brecciated vitrophyre set within an ash matrix. The lava part of this unit characteristically forms the nearly vertical canyon walls along the Owyhee River; the upper breccia part of this unit forms gently sloping recesses in the canyons. The basal part of this unit was not observed, but is presumed to be a vitrophyre and ash breccia similar to the upper 10-15 m of this unit. Upper and lower vitrophyres and vitrophyre and ash breccias are characteristic of all lava-like rhyolitic units in the study areas. Local silicification has produced small pockets of jasper, chalcedony, and common opal in the porous upper and lower breccias of these rhyolite units; more pervasive silicification, as at the White Point and Lu Lew prospects (fig. 2), is associated with faults. Trace-element concentrations of rock samples suggest that the Swisher Mountain Rhyolite has a peralkaline chemistry (J.J. Rytuba, oral commun., 1985).

In the study areas, the rhyolite units may comprise a single cooling unit (for example, the lower rhyolite of Juniper Mountain, the rhyolite of The Badlands, and the Swisher Mountain Rhyolite) or multiple cooling units (the upper rhyolite of Juniper Mountain and the Little Jacks Rhyolite). These rhyolites contain 10 to 25 percent phenocrysts, which are mainly plagioclase and (or) sanidine feldspar. Quartz phenocrysts are abundant in the lower and upper rhyolites of Juniper Mountain but absent or rare in the Swisher Mountain and Little Jacks Rhyolites. A deep green, iron-rich(?) pigeonite is ubiquitous but relatively minor in abundance. Zircon and allanite(?) may be present in trace amounts.

Upper Miocene sedimentary rocks consist of poorly lithified mudstone, sandstone, and pebble and cobble conglomerate. Clasts are most commonly rhyolitic rock fragments, and the finer grained sedimentary deposits are locally diatomaceous or tuffaceous and rarely contain pumice lapilli. Sediment deposition occurred in a fluvio-lacustrine environment, most likely within shallow grabens. These rocks generally underlie basalt, although sedimentary rocks and basalt are locally intercalated.

Upper Miocene and (or) Pliocene basalt locally forms from one to four flows of intergranular to subophitic, sparsely and finely porphyritic, olivine- or olivine and plagioclase-phyric lava. Chromian spinel is commonly included within the olivine phenocrysts. Individual flows are thin (10-40 ft) and their composite thickness is typically less than 100 ft. These lavas erupted locally from low-profile shield volcanoes, such as Spring Butte and Lambert Table (fig. 1).

Northwest- to northeast-trending high-angle normal faults displace the rhyolite and overlying sedimentary strata from 20-80 ft, to as much as 150 ft in the study areas south of Juniper Mountain (fig. 1). Most faults are located in the Owyhee River Canyon Wilderness Study Area and the western part of the Deep Creek-Owyhee River Wilderness Study Area. Most capping basalts post-date faulting in this area, but shallow grabens (10-50 ft deep) have formed in the basalt mesas along Battle Creek, 5-15 mi east of the Deep Creek-Owyhee River Wilderness Study Area.

Geochemical Studies

A reconnaissance geochemical study included analysis and evaluation of stream sediments and nonmagnetic, heavy-mineral panned concentrates (hereafter referred to as panned concentrates). These

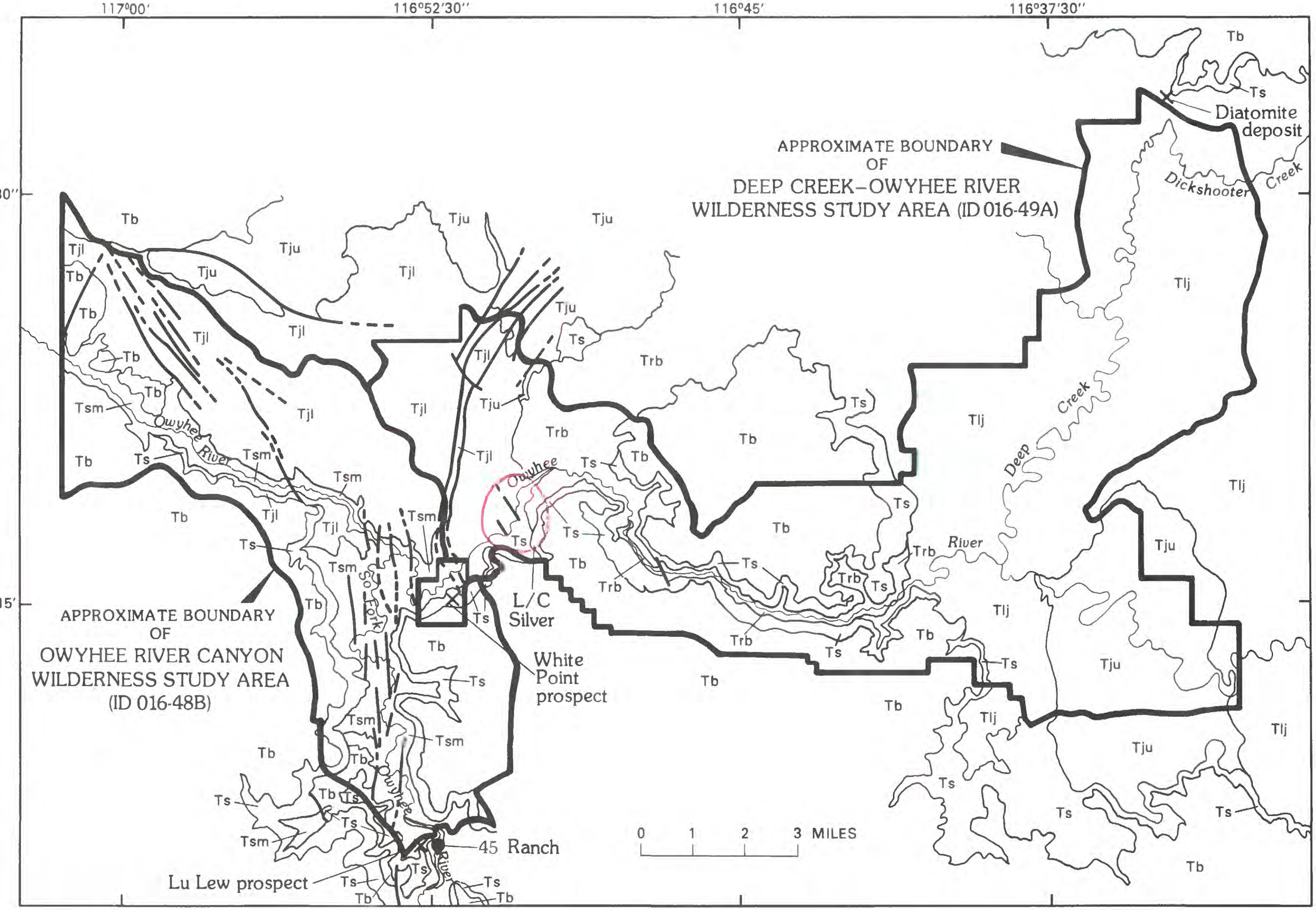
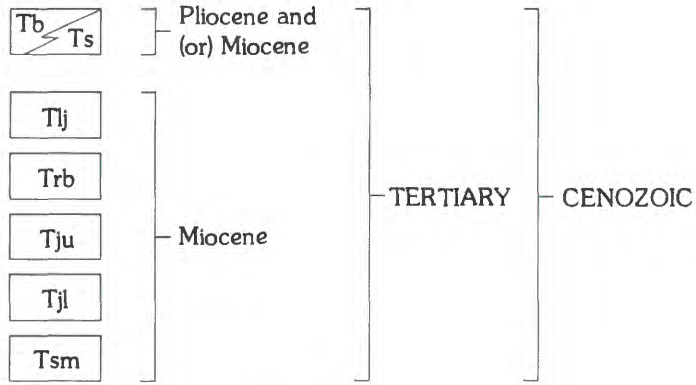


Figure 2. Map showing mineral resource potential and geology of the Owyhee River Canyon and the Deep Creek-Owyhee River Wilderness Study Areas, Owyhee County, Idaho.

EXPLANATION

AREA WITH LOW RESOURCE POTENTIAL--Certainty level C (commodity indicated). See appendix 1 and figure 3 for definition of mineral resource potential and certainty of assessment

CORRELATION OF MAP UNITS



GEOLOGIC MAP UNITS

Tb	BASALT (PLIOCENE AND (OR) MIOCENE)
Ts	SEDIMENTARY ROCKS (PLIOCENE AND (OR) MIOCENE)
Tlj	LITTLE JACKS RHYOLITE (MIOCENE)
Trb	RHYOLITE OF THE BADLANDS (MIOCENE)
Tju	UPPER RHYOLITE OF JUNIPER MOUNTAIN (MIOCENE)
Tjl	LOWER RHYOLITE OF JUNIPER MOUNTAIN (MIOCENE)
Tsm	SWISHER MOUNTAIN RHYOLITE (MIOCENE)

MAP SYMBOLS

CONTACT

FAULT-Dashed where uncertain

Figure 2. Continued

samples contain materials derived from rock units of tributary drainage basins. All samples were analyzed for 31 elements by semiquantitative emission spectrography. Analyses of stream-sediment samples were by the method of Myers and others (1961); the panned concentrates were analyzed by the method of Grimes and Marranzino (1968). Samples from the Deep Creek-Owyhee River Wilderness Study Area were analyzed for an additional five elements by inductively coupled argon plasma atomic-emission spectroscopy. In the Owyhee River Canyon Wilderness Study Area, 45 stream- sediment samples and 39 panned-concentrate samples were analyzed. In the Deep Creek-Owyhee River Canyon Wilderness Study Area, 70 stream-sediment samples and 59 panned-concentrate samples were analyzed.

Tin concentrations are generally high in panned-concentrate geochemical samples collected from rhyolite provenances within the study areas. The distribution and concentration of tin within the rhyolite units are nonsystematic, however. Analyses of the panned-concentrate samples in this study commonly exceed 1,000 parts per million (ppm) tin, a value suggested by Cox and Singer (1986) as a general exploration guide with this type of sample. However, the tin values obtained from the panned-concentrate samples in this study are not due to significantly mineralized rock. Mildly anomalous concentrations of zinc and cadmium were also observed in geochemical samples collected from rhyolitic provenances. The high levels of tin and associated elements most likely result from generally higher abundances in these particular rhyolites.

Although tin mineralization may occur in rhyolite, the geologic setting of the study areas is not favorable for significant localization of tin. Rhyolite-hosted tin deposits are characteristically located within or near vent deposits. For example, in the Mexican tin deposits tin ore is found in domes, flows, stocks, and breccias (Huspeni and others, 1984). However, rhyolites in the study areas formed as outflow-facies ash flows and are not located within a vent system. Berry and others (1982) reached a similar conclusion regarding "near-anomalous" concentrations of uranium in areas of the Owyhee plateau underlain by rhyolite. The lack of vents and associated structures favorable for uranium mineralization also applies to tin. Furthermore, rhyolite-hosted tin deposits are characteristically of low grade and tonnage (Cox and Singer, 1986).

Lead anomalies (100-3,000 ppm versus 20 ppm background) in panned-concentrate samples from the vicinity of the 45 Ranch (fig. 1) and small lead anomalies (50-200 ppm) in the southeast part of the Deep Creek-Owyhee River Wilderness Study Area are most likely due to man-made materials such as bullets, birdshot, and tin cans. Both localities are near roads easily accessible to hunters. A single heavy-mineral panned-concentrate sample containing an anomalous concentration of antimony also was found in the southeastern part of the Deep Creek-Owyhee River Wilderness Study Area.

In the northwestern part of the Owyhee River Canyon Wilderness Study Area south of Bald Mountain (fig. 2), panned-concentrate samples exhibit anomalous concentrations of bismuth (100-1,000 ppm versus 20 ppm background), lead (50-150 ppm), and beryllium (20 ppm versus 5 ppm background). These elements characteristically accompany tin (Cox and Singer, 1986). A strong gradient in bismuth anomalies, from 100 ppm at the Owyhee River to 1,000 ppm 2 mi south of Bald Mountain, may indicate minor concentrations of bismuth associated with tin. Tin and associated elements may have been concentrated in a vapor phase and deposited as these rhyolites cooled, but this hypothesis is speculative.

In the southwest part of the Deep Creek-Owyhee River Wilderness Study Area along the Owyhee River, anomalous high concentrations of silver (20 ppm versus 1 ppm background) and copper (200 ppm versus 30 ppm) were detected in one heavy-mineral panned-concentrate sample. The presence of these anomalies in a region cut by numerous faults may be due to local epithermal mineralization from fluid circulation along faults. These geochemical anomalies are not associated with silicification in tuffaceous layers in the rhyolite units. Analyses of silicified tuff from the White Point prospect by the U.S. Bureau of Mines show no geochemical anomalies.

Geophysical Studies

Geophysical data are consistent with the geological mapping that shows the study areas are underlain by extensive horizontal strata. Gravity data were obtained from files maintained by the Department of Defense and were supplemented by additional data collected in 1985. Bouguer gravity-anomaly values show only a gentle gradient of less than 10 mGal across both study areas. A broad gravity low, 40-50 mi in diameter, is approximately centered on the study areas. This gravity low generally corresponds to the distribution of the Little Jacks Rhyolite; there are no geologic indications of the presence of a caldera in this region. Aeromagnetic contours exhibit no gradient across the Owyhee River Canyon Wilderness Study Area and only about a 100-nanotesla gradient across the Deep Creek-Owyhee River Wilderness Study Area (U.S. Geological Survey, 1972, 1978). These geophysical data do not provide additional constraints on the geology, mineral resource potential, or oil and gas potential over and above those obtained from geologic mapping and geochemical studies.

Conclusions for the Owyhee River Canyon Wilderness Study Area

The absence of geologic and geochemical evidence of mineral-forming processes in the Owyhee River Canyon Wilderness Study Area indicates that there is no potential for any metallic-mineral resources in this wilderness study area. Construction-grade sand and gravel are found in the study areas, but these deposits are small and scattered and are not considered to be resources. Diatomite has been detected within the study area, but it is impure and present in quantities and too small to constitute a resource.

Available geologic and geophysical data give no indication of the presence of oil and gas resources. In Sandberg's (1983) statewide assessment of oil and gas resources, this study area and the adjacent Owyhee canyonlands were rated as having low potential for oil and gas, based largely on Warner's (1980) suggestion that hydrocarbon source rocks are present among the Cenozoic lacustrine strata. In the study area, however, there is no evidence for hydrocarbon source beds or structural traps; no surficial tar or oil seeps are present. The exposed Tertiary strata in the study area, consisting mainly of volcanic and tuffaceous sedimentary rocks, are not sources of hydrocarbons. It is conjectural whether carbonaceous source rocks are present beneath the volcanic strata in the study area. The nearest exposures of potential source rocks are carbonaceous shales of the Sucker Creek Formation of Miocene age located 40 mi to the north and northwest (Ekren and others, 1981, 1984). The structure and lithology of the subvolcanic basement is poorly known but may include plutonic and (or) metamorphic rocks associated with the Idaho batholith, and possibly Tertiary volcanic, volcaniclastic, and lacustrine sedimentary rocks.

At present, there are no producing oil or gas wells in Idaho or adjacent northernmost Nevada within 50 mi of the study area. In the Anschutz Federal No. 1 drill hole, located 45 mi north in the southern Snake River Plain, no oil or gas shows were reported and the hole bottomed-out in granite (McIntyre, 1979). Three drill holes in northern Nevada, located about 40-55 mi from the study area, have been "dry." These include an 800' hole drilled by the Bull Run Oil and Gas Company in 1922, and a 3386-ft well drilled by the Richfield Corporation in 1956; these were located within 2 mi of each other. A more recent exploration attempt by Exxon Corporation in 1985 in a locality 22 mi west of these drill holes resulted in a 14,464-ft dry hole through a stratigraphic section composed completely of rhyolitic tuff.

The thick cover of volcanic rocks, which may be as much as 1 km in thickness in the study area (Ekren and others, 1984), has undoubtedly discouraged oil and gas exploration, and petroleum industry interest in southwest Idaho appears to be declining. Atlantic Richfield Corporation, which presently holds the only leases in the study area, apparently plans to drop the lease without further exploration. In consideration of the absence of positive indications for source rocks and structural traps, and a history documenting a lack of oil and gas production in the state of Idaho and areas 50 mi south into Nevada, we conclude that there is no potential for oil and gas in the study area.

Conclusions for the Deep Creek-Owyhee River Wilderness Study Area

Geologic and geochemical studies indicate that part of the Deep Creek-Owhyee River Wilderness Study Area has low mineral resource potential for silver, certainty level C (fig. 2). The presence of silver is indicated in only a single geochemical sample, and no widespread, strongly altered, or oxidized zones were observed in this area. Hence, the source of the silver is thought to be small and local, possibly forming small hydrothermal veins along faults in the vicinity of the anomalous geochemical sample. Some high-quality diatomite appropriate for industrial use occurs in a deposit located outside the wilderness study area. Within the wilderness study area, occurrences of diatomite are poor in quality and small in volume. The study area has no resource potential for diatomite.

Available geologic and geophysical data give no indication of the presence of oil and gas resources. In Sandberg's (1983) statewide assessment of oil and gas resources, this study area and adjacent Owyhee canyonlands were rated as having low potential for oil and gas, based largely on Warner's (1980) suggestion that hydrocarbon source rocks are present among the Cenozoic lacustrine strata. In the study area, however, there is no evidence for hydrocarbon source beds or structural traps; no surficial tar or oil seeps are present. The exposed Tertiary strata in the study area, consisting mainly of volcanic and tuffaceous sedimentary rocks, are not sources of hydrocarbons. It is conjectural whether carbonaceous source rocks are present beneath the volcanic strata in the study area. The nearest exposures of potential source rocks are carbonaceous shales of the Sucker Creek Formation of Miocene age located 40 mi north and northwest (Ekren and others, 1981, 1984). The structure and lithology of the subvolcanic basement is poorly known but may include plutonic and (or) metamorphic rocks associated with the Idaho batholith, and possibly Tertiary volcanic, volcaniclastic, and lacustrine sedimentary rocks.

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The thick cover of volcanic rocks, which may be about 1 km in thickness in the study area (Ekren and others, 1984), has undoubtedly discouraged oil and gas exploration and petroleum industry interest in southwest Idaho appears to be declining. Atlantic Richfield Corporation, one of two oil and gas leasees in the study area, apparently plans on dropping the lease without further exploration. In consideration of the absence of positive indications for source rocks and structural traps, and a history documenting a lack of oil and gas production in the state of Idaho and areas 50 mi south into Nevada, we conclude that there is no potential for oil and gas in the study area.

REFERENCES CITED

Armstrong, R.L., Harakal, J.E., and Neill, W.M., 1980, K-Ar dating of Snake River Plain (Idaho) volcanic rocks—new results: Isochron/West, no. 27, p. 5-10.

Armstrong, R.L., Leeman, W.P., and Malde, H.E., 1975, K-Ar dating, Quaternary and Neogene volcanic rocks of the Snake River Plain, Idaho: American Journal of Science, v. 275, p. 225-251.

Berry, M.R., Castor, S.B., and Robins, J.W. (Bendix Field Engineering Corporation), 1982, National uranium resource evaluation, Jordan Valley quadrangle, Oregon and Idaho (contract no. DE-AC07-76GJ01664): U.S. Department of Energy Open-File Report PGJ/F-132(82), 33 p.

Capstick, D.O., and Buehler, A.R., 1985, Mineral Resources of the Deep Creek-Owyhee River Wilderness Study Area, Owyhee County, Idaho: U.S. Bureau of Mines Open-File Report MLA 54-85, 14 p.

Cox, D.P., and Singer, D.A., eds., 1986, Mineral deposit models: U.S. Geological Survey Bulletin 1693, 379 p.

Derby, Gloria, 1981, Owyhee Resource Area (Garat and '45'): unpublished Bureau of Land Management wilderness management situation supplemental, Boise District Office, Boise, Idaho, 7 p.

Ekren, E.B., McIntyre, D.H., and Bennett, E.H., 1984, High-temperature, large-volume, lavalike ash-flow tuffs without calderas in southwestern Idaho: U.S. Geological Survey Professional Paper 1272, 76 p.

Ekren, E.B., McIntyre, D.H., Bennett, E.H., and Malde, H.E., 1981, Geologic map of Owyhee County, Idaho, west of 116^{o} West Longitude: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-1256, scale 1:125,000.

Ekren, E.B., McIntyre, D.H., Bennett, E.H., and Marvin, R.F., 1982, Cenozoic stratigraphy of western Owyhee County, Idaho, in Bonnischen, Bill and Breckenridge, R. M., eds., Cenozoic geology of Idaho: Idaho Bureau of Mines and Geology Bulletin 26, p. 215-235.

Evelatorski, E.A., 1975, Idaho Industrial Minerals: MINOBRAS, 55p.

Gabby, P.N., 1985, Mineral resources of the Owyhee River Canyon Wilderness Study Area, Owyhee County, Idaho: U.S. Bureau of Mines Open-File Report MLA 68-85, 15 p.

Geodata International, Inc., 1980, Aerial radiometric and magnetic survey, national topographic map, Jordan Valley, Oregon/Idaho: prepared under Bendix Field Engineering Corp. subcontract no. 79-336-S, U.S. Department of Energy Open-File Report GJBX-95(80), 201 p.

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

Huspeni, J.R., Kesler, S.E., Ruiz, Joaquin, Tuta, Zane, Sutter, J.F., and Jones, L.M., 1984, Petrology and geochemistry of rhyolites associated with tin mineralization in northern Mexico: Economic Geology, v. 79, p. 87-105.

Mathews, G.W., and Blackburn, W.H., 1983, Assessment of geology, energy, and mineral (GEM) resources, Owyhee River GEM Resource Area (ID-010-11), Owyhee County, Idaho: prepared under U.S. Bureau of Land Management contract: YA-553-CT2-1042, TERRADATA, Lakewood, Colorado, 37 p.

McIntyre, 1979, Preliminary description of Anschutz Federal no. 1 drill hole, Owyhee County, Idaho: U.S. Geological Survey Open-File Report 79-651, 15 p.

Myers, A.T., Haven, R.G., and Dunton, P.J., 1961, A spectrochemical method for the semiquantitative analysis of rocks, minerals, and ores: U.S. Geological Survey Bulletin 1084-I, p. 207-229.

Neill, W.M., 1975, Geology of the southeastern Owyhee Mountains and environs, Owyhee County, Idaho: Stanford, Calif., Stanford University, M.S. thesis, 59 p.

Powers, H.A., 1947, Diatomite deposits of southwestern Idaho: Idaho Bureau of Mines and Geology Mineral Resources Report 4, 27 p.

Sandberg, C. A., 1983, Petroleum potential of wilderness lands in Idaho: U.S. Geological Survey Circular 902-F, 6 p.

Staley, W.W., 1964, Diatomite, in Mineral and water resources of Idaho: Idaho Bureau of Mines and Geology Special Report 1, p. 74-79.

Union Carbide Corp., 1982, Hydrogeochemical and stream sediment reconnaissance basic data for Adel, Jordan Valley, and Twin Falls, Oregon and Idaho (contract W-7405 eng 26): U.S. Geological Survey Open-File Report GJBX-170(82), 70 p.

U.S. Geological Survey, 1978, Aeromagnetic map of Idaho: U.S. Geological Survey Geophysical Investigations Map GP-919, scale 1:500,000, 1 sheet.

Warner, M.M., 1980, S. Idaho, N. Nevada, southeastern Oregon- prime exploration target: Oil and Gas Journal, p.325/341 (not inclusive).

APPENDIX 1. Definition of levels of mineral resource potential and certainty of assessment

Mineral resource potential is defined as the likelihood of the presence of mineral resources in a defined area; it is not a measure of the amount of resources or their profitability.

Mineral resources are concentrations of naturally occurring solid, liquid, or gaseous materials in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

Low mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment where the existence of resources is unlikely. This level of potential embraces areas of dispersed mineralized rock as well as areas having few or no indications of mineralization. Assignment of low potential requires specific positive knowledge; it is not used as a catchall for areas where adequate data are lacking.

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 a reasonable chance for resource accumulation, and where an application of genetic and (or) occurrence models indicates favorable ground.

High mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resources, where interpretations of data indicate a high likelihood for resource accumulation, where data support occurrence and (or) genetic models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential requires positive knowledge that resource-forming processes have been active in at least part of the area; it does not require that occurrences or deposits be identified.

Unknown mineral resource potential is assigned to areas where the level of knowledge is so inadequate that classification of the area as high, moderate, or low would be misleading. The phrase "no mineral resource potential" applies only to a specific resource type in a well-defined area. This phrase is not used if there is the slightest possibility of resource occurrence; it is not appropriate as the summary rating for any area.

Expression of the certainty of the mineral resource assessment incorporates a consideration of (1) the adequacy of the geologic, geochemical, geophysical, and resource data base available at the time of the assessment, (2) the adequacy of the occurrence or the genetic model used as the basis for a specific evaluation, and (3) an evaluation of the likelihood that the expected mineral endowment of the area is, or could be, economically extractable.

Levels of certainty of assessment are denoted by letters, A-D (fig. 3).

A. The available data are not adequate to determine the level of mineral resource potential. Level A is used with an assignment of unknown mineral resource potential.

B. The available data are adequate to suggest the geologic environment and the level of mineral resource potential, but either evidence is insufficient to establish precisely the likelihood of resource occurrence, or occurrence and (or) genetic models are not known well enough for predictive resource assessment.

C. The available data give a good indication of the geologic environment and the level of mineral resource potential, but additional evidence is needed to establish precisely the likelihood of resource occurrence, the activity of resource-forming processes, or available occurrence and (or) genetic models are minimal for predictive applications.

D. The available data clearly define the geologic environment and the level of mineral resource potential, and indicate the activity of resource—forming processes. Key evidence to interpret the presence or absence of specified types of resources is available, and occurrence and (or) genetic models are adequate for predictive resource assessment.

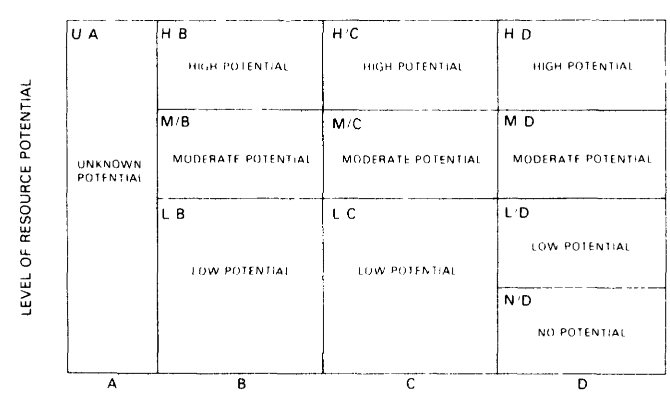

Figure 3. Major elements of mineral resource potential/certainty classification.

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.

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