DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

MINERAL RESOURCES OF THE GUANO CREEK WILDERNESS STUDY AREA, LAKE COUNTY, OREGON

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U.S. Geological Survey
Open-File Report 88-0297

Prepared by the U.S. Geological Survey and the U.S. Bureau of Mines

for the U.S. Bureau of Land Management

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature. Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey

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1988

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 U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Guano Creek (OR-001-132) Wilderness Study Area, Lake County, Oregon.

CONTENTS

FIGURES

SUMMARY

Abstract

At the request of the U.S. Bureau of Land Management, the 10,350-acre Guano Creek Wilderness Study Area (OR-001-132) was evaluated for identified mineral resources (known) and mineral resource potential (undiscovered). In this report, the area studied is referred to as the "wilderness study area" or simply "the study area." Field work was conducted in 1986 to assess the mineral resources and resource potential of the area. No mineral resources were identified within the study area.

The study area has low mineral resource potential for zeolites and oil and gas. The area has no potential for geothermal energy or energy mineral resources.

Character and Setting

The Guano Creek Wilderness Study Area (fig. 1) is approximately 10,350 acres in size and is 38 mi east of Lakeview, Oregon. The terrane is gently sloping with elevations ranging from about 5,200 ft in Guano Valley on the east side of the area to 5,978 ft on the top of the highest bluff. Access to the east side of the area is gained by 2-wheel-drive dirt roads leading from State Highway 140; the west side of the area and Clover Swale (fig. 2) are accessible by 4-wheel-drive trails.

The exposed bedrock in the area consists of a lower unit of olivine basalt, a middle unit of ash-flow and air-fall tuff and tuffaceous sedimentary rocks, and an upper unit of basalt. The age of the volcanic rocks is Miocene (see appendixes for geologic time chart). The surficial geology of the study area consists of Quaternary alluvium and colluvium in the valley floor and lacustrine deposits in Billy Burr Lake and a lake 1 mi to the southeast (fig. 2). Landslide scarps are conspicuous along the eastern slopes of the area.

Identified Mineral Resources

No mineral resources were identified within the study area. Investigation of localities favorable for resources of diatomite, zeolite, gold, silver, and mercury, as postulated by the U.S. Bureau of Land Management (1985), indicated the presence of only minor zeolite. Zeolite is used primarily for filtering liquids and as a filler in such products as paper and paint.

Mineral Resource Potential

Areas of the Guano Creek Wilderness Study Area that are underlain by tuff and tuffaceous sediments have low mineral resource potential for zeolites. The entire study area has low oil and gas resource potential (fig. 2). The wilderness study area has no geothermal energy or energy mineral resource potential.

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). U.S. Geological Survey studies are designed to provide a 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.

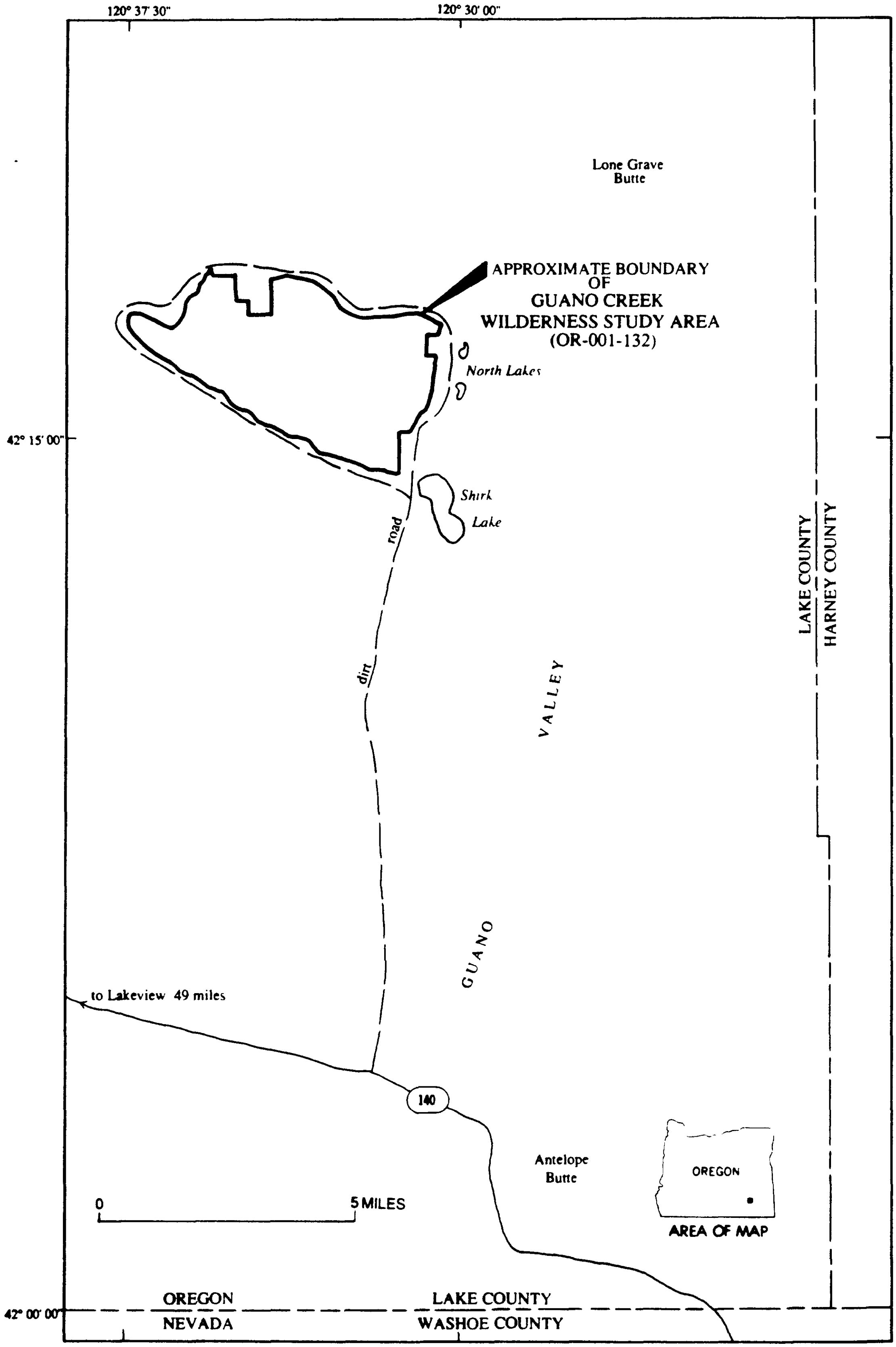

Figure 1. Index map showing location of the Guano Creek Wilderness Study Area, Lake County, Oregon.

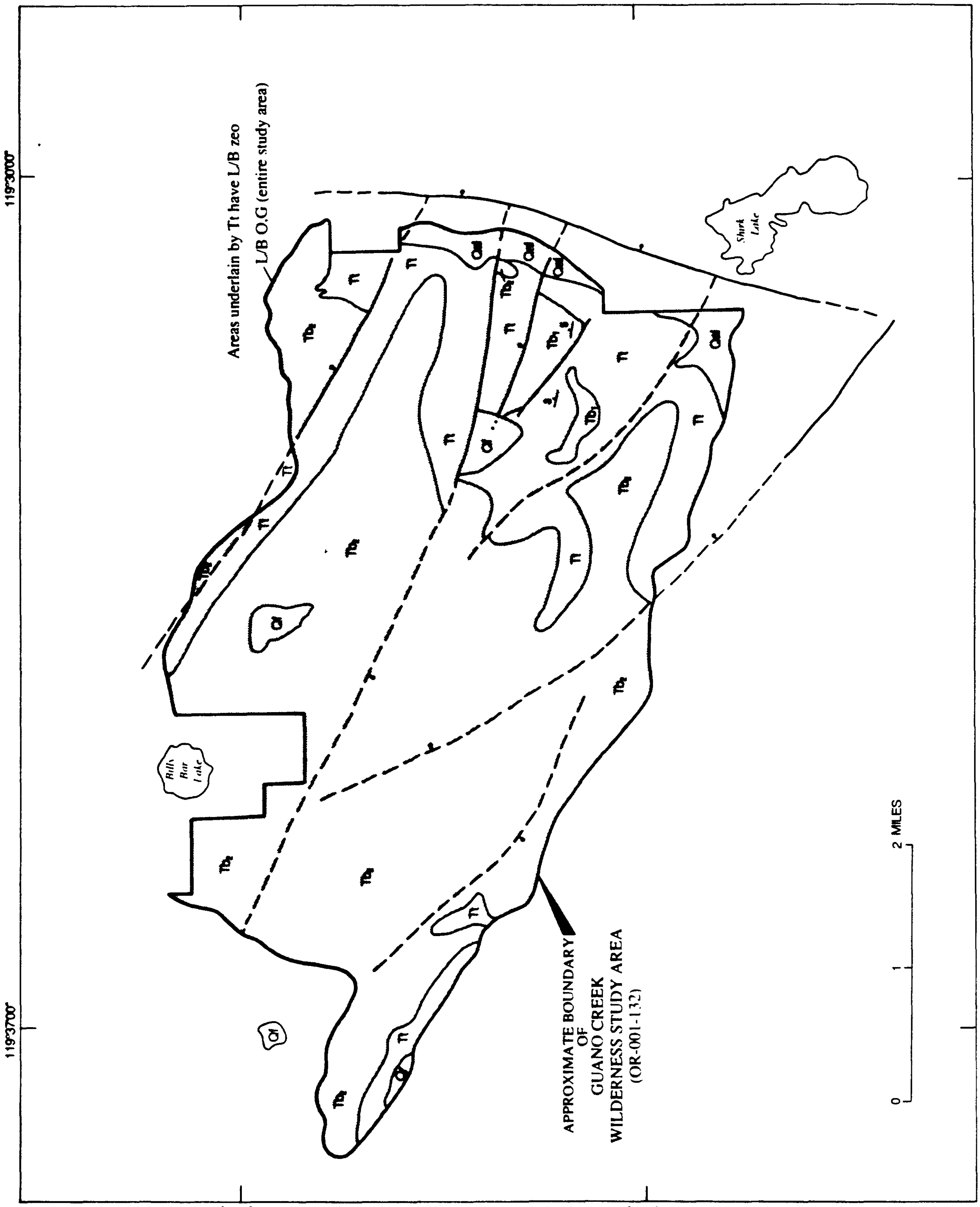

Figure 2. Mineral resource potential and generalized geology of the Guano Creek Wilderness Study Area, Lake County, Oregon. Entire study area has low potential, certainty level B, for oil and gas resources and areas underlain by unit Tt have low resource potential, certainty B, for zeolites. See appendixes for definition of levels of mineral resource potential and certainty of assessment.

EXPLANATION

[ ]	Area having low mineral resource (L) potential
	Levels of certainty of assessment
B	Data suggest level of potential
C	Data give good indication of level of potential

Commodities

O-G	Oil and gas
Zeo	Zeolites

Geologic map units

Qal	**Alluvium (Quaternary)**--Unconsolidated silt, sand, gravel deposited by fluvial processes; also includes colluvial, aeolian, and landslide deposits
Qt	**Talus (Quaternary)**
Qf	**Fluvial deposits (Quaternary)**
Tb_2	**Upper basalt (Tertiary)**--Olivine basalt flows consisting of plagioclase-phyric medium-grained vesicular rocks that contain phenocrysts of olivine (less than 1 mm), commonly altered to iddingsite or with iddingsite rims. Potassium-argon age is 7.7±1.2 Ma
Tt	**Tuff and tuffaceous sediments (Tertiary)**--Consists of interbedded buff-colored pumice lapilli tuff, gray lapilli tuff, crystal lithic ash-flow and water-lain tuff, and tuffaceous sediments
Tb_1	**Lower basalt (Tertiary)**--Olivine basalt flows similar to Upper basalt. Potassium-argon age is 12.0±0.4 Ma
———	**Contact**
——·—— - - - ···	**Fault**--Dashed where inferred, dotted where concealed; ball and bar on downthrown side
⊥ 5	**Dip and strike of flows and beds**

Figure 2. Continued.

Location and Physiography

The Guano Creek Wilderness Study Area is located in the volcanic plateau region south of the Blue Mountains and east of the High Cascades; it is in the High Lava Plains physiographic province. Elevations in the area range from 5,200 ft in Guano Valley on the east side of the area to 5,978 ft on the top of the highest bluff above North Lakes. The climate is arid and the sparse rainfall in the area results in only intermittent stream flow. Vegetation consists of creosote bush, burroweed, boxthorn and sagebrush.

Procedures and Sources of Data

Several previous reports discussed the geology and mineral resources of the study area. The geology of area was mapped by Larson (1965), Walker and Repenning (1965), Walker (1977), and Walker and King (1969). Topical geological work was conducted by Lawrence (1976), and McKee and others (1983). Mathews and others (1983) described the Geology, Energy, and Mineral (GEM) resources of the study area.

The U.S. Geological Survey conducted detailed field investigations of the Guano Creek Wilderness Study Area in the summer of 1986. This work consisted of geologic mapping at a scale of 1:24,000, field checking existing geologic maps, geochemical sampling, and examining outcrops for evidence of mineralization. M.S. Erickson (written commun., 1987) provided the data from the U.S. Geological Survey stream-sediment sampling program for this study.

The U.S. Bureau of Mines investigation consisted of prefield research, field work, and report preparation phases that took place from 1985-87. Prefield studies included a literature search and an examination of Lake County, Oreg., and U.S. Bureau of Land Management mining claim and mineral lease records. U.S. Bureau of Mines, State of Oregon, and U.S. Bureau of Land Management mineral property files also were perused and pertinent data compiled. Field work included a search for evidence of mining activity and mineralized sites in and near the study area.

Most U.S. Bureau of Mines field work consisted of examination of tuff beds and basalt flows for the presence of diatomite, zeolite, gold, silver, and mercury postulated by the U.S. Bureau of Land Management (1985). Eight rock samples were collected from tuff beds during field investigations. All were examined for radioactivity and fluorescence, and four (Benjamin, 1987, Nos. 1, 4-6) were analyzed for 40 elements using atomic absorption methods. Samples were also examined petrographically for diatomite and were tested for zeolite content by an ion-exchange-capacity method developed by Helfferich (1964). The only sample that tested positive for zeolite was further examined using X-ray diffraction.

Additional information concerning analytical and testing methodologies, detection limits, and results were reported by Benjamin (1987) and are available at the U.S. Bureau of Mines, Western Field Operations Center, E. 360 Third Ave., Spokane, WA 99202.

Acknowledgments

The authors greatly appreciate the cooperation of Douglas Troutman of the U.S. Bureau of Land Management's Lakeview office for information concerning road conditions and mining-related activity in and around the study area. Much assistance in the field was made possible by an appointment based on the recommendation of the National Association of Geology Teachers (NAGT). Gerilyn S. Andrews was employed by the U.S. Geological Survey through the NAGT program to assist with field work for this study. Cliff D. Taylor of the U.S. Geological Survey assisted in the geochemical sampling. Terry R. Neumann and Spencee L. Willett, U.S. Bureau of Mines geologists, assisted in the U.S. Bureau of Mines field work.

APPRAISAL OF IDENTIFIED RESOURCES

By David A. Benjamin
U.S. Bureau of Mines

No identified mineral resources or mining claims are known to exist in or within 1 mi of the study area. This is in contrast to a U.S. Bureau of Land Management (1985) study that suggested a moderate favorability for gold, silver, and mercury resources. Tuffaceous interbeds in the area were postulated to contain minor amounts of diatomite and zeolite. However, samples analyzed for gold, silver, mercury, and 15 other elements contained only background or lower quantities. None of the samples collected contained diatomite, and only one sample contained a minor amount of zeolite.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

By Michael F. Diggles, Harley D. King, Donald Plouff, James E. Conrad, and Don L. Sawatzky
U.S. Geological Survey

Geology

The bedrock geology of the area consists of a lower unit of basalt, a middle unit of ash-flow and air-fall rhyolitic tuff and tuffaceous sedimentary rocks, and an upper unit of basalt. The lower basalt consists of plagioclase-phyric medium-grained vesicular flows that contain phenocrysts of olivine (less than 1 mm), commonly altered to iddingsite or with iddingsite rims. A potassium-argon age determination of 12.0±0.4 Ma (Mega-annum) was made on a whole-rock basalt sample collected from the lower flows (M.F. Diggles, unpub. data, 1987). The middle unit of tuff and tuffaceous sedimentary rocks consists of interbedded buff-colored pumice lapilli tuff, gray lapilli tuff, crystal lithic ash-flow and water-lain tuff, and tuffaceous sediments. The upper basalt is petrographically similar to the lower basalt and has a potassium-argon age of 7.7±1.2 Ma (M.F. Diggles, unpub. data, 1987). This unit forms a cap over the tuff and tuffaceous sedimentary unit.

The surficial geology of the study area consists of Quaternary alluvium and colluvium in the valley floor and lacustrine deposits in Billy Burr Lake and a lake 1 mi to the southeast. Landslide scarps are conspicuous along the eastern slopes of the area.

The structural geology of the study area mostly consists of high-angle normal faults that have cut the range into blocks. These faults are of probable Pliocene age. The north-south-trending scarp along the west edge of Guano Valley is the most extensive scarp that resulted from this faulting. The Brothers fault zone extends across the study area. The middle tuff unit is less competent than the overlying basalt cap and therefore tends to erode when exposed in steep fault scarps. This results in landslides and basalt-cobble talus slopes.

Geochemistry

A reconnaissance geochemical survey was conducted in the Guano Creek Wilderness Study Area in the summer of 1986. Minus-80 mesh stream sediments, nonmagnetic heavy-mineral concentrates of stream sediments, and one rock were used as the sample media in this survey. Twelve minus-80-mesh stream-sediment, 11 nonmagnetic heavy-mineral-concentrate, and the rock sample were collected; the total number of sample-collection sites is 12. The stream-sediment samples and the stream sediment from which the concentrates were derived were collected from the active alluvium in stream channels.

Stream sediments were selected as a sample medium because they represent a composite of the rock and soil exposed upstream from the sample-collection site. Nonmagnetic heavy-mineral-concentrate samples provided information about the chemistry of a limited number of minerals in rock material eroded from the drainage basin upstream from each sample-collection site. Many of the minerals found in the nonmagnetic fraction of heavy-mineral concentrates may be ore-forming or ore related, provided mineralization has occurred in the area. The selective concentration of minerals permits determination of some elements that are not easily detected in bulk stream-sediment samples. The rock sample was crushed and pulverized to minus-80-mesh grain size particles prior to analysis. Stream-sediment samples were sieved using 80-mesh stainless steel sieves and the minus-80-mesh fraction was used for analysis. The heavy-mineral concentrate was obtained by panning minus-10-mesh stream sediment to remove most of the quartz, feldspar, organic material, and clay-size material. Bromoform (specific gravity, 2.86) was then used to remove light mineral grains from the panned concentrate. The resulting heavy-mineral concentrate was then separated into three fractions using an electromagnet: a magnetic fraction, chiefly magnetite; a largely mafic rock-forming-mineral fraction; and a nonmagnetic fraction, mostly light-colored rock forming accessory minerals, as well as primary and secondary ore-forming and ore-related minerals. Using a microsplitter, the nonmagnetic fraction was split into two fractions. One fraction was analyzed and the other was examined using a binocular microscope. For some samples, the volume was too small to provide a separate split for visual examination. These smaller samples were examined visually prior to grinding for analysis; archived samples contain only material ground to fine powder.

All samples were analyzed semiquantitatively for 31 elements using direct-current-arc emission spectrography (Grimes and Marranzino, 1968). Rock and stream-sediment samples were also analyzed by atomic-absorption spectrometry for certain elements of special interest or for those elements that have high lower limits of determination by emission spectrography. Antimony, arsenic, bismuth, cadmium, and zinc were analyzed by the O'Leary and Viets (1986) method, gold by the Thompson and others (1968) method, and mercury by the method described by Crock and others (1987).

Stream-sediment samples collected from two sites, (M.S. Erickson, written commun., 1987, Nos. GC002H, and GC009C) which are about 2.5 mi apart in the eastern part of the study area contained slightly anomalous values of zinc (270 and 180 parts per million (ppm), respectively). The samples also contained slightly anomalous values of cadmium (2.9 and 1.9 ppm, respectively). Cadmium is commonly associated with zinc. A rock sample from a site (M.S. Erickson, written commun., 1987, No. GC005C) in the southeastern part of the study area contained a slightly anomalous value of arsenic (12 ppm). The rock sample, tuff stained with iron oxides, was collected about 0.5 mi north of the site where GC009C, the sediment sample that gave the lower zinc concentration, was collected. The arsenic enrichment may have resulted from adsorption of the arsenic on the iron oxides. Enrichment of zinc and cadmium in the sediments may have resulted from the same process. Sources of these elements may have been faults located within the drainage basins upstream from the sample-collection sites. The anomalous values are believed to be nonsignificant because they probably do not suggest mineralized rock.

No other anomalous concentrations were measured in the samples discussed above or in any other samples collected and analyzed as part of the geochemical study of the Guano Creek Wilderness Study Area. No ore minerals were observed in the nonmagnetic heavy-mineral concentrates.

Geophysics

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

Radiometric data were compiled by Geodata International, Inc. (1980), for the National Uranium Resource Evaluation (NURE) program of the Department of Energy. The coverage in the study area consists of an east-west flightline, 6 mi in length, located about 1 mi south of the northern edge of the study area. Flight altitude ranged from 300 to 600 ft above the ground. Recordings were made of gamma-ray flux from radioactive isotopes of uranium, thorium, and potassium. No radioelement anomalies were recorded in the study area.

A regional aeromagnetic survey in the region included two east-west flightlines that crossed the study area (U.S. Geological Survey, 1972). Flightlines were flown at an interval of 2 mi at a constant barometric elevation of 9,000 ft above sea level. A small magnetic low is centered over the westernmost mile of the study area. A conspicuous magnetic gradient to the west of a magnetic low inside the east boundary of the study area extends westward for about 2 mi into the study area. The trends of the eastern magnetic low and a larger magnetic low to the south parallel the normal fault along the west side of Guano Valley. Magnetic-intensity contours trend northeastward in the study area, to parallel approximately the contact between tuff and tuffaceous sediments and the basalt units rather than to parallel the north trend of Guano Valley. Aeromagnetic data do not indicate any zones of concentrated metals.

In 1986, the U.S. Geological Survey established 17 gravity stations in and within 2 mi outside the border of the study area (Plouff, 1987). A preliminary gravity map (Donald Plouff, unpub. data, 1987) prepared from these data shows a small gravity high centered 1.5 mi west of the southeast corner of the study area and a small gravity low centered 1.5 mi west of the northeast corner of the study area.

Linear features in Landsat multispectral scanner (MSS) images at a scale of 1:800,000 were mapped by photogeologic interpretation for the region of southeastern Oregon, and trend concentration maps were made. Linear features are the topographic and spectral expression of rock fractures and other structural and lithologic lineaments. This expression can be enhanced or subdued by scanner resolution, sun orientation, atmospheric phenomena, and vegetation. Linear features of every orientation are expressed in southeastern Oregon, except in terrains underlain by volcanic rocks. Locally, areas have preferred trends related to faults or to rock joint systems. Trend-concentration maps were made at 20° intervals of azimuth covering a range of 30°. In the area north and east of 120° W. and 42° N. linear features are not expressed well except for a broad northwest trend more prominent to the east. This trend has a wide range of N. 25-75° W. and a dominant trend of N. 60° W. As linear features that cause this trend are not associated with mineralized zones, the trend does not suggest mineral resource potential.

Mineral Resource Potential

Within the Guano Creek Wilderness Study Area, areas that are underlain by tuff and tuffaceous sediments have low mineral resource potential for zeolites. Inasmuch as zeolites were observed in only one sample collected by the U.S. Bureau of Mines, and any undiscovered resources are likely to be highly contaminated with other rock fragments, this assessment could be too high. The certainty of assessment, therefore, is B.

There is low oil and gas resource potential in the entire study area (Fouch, 1982; 1983). On the basis of a thin sedimentary section for sources and (or) reservoirs, this assessment could be too high. The certainty of assessment, therefore, is B.

Observations made during field mapping and the results of the geochemical studies did not reveal evidence of metallic mineral resource potential in the study area. Rock, sand, and gravel are present in the wilderness study area but development of these materials is unlikely because similar materials of equal or better quality are abundant closer to existing markets.

The Guano Creek Wilderness Study Area has no geothermal energy potential (Muffler, 1979). This assessment is corroborated by Luedke and Smith (1982) who show no young volcanic centers in or near the study area. The youngest igneous rocks in the study area are 7.7 Ma. Bliss (1983) shows locations of thermal springs and wells in Oregon that describe two north-south belts distal to the study area. One belt is located along the valley that runs from Adel to Warner Lakes, 20 mi west of the study area, and the other is located along Pueblo Valley/Alvord Desert, 42 mi east of the study area. It is unlikely that faults in the area penetrate to great enough depth to allow for deep circulation of groundwater. The certainty of assessment is therefore D. There is no energy mineral resource potential in the study area with a certainty of D on the basis of lack of permissive host rocks and the results of the gamma-ray survey described above.

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APPENDIXES

DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

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

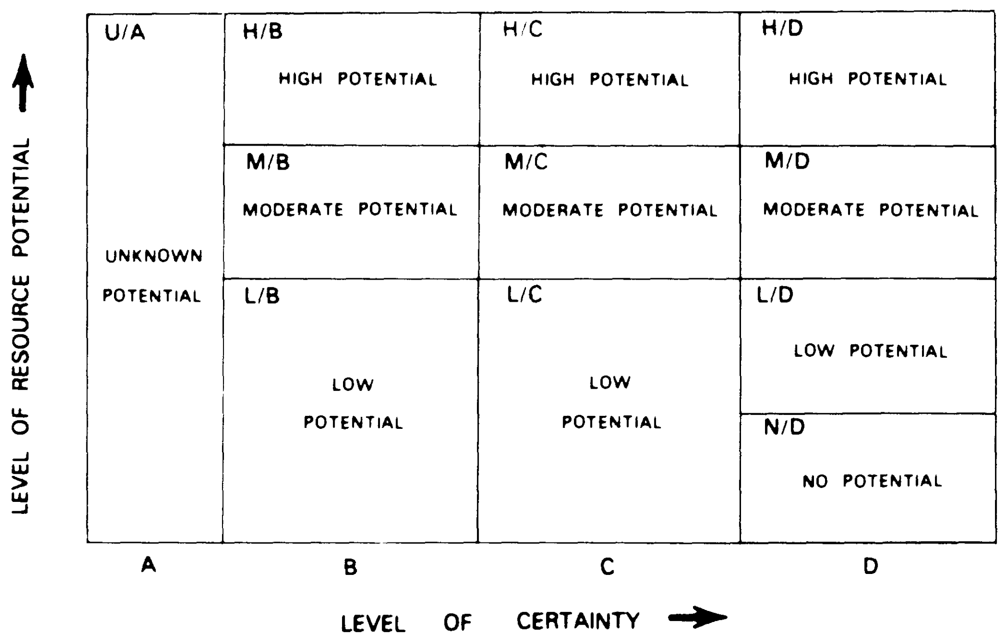
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate reasonable likelihood of resource accumulation, and (or) where an application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

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

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

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

Levels of Certainty



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

Abstracted with minor modifications from:

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RESOURCE/RESERVE CLASSIFICATION

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

Major elements of mineral resource classification, excluding reserve base and inferred reserve base. Modified from V.E. McKelvey, 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, 5 p

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.