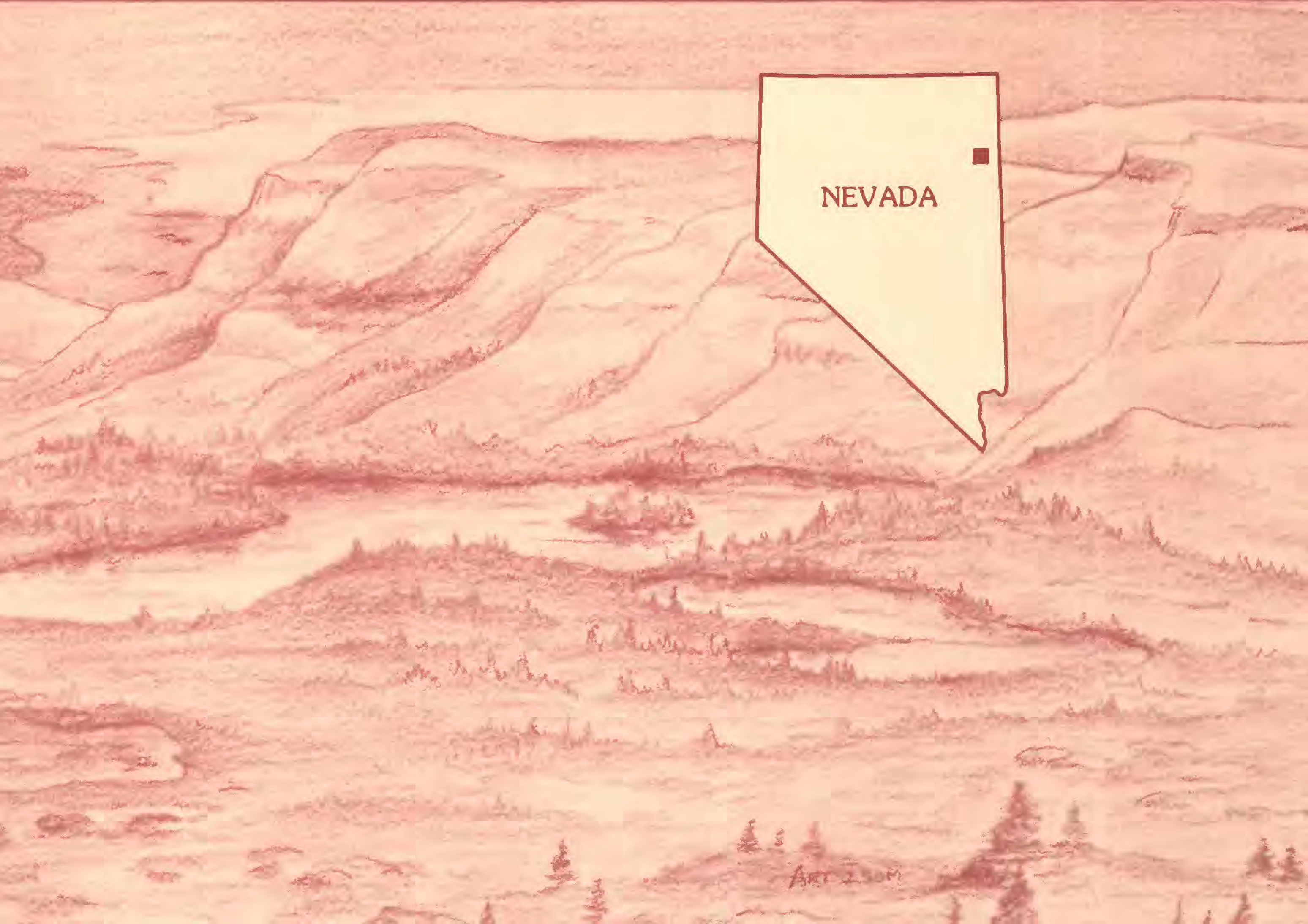
Mineral Resources of the Bluebell and Goshute Peak Wilderness Study Areas, Elko County, Nevada

U.S. GEOLOGICAL SURVEY BULLETIN 1725–C



Chapter C

Mineral Resources of the Bluebell and Goshute Peak Wilderness Study Areas, Elko County, Nevada

By KEITH B. KETNER, WARREN C. DAY,
MAYA ELRICK, MYRA K. VAAG,
CAROL N. GERLITZ, HARLAN N. BARTON, and
RICHARD W. SALTUS
U.S. Geological Survey

S. DON BROWN
U.S. Bureau of Mines

U.S. GEOLOGICAL SURVEY BULLETIN 1725

MINERAL RESOURCES OF WILDERNESS STUDY AREAS—
NORTHEASTERN NEVADA

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

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

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1987

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 Bluebell and Goshute Peak Wilderness Study Areas, Elko County, Nevada.

(Mineral resources of wilderness study areas—northeastern Nevada ; ch. C) (U.S. Geological Survey bulletin ; 1725–C)
Bibliography: p.
Supt. of Docs. No.: I 19.3:1725–C
1. Mines and mineral resources—Nevada—Bluebell Wilderness (Nev.) 2. Mines and mineral resources—Nevada—Goshute Peak Wilderness. 3. Bluebell Wilderness (Nev.) 4. Goshute Peak Wilderness (Nev) I. Ketner, Keith Brindley, 1921– . II. Series. III. Series: U.S. Geological Survey bulletin ; 1725–C.
QE75.B9 no. 1725–C 557.3 s 87–600278
[TN24.N3] [553'.09793'16]

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 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 parts of the Bluebell (N–010–027) and Goshute Peak (NV–010–033) Wilderness Study Areas, Elko County, Nevada.

CONTENTS

PLATES

[In pocket]

FIGURES

TABLES

Mineral Resources of the Bluebell and Goshute Peak Wilderness Study Areas, Elko County, Nevada

By Keith B. Ketner, Warren C. Day, Maya Elrick, Myra K. Vaag, Carol N. Gerlitz, Harlan N. Barton, and Richard W. Saltus
U.S. Geological Survey and

S. Don Brown
U.S. Bureau of Mines

SUMMARY

At the request of the U.S. Bureau of Land Management (BLM) about 41,324 acres of the Bluebell Wilderness Study Area and about 61,004 acres of the Goshute Peak Wilderness Study Area were jointly investigated by the U.S. Geological Survey (USGS) and the U.S. Bureau of Mines (USBM) to assess potential for undiscovered resources and appraise identified resources. The Bluebell Wilderness Study Area (NV–010–027) and the Goshute Peak Wilderness Study Area (NV–010–033) occupy most of the area between Silver Zone and White Horse Passes in the southern Toano Range and northern Goshute Mountains (herein the Goshute-Toano Range), northeastern Nevada (fig. 1). This nearly north-south trending range is flanked on the west by a broad flat valley and on the east by the extensive Bonneville salt flats. Access to the wilderness study areas is from the town of Wendover on the Utah-Nevada border via dirt roads branching from Interstate Highway I–80 and U.S. Highway 93. Rock formations of the wilderness study areas are mainly limestone and dolomite ranging in age from Cambrian to Permian (245 to 540 million years old). Less extensive areas are underlain by younger igneous rocks and unconsolidated alluvium. Part of the Bluebell Wilderness Study Area has a high mineral resource potential for undiscovered gold, and part has a moderate resource potential for undiscovered gold. Part of the Goshute Peak Wilderness Study Area has a low resource potential for undiscovered gold. Both areas have a high resource potential for large, undiscovered deposits of high-purity limestone. The Bluebell Wilderness Study Area has a moderate resource potential for undiscovered high-purity phosphate. Both study areas have a low resource potential for undiscovered oil and gas. The Bluebell study area has a low resource potential for undiscovered tin, tungsten, beryllium, uranium, and thorium. Identified resources include gold (Bluebell study area only), high-calcium limestone, and sand and gravel (fig. 2).

INTRODUCTION

At the request of the BLM the USGS and the USBM studied about 41,324 acres of the Bluebell Wilderness Study Area (NV–010–027) and about 61,004 acres of the Goshute Peak Wilderness Study Area (NV–010–033). In this report the wilderness study areas are called simply the study areas. The two study areas are separated only by a 4-wheel-drive trail that crosses the range at Morgan Pass.

The Goshute Mountains and the Toano Range constitute a single geomorphic and geologic mountain range which, for the sake of brevity, is hereinafter called the Goshute-Toano Range or simply, the range. This range, like so many in northern Nevada, extends nearly north-south and is flanked on both sides by broad, flat valleys: Goshute Valley, on the west, and the Bonneville salt flats, on the east (fig. 1).

The Goshute-Toano Range is an uplifted elongate block of marine Paleozoic rocks that range from Cambrian to Permian in age, marine rocks of Triassic age, igneous rocks and unconsolidated sedimentary units of relatively recent age (see geologic time scale in appendix). Principal structures in the range include the following: low-angle planar faults that locally cut out portions of the stratigraphic column; listric, or curved, faults that merge from high angles to low angles; and near-vertical planar faults. Some of the high-angle faults are mineralized with gold.

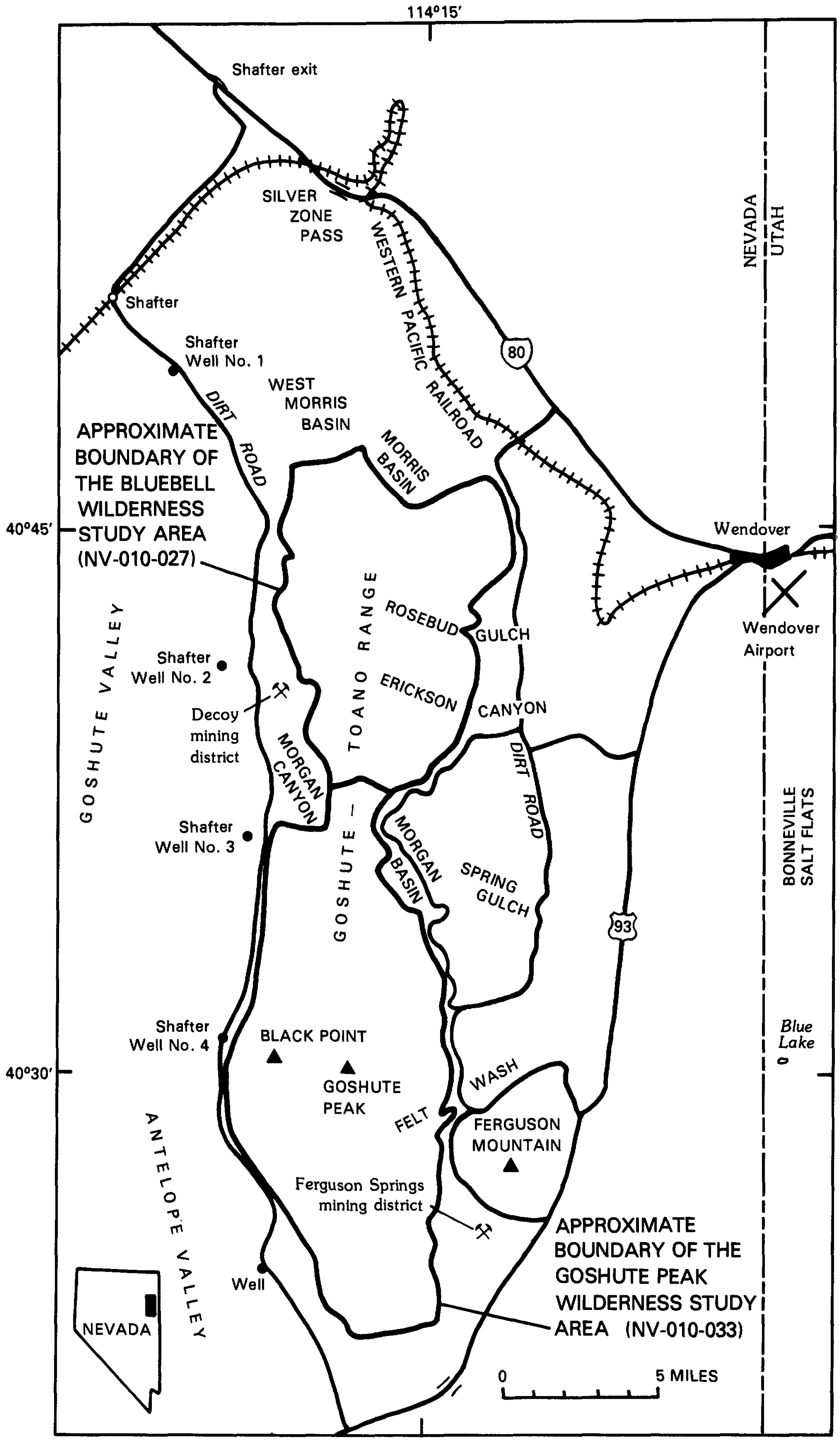
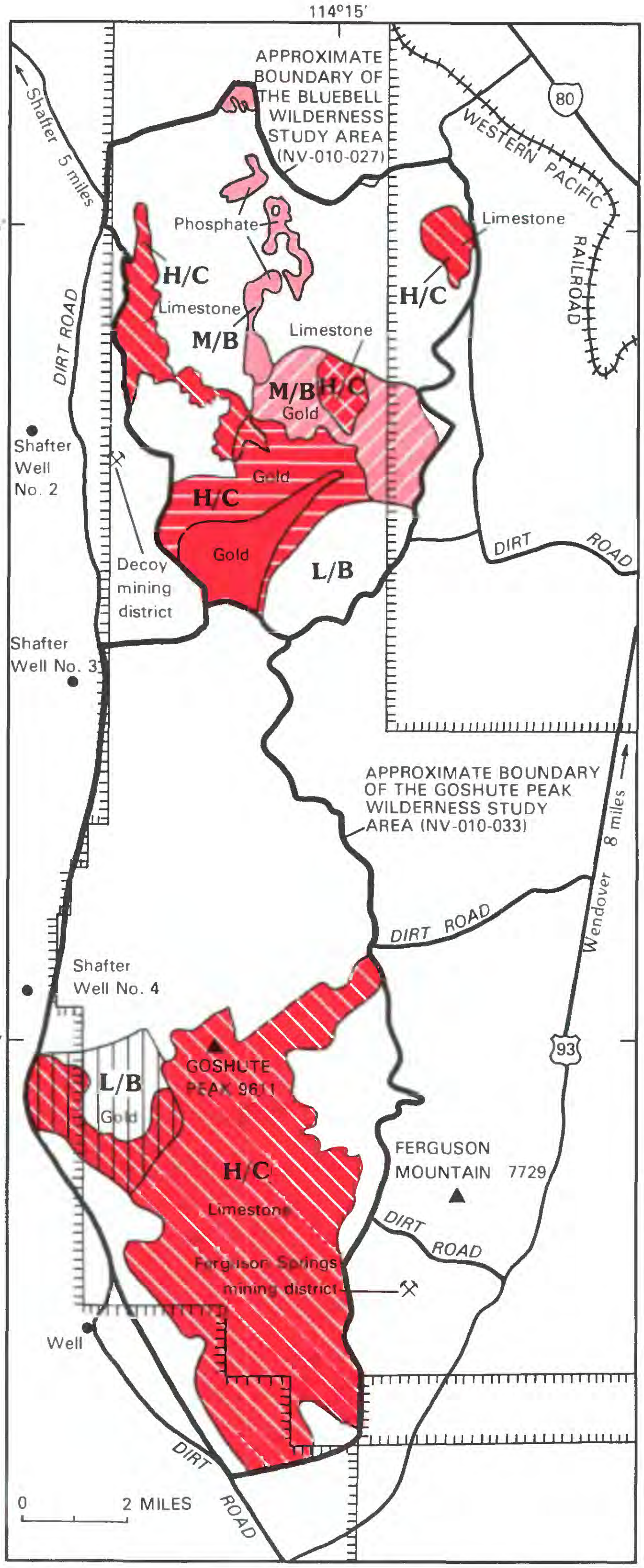


Figure 1. Index map showing location of Bluebell and Goshute Peak Wilderness Study Areas, Elko County, Nevada.



EXPLANATION

[Identified resources of common sand and gravel are present in small areas throughout both the Bluebell and Goshute Peak study areas. Both study areas have low resource potential for energy sources]

- Area with identified resources of gold
- Geologic terrane having high mineral resource potential for gold, certainty level C
- Geologic terrane having moderate mineral resource potential for gold, certainty level B
- Geologic terrane having a low mineral resource potential for gold, certainty level B
- Areas with identified resources of limestone and also having a high resource potential for high-purity limestone, certainty level C
- Geologic terrane having moderate mineral resource potential for phosphate, certainty level B
- **L/B** Geologic terrane in the southeast part of the Bluebell study area that has a low resource potential for tin, tungsten, molybdenum, beryllium, uranium, and thorium, certainty level B
- Boundary of oil and gas leases, hachured toward leases

Figure 2. Map showing areas of mineral resource potential in the Bluebell and Goshute Peak Wilderness Study Areas, Elko County, Nevada.

The east slopes of both study areas can be reached via dirt roads from U.S. Highway 93, which extends south from the town of Wendover along the east side of the range. Several of these roads lead from the highway to the boundaries of the study areas and penetrate them deeply in Morris Basin, Rosebud Canyon, Erickson Canyon, and Morgan Basin. The west slopes of the study areas can be reached via gravel and dirt roads from Interstate Highway I–80 at the Shafter exit, approximately 23 mi northwest of Wendover, and from Highway 93, near White Horse Pass. The study areas can be reached by 4-wheel-drive vehicles and pickup trucks under most weather conditions, but some of the dirt roads in Goshute and Antelope Valleys can be extremely muddy and impassable at times.

The maximum topographic relief in the Bluebell study area is about 3,600 feet (ft); the maximum relief in the Goshute Peak study area, from Antelope Valley to the highest point in the range, Goshute Peak, is about 4,000 ft. The Goshute–Toano Range is topographically asymmetrical, presenting its steepest side, characterized by impressively high cliffs, to the west and its more gently sloping side to the east. The range is quite arid because it lies in the rain shadow of the Ruby and East Humboldt Mountains to the west, and vegetation therefore consists mainly of stunted pinyon pines and junipers. However, along the east side of the range crest where snow drifts lodge, are sporadic stands of various species of tall pines. Spring rains and melting snow stimulate a brief explosion of wildflowers at all altitudes and provide a fair crop of grass for several large herds of wild horses and a sparse population of deer and antelope.

This report presents an evaluation of the mineral endowment (identified resources and mineral resource potential) of the study areas and is the product of several separate studies by the USBM and the USGS. Identified resources are classified according to the system of the USBM and the USGS (1980) which is shown in the appendix of this report. Mineral resource potential is the likelihood of occurrence of undiscovered concentrations of metal and nonmetals, of unappraised industrial rocks and minerals, and of undiscovered energy sources such as coal, oil, gas, oil shale, and geothermal sources; resource potential is classified according to the system of Goudarzi (1984) and is shown in the appendix of this report.

Investigations by the U.S. Bureau of Mines

In 1983 and 1984 the USBM investigated mines, quarries, prospect pits, for identified resources and evidence of mineralization in and near the study areas (Brown, 1985). Identified resources are those whose location, grade, quality, and quantity are known or can be estimated from specific geologic evidence. Identified resources include economic, marginally economic and subeconomic components (USBM and USGS, 1980). County records were consulted for the locations of mining claims, and BLM records were examined for the location of oil and gas leases and the locations of exploratory wells.

Previous reports were reviewed for references to mineral deposits. The most recent geologic map of the study area is by Day and others (1987). The geology, mineralization, and history of the Ferguson Springs mining district, adjacent and southeast of the Goshute Peak study area were described by Hill (1916) and Smith (1976). The geology, mineralization, and history of the Darky manganese mine in the Decoy mining district, west of the Bluebell study area, were discussed by Pardee and Jones (1920).

Investigations by the U.S. Geological Survey

In 1984 and 1985 the USGS studied and mapped the geologic formations of the study areas (Day and others, 1987; Elrick, 1986); sampled and analyzed stream sediments (Gerlitz and others, 1986; Day and Barton, 1986a); sampled and analyzed soils and bedrock (Day and Barton, 1986b; this report); and conducted gravity and aeromagnetic surveys (Saltus and Harris, 1986).

Acknowledgments.—We are grateful to Scott Gum, Dirk Hovorka, Robert Walker, and Robert Yambrick of the USGS for help in the field and to Leroy Brown for safe, efficient helicopter service. David Blake, Frederick Reisbick, Robert Metz, and Luis Vega of Battle Mountain Gold Company provided information on gold prospects in the study areas.

APPRAISAL OF IDENTIFIED RESOURCES

By S. Don Brown
U.S. Bureau of Mines

A comprehensive background search was conducted for information on mines and mineralized areas in and near the study areas. Literature pertaining to the areas was reviewed, and individuals having information on mines and mineralized rock were consulted. Mining claim locations were obtained from the Elko County courthouse, and oil and gas plats were acquired from the Nevada state office of the BLM.

Mines, prospects, and mineralized rock were investigated in and within about 2 mi of the boundaries of the study areas (Brown, 1985). Most dirt roads and jeep trails were driven, and foot traverses were made across areas with mining claims or areas with suspected mineralization. In addition, a helicopter reconnaissance was made to search for workings and mineralized rock.

Seventy-six rock samples were collected. Fifty-eight samples were fire assayed for gold and silver by both standard fire assay and fire assay combined with inductively coupled plasma analysis. In addition, the 58 samples were analyzed spectrographically for 40 elements. Specific analyses were made for copper, manganese, and phosphorus when rocks or minerals with these elements were identified or suspected in samples. Analyses were made for antimony, arsenic, mercury, and thallium when these gold pathfinder elements were suspected in altered rock. The types of analyses include atomic-absorption spectrophotometry for arsenic, antimony, copper, manganese, and mercury; X-ray fluorescence for phosphorus, and special chemical analysis for thallium. Eighteen of the 76 samples were collected from limestone outcrops and analyzed by the inductively coupled plasma method for purity and suitability for chemical and metallurgical use. Analyses for selected elements were performed by the USBM Reno Research Center; by IGAL, Inc. of Cheney, Wash.; and by Bondar–Clegg of Lakewood, Colo. These analyses are summarized in Brown (1985, tables 2–4), and complete analytical data are available for public inspection at the USBM, Intermountain Field Operations Center, Building 20, Denver Federal Center, Denver, CO 80225.

Mining Activity

Two mining districts are close to the study areas; the Ferguson Springs district (also called the Allegheny district) is adjacent to and southeast of the Goshute Peak study area and the Decoy district is west of the Bluebell study area. No mining claims or mine workings extend into the study areas from these two mining districts, but several other blocks of unpatented mining claims are near them and 3 other claim blocks (93 unpatented claims) are in the study areas. Mining claims current as of March 21, 1985, are shown on plates 1 and 2.

The Ferguson Springs mining district was a past producer of copper-silver ore. A small amount of production was first recorded for this district in 1917 (Granger and others, 1957, p. 63). Production was also recorded for the years 1935, 1937, 1949, and 1953. The largest mine in the district, the Dead Cedar mine, is credited with less than $5,000 in total production (Smith, 1976, p. 67). The workings in this district consist of adits, shafts, prospect pits, and trenches.

Mining and production are recorded for the Decoy mining district. The Darky mine produced manganese in 1917 and 1918 and the Blackbird mine produced manganese in 1952 (these may be successive names for the same mine). Total production is not known but is probably less than 2,000 tons (Smith, 1976, p. 48).

In the study areas, Battle Mountain Gold Company (formerly Duval Corporation) explored for gold and drilled the gold-bearing outcrops on their mining claims in June and July 1985. The drill sites are in the south end of the Bluebell study area near sample sites 33–35, 38–43 (pl. 1) and on their claim block on the west side of the Goshute Peak study area, southwest of Goshute Peak (BNL claims, pl. 2). A second drilling program by Battle Mountain Gold Company is currently (1986) in the planning stages.

About 2 mi north of the Bluebell study area, the Marblehead Lime Company quarried high-calcium limestone at the rate of about 150,000 tons per year (Phil Raines, Marblehead Lime Company, oral commun., May 1985).

No other current mining activity is known in or near the study areas.

Appraisal of Sites Examined

Disseminated gold deposits, which may be commercial, are known in two areas within the study areas. In addition, vast quantities of limestone, similar to that being quarried north of the Bluebell study area, are present in both study areas.

Gold

Carlin-type disseminated gold deposits are found in both the Bluebell and Goshute Peak study areas. In the Bluebell study area, the mineralized rock with highest gold values was found in three prominent zones in an area about 1 mi across. The largest exposed mineralized zone is about 1,200 ft long and as much as 500 ft wide. The mineralized rock consists of moderately to highly iron-stained limestone with prominent brecciation and silicification. Some jasperoid and disseminated pyrite are present also. Six samples collected by the USBM from the mineralized zones contained from 0.006 to 0.023 oz (troy) gold/t (samples 38–43, table 1). Sampling by the BLM from this area indicated as much as 0.064 oz gold/t in one of three samples (Steve Brooks, oral commun., 1985). In June 1985, Duval Corporation (now Battle Mountain Gold Co.) conducted a preliminary exploration drilling program in this area and reported intercepts of mineralized rocks that contained from 0.03 to 0.24 oz gold/t (Duval Corporation, written commun., 1985).

In addition to the presence of gold, other elements that are indicators of gold mineralization are present in samples from this area. Arsenic values were as high as 450 ppm; antimony values were as high as 43 ppm; thallium values were as high as 6.2 ppm; and mercury values were as high as 2.05 ppm (Brown, 1985, table 2). All of these elements are closely associated with gold in some disseminated gold deposits in Nevada. These elements are commonly more widely dispersed than gold and provide exploration guides for gold.

Samples 44–48 (pl. 1) were taken from small jasperoid outcrops south of the three main mineralized zones. The gold values were low, but several indicator elements (arsenic, antimony, thallium, and mercury) were detected. These findings support the evidence that gold mineralization has occurred in the area. These jasperoid outcrops evidently are a part of the terrane mineralized with gold. Samples 37 and 49 (pl. 1) were taken from barren-looking limestone. Assay values for all indicator elements were below the detection limit in sample 37, but gold, thallium, and mercury were detected in sample 49.

A second disseminated gold occurrence is in the Goshute Peak study area about 3 mi southwest of Goshute Peak (BNL claims, pl. 2). This occurrence was not examined by the USBM, but information was provided by David Blake and Frederick Reisbick (oral communs., 1985). In this area, jasperoids were said to be structurally controlled and associated with andesite porphyry dikes and sills. Blake noted that the size of the largest jasperoid outcrop is approximately 500 by 100 ft at the surface.

Table 1. Gold, silver, arsenic, and antimony contents of bedrock samples, Erickson Canyon and Morgan Pass areas, Bluebell Wilderness Study Area

[Analytical methods: spectrography for silver; atomic-absorption spectrophotometry for gold; fire assay for gold and silver; ICP for arsenic and antimony. USGS samples analyzed by M.J. Malcolm, P.H. Briggs, J.G. Crock, and S.A. Wilson; USBM samples analyzed by USBM Reno Research Center, IGAL, Inc., and Bondar–Clegg Inc.]

Sample no. (pl. 1)	Gold	Silver	Arsenic	Antimony	Rock type
			USGS samples		
			Parts per million		
1	<0.1	0.7	24	3	Jasperoid
2	<0.1	1.5	<5	<2	Quartz vein
3	0.2	10.	120	10	Jasperoid
4	<0.1	0.5	8	<2	Jasperoid
5	<0.1	1.5	65	13	Jasperoid
6	<0.1	<0.5	62	<2	Altered volcanics
7	0.4	0.5	39	13	Jasperoid
8	0.4	1.5	140	11	Jasperoid
9	<0.1	0.5	310	21	Jasperoid
10	0.2	1.0	210	14	Jasperoid
10	0.4	10.	570	35	Jasperoid
11	<0.1	<0.5	120	18	Jasperoid
12	<0.1	0.7	78	5	Jasperoid
13	0.1	20.	130	15	Jasperoid
			USBM samples		
	Ounces per ton		Parts per million		
33	<.0002	<.009	13	<2	Altered quartzite
34	<.0002	<.009	<2	<2	Altered quartzite
35	<.005	<.1			Altered limestone
37	<.0002	<.009	<2	<2	Limestone
38	.006	.06	59	8	Altered limestone
39	.014	.022	35	6	Altered limestone
40	.018	<.009	60	8	Altered limestone
41	.007	.017	365	5	Altered limestone
42	.023	.015	450	43	Altered limestone
43	.011	<.009	180	7	Altered limestone
44	<.005	.2			Limestone, jasperoid
45	.0002	<.009			Limestone, jasperoid
46	<.005	.2			Limestone, jasperoid
47	.0017	.009	33	10	Limestone, jasperoid
48	.0004	.009	46	20	Limestone, jasperoid
49	.0004	<.009	<2	<2	Limestone

Of the surface samples collected by Blake, the highest assay value for gold was 1.36 ppm (0.04 oz/t). Quartz veins containing galena, tetrahedrite, and copper oxide minerals were also observed in this area (David Blake, oral commun., May 1985). Drilling was conducted during July 1985, and results were favorable enough to warrant more drilling (Fred Reisbick, oral commun., October 1985). Mapping and surface and subsurface sampling of the occurrences in the Bluebell and Goshute Peak study areas would be required to estimate the amount of gold present. Disseminated gold deposits somewhat similar in occurrence to the prospects in the Bluebell and Goshute Peak study areas are described by Wilkins (1984).

Limestone

A large identified resource of high-calcium and other limestone is present in both study areas. Eight of eighteen samples collected from outcrops in and near the study areas contain 96 percent or more calcium carbonate suggesting that some limestone is suitable for certain industrial uses such as flux for steel, lime, and cement. In 1985, the Marblehead Lime Company quarried high-calcium limestone from the Devonian Guilmette Formation, one of the limestone formations in the study area, about 2 mi north of the Bluebell study area, where the limestone is adjacent to highway and rail transportation.

Construction Material

Identified resources of sand and gravel inside the study areas can be used for common construction purposes but have no unique characteristics to make them more useful than deposits found elsewhere.

ASSESSMENT OF POTENTIAL FOR UNDISCOVERED RESOURCES

By Keith B. Ketner, Warren C. Day, Maya Elrick, Myra K. Vaag, Carol N. Gerlitz, Harlan N. Barton, and Richard W. Saltus
U.S. Geological Survey

Geology

The Goshute–Toano Range is a typical block-faulted range in the center of the Great Basin geomorphic province and the Basin and Range structural province. The range is bounded by steep Basin and Range faults on the west which produce impressively high west-facing cliffs. Its eastern margin, defined by erosional patterns, is more subdued and indefinite. Rocks exposed in and near the study areas are shallow-water marine formations of Middle Cambrian to Early Permian age, igneous, mostly rhyolitic, rocks of Tertiary age, and terrestrial sediments of Tertiary and Quaternary age. Metamorphosed lower Paleozoic rocks are exposed north of the Bluebell study area and Triassic rocks are exposed east of the Goshute Peak study area. A Tertiary rhyolite complex forms foothills immediately east of the boundary between the two study areas.

Of all the many carbonate formations in the Goshute–Toano Range, only the Devonian Guilmette Formation includes thick beds of almost pure calcium carbonate, free from nodules and interbeds of siliceous and argillaceous minerals. Certain beds in other stratigraphic units are composed of nearly pure calcium carbonate but they are generally thin and are interlayered with argillaceous, dolomitic, and siliceous beds.

The Plympton Formation of Permian age is a heterogeneous stratigraphic unit that is approximately correlative with, and lithically similar to, the Phosphoria Formation of southeastern Idaho and adjacent areas. The Phosphoria is an important source of phosphate, an essential ingredient of fertilizer. Although no beds of phosphorite are exposed in the study areas of the Goshute–Toano Range, a few small chips of moderately rich phosphorite were observed in the soil covering the formation. These chips indicate the presence of phosphorite beds in the bedrock below the surface, but the sparsity of phosphorite chips and their small size suggest that such beds are probably very thin and perhaps discontinuous.

Two formations include organic-rich shale units that, under favorable conditions, could be possible source rocks for oil and gas. These are the Mississippian Chainman Shale and the Permian Plympton Formation.

The lower Paleozoic sequence forms a gentle anticline whose axis trends north in the southern part of the range, veers westward toward Goshute Valley in the middle part of the range, and disappears under the valley sediments. Upper Paleozoic rocks exposed in the middle part of the range do not display evidence of having been folded with the lower Paleozoic formations.

Rocks of the Goshute–Toano Range display outstanding examples of extensional tectonics. Two styles of brittle extension are displayed in the study areas. Extension within the Middle Cambrian to Devonian sequence was accommodated by younger-on-older, low-angle planar faults that caused thinning or elimination of stratigraphic units. These faults are concentrated mainly in the Ordovician rocks, although in one area the normally very thick Devonian Guilmette Formation has been thinned almost to the vanishing point. Extension within the overlying Pennsylvanian to Permian sequence was accommodated by high-angle listric faults that flatten downward nearly parallel to bedding in, or sporadically below, Mississippian shale. In the central part of the range, blocks of upper Paleozoic rocks are only slightly tilted, and they completely blanket the lower Paleozoic sequence. But in the southern part of the range, blocks of upper Paleozoic rocks have rotated as much as 90 degrees and have spread apart leaving the lower Paleozoic sequence almost completely denuded.

Jasperoid bodies, some of which bear gold, are concentrated along high-angle faults in lower Paleozoic rocks in two areas: one just north of Morgan Pass, especially in Erickson Canyon in the Bluebell study area, and the other in an unnamed canyon 2 mi south of Black Point in the western part of the Goshute Peak study area (pl. 2).

Rhyolitic volcanic rocks are widely exposed on the east flank of the Goshute–Toano Range and in the eastern foothills, mainly outside the boundaries of the study areas. They extend into the southeastern part of the Bluebell study area and occur as erosional remnants along the high ridge in the east-central part.

The volcanic rocks form discontinuous flow- and dome-complexes comprised of foliated crystal-rich rhyolite flows of variable composition that are interlayered with minor rhyolite flow breccias, reworked tuffs, agglomerates, lahar deposits, and volcanogenic siltstones.

The rhyolites are porphyritic (25–45 percent phenocrysts) and exhibit a continuous range in composition (fig. 3) from pigeonite-bearing quartz-plagioclase-sanidine rhyolite (68.4 wt. percent SiO_2) to high-silica topaz-bearing sanidine-quartz rhyolite (76.5 wt. percent SiO_2).

All of the rhyolite units are highly evolved, high-potassium rhyolite according to the classification of Ewart (1979). With respect to mineral potential, the topaz rhyolite, in particular, is anomalously enriched in the lithophile elements thorium (50–90 ppm), uranium (<20 ppm), lead (70–100), tin (<17 ppm), rubidium (500–670 ppm), niobium (45–60 ppm), and yttrium (53–111 ppm). The topaz rhyolite exhibits moderate to low concentrations of zirconium (103–154 ppm), arsenic (<19 ppm), and molybdenum (<10 ppm), and is depleted in strontium (3–12 ppm).

Based on mineralogy, chemistry, and mode of occurrence, the high-silica topaz rhyolite (unit Tvsg in Day and others, 1987) is similar to other topaz rhyolites that are associated with beryllium, fluorine, and uranium mineralization at Spor Mountain, Utah (Lindsey, 1982). In addition, the topaz rhyolites are similar to rhyolites

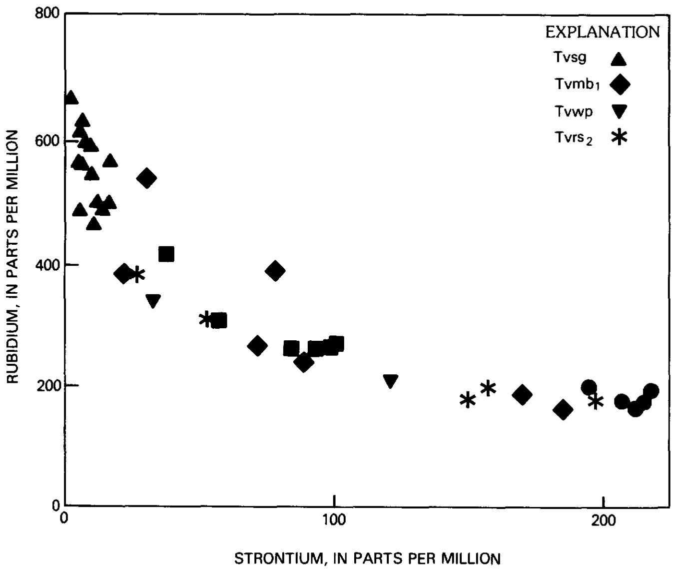


Figure 3. Rubidium strontium variation diagram for the rhyolite units exposed on the east side of the Goshute–Toano range. Trace element composition, given in parts per million (ppm), ranges from the least evolved rhyolite of Morgan Basin ($Tvmb_2$) to the most evolved high silica topaz rhyolite of Spring Gulch (Tvsg). This continuum suggests that the Tertiary rhyolite units are genetically related. Symbols for rhyolite units $Tvmb_1$ (flow dome complexes of Morgan Basin), Tvwp (rhyolite flows of Wildcat Peak), Tvrs (flow dome complex of Rock Spring) correspond to map units given in Day and others (1987).

that host tin and tungsten minerals in the Black Range, New Mexico (Lufkin, 1977). Furthermore, Burt and others (1982) have suggested that topaz rhyolites are the extrusive equivalent of the intrusive Climax-type porphyry molybdenum deposits.

Geochemistry

Stream-sediment sampling of the Bluebell Wilderness Study Area

By C. N. Gerlitz

This section presents a geochemical evaluation of the Bluebell study area based on analyses of: (1) minus-80-mesh stream-sediment samples and (2) the nonmagnetic fraction of heavy-mineral samples concentrated from stream sediments. These samples were collected from 111 sites during June and July 1985. The sediments sampled are from the erosional debris derived by natural processes from rocks within the drainage basin upstream from each sample site; these basins range in area from 0.1 to 3 sq mi (fig. 4).

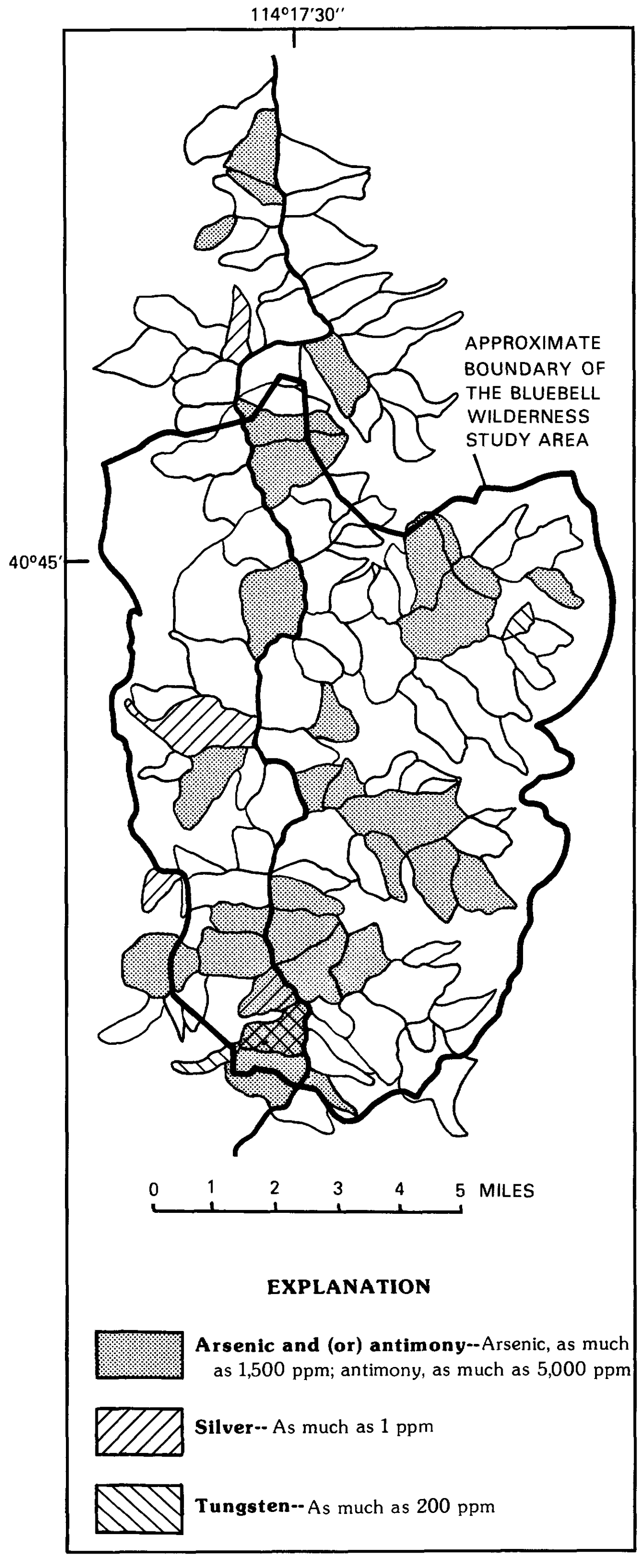


Figure 4. Map of drainage basins in the Bluebell Wilderness Study Area, showing basins in which arsenic, antimony, silver, and tungsten were detected in the nonmagnetic fraction of heavy-mineral concentrates of stream sediments.

Methods

Minus-80-mesh stream-sediment samples were analyzed by inductively coupled plasma atomic-emission spectroscopy for antimony, arsenic, bismuth, cadmium, copper, gold, lead, molybdenum, silver and zinc. The analytical procedure was modified from Motooka and others, (1979). The nonmagnetic fraction of the heavy-mineral concentrates was analyzed for 31 elements using the six-step semiquantitative emission spectrographic method of Grimes and Marranzino (1968). Determination limits and estimated anomalous concentrations of these elements are shown in table 2. Descriptions of sampling and analytical techniques are included with the data in Gerlitz and others (1987).

Results

Single element plots of the heavy-mineral-concentrate data suggest that parts of the study area have been moderately mineralized. For example, we consider the arsenic-antimony-silver-tungsten suite found in the southern part of the study area (fig. 4) to be a good indicator of gold mineralization. In Morgan Canyon at the south end of the Bluebell study area, anomalous arsenic, antimony, tungsten, lead, zinc, and chromium correlate with moderate-to-high tin and cobalt concentrations (fig. 4 and pl. 1). All of these elements are probably associated with jasperoids and silicic intrusions that occur along high-angle faults in this area (pl. 1). Arsenic, antimony, lead, and zinc occur together in Erickson Canyon, in the southeastern part of the study area, where anomalous values are spatially related to faulted, silicified Cambrian carbonate rocks (fig. 4 and pl. 1). Analytical data derived from the minus-80-mesh stream-sediment samples indicate anomalously high concentrations of arsenic, antimony, and silver in the Erickson and Morgan Canyon areas, confirming the indications of possible mineralization derived from analysis of heavy-mineral concentrates.

Most of the heavy-mineral-concentrate samples containing anomalous tin and niobium values are also grouped at the southern end of the study area in Morgan Basin and Erickson Canyon (pl. 1). In this area, which is underlain by Tertiary volcanic rocks, tin and niobium are associated with anomalous lead values.

Noteworthy concentrations elsewhere in the range include southern Morris Basin near Rock Spring (pl. 1) where anomalous tin, lead, zinc, arsenic, and antimony, together with relatively high values of nickel and cobalt, may also be attributed to the presence of volcanic rocks. Anomalous concentrations of lead, zinc, arsenic, tin, and niobium occur about 2 mi north of Erickson Canyon in the vicinity of Rosebud Spring (pl. 1) and seem to be associated with rhyolitic volcanic rocks in the area and with a major high-angle fault that extends northward from Erickson Canyon.

Table 2. Determination limits and anomalous concentrations of elements sought by semiquantitative spectrographic analysis in the nonmagnetic fraction of heavy-mineral concentrates from stream-sediment samples from the Bluebell Wilderness Study Area

[L, any detected quantity is anomalous, including amounts below determination limit; —, detected but not anomalous; ND, not detected]

Element	Lower determination limit for 5 mg sample	Anomaly threshold
	Percent	
Iron (Fe)	0.1	--
Magnesium (Mg)	.05	--
Calcium (Ca)	.1	--
Titanium (Ti)	.005	2.0
	Parts per million	
Silver (Ag)	1	L
Arsenic (As)	500	L
Gold (Au)	20	ND
Boron (B)	20	--
Barium (Ba)	50	10,000
Beryllium (Be)	2	--
Bismuth (Bi)	20	ND
Cadium (Cd)	50	ND
Cobalt (Co)	10	--
Chromium (Cr)	20	500
Copper (Cu)	10	150
Lanthanum (La)	50	500
Manganese (Mn)	20	--
Molybdenum (Mo)	10	50
Niobium (Nb)	50	100
Nickel (Ni)	20	--
Lead (Pb)	20	200
Antimony (Sb)	200	L
Scandium (Sc)	10	--
Tin (Sn)	20	100
Strontium (Sr)	200	5,000
Thorium (Th)	200	--
Vanadium (V)	20	--
Tungsten (W)	100	L
Yttrium (Y)	20	--
Zinc (Zn)	500	L
Zirconium (Zr)	20	--

In general, most of the heavy-mineral-concentrate samples that contain detectable zinc were taken from the area south of Morris and West Morris Basins (pl. 1). This area is underlain by carbonates and shales of Devonian through Permian age. Stream-sediment data confirm that samples containing high zinc and cadmium values are grouped in this carbonate-shale terrane. Samples containing anomalous lead but no zinc are clustered together north of Morris Basin.

Heavy-mineral-concentrate samples with anomalous barium, copper, or molybdenum values, as well as a few samples with anomalous chromium, lead, and zinc values, are from locations randomly scattered throughout the study area and do not seem to be related to any known geologic feature.

High zirconium values are due to abundant zircon in the heavy-mineral concentrates. The zircon grains, clearly identifiable as such under the binocular microscope, probably were derived mainly from igneous rocks in the study area.

Anomalously high titanium values, located mainly in the southeast part of the study area, also reflect the presence of igneous rocks.

No gold or bismuth was detected either in the heavy-mineral concentrates or the minus-80-mesh stream sediments. Detection of cadmium in the minus-80-mesh stream sediments, but not in the heavy-mineral-concentrate samples, may simply reflect the difference in detection limit for cadmium by the different analytical methods used. Alternatively, the presence of cadmium in the minus-80-mesh stream sediments may be due to dissolution of a zinc-cadmium phase during weathering and subsequent adsorption onto fine fraction silt particles.

Soil and Bedrock Sampling of the Bluebell Wilderness Study Area

By H. N. Barton, S. D. Brown, and K. B. Ketner

Methods

Soil samples were collected along ridge lines in the southwestern part of the study area (pl. 1). Both the raw soil samples and heavy-mineral concentrates derived from soil samples were analyzed; the soil by emission spectroscopy and atomic-absorption spectrophotometry and the heavy-mineral concentrates by emission spectroscopy only. Details on sample preparation and presentation of data and sample sites are given by Day and Barton (1986b).

Results

Results of this detailed study show the ridges just north of Morgan Pass in the Bluebell study area, mainly within section 15 and the western third of sec. 16 (T. 32 N., R. 68 E.), contain high concentrations of a number of elements in both sample media. Concentrations as high as the following values in parts per million were found in soil samples: silver 1, arsenic 950, molybdenum 10, antimony 65, and zinc 240. Heavy-mineral concentrates from soil samples contained concentrations as high as the following: silver 300, arsenic 700, molybdenum 150, lead 2,000, antimony 20,000, tin 500, tungsten 3,000, zinc 1,000, and thorium 1,500. An area containing anomalously high concentrations of lead in several samples of both soils and heavy-mineral concentrates is in the vicinity of Morgan and Sidehill Springs, where concentrations as high as 20,000 ppm lead were found in the heavy-mineral concentrates.

Bedrock samples, mainly of jasperoid and altered limestone, were collected in the vicinity of Erickson and Morgan Canyons in the southern part of the Bluebell study area where stream-sediment and soil samples indicated the presence of mineralized rock (pl. 1). Many of these samples contain detectable gold and significant amounts of the indicators of gold mineralization: silver, arsenic, and antimony (table 1).

Stream-sediment sampling of the Goshute Peak Wilderness Study Area

By H. N. Barton

Methods

This section presents an evaluation of the Goshute Peak study area based on analyses of the nonmagnetic fractions of heavy-mineral concentrates of stream sediments. Details on sample preparation and analysis, along with the presentation of data and location of sample sites, are given in Day and Barton (1986a). Heavy-mineral concentrates and rock samples were analyzed for 31 elements by the semiquantitative emission spectrographic method of Grimes and Marranzino (1968). Samples were collected from 145 streambed sites within or peripheral to the study area, giving a sampling density of approximately 1.4 samples per square mile.

Results

Heavy-mineral concentrates from the vicinity of Morgan Pass contain as much as 5,000 ppm antimony and 500 ppm tungsten. The anomaly is mainly confined to an area west of the range divide and extends south from Morgan Canyon approximately 2.5 mi to a point near the center of section 31. One sample from outside the study area on the eastern side of the divide, 1.3 mi south-southeast of Morgan Pass contains 10,000 ppm antimony.

In addition to those mentioned, two sites anomalous in antimony or tungsten were found farther south along the western range front. A site 1.5 mi west-northwest of Black Point contains 500 ppm tungsten. Another site, the north fork of a stream junction near the center of sec. 21, T. 30 N., R. 68 E. at a distance of 3.5 mi south-southeast of Black Point, contains 2,000 ppm antimony. No anomalous values were found in the southeastern part of the study area where the boundary is nearest (1.6 mi) to the Ferguson Spring (or Allegheny) District. This district is the site of minor past production of copper with minor silver and lead (Granger and others, 1957).

Soil and Bedrock Sampling of the Goshute Peak Wilderness Study Area

By H. N. Barton and K. B. Ketner

Methods

Soil samples were collected and analyzed in the Bluebell study area. Bedrock samples were collected from jasperoid and quartz vein material. Each bedrock sample from the Goshute Peak study area is a composite of several chips randomly selected from an area of several square feet and is therefore representative of a significant volume of rock. All samples were analyzed twice for gold, some of them by fire assay.

Results

Analysis of soil samples collected along ridges in the northern part of the study area (pl. 2) did not indicate significant mineralization; no obviously altered or mineralized rock was seen and therefore bedrock samples were not collected in that area.

Analyses of composite samples of jasperoid and composite samples of quartz vein material in the area just south of Black Point (pl. 2) indicate only sporadic slight mineralization in this area (table 3). All gold values are less than 0.1 ppm. Silver, arsenic, and antimony values tend to be low in comparison with those present in gold-bearing samples of the Erickson Canyon area (table 2). Five surface samples supplied by the Battle Mountain Gold Company were analyzed in USGS laboratories and found to contain 0.15 to 1.2 ppm gold.

Geophysics

Gravity Data

An isostatic residual gravity map of a 30-minute square area containing the Bluebell and Goshute Peak study areas is shown in figure 5. This map was compiled from 200 gravity observations, 114 from Saltus and Harris (1986), the rest from the Defense Mapping Agency data base, National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. A Bouguer reduction density of 2.67 g/cm^3 (grams per cubic centimeter) was used.

As the final step to the gravity reduction process, a broad regional model based on the gravitational effect of Airy isostatic roots (Simpson and others, 1983) was removed from the data. The resultant isostatic residual anomaly emphasizes the gravity effect of density distributions in the upper crust (Simpson and others, 1986). Details of the gravity reduction procedure are given in Saltus and Harris (1986).

A closed isostatic residual gravity high of 6- to 8-mGal amplitude occurs over the Goshute–Toano Range (fig. 5). This gravity high is flanked on the west by an elongate 25 mGal low caused by low-density Cenozoic alluvial fill in Goshute Valley. A two-dimensional gravity model assuming a density of 2.0 g/cm^3 across the valley gives a maximum alluvium depth of approximately 5,000 ft at point A (fig. 5). To the east of the Goshute–Toano Range high is a north-south series of rounded 4- to 10-mGal, closed, residual-gravity lows caused by moderately low density Tertiary volcanic rocks. A two-dimensional gravity model assuming a density of 2.4 g/cm^3 gives an approximate thickness of 4,500 ft for the volcanic rocks at point B.

The thick dashed lines in figure 5 trace steep boundaries between blocks of contrasting density (Cordell, 1979), for example the probable location of high-angle range-front faults bounding Goshute Valley. In addition to the north-south faults paralleling the basin and range structure, a number of northwest-southeast trending density boundaries are indicated. The direction of these trends is not tightly constrained by the sparse gravity data, however.

The elongate north-south residual gravity high over the Goshute–Toano Range has a central minimum which forms a saddle centered near Morgan Pass. This saddle could be caused by a buried broad domal igneous intrusion centered under Morgan Pass. A two-dimensional gravity model of a north-south profile through Morgan Pass suggests that the intrusion reaches a maximum elevation of about 6,500 ft above sea level (the elevation of Morgan Pass is approximately 7,300 ft). This broad intrusion may be the source of all the mapped Tertiary intrusions as well as of a presumed dike interpreted from the aeromagnetic data.

Aeromagnetic Data

Two published aeromagnetic surveys provide partial coverage of the study areas; a survey flown at 12,000 ft constant barometric elevation with a north-south flight-line spacing of 5 mi (U.S. Geological Survey, 1978), and a survey flown at 400 ft above ground with an east-west flight line spacing of 3 mi as part of the National Uranium Resource Evaluation program or NURE (Geodata International, 1979). The high-level USGS survey shows only broad regional anomalies. In addition, the USGS has obtained a closely spaced, low-level survey of the study

Table 3. Gold, silver, arsenic, and antimony contents of bedrock and float samples, Black Point area, Goshute Peak Wilderness Study Area

[Analytical methods: spectrography for silver, atomic absorption spectrophotometry, fire assay for gold, ICP for arsenic and antimony. Analyzed by C.D. Taylor, T.M. McCollom, A.H. Love, J.G. Crock, L.R. Layman, and S.A. Wilson; samples were analyzed twice for gold]

Sample no. (pl. 2)	Gold 1	Gold 2	Silver	Arsenic	Antimony	Rock type
			USGS samples			
			Parts per million			
1	<0.1	<0.1	<0.5	<5	7	Quartz vein float
2	<0.1	<0.1	<0.5	29	47	Quartz vein
3	<.05	<0.1	<0.5	16	7	Jasperoid
4	.006	<0.1	<0.5	13	2	Jasperoid
5	<0.1	<0.1	<0.5	13	2	Jasperoid
6	<.05	<0.1	<0.5	6	10	Jasperoid
7	.004	<0.1	<0.5	230	32	Jasperoid
7	<0.1	<0.1	<0.5	7	8	Jasperoid
8	<.05	<0.1	<0.5	22	6	Jasperoid float
9	<.05	<0.1	<0.5	5	4	Jasperoid
10	<.05	<0.1	<0.5	30	5	Jasperoid float
11	0.15	<0.1	<0.5	29	5	Jasperoid float
11	<.05	<0.1	<0.5	<5	11	Quartz vein float
12	.05	<0.1	<0.5	20	6	Quartz vein float
13	<0.1	<0.1	<0.5	<5	8	Jasperoid
14	.05	<0.1	<0.5	5	6	Jasperoid
15	<0.1	<0.1	<0.5	24	3	Jasperoid
15	.048	<0.1	0.5	31	6	Jasperoid
16	<.05	<0.1	0.5	16	7	Jasperoid float
17	<0.1	<0.1	1.0	<5	2	Jasperoid
18	<.05	<0.1	0.5	<5	8	Jasperoid
19	<0.1	<0.1	<0.5	<5	3	Jasperoid
19	<.05	<0.1	<0.5	5	8	Jasperoid
20	.026	<0.1	0.7	40	5	Jasperoid
21	<.05	<0.1	<0.5	7	13	Jasperoid
22	<.05	<0.1	<0.5	<5	<2	Jasperoid
23	<.05	<0.1	0.5	<5	4	Jasperoid
24	<0.1	<0.1	<0.5	31	4	Jasperoid

areas with east-west flight lines, but only preliminary plots of the data are available. A preliminary map shows the same anomalies as those interpreted here. A contour map constructed from total-intensity profiles for NURE flight lines in the vicinity of the study areas is shown in figure 6. The deep magnetic low in the southwest corner of the map is associated with the magnetic signature of the partly granitic Dolly Varden Mountains. A broad, low-amplitude, magnetic high occurs over Morgan Pass near the center of the map with an associated low

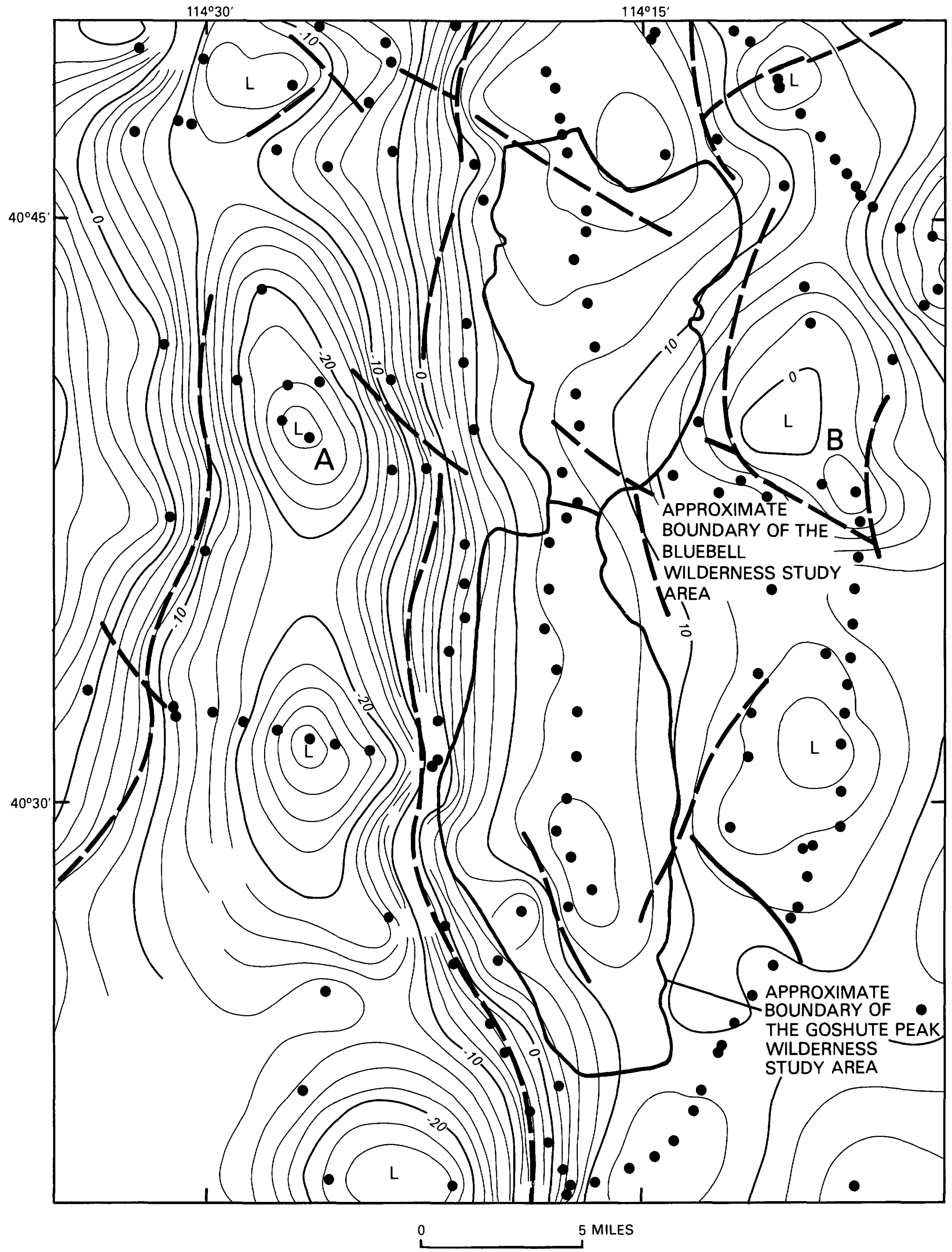


Figure 5. Isostatic residual gravity map of the Bluebell and Goshute Peak Wilderness Study Areas. Bouguer reduction density is 2.67 g/cm^3; contour interval is 2 mGal, hachures point toward minima; gravity measurement location shown by dot. Thick dashed lines mark maximum gradients indicating near-vertical boundaries between rocks of contrasting density.

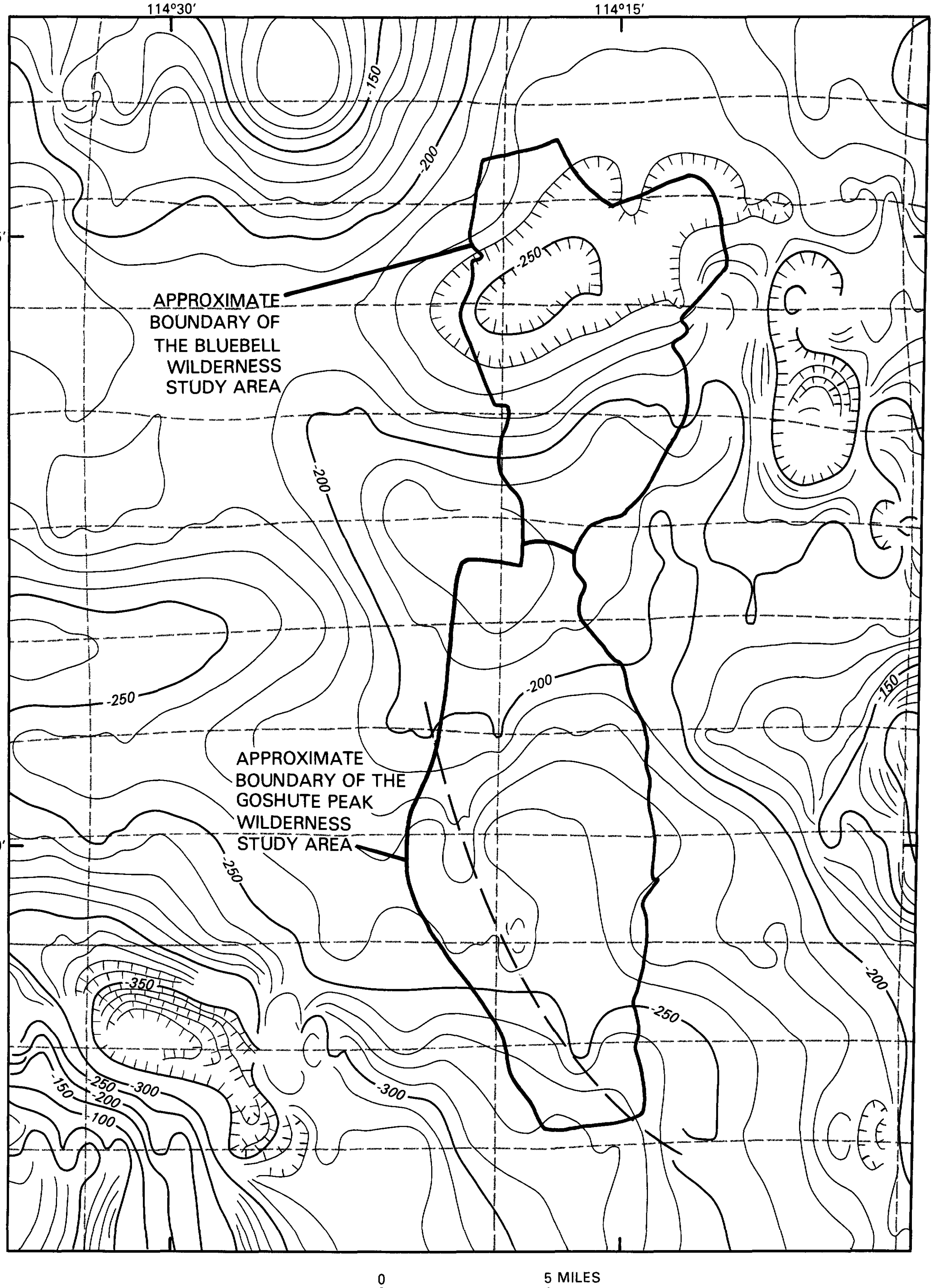


Figure 6. Contour map of residual total magnetic field intensity, constructed from NURE aeromagnetic profiles using minimum curvature. Flight lines are dashed. Contour interval is 10 nanoteslas. The thin dashed line shows inferred location of near-vertical dike.

to the northeast. The presence of this high-low pair is consistent with the existence of a broad domal intrusion under the center of the range.

On figure 6 a sequence of sharp (±1.0 km width by 40- to 100-nanoTesla-amplitude) magnetic highs within and paralleling the southwest border of the Goshute Peak study area imply the existence of a steeply dipping, thin, planar source, possibly an intrusive dike. The presumed trend and extent of this feature is shown by a thin dashed line on figure 6.

Radiometric Data

Based on aerial gamma-ray spectroscopy measured along the NURE profiles, the Bluebell study area has overall low radioactivity with values of 0.5–2.0 percent potassium, 1.5–3.0 ppm equivalent uranium, and 2.0–9.0 ppm equivalent thorium. There are no thorium or potassium anomalies within the boundaries of the area, but a uranium anomaly occurs outside the east border of the Bluebell study area. The Goshute Peak study area has overall low radioactivity with values of 0–2.0 percent potassium, 0–2.5 ppm equivalent uranium, and 2–8 ppm equivalent thorium. There are no gamma-ray anomalies within the boundaries of the Goshute Peak study area or in the immediate vicinity (Joseph Duval, USGS, written commun., 1986).

Mineral and Energy Resources of the Bluebell Wilderness Study Area

Gold, high-purity limestone, and phosphate are the most notable mineral occurrences in this wilderness study area.

Gold

Jasperoid bodies along some of the high-angle faults in the Erickson Canyon area bear significant concentrations of gold or of gold indicators such as silver, arsenic, and antimony (pl. 1; table 2; Brown, 1985; David Blake, oral communs., 1984, 1985). Altered limestone in the area may also be significantly mineralized with gold (Brown, 1985). The abundance of high-angle faults in this area and the possibility that many of them may contain jasperoid bodies just below the surface in addition to the ones that crop out require that the area around Erickson Canyon be regarded as having a high mineral resource potential for gold. This estimate is made with a certainty level of C. The jasperoid bodies exposed at the surface are not large and many of the samples tested in the course of the present investigation by the USBM and the USGS are barren. However, the exploration of this area is in the early stages and future drilling may reveal larger and higher grade jasperoid bodies and possibly significant gold deposits in altered limestone.

Geochemical anomalies in the area between Erickson and Rosebud Canyons (pl. 1) indicate the possible presence of gold deposits, and this area is regarded as having a moderate mineral resource potential for gold with a certainty level of B.

Limestone

Many thick beds in the Devonian Guilmette Formation are composed of nearly pure calcium carbonate and constitute a potential source for high-purity limestone. The formation crops out extensively on both the west and east sides of the Bluebell study area (pl. 1). Two miles outside the northern boundary of the Bluebell study area limestone from this formation was being quarried in 1985 and trucked to distant consumers. Although it has not been thoroughly tested, the general uniformity of the Guilmette Formation over distances of tens of miles indicates the quality of the limestone within the Bluebell study area would be about the same as it is at the quarry site. However, the purest beds have yet to be identified. The resource potential of the Bluebell study area for unusually high-purity limestone is regarded as high, and this estimate is made with a certainty level of C.

Phosphate

Although the Plympton Formation, widely exposed in the Bluebell study area, includes beds of phosphorite (the raw material of phosphate fertilizer) the phosphorite beds do not crop out. Their existence is inferred, however, from the presence of phosphorite chips in the soil covering the formation. The thickness of the beds and their phosphorus content are unknown, but by analogy with the better known deposits of the neighboring Pequop Mountains (Wood, 1985; Ketner and others, 1986), it is unlikely that the beds are as thick or as rich as deposits being mined elsewhere. Because thickness and grade of phosphatic beds varies from place to place, it is possible that future exploration could reveal local occurrences of thicker and richer beds. The Bluebell study area is regarded as having a moderate resource potential for phosphate in small deposits. This estimate is made with a certainty level of B.

Tin, Tungsten, Molybdenum, Uranium, and Beryllium

As mentioned in a preceding section, beryllium, fluorine, and uranium are associated with high-silica topaz rhyolites at Spor Mountain, Utah (Lindsey, 1982). Tin and tungsten are associated with such rhyolites in the

Black Range, New Mexico (Lufkin, 1977), and topaz rhyolites may overlie molybdenum deposits (Burt and others, 1982). High-silica topaz rhyolite is exposed in the Spring Gulch area just east of the southern part of the Bluebell study area (Tvsg of Day and others, 1986). The particular type of volcanic rocks that extend into the Bluebell study area (units Tvmb and Tvrs of Day and others, 1986), however, are generally less silicic than those of Spring Gulch just outside the study area. The less silicic types are less likely to host significant metallic deposits. However, the highly evolved topaz rhyolites of Spring Gulch are close to the study area boundary and may be found to extend inside the boundary in places. In addition, the aeromagnetic and gravity data suggest that there are buried intrusive rocks at depth beneath the study area. It is possible that the buried intrusions were the source for the high-silica topaz rhyolites and may have undergone skarn and stockwork mineralization similar to Climax-type porphyry systems (e.g., molybdenum, tin, tungsten, etc.). However, the exact depth and the extent of these buried intrusions and the presence of mineralized rock is unknown. Therefore the Bluebell study area is assigned a low resource potential for tin, tungsten, molybdenum, uranium, thorium, and beryllium. This estimate is made with a certainty level of B.

Oil and Gas

Conditions for the generation and accumulation of oil and gas are generally unfavorable in the Bluebell study area. Mississippian and older rocks have conodont color alteration indices (CAI; Epstein and others, 1977) of 4½ to 5 and are therefore overcooked, that is, they have been heated above the optimum temperature for the generation of oil and gas from source beds. Pennsylvanian and Permian rocks have CAIs of 2 and therefore have not been overcooked. Shale beds in the Permian Plympton Formation are a possible source of oil and gas, but because these rocks are exposed, or uncapped, within the study area there is no possibility that either oil or gas could be retained. Alluvial fans occupy small areas around the borders of the study areas. These fans are thin wedges of sand and gravel that lap up on Paleozoic rocks similar to those exposed throughout the range. They are most unlikely to conceal or contain significant amounts of oil and gas. The resource potential for oil and gas is low, and this estimate is made with a certainty level of C.

Mineral and Energy Resources of the Goshute Peak Wilderness Study Area

Gold and high-purity limestone are the most notable mineral occurrences of this study area.

Gold

Jasperoid bodies and quartz veins on the west side of the range 2 mi south of Black Point (BNL claims, pl. 2) were found to be gold bearing according to Robert Metz and David Blake, Battle Mountain Gold Company, (oral and written communs., 1985). Their samples from outcrops and drill cuttings contain as much as 1.2 ppm gold, 58 ppm silver, and anomalously high amounts of copper, lead, zinc, arsenic, and antimony.

Personnel of the USGS sampled stream sediments, jasperoid bodies, and quartz veins in this area in 1984 and again in 1985. Heavy-mineral concentrates from stream-sediment samples and bedrock samples in this area did not contain anomalously high gold values (table 3). Silver, arsenic, and antimony tend to be low in comparison with gold-bearing samples from the Bluebell study area. The USGS bedrock samples are composite samples, each composed of several chips, and are thought to be representative of the outcrop or a large part of the outcrop from which they were obtained. Selected specimens of the most altered or mineralized portion of the outcrop might yield higher values of gold but would not be representative of a significant volume of rock. The area just south of Black Point in the Goshute Peak study area (pl. 2) is regarded as having a low mineral resource potential for gold. This estimate, made with a certainty level of B, is based on USGS analyses of surface exposures and comparison of these analyses with those obtained from the Erickson Canyon area of the Bluebell study area. If favorable data reported by personnel of Battle Mountain Gold Company are confirmed by future work, this estimate may have to be revised.

Limestone

The Guilmette Formation is widely exposed in the Goshute Peak study area. This formation is known to be composed of very pure limestone generally, but the uppermost beds, which are scattered in outcrop, probably are the purest part of the formation. In the southern part of the Goshute Peak study area these uppermost beds are widely exposed close to U.S. Highway 93. The Goshute Peak study area has a high mineral resource potential for high-purity limestone. This estimate is made with a certainty level of C.

Oil and Gas

The Paleozoic rocks of the Goshute Peak study area are overcooked with respect to oil and gas generation as determined by conodont color alteration indices of 4 to 5. That is, they have been heated above the temperature at which oil and gas can be generated and retained. Post-Paleozoic rocks consist of alluvial fan deposits that lap up on the Paleozoic formations in small areas around the edges of the study area. These are most unlikely to contain or conceal significant resources of oil and gas. The energy resource potential of the Goshute Peak study area for oil and gas is low, and this estimate is made with a certainty level of C.

RECOMMENDATIONS

The extent and nature of gold mineralization in both study areas can be determined only be detailed geologic mapping, thorough surface sampling, and ultimately by drilling in areas found to be promising. This was being done by the Battle Mountain Gold Company in 1986.

More detailed information is needed on both the high-purity limestone in both study areas and on phosphate deposits in the Bluebell study area. Thick beds in the upper part of the Guilmette Formation that, on field examination, appear to be composed of pure limestone should be sampled at close intervals and analyzed. The thickness and grade of phosphatic beds in the Plympton Formation can be determined by trenching across the strike of the formation in places where phosphorite chips are present on the surface.

Volcanic rocks in and near the southeastern part of the Bluebell study area should be mapped in detail and intensively studied. Using the beryllium-fluorine-uranium mineralization at Spor Mountain (Lindsey, 1982) as a model, mineral concentrations could be expected to occur in tuffs that may underlie or be interlayered with topaz rhyolites near high-angle faults. Using as a model the deposits of the Black Range (Lufkin, 1977), tin could be sought in fractured lavas and vent breccias. The possible existence of Climax-type porphyry molybdenum deposits beneath the volcanic field can be determined only by drilling.

REFERENCES

Brown, S.D., 1985, Mineral resources of part of the Bluebell (NV–010–027) and Goshute Peak (NV–010–033) Wilderness Study Areas, Elko County, Nevada: U.S. Bureau of Mines Open-File Report MLA 66–85, 22 p.

Burt, D.M., Sheridan, M.F., Bikun, J.V., and Christiansen, E.H., 1982, Topaz rhyolites-distribution, origin, and significance for exploration: Economic Geology, v. 77, p. 1818–1836.

Cordell, Lindrith, 1979, Gravimetric expression of graben faulting in Santa Fe County and the Espanola Basin, New Mexico, *in* New Mexico Geological Society Guidebook: New Mexico Geological Society Annual Field Conference, v. 30, p. 59–64.

Day, G.W., and Barton, H.N., 1986a, Analytical results and sample location map of heavy-mineral-concentrate samples from the Goshute Peak Wilderness Study Area, (NV–010–033), Elko County, Nevada: U.S. Geological Survey Open-File Report 86–357.

———1986b, Geochemical data for the Morgan Pass area, Goshute Peak and Bluebell Wilderness Study Areas, Elko County, Nevada: U.S., Geological Survey Open-File Report 87–51.

Day, W.C., Elrick, Maya, Ketner, K.B., and Vaag, M.K., 1987, Geologic map of the Bluebell and Goshute Peak Wilderness Study Areas, Elko County, Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF–1932.

Elrick, Maya, 1986, Depositional and diagenetic history of the Devonian Guilmette Formation, southern Goshute Range, Elko County, Nevada: Oregon State University, M.S. thesis, 109 p.

Epstein, A.G., Epstein, J.B., and Harris, L.D., 1977, Conodont color alteration—an index to organic metamorphism: U.S. Geological Survey Professional Paper 995, 27 p.

Ewart, A., 1979, A review of the mineralogy and chemistry of Tertiary-Recent dacitic, latitic, rhyolitic, and related rocks, *in* Barker, F., 1979, Trondhjemites, dacites, and related rocks: Amsterdam, Elsevier.

Geodata International, 1979, Aerial radiometric and magnetic survey, Elko National Topographic Map Nevada and Utah: U.S. Department of Energy, Grand Junction Office, Open-File Report GJBX–159 (79).

Gerlitz, C.N., Detra, D.E., and Motooka, J.M., 1987, Analytical results and sample locality map of stream sediment and heavy-mineral concentrate samples from the Bluebell Wilderness Study Area, Elko County, Nevada: U.S. Geological Survey Open-File Report 87–0088.

Goudarzi, G.H., 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report OF84–787, 41 p.

Granger, A.E., Bell, M.M., Simmons, G.C., Lee, Florence, 1957, Geology and mineral resources of Elko County, Nevada: Nevada Bureau of Mines Bulletin 54, 190 p.

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

Hill, J.M., 1916, Notes on some mining districts in eastern Nevada: U.S. Geological Survey Bulletin 648, p. 97–98.

Ketner, K.B., Gerlitz, C.N., Saltus, R.W., and Wood, R.H. II, 1987, Mineral and energy resources of the South Pequop Wilderness Study Area, Elko County, Nevada: U.S. Geological Survey Bulletin 1725–B.

Lindsey, D.A., 1982, Tertiary volcanic rocks and uranium in the Thomas Range and northern Drum Mountains, Juab County, Utah: U.S. Geological Survey Professional Paper 1221, 71 p.

Lufkin, J.L., 1977, Chemistry and mineralogy of wood tin, Black Range, New Mexico: American Mineralogist, v. 62, p. 100–106.

Motooka, J.M., Mosier, E.L., Sutley, S.J., and Viets, J.G., 1979, Induction-coupled plasma determination of Ag, Au, Bi, Cd, Cu, Pb, and Zn in geologic materials using a selective extraction technique: Applied Spectroscopy, v. 33, p. 456–460.

Pardee, J.T., and Jones, E.L., 1920, Deposits of manganese ore in Nevada: U.S. Geological Survey Bulletin 710–F, p. 241.

Saltus, R.W., and Harris, R.N., 1986, Principal facts for 125 gravity stations in and around the Goshute Mountains–Toano Range, Elko County, Nevada: U.S. Geological Survey Open-File Report 86–153.

Simpson, R.W., Jachens, R.C., and Blakely, R.J., 1983, AIRYROOT: A Fortran program for calculating the gravitational attraction of an Airy isostatic root out to 166.7 km: U.S. Geological Survey Open-File Report 83–883, 66 p.

Simpson, R.W., Jachens, R.C., Blakely, R.J., and Saltus, R.W., 1986, A new isostatic residual gravity map of the conterminous United States with a discussion on the significance of isostatic residual anomalies: Journal of Geophysical Research, in press.

Smith, R.M., 1976, Mineral resources of Elko County; U.S. Geological Survey Open-File Report 76–56, 194 p.

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, 1978, Aeromagnetic map of northeastern Nevada: U.S. Geological Survey Open-File Report 78–280.

Wilkins, J., Jr., 1984, The distribution of gold- and silver- bearing deposits in the Basin and Range Province, western United States, *in* Wilkins, J., Jr., ed., Gold and silver deposits of the Basin and Range Province, Western U.S.A.: Arizona Geological Society Digest, v. 125, p. 6–7.

Wood, R.H., II, 1985, Mineral resources of the South Pequop Wilderness Study Area, Elko County, Nevada: U.S. Bureau of Mines Open-File Report MLA 56–83.

APPENDIX

DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

Definitions of Mineral Resource Potential

LOW mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources is unlikely. 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 a 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 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.

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

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 →

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:

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 (or)	Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUB-ECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		

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

GEOLOGIC TIME CHART

Terms and boundary ages used in this report

EON	ERA	PERIOD		EPOCH	BOUNDARY AGE IN MILLION YEARS
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 m.y. also called Precambrian, a time term without specific rank.

[2] Informal time term without specific rank.

U.S. GOVERNMENT PRINTING OFFICE: 1987—573-047/66,012 REGION NO. 8