Mineral Resources of the Mount Grafton Wilderness Study Area, Lincoln and White Pine Counties, Nevada

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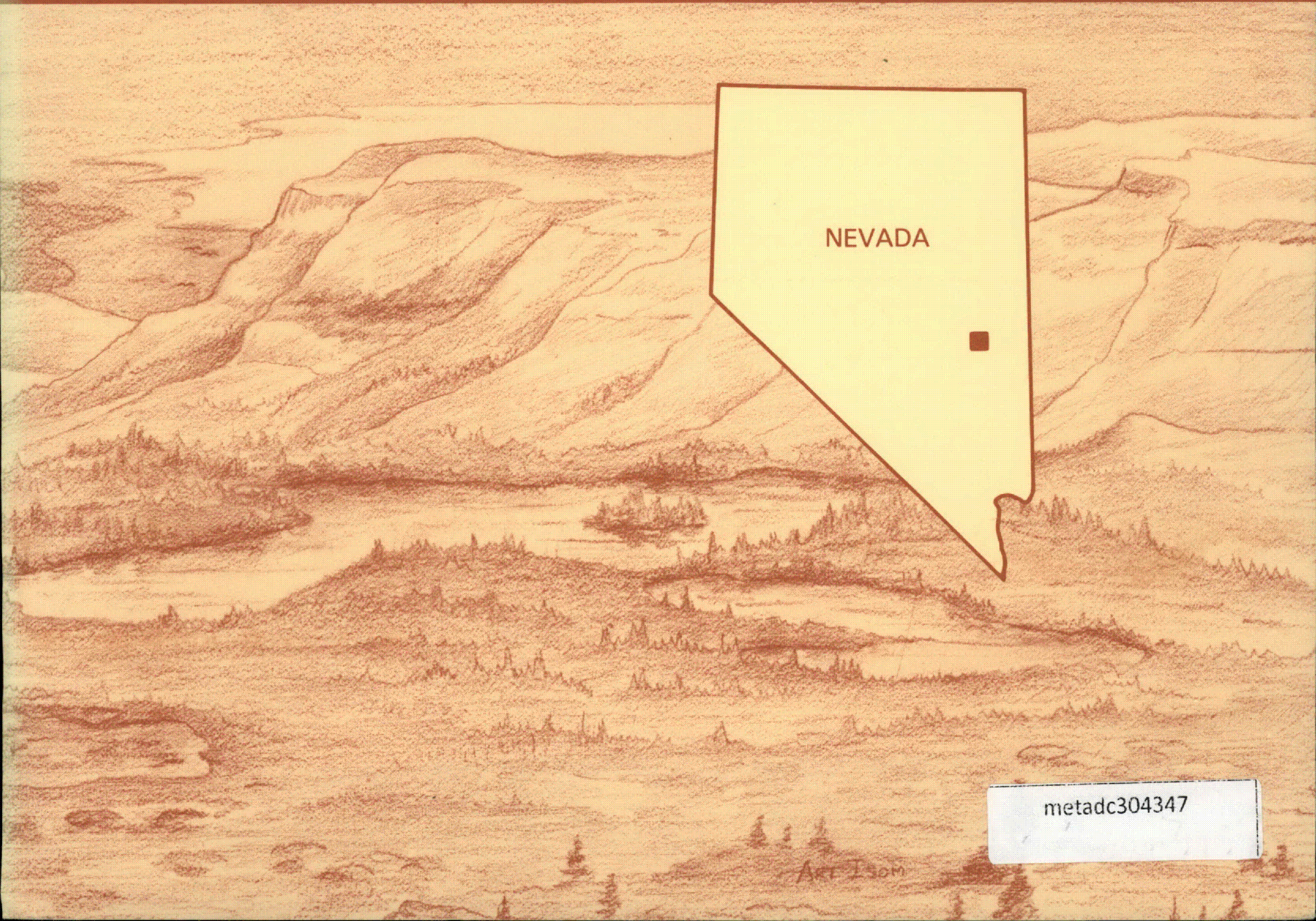


DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

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.

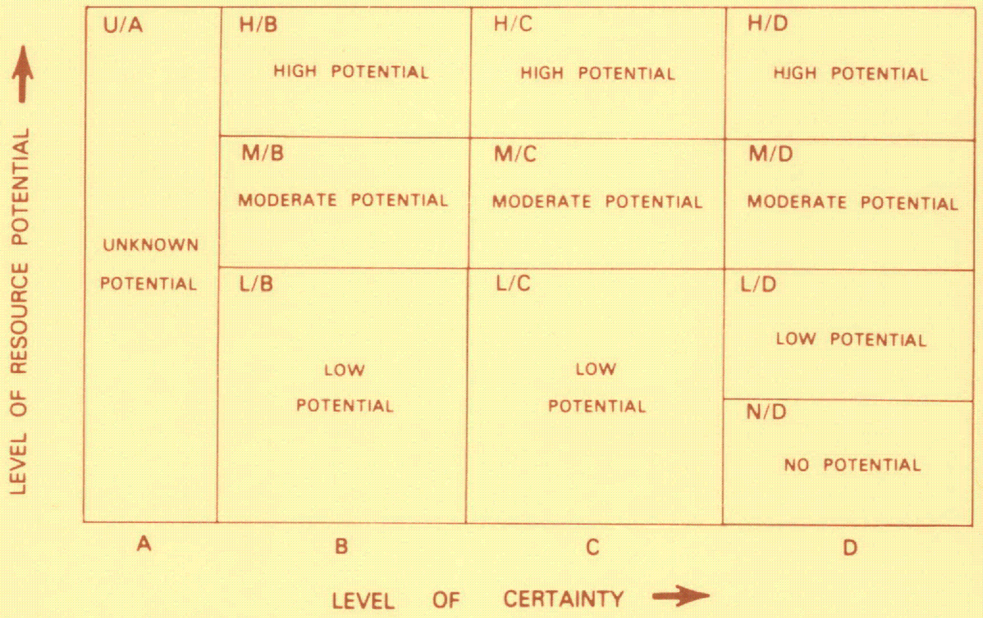
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application 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



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.

Chapter F

Mineral Resources of the Mount Grafton Wilderness Study Area, Lincoln and White Pine Counties, Nevada

By R. E. VAN LOENEN, H. R. BLANK, Jr., and
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U.S. GEOLOGICAL SURVEY BULLETIN 1728

MINERAL RESOURCES OF WILDERNESS STUDY AREAS—
EAST-CENTRAL NEVADA AND PART OF ADJACENT BEAVER AND IRON COUNTIES, UTAH

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

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

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STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94–579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys 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 a part of the Mount Grafton Wilderness Study Area (NV–040–169), Lincoln and White Pine Counties, Nevada.

RESOURCE / RESERVE CLASSIFICATION

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

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

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[Plate in pocket]

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Mineral Resources of the Mount Grafton Wilderness Study Area, Lincoln and White Pine Counties, Nevada

By R. E. Van Loenen, H. R. Blank, Jr., *and* Harlan Barton
U.S. Geological Survey

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SUMMARY

Abstract

The Mount Grafton Wilderness Study Area (NV–040–169) is in a remote area of the Schell Creek Range, Nevada. In 1984 and 1985 the U.S. Geological Survey and the U.S. Bureau of Mines evaluated the identified mineral resources and mineral resource potential of approximately 30,115 acres of the study area at the request of the U.S. Bureau of Land Management. The study area contains identified low-grade resources of zinc and tungsten. A high mineral resource potential exists for tungsten, zinc, and copper in tactite deposits. A moderate mineral resource potential was assigned to areas that may contain small vein and replacement deposits of one or more of the following commodities: tungsten, silver, zinc, lead, gold, and fluorite resources; potential for these commodities in all other areas is low. The study area has a low potential for oil and gas, uranium and thorium, and geothermal and clay resources.

Character and Setting

The Mount Grafton Wilderness Study Area lies in the southern part of the Schell Creek Range in east-central Nevada about 25 mi (miles) west of the Nevada–Utah border and about 50 mi south of Ely, Nev. (fig. 1). It is situated in a basin-and-range physiographic province that consists of a north-trending mountainous terrain bordered on the west by Cave Valley and on the east by Lake Valley. The study area is almost entirely in the mountains; only small parts are on piedmont slopes. From the flat-bottomed valley floors at 5,600 ft (feet) elevation, the terrain rises gently up the piedmont to the mountain front and thence abruptly to more than 10,000 ft. Spring-fed streams within the study area discharge into internal drainage basins. The lower slopes of the study area are covered with pinyon-juniper and sagebrush; limber pine, bristlecone pine, and fir dominate the higher elevations.

The wilderness study area is underlain mainly by a thick sequence (approximately 20,000 ft) of clastic and carbonate rocks that was deposited in the Great Basin during the Late Proterozoic and Paleozoic Eras (see geologic time scale on last page of this report). These rocks, mainly quartzite, shale, limestone, and dolostone, range in age from Late Proterozoic through Middle Devonian. During the late Cenozoic this thick sequence of rocks was shaped by uplift and fractured into its present form. Nearly 14,000 ft of displacement is estimated to have occurred along the major border faults responsible for the present high relief.

The southern part of the study area is a relatively simple uplifted fault block of quartzite tilted 35° toward the east. The northern part of the study area is characterized by many small irregularly shaped fault blocks displaying a down-to-the-north stair-stepping caused by east-west faulting. Folding is absent in these strata except where expressed as drag along the high-angle faults.

Prospecting and limited mining activity, initiated probably during the late 1860's, has continued intermittently to the present time both within and near the study area. Production consisted mainly of silver and tungsten that were mined from veins and replacement deposits hosted by carbonate rock. The Patterson mining district,

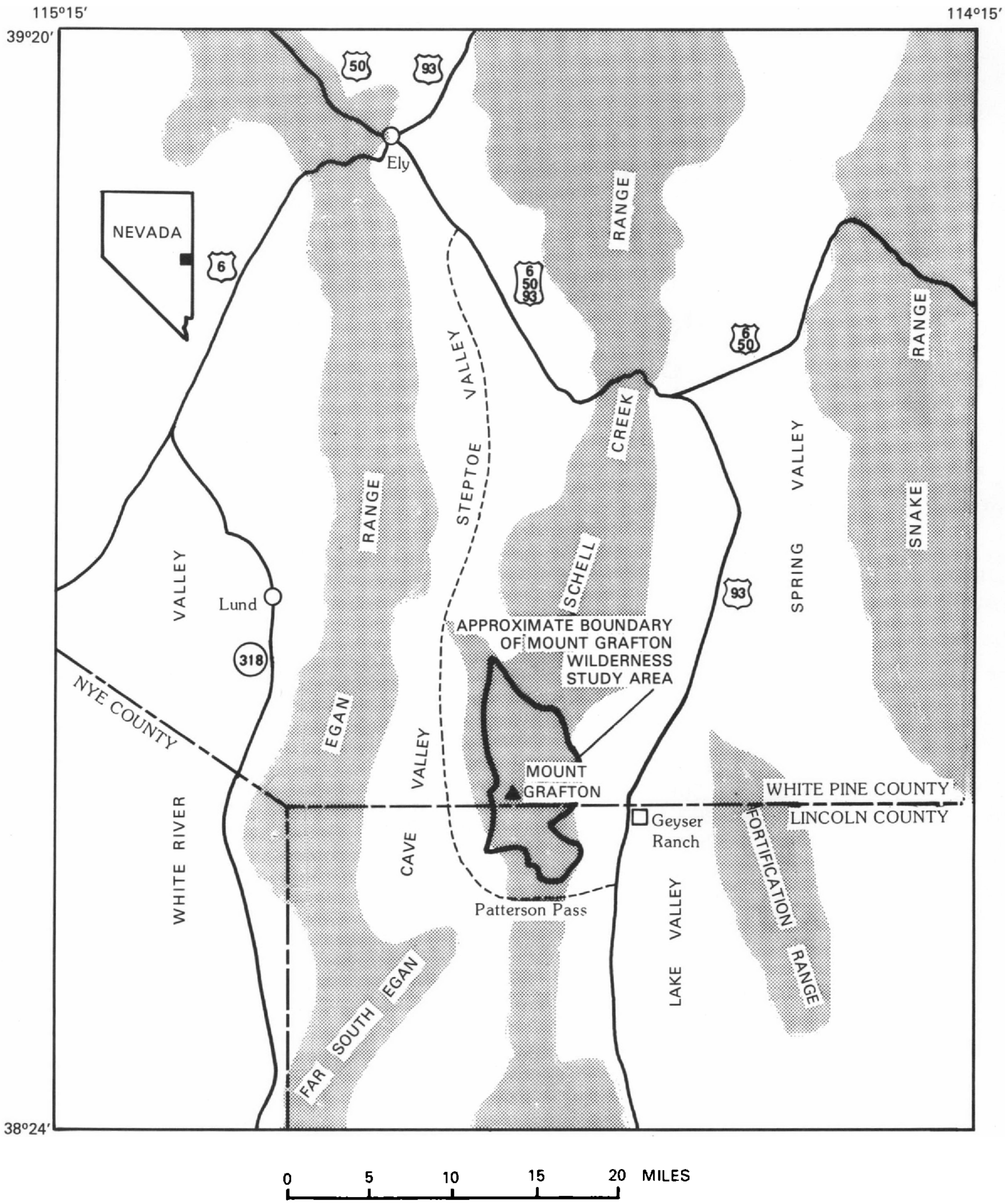


Figure 1. Index map showing location of the Mount Grafton Wilderness Study Area, Lincoln and White Pine Counties, Nev.

south of the study area, was probably the most productive of any nearby. The Deer Trail and Lake Valley mines, along the eastern border, also produced tungsten and silver. There is little evidence of prospecting activity within the wilderness study area except that at the Deer Trail mine.

Identified Resources

Seventeen mines and prospects (includes groupings of several prospects) were examined both within and near the wilderness study area. Five areas are shown on figure 2 and plate 1 as having identified mineral resources. Part of the area shown as the tactite body (no. 5, fig. 2) and the Deer Trail mine (no. 3, fig. 2) are within the study area boundary. Identified resources within the small part of the tactite body that lies within the study area are 1.0 million st (short tons) containing 0.4 percent zinc. Tungsten and minor amounts of silver and gold are associated with this deposit. The Deer Trail mine contains identified resources of 2,000 st of material that contains 0.1 percent WO_3. The only known mineral production from within the study area boundary was from the Deer Trail mine; in 1956, 134 st of tungsten ore were mined. Metals produced from the area surrounding the wilderness study area include silver, tungsten, lead, and possibly zinc, copper, and gold.

Rock products are abundant in the Mount Grafton study area; however, the area is isolated from any major markets and none of the products has been used. Some of the carbonate rocks and quartzite are known for their purity, and elsewhere in the region quartzite and limestone from the same formations as those in the study area have been used for crushed-rock aggregate and building stone.

Mineral Resource Potential

The geologic setting and geochemical and geophysical studies indicate that possibilities exist for (1) tactite (contact metasomatic) deposits that contain tungsten and zinc with associated copper; and also (2) hydrothermal veins and related replacement deposits containing tungsten and silver, with associated lead, zinc, gold, and fluorite.

Geologic conditions along the southern border of the study area (fig. 2) favor undiscovered low-grade tungsten, zinc, and copper resources in a tactite deposit. The mineral resource potential of that area is considered high on the basis of the following criteria: (1) the Pioche Formation, which contains favorable host rock limestone beds, underlies the area; (2) presence of a near-surface intrusive body is indicated by aeromagnetic anomalies and by alteration and replacement of host rocks; (3) metals commonly associated with tactites (tungsten, zinc, copper, and traces of beryllium, bismuth, and molybdenum) are present in outcrop, in geochemical samples, and in mines and prospects. Tactite deposits probably do not occur in any other part of the study area. Carbonate rocks are widespread in the study area; however, none shows signs of having been affected by intrusive activity. The intrusive body identified by the aeromagnetic anomalies is not in contact with limestone in the study area except at the tactite described above.

The geologic environment of the southeastern part of the study area is favorable for the occurrence of hydrothermal veins, stockworks, and related replacement (nontactite) deposits in structurally prepared quartzites, shales, limestones, and dolostones. An east-west fault through Patterson Pass, south of the study area, localized mineralization there. This part of the area is assigned a moderate potential for the occurrence of undiscovered resources containing tungsten, silver, zinc, lead, gold, and fluorite. The southern limit of this favorable geologic environment is not defined; however, it would probably extend through the Patterson mining district. This assignment is based on (1) the presence of a buried shallow intrusive body that is a possible source of metals; (2) a geochemical signature that shows anomalous concentrations of metals adjacent to that part of the area; (3) the presence of major fractures that could have provided passage for hydrothermal fluids; and (4) the presence nearby of deposits having past production and identified resources. For example, in the Patterson mining district hydrothermal veins and related replacement deposits hosted by carbonate rock contain tungsten and silver.

The area north of the Patterson Pass area and along the eastern boundary of the study area has a moderate potential for undiscovered tungsten and silver resources in vein deposits. This assessment is based on the abundance of tungsten and silver in stream sediments derived from that area, favorable structures, and the occurrence of tungsten and silver in rock collected from mines and prospects.

A moderate potential exists for undiscovered hydrothermal deposits of gold and silver resources in the northwestern part of the study area. Geochemical anomalies were found to be localized on favorable structures near there. Prospects have explored weakly mineralized rock along the structure just outside the study area.

Mineral resource potential for undiscovered uranium and thorium is low. Aerial gamma-ray surveys do not indicate any radiometric anomalies within the study area or in the immediate vicinity.

Energy resource potential for oil and gas is low. The geologic setting of the study area does not compare favorably to the present model defining oil and gas accumulations in Nevada. Geothermal energy resource potential in the study area is considered low; warm springs are present nearby, but they are controlled by structures unrelated to the study area; all spring waters in the study area are cold.

INTRODUCTION

Area Description

The U.S. Geological Survey (USGS) and the U.S. Bureau of Mines (USBM) studied 30,115 acres of the Mount Grafton Wilderness Study Area (NV–040–169). The study of this acreage was requested by the U.S. Bureau of Land Management (BLM). In this report the studied area is called the "wilderness study area" or simply the "study area."

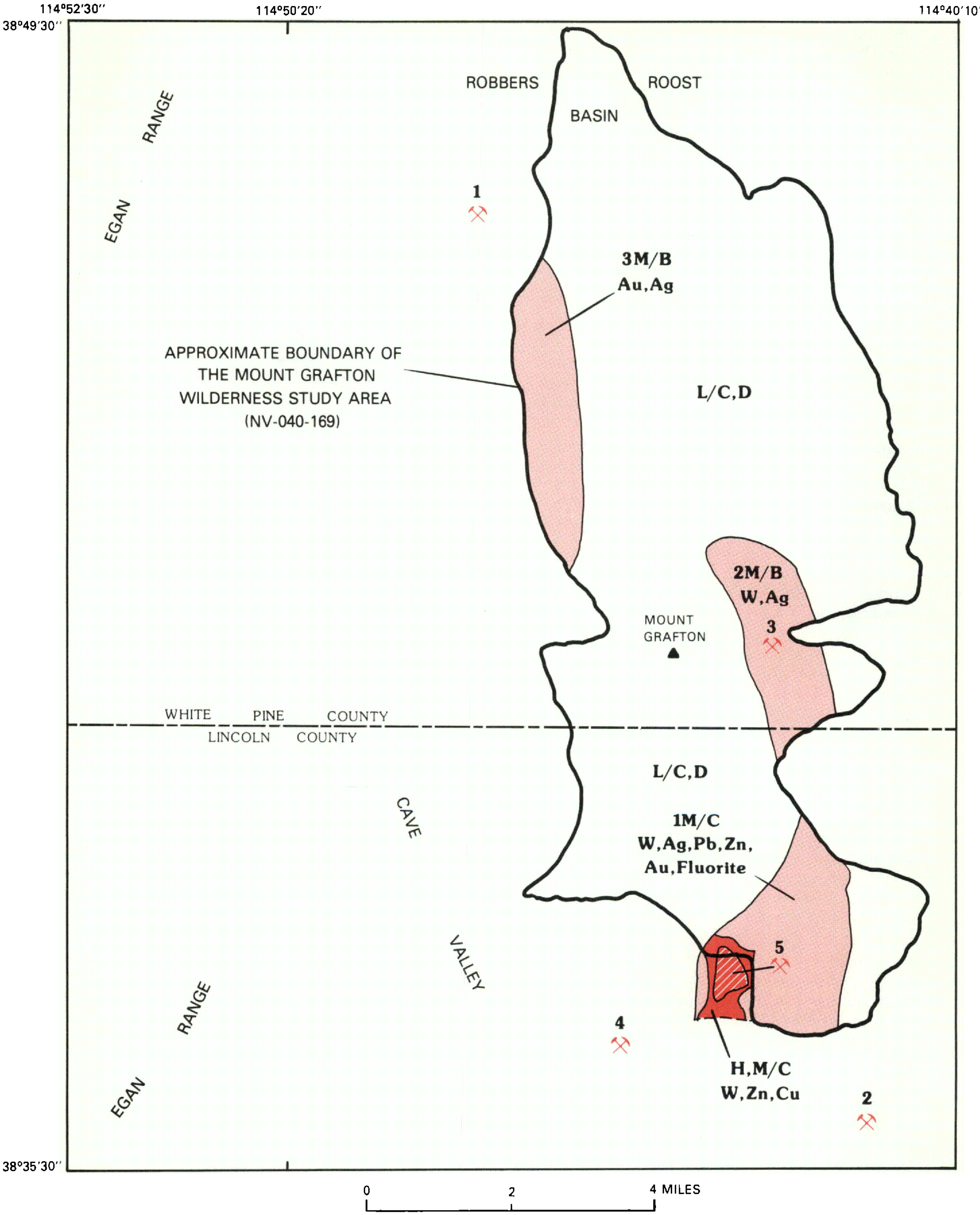


Figure 2 (above and facing page). Summary map showing mineral resource potential of the Mount Grafton Wilderness Study Area, Lincoln and White Pine Counties, Nev.

EXPLANATION

[hatched red box]	Area of identified resources of zinc in low-grade deposits and geologic terrane having high resource potential for tungsten and copper in a tactite deposit, with certainty level C
[mine symbol]	Mine or prospect having identified resources 1. Marich claims (silver) 2. Cinch mine (tungsten) 3. Deer Trail mine (tungsten) 4. Eagle Rock mine (tungsten, silver) 5. Workings at the head of Schwartz Canyon (zinc)
H,M/C	Geologic terrane having high resource potential for tungsten, zinc, and copper in a tactite deposit, with certainty level C, and moderate resource potential for tungsten, lead, zinc, silver, gold, and fluorite in hydrothermal veins and replacement deposits, with certainty level C
1 M/C	Geologic terrane having moderate resource potential for tungsten, lead, zinc, silver, gold, and fluorite in veins and replacement deposits, with certainty level C
2 M/B	Geologic terrane having moderate resource potential for tungsten and silver in vein deposits, with certainty level B
3M/B	Geologic terrane having moderate resource potential for gold and silver in veins, with certainty level B
L/C,D	Geologic terrane having low resource potential for (1) tungsten, lead, zinc, silver, and gold in tactite, hydrothermal vein, and replacement deposits (applies to all uncolored areas), and (2) uranium and thorium, oil and gas, and geothermal resources (applies to entire study area), with certainty level C; and for clay (applies to entire study area), with certainty level D

The Mount Grafton Wilderness Study Area is in a remote part of the Schell Creek Range about 50 mi south of Ely, Nev., and about 25 mi west of the Nevada–Utah State line (fig. 1). The study area occupies about 47 mi^2 (square miles); two-thirds of it is in White Pine County and the southern one-third is in Lincoln County. Its basin-and-range physiographic setting consists of a north-trending mountainous terrain bordered on the west by Cave Valley, on the east by Lake Valley, and on the south by Patterson Pass; Robbers Roost Basin roughly defines the northern boundary. Small areas of the piedmont slope are included in the study area along with the mountainous terrain. Topographic relief exceeds 5,000 ft; elevations of the adjoining flat-bottomed valleys to the east and west are about 5,600 ft. From there the terrain rises gently up the piedmont slopes to the mountain fronts, where elevations then rise abruptly to more than 10,000 ft.

Small intermittent streams, fed mainly by springs, discharge into the internal drainage basins adjacent to the study area. The lower slopes of the study area are covered with pinyon-juniper and sagebrush, with limber pine, bristlecone pine, and fir dominating the higher elevations. Aspen groves are prolific along many of the drainages. Deer, elk, and wild horses are fairly common, and at least one of the streams (North Creek) provides trout fishing. Besides hunting and fishing, other recreational activities there include spelunking in a cave in Cave Valley.

Mining and prospecting activity, initiated probably during the late 1860's, has continued intermittently to the present time both in and near the study area. The Patterson mining district, which is south of the study area, was probably the most productive of any in the vicinity. Silver, tungsten, zinc, and copper were reportedly mined (Tschanz and Pampeyan, 1970, p. 167) from this short-lived district. Core drilling and a surface geochemical survey were carried out in the Patterson Pass area during the summer of 1984 by a mineral exploration company. The Lake Valley mine, on the east side of the range below Mount Grafton, is reported to have produced silver and tungsten (Tschanz and Pampeyan, 1970, p. 168). There are remains of an aerial tram, mill, and tailings ponds below this mine. Evidence of limited mining and prospecting activity also exist on the west side of the study area in Cave Valley.

Ranching continues to be the major industry in the area. Water from the eastern side of the study area is diverted and carried by aqueducts to the Geyser Ranch in Lake Valley for irrigating crops.

Main access to the study area and vicinity from Ely, Nev., is from State Highways 6, 50, and 93, which cross the Schell Creek Range north of the study area. Highway 93 continues south through Spring and Lake Valleys, providing access from the east by way of several unimproved roads, including the Patterson Pass road. The Patterson Pass road continues north in Cave Valley and eventually joins the State highway again south of Ely. Early-day roads constructed up most of the canyons lead to springs that are used for watering stock. These roads approach the study area boundary in many places, and from the north they reach well into the area. There are no established hiking trails in the study area, but livestock and game trails are common.

This report presents an evaluation of the mineral endowment (identified resources and mineral resource potential) of the study area and is the product of several separate studies by the USBM and the USGS. Identified resources are classified according to the system of the U.S. Bureau of Mines and U.S. Geological Survey (1980), which is shown on p. IV of this report. Identified resources are studied by the USBM. Mineral resource potential is the likelihood of occurrence of undiscovered metals and nonmetals, industrial rocks and minerals, and undiscovered energy sources (coal, oil, gas, oil shale, and geothermal sources). It is classified according to the system of Goudarzi (1984) and is shown on the inside front cover of this report.

Investigations by the U.S. Bureau of Mines

The U.S. Bureau of Mines studied mines, prospects, and mineralized sites within and near the study area, compiled the history of mining and production in the immediate vicinity of the study area, and appraised the identified mineral resources. The USBM study involved a literature search, field examination of mine workings and mineralized areas, foot and helicopter reconnaissance of additional mine sites, and laboratory analysis of samples collected in the field (Chatman, 1986).

Prior to field work, information was collected from various sources concerning mining and mineral production in the region. Sources included published literature, claimants with active mining claims, and BLM mining claim records and contracted minerals studies. Published reports containing information on mining and production within and near the study area include those by White (1871), Hill (1916), Lincoln (1923), and Schrader (1931). More recent compilations that address mining and prospecting are in Tschanz and Pampeyan (1970), Smith (1976), Tingley and Bentz (1982), and Great Basin GEM Joint Venture (1983). Data for oil and gas leases were obtained from the BLM.

A field evaluation of mines, prospects, and mineralized structures within the study area and on the periphery was conducted in August and September 1984. Mine workings and mineralized areas were located, mapped, and sampled to determine reserves and subeconomic resources. A total of 294 samples was collected, including 199 samples from unmineralized outcrops and mineralized rocks in and near mine and prospect sites, 18 rock samples from unmined mineralized structures located during reconnaissance, and 72 stream-sediment samples and 5 soil samples collected to help delineate the extent of known mineralization. Samples were taken to obtain an indication of the type and grade of mineralized rock present, and assay values obtained were used to estimate resource quantities, where possible. USBM rock samples were analyzed by the USBM Reno Research Center, Reno, Nev. These samples were tested by semiquantitative optical-emission spectrography for 40 elements (Chatman, 1986). Depending on the type of mineralization suspected, some rock samples were also analyzed by atomic absorption for arsenic, rubidium, and tellurium; by atomic absorption or inductively coupled plasma for mercury; by colorimetry or X-ray fluorescence for tungsten; by fire assay or combined fire assay and inductively coupled plasma for gold and silver; and by inductively coupled plasma for copper, lead, molybdenum, and zinc. Stream-sediment and soil samples were analyzed by Barringer Resources, Inc., in Wheatridge, Colo., by means of atomic absorption for copper, gold, lead, rubidium, silver, strontium, and zinc; colorimetry was used to test for tungsten. Complete analytical data and detailed maps of mines and prospects can be found in Chatman (1986).

Investigations by the U.S. Geological Survey

The U.S. Geological Survey conducted field investigations during the summers of 1984 and 1985. Van Loenen (1987) prepared a geologic map incorporating new field data as well as previously published mapping. The Mount Grafton Wilderness Study Area is included in published regional studies of White Pine and Lincoln Counties. These studies, which include 1:250,000-scale geologic maps and discussions of mineral deposits, were completed for White Pine County by Hose and Blake (1976) and for Lincoln County by Tschanz and Pampeyan (1970). The southern and western parts of the area were mapped by Kellogg (1963, 1964). Formation names and map units used on the geologic base map for the mineral resource potential map (pl. 1) are, in part, those proposed and used by the above-mentioned authors. Geophysical studies included gravity, aeromagnetic (U.S. Geological Survey, 1985), and aeroradiometric surveys. Geophysical interpretations for this report are by H. R. Blank, Jr. Sixty-nine stream sites were panned for heavy-mineral concentrates; mine dumps, unaltered rocks, and spring waters were collected and analyzed. Analytical data for the stream-sediment concentrates and a few selected rock samples are given by Day and Barton (1986).

APPRAISAL OF IDENTIFIED RESOURCES

By M. L. Chatman
U.S. Bureau of Mines

History of Mining and Mineral Exploration

Mineralized fractures in the study area and its periphery were evaluated intermittently between the mid-1800's and the late 1970's. At various times, adits, trenches, shafts, and pits were excavated to explore for silver, gold, lead, tungsten, zinc, and copper. The most recent mining took place in 1956, when 134 tons of tungsten ore were mined at the Deer Trail mine. This is the only known mineral production within the study area.

Patterson and Cave Mining Districts

The southern part of the study area is within the Patterson and Cave (also called "Cave Valley") mining districts. Both districts have indefinite boundaries but extend no farther than 3 mi from the study area boundary. Tschanz and Pampeyan (1970, p. 165) consider the Patterson district and the "Cave Valley" district to be one and the same. Smith (1976, p. 53) recognized a third mining area, referred to as the "Geyser Ranch area," which includes the Deer Trail and Lake Valley mines, but this area was never organized as a mining district. Mines and developed sites of the Patterson district that are within or near the study area include the Lake Valley, Cinch, and Pip mines, all workings at or near Patterson Pass and Patterson Peak, the workings at the head of Schwartz Canyon, the Lanter mine, Eagle Rock mine, Cave Valley mine, and Streator mine (see pl. 1). The latter four sites are also recognized as being in the Cave district. Metals produced from these areas include silver, gold, tungsten, lead, and possibly copper and zinc. It is doubtful that more than about 500 tons of ore has been mined from any of these deposits. No record of production is known for most of the mines.

Mining in the Patterson district began in 1869 after argentiferous "rich oxidized material" was shown to R. G. Patterson by an Indian. Some 200–250 claims were then staked north of Patterson Pass, but the rich ore "soon gave out" and the district was abandoned. Ore values[1] of \$212 to \$520 silver/ton (st) and \$22 gold/ton (st) were reported. (See Hill, 1916, p. 123; Lincoln, 1923, p. 123.) Silver occurrences in the Cave district were discovered in 1869 by John Hughes (Smith, 1976, p. 88), probably in conjunction with exploration of the Patterson district.

Mines, Claims, and Leases

Mining and mineral prospecting within the study area has not been extensive. Active mining claims in the study area include the Lake Valley silver claim group (and the Lake Valley mine) and the Lady Linda claim group (see pl. 1 for locations). Prospecting on these claims had not involved excavation or drilling within the study area as of September 1985. Rock samples collected in 1985 by the claim holder in the south-central part of the Lady Linda group reportedly contained gold and silver. Additional prospecting was planned, but no other details are currently available (Donald W. Miller, Baker, Nev., oral commun., 1985).

Sites formerly prospected or mined within the study area boundary (pl. 1) include a caved working on North Creek (minor amounts of silver, gold), the Deer Trail mine (tungsten, minor amounts of silver, gold), the Lanter mine (lead, silver, minor amounts of copper, zinc, tungsten, gold), and two small prospect pits (zinc) on the study area boundary at the head of Schwartz Canyon. Only the Deer Trail mine, which was worked for tungsten, has recorded production. These sites are detailed in table 1, which accompanies descriptions of deposit types in sections that follow.

Oil and gas leases cover about 0.2 mi^2 of the study area near Lanter Canyon (fig. 3). This leased area is a part of one of several large oil and gas lease blocks that cover most of Cave Valley west of the study area. Four test wells drilled in Cave Valley were dry. The closest of these test wells was drilled about 3 mi west of the study area; the deepest of these wells was 7,024 ft (Garside and Schilling, 1977). Some oil and gas leases are in Lake Valley, to the east within 1 mi of the study area, but there has been no drilling on these leases. Lease data are from the BLM, Reno, Nev., as of September 1984. The nearest oil fields are the Eagle Springs, Trap Spring, and Bacon Flat–Grant Canyon fields of Railroad Valley, about 45 mi west of the study area (Jones and Papke, 1984). Oil traps of these fields are in Tertiary volcanic rocks and are mostly more than 4,000 ft deep (Garside and others, 1977).

Mineral Deposits and Occurrences

The metallic mineral deposits examined by the USBM contain at least detectable concentrations of several metals—mainly copper, gold, lead, silver, tungsten, and zinc. Identified resources have been estimated for two sites inside the study area (tungsten at the Deer Trail mine; zinc at the head of Schwartz Canyon), and other resources have been estimated at four sites on the study area periphery (zinc in a continuation of the Schwartz Canyon deposit, tungsten at the Eagle Rock mine, tungsten and silver at the Cinch mine, and silver at the Marich claims) (see pl. 1). The three deposit types in which these metals occur are described below.

Metals Deposits

Mineralized sites include one tactite (a metasomatically altered carbonate rock) occurrence in the southern

[1]These silver ores graded approximately 160 oz (ounces)/ton (troy oz/st) to 400 oz/ton, based on an average silver price of \$1.29/oz for the years 1866–1870. The gold ores graded approximately 1 oz/ton (troy oz/st), the calculation based on an average gold price of \$20.67/oz (troy) for the years 1866–1870 (Williams, 1883, p. 182). The gold grade may have been higher; another valuation of gold mines during this era used gold values of about \$14.50/oz (troy) (Raymond, 1872, p. 13).

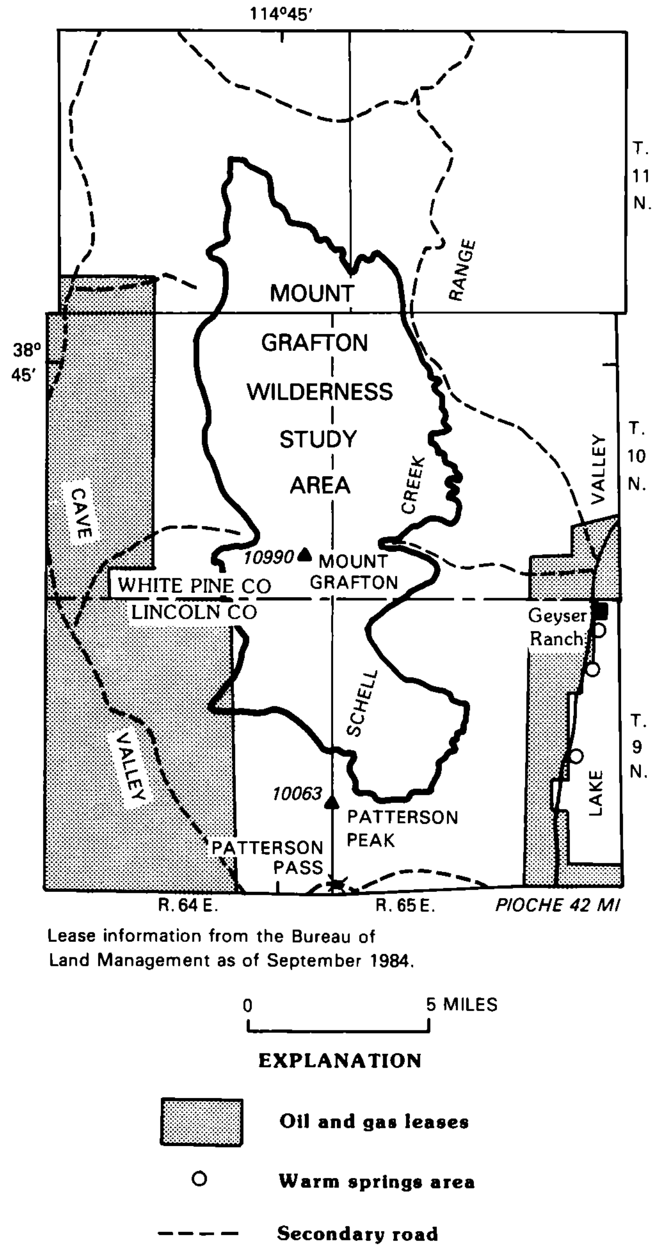


Figure 3. Map showing oil and gas leases near the Mount Grafton Wilderness Study Area, Lincoln and White Pine Counties, Nev.

part of the study area and numerous fracture fillings within fault zones and joints in the sedimentary strata. The mineralization has formed silver, tungsten, gold, lead, zinc, and copper(?) deposits, some in the study area and some nearby. Deposits are grouped into three types, discussed below, which are described in detail in Chatman (1986).

Resources and Mineralized Sites in Tactite

Tactite in limestone at the head of Schwartz Canyon and the adjacent pass has concentrations of zinc and tungsten and minor amounts of silver and gold (table 1; locality 5, pl. 1). The mineralized site is partly within the southern end of the study area. The tactite is a 9-ft-thick tabular body, dipping 16°–25° E. It crops out south of the study area in the saddle at the head of Schwartz Canyon. Intrusive rock is not exposed at the surface there; however, collection of two samples of cryptocrystalline igneous rock from dumps of two caved adits at the head of Schwartz Canyon (Chatman, 1986, p. 13, table 2) indicates that the intrusion is present at elevations as high as 9,500 ft. The granitic intrusion recognized by Hill (1916, p. 123) at the head of Schwartz Canyon was not found in this study, but its location is in, or very close to, the tactite zone. A granitic intrusive is exposed in a very small outcrop about 0.75 mi southeast of the study area. Drilling in 1981 by Union Carbide Corporation showed that the granitic rock is present over a more extensive area at depth (Grigsby, 1981).

The tactite deposit is summarized in table 1. Calculations of resources are based on a tabular body, which field evidence shows to be 9 ft thick, occurring over a 5.9-million-ft^2 area. Sample results from zinc-bearing rocks other than tactite were also used to calculate grade because the analyses show that limestone and fault gouge not containing tactite also have high concentrations of zinc; this relationship is particularly apparent in samples from a 28-ft-long adit in limestone (Chatman, 1986, p. 16, 44). The average silver content of the deposit is 0.4 ppm (parts per million). Silver is too irregularly distributed and low in grade to permit resource estimation, but some may be recoverable. Minerals identified in the tactite include scheelite, chalcopyrite, sphalerite, and fluorite (Tingley and Bentz, 1982).

Resources and Mineralized Sites in Carbonate Rocks and Shale

Fracture fillings in carbonate rock and shale are in the form of quartz veins and breccias, limestone breccias, and calcite veins. Most are within the Pioche Formation and Pole Canyon Limestone. Some of the fracture fillings contain silver in concentrations that were economically recoverable in the past. Other sites that have been prospected contain tungsten, lead, zinc, and possibly copper and gold. The fracture fillings are in known fault zones, many of which may be related to the Patterson Pass fault near the south end of the study area. Mines and prospects in carbonates and shale include the Marich claims, Cinch mine, Pip mine, Patterson Pass workings, several workings along the northwest-trending fault between Patterson Pass and Patterson Peak, the Cave Valley mine, and the Streator mine (pl. 1).

Most of these deposits are outside the study area and are on fractures that apparently do not extend into the study area. The Marich claims, northwest of the study area, are an exception in that they are on a fault that

Table 1. Description of resources and mineralized sites in the Mount Grafton Wilderness Study Area and vicinity, Lincoln and White Pine Counties, Nev.

[Locality numbers keyed to plate 1]

Development	History and production	Resources
Carbonate rock and shale All sites are outside the study area.		
LOCALITY 1 Marich claims (silver, lead, minor gold)		
Twenty-two prospect pits and two shafts (one caved, one 10 ft deep), all shallow.	No production known; development by shovel and wheelbarrow as recently as 1984.	Identified 20,000 tons with 0.6 oz silver/ton, and 40,000 tons at 4.5 oz silver/ton.
LOCALITY 2 Cinch mine (tungsten, minor silver, gold)		
165 ft underground workings on three levels; inclined shaft; small open cut.	1,000 tons of 0.75 percent WO_3 in 1941, 1942 (Tschanz and Pampeyan, 1970, p. 171).	75,000 tons of 0.41 percent WO_3, 25,000 tons of 0.033 percent WO_3.
LOCALITIES 7 AND 8 Workings at Patterson Pass (silver, minor tungsten, lead)		
Four shafts, two shallow pits; most shafts 20-30 ft deep; one is open to 100 ft.	Amount of production not recorded; worked sporadically in 1800's, and as late as 1920.	Not estimated.
LOCALITIES 9-12 Patterson district workings on a northwest-trending fault (silver, copper, lead, zinc)		
Five pits, two shafts, two trenches (one is a caved adit).	No production recorded, but some silver, copper, lead, and zinc may have been produced, a conclusion based on high assay values; southernmost workings may date from early Patterson district mining era; northernmost shaft and adit begun in 1913 (Hill, 1916, p. 124; Schrader, 1931, p. 7).	Not estimated.

has an extent of about 3 mi in the study area. Mineralized sites along the study area periphery may be typical of the type and grade of deposits that can be expected in fractured parts of the Pioche Formation and Pole Canyon Limestone. These formations are present in the southeastern and northwestern parts of the study area. Deposits of this type are summarized in table 1.

Resources and Mineralized Sites in Prospect Mountain Quartzite

Quartz veins and breccias in the Prospect Mountain Quartzite contain tungsten, in quantities that were considered economically recoverable in the past, and minor gold and silver, some of which may be recoverable. Rocks

Table 1. Description of resources and mineralized sites in the Mount Grafton Wilderness Study Area and vicinity, Lincoln and White Pine Counties, Nev.—Continued

LOCALITY 13 Cave Valley mine (silver, copper, lead, minor zinc, gold)		
Four caved shafts, 150-ft-long, sloughed-in trench, 45-ft-long accessible adit, one caved adit, six prospect pits.	Production amount not recorded; literature suggests only a "few tons" of ore produced (Smith, 1976, p. 88); ore shipments made in 1878, 1925, and the 1930's (Schrader, 1931, p. 9; Smith, 1976, p. 88; Pat Fraser, Ely, Nev., oral commun., 1984); most development took place in 1920's (Schrader, 1931, p. 9).	Not estimated.
LOCALITY 14 Streator mine (silver, lead, copper, minor gold)		
Four shafts (one caved), two prospect pits; two of the shafts intersected by 45° inclines from surface.	Production amount not reported; Schrader (1931, p. 14) notes 90 tons of "mill ore" on a stockpile; most mining was in 1929 and 1930; intermittent development continued until 1983.	Not estimated.
LOCALITY 17 Pip mine (tungsten, minor silver)		
Three shafts and three small prospect pits; no bedrock exposed in two of the pits; two shafts are 50-75 ft deep; one shaft is about 45 ft deep; all are caved to some degree.	Production unknown----------	Not estimated.

at most of the sites also contain lead, and some contain high concentrations of copper and zinc. The quartz veins and breccias are fracture fillings and are commonly in mapped fault zones. Mineralized sites include the North Creek Spring prospect, Deer Trail mine, Lanter mine, Lake Valley mine, and Eagle Rock mine. The first three sites listed are inside the study area. Deposit descriptions are summarized in table 1.

Rock Products

Quartzite and carbonate rocks within the study area could be used as commercial rock products. Prospect Mountain Quartzite, the most common formation in the study area, has been quarried at Caliente in Lincoln County for crushed-rock aggregate (Tschanz and Pampeyan, 1970, p. 125). The formation has also been quarried for dimension and flagging stone in White Pine County, on the eastern slope of Mount Moriah (Smith, 1976, p. 57–58). Eureka Quartzite, exposed in the north-central part of the study area, has been noted as a source of nearly pure silica at numerous places in Nevada (Ketner, 1976).

A Middle Cambrian limestone at McGill, in White Pine County, is noted for its high calcium content; several thousand tons have been quarried there (Smith, 1976, p. 51). Similar Middle Cambrian limestone crops out in the northeast quadrant and along the eastern edge of the study

Table 1. Description of resources and mineralized sites in the Mount Grafton Wilderness Study Area and vicinity, Lincoln and White Pine Counties, Nev.—Continued

Prospect Mountain Quartzite All sites, with the exception of the Lake Valley mine and the Eagle Rock mine, are inside the study area		
LOCALITY 3 Deer Trail mine (tungsten, minor silver, gold)		
One 270-ft adit; small prospect pit 400 ft west of adit, bulldozer cut extends for 800 ft west of adit portal.	Discovered 1918; 30-ft adit and pits in 1940 and 1942 (Smith, 1976, p. 53); adit extended in 1956, when mining produced 134 tons yielding 47 tons WO_3 concentrates.	2,000 tons (st) of material containing 0.1 percent WO_3 identified. Ag and Au resources were not estimated.
LOCALITY 4 Eagle Rock mine (tungsten, silver, minor lead, copper, gold)		
One 104-ft adit; prospect pit.	Mined in 1930's (Schrader, 1931, p. 16); amount of production not known; 1.5 percent copper reported (Tschanz and Pampeyan, 1970, p. 171); Schrader (1931, p. 16) reports "tungsten ore" assay of $8/ton in gold, with "appreciable" silver.	A total of 10,000 tons with 0.33 percent WO_3 and 2.4 oz silver/ton identified and 400 tons of 0.19-percent WO_3 and 1.5 oz silver/ton. Pb, Cu, and Au were not estimated.
LOCALITY 6 Lake Valley (Geyser) mine (silver, tungsten, fluorine, minor gold)		
Three west-trending adits with 800 ft of workings (Smith, 1926); drifts trend north; prospect pit and development bulldozer cuts; one bulldozer cut obliterated upper adit portal (J. W. Cole, Pioche, Nev., oral commun., 1984).	Production unknown; silver ore shipped by Lake Valley Mining Co. (1921) (Lincoln, 1923, p. 123-124); mined intermittently 1920 to early 1930's; caved in 1937; a "50-ton capacity stamp mill" was on property (Smith, 1926).	Not estimated.
LOCALITY 15 North Creek Spring prospect (minor silver, gold)		
One caved shaft; development apparently east-west-trending drifts off shaft to follow breccia; dump size suggests 200-300 ft of underground workings were excavated.	No production known; as much as 0.02 ppm Au, 0.4 ppm Ag, 20 ppm W, 78 ppm Zn, and 0.2 percent Ba detected in samples.	Not estimated.

area, but it has not been analyzed for calcium content. Upper Cambrian limestone has been quarried in western Lincoln County from the Groom Range for use as building stone (Tschanz and Pampeyan, 1970, p. 125); limestone of similar age is exposed in the northeast quadrant of the study area. Limestone of the Pogonip Group of Ordovician age, sampled from the Worthington Mountains in western Lincoln County about 75 mi southwest of the study area, is 98 percent calcium carbonate (Wood, 1985, p. 28, 29). Limestone of the Pogonip Group, exposed

Table 1. Description of resources and mineralized sites in the Mount Grafton Wilderness Study Area and vicinity, Lincoln and White Pine Counties, Nev.—Continued

LOCALITY 16 Lanter mine (lead, silver, minor copper, zinc, tungsten, gold)		
One caved shaft; dump suggests the shaft was 30 ft deep.	Mined in early 1900's (J. W. Cole, Pioche, Nev., oral commun., 1984); no production known.	Not estimated.
Tactite		
LOCALITY 5 Workings at the head of Schwartz Canyon, including "Ad mine" (zinc, tungsten, minor silver, gold); all workings except for two small prospect pits are outside the study area boundary.		
Caved shaft, about 2,000 ft of exploratory bulldozer cuts on west side of pass; three adits (one accessible), four pits, and 300-ft-long development crosscut on east side of pass; crosscut strikes N. 25° W. through unmineralized rock; probably designed to intersect tactite and provide haulage; other workings intersect tactite or gossan.	No recorded production; worked in early 1900's (Hill, 1916, p. 124); last staked in 1979 when minor excavation took place (Tingley and Bentz, 1982).	Total of 6.6 million tons of indicated resources, 1.1 percent Zn in tactite deposit; 1 million tons of inferred resources inside study area, but grade is lower--about 0.4 percent Zn. Resource estimates for W, Ag, and Au could not be made.

in the north-central part of the study area (Hose and Blake, 1976, pl. 2), may include some high-calcium limestone.

Rock products are commodities of high bulk and low unit value; transportation costs are a major determinant in their development. Deposits in the study area are isolated from major markets and similar rocks are present closer to the markets. Thus there is little probability the rock resources in the study area will be developed.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

By R. E. Van Loenen, H. R. Blank, Jr., and Harlan Barton
U.S. Geological Survey

Geology

Geologic Setting

The Mount Grafton Wilderness Study Area is in the Great Basin near the center of the Basin and Range physiographic province. Periods of tectonism (structural deformation) affected parts of the province during the Mesozoic Era (see age terms in geologic time chart at end of report), mainly as mild warping and some stacking of the sedimentary rocks by thrust faulting. The present basins and ranges were formed by high-angle faulting that started during late Cenozoic time and continues to the present in parts of the province. The Schell Creek Range, which includes the Mount Grafton Wilderness Study Area, is a product of Neogene block faulting and is a major north-trending mountain range that continues for nearly 100 mi across east-central Nevada.

Internal drainage basins, separating the ranges, are characterized by nearly flat basin floors grading into piedmont slopes that rise gradually and end abruptly at the mountain front. Several separate basins bound the Schell Creek Range along its length. Adjacent to the study area, Cave Valley separates the range from the Egan Range on the west and Lake Valley separates it from the Fortification Range on the east. These valleys contain thousands of feet of fill derived from the eroding mountain ranges.

The study area is underlain mainly by a thick sequence (approximately 20,000 ft) of clastic and carbonate sedimentary rocks that were deposited on a continental shelf before and during the Paleozoic Era. These rocks, ranging in age from Late Proterozoic through Middle Devonian, are part of a wedge of sediments that thickens from central Utah to central Nevada. The study area is near the thickest part of the wedge. The oldest and lowermost rock unit exposed in the study area is the Proterozoic(?) and Lower Cambrian Prospect Mountain Quartzite. This map unit is a very thick sequence (nearly 5,600 ft) consisting mainly of fine- to medium-bedded quartzite interbedded with argillite near the top. This quartzite is very resistant to erosion; Mount Grafton is formed from quartzite of this unit. The lowest part of the unit, which contains quartzite and conglomerate, may be Late Proterozoic in age. The upper and lower units are separated by a thin Lower Cambrian basalt flow. The quartzite has no special economic significance except that fractures that developed within it host veins that may contain metals. The Prospect Mountain Quartzite is overlain by Pioche Formation of Early Cambrian age. This unit, about 400 ft thick, consists mainly of argillite and contains minor amounts of quartzite near the bottom and interbedded limestone near the top. The limestone beds are relatively pure; they are the lowest rock unit in the thick Paleozoic sequence that would provide a suitable medium for replacement mineralization should the rocks be invaded by magmatic fluids from below.

The overlying Cambrian rocks in the study area are thick sequences of limestone belonging to the Middle Cambrian Pole Canyon Limestone and the Middle and Upper Cambrian Emigrant Springs Limestone of Kellogg (1963). These are mainly medium- to dark-gray, detrital, cliff-forming limestone. The Emigrant Springs is incomplete in the wilderness study area, as are all of the overlying map units, due to intense faulting throughout the northern half of the study area. Upper Cambrian rocks are the Dunderberg Shale. The overlying Upper Cambrian and Lower Ordovician Whipple Cave Formation is composed of dolostone and limestone. The Dunderberg and Whipple Cave rocks crop out in the central part of the study area. Lower and Middle Ordovician rocks, shown undivided as the Pogonip Group, are characterized by medium-gray limestone that is cherty and fossiliferous in many places and by dolostone in a few places. The Middle Ordovician Eureka Quartzite is a clean white quartzite that separates mainly limestone below from the predominately dolostone units above. Upper Ordovician rocks belong to the Ely Springs Dolostone and the Silurian rocks to the Laketown Dolostone. The upper part of the Laketown Dolostone is light gray and saccharoidal; the lower part is brownish-gray, crystalline, and fossiliferous dolomite similar to the underlying Ely Springs Dolostone.

The youngest Paleozoic rocks in the study area are the Lower and Middle Devonian Guilmette Limestone, which is in fault contact with Lower and Middle Devonian Sevy Dolostone and the Middle Devonian Simonson Dolostone. No rocks are present in the study area representing the time period between Upper Devonian and late Tertiary and Quaternary. Younger sedimentary rocks (mainly conglomerate), deposited during and after the range was uplifted, are exposed in the low-lying area along the northern part of the study area. They also are present in areas along the mountain front but are covered by younger alluvial deposits.

Since uplift, the Schell Creek Range has been greatly modified by erosion. Tertiary volcanic ash flows, which are present over much of the region and perhaps at one time covered the study area, have since been eroded or structurally removed. A very small outcrop of ash-flow tuff is exposed along a stream about 0.25 mi southeast of the study area (not shown on pl. 1).

Shallow intrusive bodies may underlie parts of the map area. Shale in the Pioche Formation in the southern part is strongly phyllitic (metamorphosed), which suggests thermal effects from an intrusive body. This area also contains the mineralized rock in the Patterson mining district, further suggesting the presence of an intrusive body.

Structure

During the Neogene this thick sequence of relatively flat-lying Proterozoic(?) and Paleozoic rocks were reshaped by faulting and uplift. The Mount Grafton Wilderness Study Area is part of a segment of the Schell Creek Range structural block. This segment is defined by border faults on the west and east, Patterson Pass fault on the south, and a low-angle reverse fault along the northeast. Internally, the block is dissected by many major north-trending, high-angle faults that complement the border faults and by a series of faults that cut the block at oblique angles.

The border faults are high-angle faults that caused most of the high relief found in the range. Displacement along the border faults on both sides of the block increases from north to south. Cambrian rocks in the south are elevated well above younger Devonian rocks exposed in the north.

The border fault on the west, named the "Cave Valley fault" (Kellogg, 1964), trends north-northwest about 1–2 mi west of the mountain front (pl. 1). It is concealed beneath alluvium that forms the piedmont slope. Kellogg (1964) estimated that maximum displacement near the southern boundary of the map area is 14,000 ft. An unnamed border fault to the east of the range is partly exposed near the southeast boundary of the study area. There, Lower Cambrian Pioche Shale is juxtaposed against Middle Ordovician Eureka Quartzite. Assuming the down-dropped block has not previously been thinned by low-angle faulting, the stratigraphic displacement along the fault must be nearly 13,000 ft. Vertical strata adjacent to the fault indicate the high-angle nature of this border fault.

The Patterson Pass fault (see the bottom edge of the map, pl. 1) trends east-northeast across the range at Patterson Pass. This fault has dropped the terrane down on the south and has a possible component of movement to the right (right-slip). Mineralization in the Patterson mining district may have been localized by this fault.

The northeast boundary of the study area roughly coincides with the trace of a low-angle reverse fault that places younger over older rocks. This fault, with relative movement from northeast to southwest has, in part, cut out the Middle Devonian Simonson Dolostone and placed Upper and Middle Devonian Guilmette Limestone on Middle and Lower Devonian Sevy Dolostone. No altered rock or indications of mineralization were found along the low-angle fault.

The study area can be divided roughly into two areas having distinctive structural styles. The southern part, south of an east-west fault on the north side of Mount Grafton, is a relatively simple uplifted fault block tilted approximately 35° toward the east. This block is made up of Late Proterozoic(?) and Lower and Middle Cambrian rocks. North-trending, high-angle faults dissect this terrain; some complement the border faults with added uplift and some drop down parts of the block.

The northern part of the study area is characterized by many small irregularly shaped fault blocks, all of which show progressive uplift from the northeast to the southern structural block.

Folding is absent in these strata except where expressed as drag along the high-angle faults.

Geochemical Studies

Heavy-mineral concentrates from stream sediments were the primary sample medium used for the geochemical survey, but water samples from all major springs and altered and fresh rocks, and some unpanned stream sediments were also collected and analyzed. The concentrates were chosen as a sample medium because the selective concentration of minerals permits determination of some elements that are not easily detected in stream-sediment samples. The geochemical signature from stream sediments may reflect the redistribution of metals from deposits. The amount and type of metals present in the deposits, the type of host rock, the terrane, and the climate determine what is detected by geochemical sampling. Sixty-nine stream-sediment samples were collected from the most active part of the stream beds; each sample is a composite of several collected from different sites within a 100-ft distance. Composites were screened in the field with a 2.0-mm (millimeters) (10-mesh) screen to remove the coarse material. The less-than-2.0-mm fraction was panned until most of the quartz, feldspar, organic material, and clay were removed. In the laboratory the samples were further processed using bromoform and a magnetic separator; the resulting nonmagnetic heavy-mineral concentrate was then analyzed. Due to the concentration of minerals, which may be several orders of magnitude, element contents of the concentrates do not necessarily imply that the element is present in anomalous amounts in the stream sediment. Further details on sample preparation and analysis, along with the chemical data and location of sample sites, are found in Day and Barton (1986). Heavy-mineral concentrates were analyzed for 31 elements by the semiquantitative emission spectrographic method of Grimes and Marranzino (1968).

The localities of the 69 heavy-mineral concentrates are shown on plate 1 along with the relative amounts of tungsten, silver, gold, zinc, bismuth, molybdenum, lead, and antimony found in each sample. Each point on the eight-sided star represents a specific element, and the length of the point indicates the amount of that element present. A range of values is shown for some elements rather than a specific amount.

Elements relevant to this survey that were found in heavy-mineral-concentrate samples are as follows (see also pl. 1):

Bismuth.—Concentrations of bismuth (70–500 ppm) were found in three samples (localities 36, 37, 44) from the Patterson Pass area. Tungsten is also present in these samples.

Antimony.—Antimony (200–7,000 ppm) associated with tungsten was found in samples from the vicinity of the Lake Valley and Deer Trail mines (sample localities 27, 28, 29, 30) and in the Patterson Pass area (sample localities 40, 42, 43). Antimony was also found in samples from scattered localities in Robbers Roost Basin, in the northern part of the study area.

Gold.—Three samples contain gold (100 ppm) (sample localities 31, 60, 63); they also contain silver. Gold was found on Wambolt Creek (sample locality 31) near the Lake Valley mine, and in an unnamed drainage basin on the western side of the range 2 mi north of the Streator mine and approximately 1 mi south of Wildcat Canyon (sample locality 60). Sample 63 was from the north fork of Wildcat Canyon, 4 mi northeast of the Streator mine. Gold could not be detected in raw (untreated) stream sediments collected from these sites.

Lead.—Lead ranging from 50 to 500 ppm was found in about half of the samples; however, most lead-bearing samples were from the Patterson Pass area (south of the study area) and the eastern flank of the range from Patterson Pass northward through the vicinities of the Lake Valley and Deer Trail mines to Campbell Spring. Lead is present in Robbers Roost Basin in scattered localities; however, it does not occur with other metals.

Molybdenum.—Molybdenum (15–50 ppm) with associated tungsten was found in two samples on the eastern flank of the range just north of Patterson Pass (sample localities 36, 41), and another sample containing molybdenum was collected on the eastern flank of the range on a tributary to Campbell Spring (sample locality 22).

Silver.—Six samples contain silver, four of which were collected along the eastern flank of the range in the vicinity of the Lake Valley and Deer Trail mines (sample localities 27, 28, 29, 31; sample 31 also contains gold). Two samples collected along the west side of the study area each contains 3 ppm silver (sample localities 60 and 63). These samples also contain gold.

Tin.—Seven heavy-mineral-concentrate samples, containing from 20 to 100 ppm tin, were collected from stream beds along the east side of the study area from Robbers Roost Basin south to near Patterson Pass. Tin is not shown on plate 1, but samples containing tin are from localities 6, 8, 22, 24, 28, and 37. All altered-rock samples collected from the Patterson Pass area contain tin ranging from 15 to 100 ppm (Day and Barton, 1986).

Tungsten.—Tungsten is present (100–5,000 ppm) in 32 samples collected from both the east and the west sides of Patterson Pass and along the eastern flank of the range northward from Patterson Pass to Campbell Spring.

Zinc.—Zinc was found only in samples 39, 41, and 44 (ranging from 500 to 1,000 ppm) from the Patterson Pass area, south of the study area. These samples also contain lead and tungsten.

In most cases, metals in heavy-mineral concentrates of stream sediments collected from within and near the Mount Grafton Wilderness Study Area can be traced directly to mines and prospects that explored and exploited known mineralized rock. Exceptions are the Wildcat Canyon vicinity, where gold was found in two samples, and Robbers Roost Basin, where antimony, lead, and tin occur separately in a few scattered sites; there are no known mines or prospects.

Samples 1 through 8 (see pl. 1) were collected in Robbers Roost Basin; traces of lead were detected in four of these samples and one contains a trace of tungsten and antimony. Robbers Roost Basin is underlain by Tertiary sedimentary rocks, rocks that are unlikely to host mineralization. Gold found in the Wildcat Canyon vicinity (sample localities 60 and 63, pl. 1) may be derived from veins in fractures in the area.

The most pronounced anomalies found in the heavy-mineral concentrates in the study area are those of tungsten. Widespread tungsten anomalies in the southern and eastern parts of the study area reflect the tungsten-bearing tactite and quartz-tungsten veins there. Most of the heavy-mineral concentrates from this area contain scheelite ($CaWO_4$). The concentrates collected throughout the area consist predominately of zircon. The variety of metals detected in samples from the large area of tungsten-lead anomalies (southeast quarter of the study area) may indicate the presence of more than one type of mineralization. Antimony, silver, lead, zinc, and gold are most often associated with hydrothermal vein deposits, whereas beryllium, tin, bismuth, and molybdenum are most often related to higher temperature deposits, such as tactites.

Water samples were collected from all major springs (nine) and analyzed for Cu, U, Zn, Cl^-, F^-, and $SO_4^=$. Spring waters that move along faults could conceivably become enriched when passing through mineralized rock; however, the waters were not anomalous in any of these elements or ions. Water analysis was by W. Ficklin and J. McHugh.

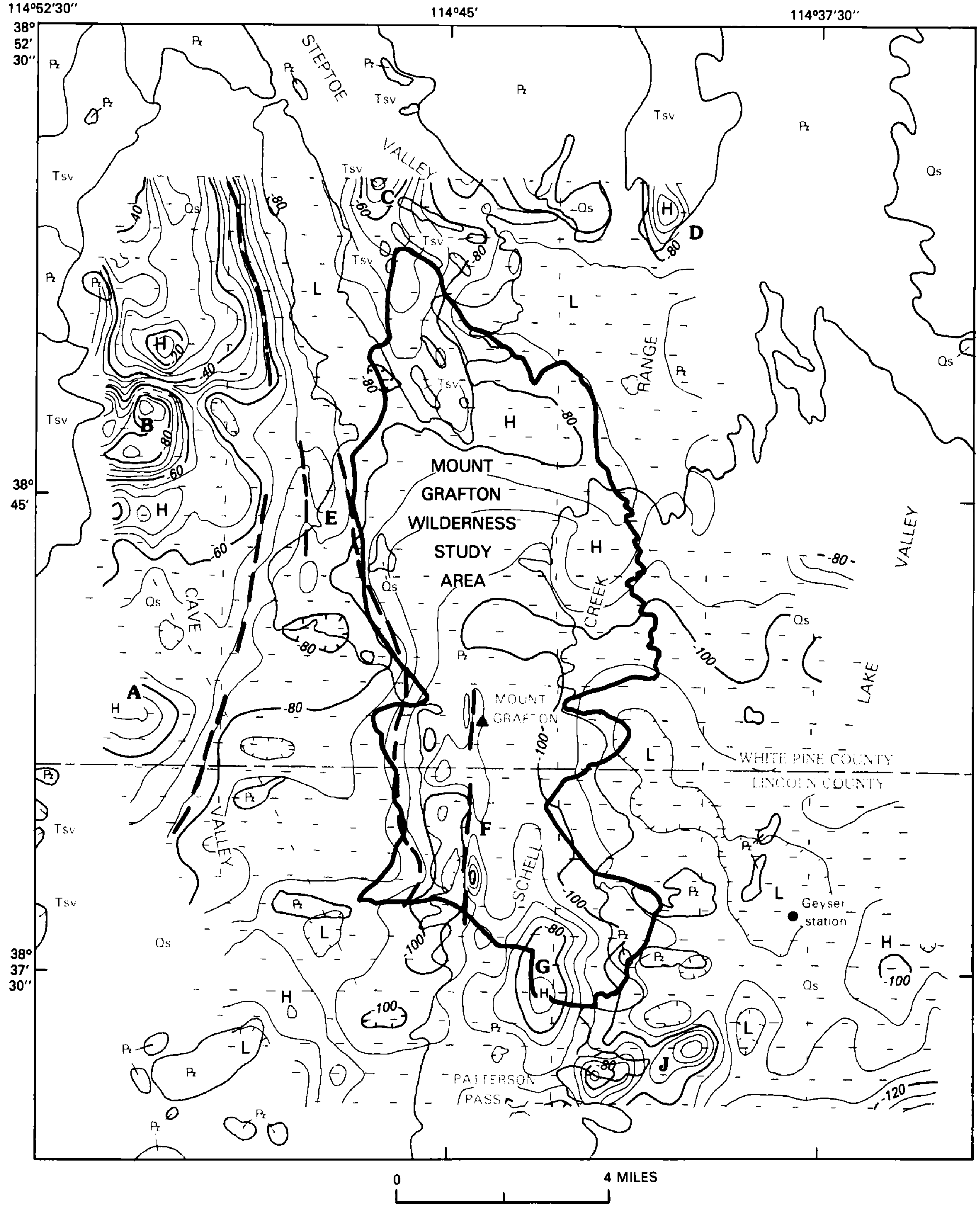
Geophysical Studies

Data

Reconnaissance aeromagnetic, aeroradiometric, and gravity data are available for the Mount Grafton Wilderness Study Area and vicinity. For the present investigation, a total-intensity aeromagnetic survey of the wilderness study area was flown 1,000 ft above terrain along east-west lines, spaced 0.5 mi apart, in January 1985 (U.S. Geological Survey, 1985). The International Geomagnetic Reference Field was removed from the data, and the resulting map of residual field anomalies relative to an arbitrary datum is reproduced as figure 4. Spectral radiometric data were obtained at a nominal 400 ft above terrain along east-west lines, spaced 3 mi apart, by the National Uranium Resource Evaluation (NURE) program. J. S. Duval (written commun., 1985) reported that the target area has low natural gamma radiation, with values of 0–1.8 percent potassium, 0–25 ppm equivalent uranium, and 2–10 ppm equivalent thorium; no anomalies were detected within the boundaries of the wilderness study area nor in the immediate vicinity, and therefore no further work has been done with the radiometrics. A complete Bouguer gravity anomaly map of the wilderness study area and surrounding region (fig. 5) was compiled from the data on file with the U.S. Defense Mapping Agency (available from the National Geophysical and Solar-Terrestrial Data Center, Boulder, CO 80303), and 15 additional stations were established during November 1985 by J. H. Hassemer (U.S. Geological Survey). Observed gravity at each station was reduced by standard procedures at a density of 2.67 grams per cubic centimeter (see, for example, Cordell and others, 1982), and terrain corrections were applied from digital topography out to a radius of 100 mi.

Magnetic Anomalies

Magnetic relief in the area of coverage is relatively low, only about 100 nanoteslas. Most of the anomalies (fig. 4) occur where Paleozoic bedrock is concealed beneath surficial deposits or Tertiary to Quaternary sedimentary rocks; the anomaly sources are probably mafic lavas


114°52'30"
114°45'
114°37'30"
38° 52' 30"
38° 45'
38° 37' 30"
STEPTOE
VALLEY
RANGE
MOUNT GRAFTON WILDERNESS STUDY AREA
CAVE
VALLEY
CREEK
SCHELL
LAKE
VALLEY
MOUNT GRAFTON
WHITE PINE COUNTY
LINCOLN COUNTY
Geyser station
PATTERSON PASS
0
4 MILES

or iron-rich ash flows that filled topographic depressions in the Tertiary landscape and have subsequently been buried by clastic debris and lake beds. These include anomalies A, B, C, and D of figure 4. The most intense of these (B) is a negative anomaly in upper Cave Valley, 3–4 mi west of the study area, whose source may be reversely polarized. In contrast, the carbonate terrane is associated with areas of very weak magnetic expression and low background levels (for example, Mollys Nipples, a quartzite-capped carbonate ridge on the east flank of uppermost Cave Valley, occupies the magnetically flat terrain between anomalies B and C). Also, the highest part of the Schell Creek Range in the area of coverage, extending south from the vicinity of Mount Grafton to Patterson Pass, is composed mainly of Prospect Mountain Quartzite and has low magnetic relief and a still lower anomaly background level.

Several pronounced linear magnetic gradients on the west side of the study area are shown on figure 4. These gradients generally trend north-south, parallel with the range front; three short segments in the vicinity of anomaly E (fig. 4) appear to be splays of a single feature to the north that coincides with a gravity gradient and that is probably the expression of a major structural discontinuity west of the carbonate outliers mapped in Cave Valley (fig. 4). The splays are more closely associated with the system of range-front normal faults that displace carbonates down to the west relative to the Prospect Mountain block of the high part of the Schell Creek Range, although they do not seem to coincide exactly with mapped structures.

Anomalies F (fig. 4) are a set of three very weak, narrow, high-low anomaly pairs that pass through and extend due south from Mount Grafton. The southernmost pair directly overlies an east-dipping stratum of basalt, the likely cause of the anomalies, interlayered with the quartzite. This basalt flow is repeated locally as many as three times by faults, but only where it occurs near the crest of the range does it produce a discrete anomaly; at lower elevations the aeromagnetic-flight terrain clearance was as much as twice the nominal clearance of 1,000 ft, and the signature of any near-surface sources would have been diminished accordingly. No basalt has been mapped in the vicinity of the anomaly near the summit of Mount Grafton, which suggests that the source, whether intrusive or extrusive, lacks surface continuity.

Figure 4 (facing page). Total-intensity residual aeromagnetic map of the Mount Grafton Wilderness Study Area, Lincoln and White Pine Counties, Nev. Flown 1,000 ft above ground, January 1985; datum arbitrary. Contour interval 5 nanoteslas; hachured in area of closed magnetic low. H, anomaly high; L, anomaly low; A–J, anomalies referred to in text; heavy dashed lines are anomaly lineaments interpreted as faults. Light dashed lines show flight traverses. Generalized geologic units: Pz, Paleozoic rocks; Tsv, Tertiary sedimentary and volcanic rocks; Qs, Quaternary sedimentary rocks (geology from Tschanz and Pampeyan (1970), and Hose and others (1976)).

Another, and probably more significant, exception to the general association of low anomaly levels with Prospect Mountain quartzite is anomaly G, which occupies an area extending several miles north-south approximately along the crest of the range and which passes through the southern boundary of the wilderness study area. This feature occurs over outcrops of Pioche Formation and Pole Canyon Limestone as well as over Prospect Mountain Quartzite. It has no obvious source in the Paleozoic rocks, yet its gradients imply a depth to source no greater than about 500 ft below the surface. This anomaly is probably the signature of a hypabyssal intrusive body in the Paleozoic rocks. Because tactite deposits and anomalous metal concentrations are present in the vicinity of the anomaly, it may indicate an exploration target. Numerous prospect workings and the Schwartz tunnel attest to past interest in this part of the area.

Two additional anomalies (J, fig. 4) occur southeast of anomaly G in the vicinity of the Cinch mine. These anomalies have been detailed by ground surveys carried out on behalf of Union Carbide Co. (R. N. Grigsby, written commun., 1981). Exploratory drilling has delineated a sill-like body of quartz diorite, the probable source rock, in Paleozoic rocks about 200 ft below the surface. At greater depth the sources of anomalies J and G may be connected. An outcrop of crystal-rich ash-flow tuff in a wash midway between the two anomaly maxima was noted by geologists mapping in conjunction with the present study, and this rock, if sufficiently thick, could also produce anomalies such as J and G.

Anomalies J are roughly aligned east-northeasterly. Their northern margins, and the southern flank of anomaly G, are colinear with a gravity discontinuity that passes east-northeasterly from Cave Valley into the Schell Creek Range about 1 mi north of Patterson Pass (see discussion of gravity anomalies and figure 5). These and other subtle east-northeasterly magnetic trends, together with numerous mapped faults having similar strike, suggest the existence of a regionally pervasive fracture system that may have influenced the localization of northeast-trending, tungsten-bearing veins that were mined near the southern part of the wilderness study area and elsewhere.

Gravity Anomalies

The Bouguer gravity anomaly relief in the Mount Grafton Wilderness Study Area and vicinity (fig. 5) is markedly subdued relative to that of typical basin-and-range terrain in this part of Nevada, probably because much of the Schell Creek Range in the target area is composed of Prospect Mountain Quartzite. The mean density of the quartzite is probably somewhat less than the reduction density used (2.67 grams per cubic centimeter), whereas denser rock of the Paleozoic carbonate succession is absent from much of the range but occurs at shallow depth in the flanking valleys. Lows having amplitudes of 4–8 mGals (milligals) occur in upper Cave Valley, upper Steptoe Valley, Cave Valley west of Patterson Pass, and Lake Valley at about the latitude of the Lincoln County–White Pine County line (fig. 5). These lows reflect valley fill sandwiched between Paleozoic ridges, including those that are now largely concealed. In upper Cave and Steptoe Valleys, as we have seen, the Tertiary to Quaternary intermontane basin fill includes strongly magnetized rocks, which are probably volcanic. In addition, the sharp gradient only partly delineated in the southeast corner of the map area (fig. 5) marks the northwestern limit of thick alluvial deposits in Lake Valley, which produce a negative anomaly closure of approximately 30 mGals centered southeast of the study area. A shallow bedrock ridge is inferred to connect Paleozoic rocks of the Schell Creek and Fortification Ranges (fig. 1) across Lake Valley north of the Geyser maintenance station, and similarly a Paleozoic carbonate ridge extends from the Far South Egan Range across Cave Valley and up its east side well north of the latitude of Mount Grafton.

There is no evidence in the gravity data of the intrusive bodies inferred from aeromagnetic data in the Patterson Pass area. Closer station spacing and manual inner-zone terrain corrections would be required in order to obtain sufficiently high resolution of the Bouguer anomaly field for detection of targets with the expected density contrasts.

Mineral and Energy Resources

The geologic setting, the geochemical and geophysical surveys, and the examination of mines and prospects suggest that parts of the study area have low, moderate, and high potential for the occurrence of mineral resources.

A sequence of events that may have led to the formation of ore deposits in the area is briefly summarized as follows: (1) basin-and-range-style faulting and uplift, (2) intrusive activity concurrent with, or following, uplift, (3) formation of tactite in rock that hosted intrusion, (4) introduction of metals from plutons and (or) remobilization of metals from pre-existing metal-bearing rock (mineralization predating basin-and-range-style deformation), and (5) migration of hydrothermal metals to more remote sites by way of the fracture system that developed during uplift.

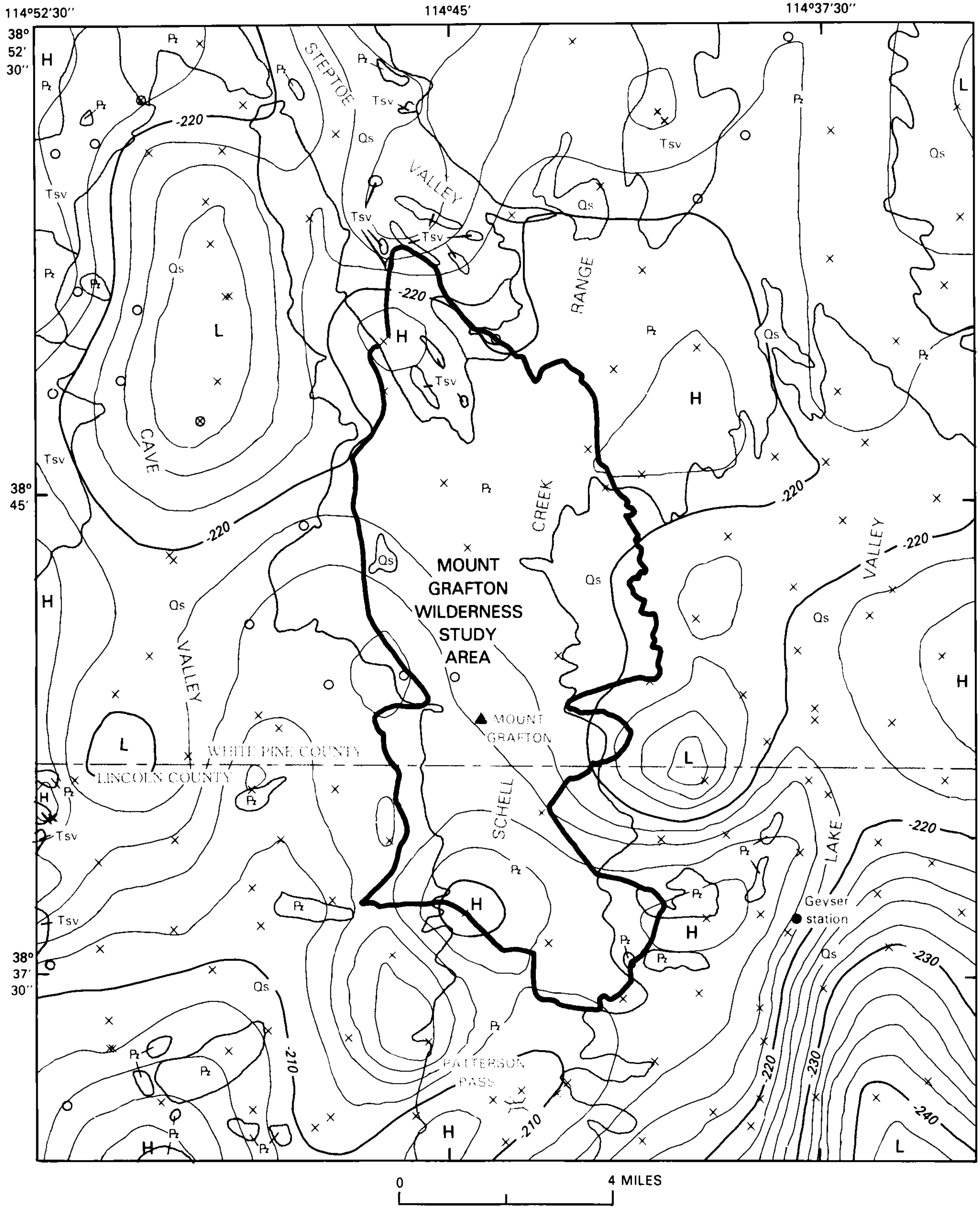
The ore-deposit types that exist or that may exist in the study area include (1) tactite (contact metasomatic deposits) containing tungsten, zinc, copper, and (2) hydrothermal veins (mesothermal and epithermal) containing tungsten, silver, gold, lead, zinc, copper, and fluorite.

Tactite (Contact Metasomatic Deposits)

Tactite deposits form when a favorable host rock reacts by replacement and recrystallization along its contact with an igneous intrusion. The most favorable host rocks are nearly pure nonclastic (carbonate) rocks that contain beds of clastic rocks. Intruding igneous bodies, which supply heat for the reaction and metals, are commonly the siliceous variety of granitoid rocks. Iron, copper, tungsten, zinc, lead, molybdenum, tin, and gold are common in tactite deposits. In addition to the above metals, the geochemical signature may show beryllium, bismuth, sulfur, and fluorine. Geophysical studies will usually identify and locate the igneous intrusion. The wall rocks show diminishing degrees of alteration with increasing distance from the tactite. Metals introduced by the intrusion are generally dispersed according to their mobility in a zonal arrangement radially away from the contact.

Conditions along the southern border of the study area (pl. 1) favor the occurrence of tungsten, zinc, and copper resources in a tactite deposit. This area is assigned a high mineral resource potential for that type of deposit, with a certainty level C, on the basis of the following criteria: (1) favorable host rock; (2) near-surface intrusion; (3) metals present in outcrop, in geochemical samples, and in mines and prospects. The host rock in this area is the Cambrian Pioche Formation; it is overlain by the

Figure 5 (facing page). Complete Bouguer gravity anomaly map of the Mount Grafton Wilderness Study Area, Lincoln and White Pine Counties, Nev. Contour interval 2 milligals; reduction density 2.67 grams per cubic centimeter. H, anomaly high; L, anomaly low. x, gravity stations from U.S. Defense Mapping Agency; o, gravity stations established in this study. Generalized geologic units: **Pz**, Paleozoic rocks; **Tsv**, Tertiary sedimentary and volcanic rocks; **Qs**, Quaternary sedimentary rocks (geology from Tschanz and Pampeyan (1970), and Hose and others (1976)).


114°52'30"
114°45'
114°37'30"
38° 52' 30"
38° 45'
38° 37' 30"
STEPTOE
VALLEY
CAVE
VALLEY
RANGE
CREEK
SCHELL
LAKE
VALLEY
MOUNT GRAFTON WILDERNESS STUDY AREA
MOUNT GRAFTON
WHITE PINE COUNTY
LINCOLN COUNTY
PATTERSON PASS
Geyser station
-220
-210
-230
-240
H
L
Qs
Tsv
Pz
0
4 MILES

Cambrian Pole Canyon Limestone. The upper part of the Pioche contains relatively pure limestone beds. Stratigraphically equivalent limestone beds in the Pioche mining district, some 60 mi south, host important deposits of lead, zinc, and silver. The ore horizon there, in the Combined Metals Member of the Pioche (Tschanz and Pampeyan, 1970), illustrates the ease with which limestone in this formation is replaced. For a further assessment of the Pioche Formation, channel samples were collected from two complete stratigraphic sections of the unit from both the east and west sides of the study area and analyzed for metals that might indicate mineralization, but no significant amounts were found.

A geochemical survey using heavy-mineral concentrates indicates tungsten, lead, zinc, antimony, molybdenum, bismuth, and tin in samples collected from the vicinity of the tactite body (mostly south of the study area). Selected mineralized rock samples from the prospects in this area typically contained from 200 to 500 ppm tungsten, 300 to 700 ppm copper, and 700 to 10,000 ppm zinc (Day and Barton, 1986).

Aeromagnetic anomalies delineated by geophysical studies (fig. 4) are interpreted to indicate the presence of a near-surface intrusive body centered below and about 0.5 mi east of the tactite body. Anomaly G (fig. 4), a relatively strong magnetic expression, is present in this area. This relatively shallow intrusive body undoubtedly formed the tactite deposits and probably supplied metals for them. Outcrops of igneous rocks were not found on the surface in the area defined by the magnetic anomaly; however, igneous dikes and sills have been reported to be there by Tschanz and Pampeyan (1970). Furthermore, the USBM reported finding igneous rock on two of the mine dumps (Chatman, 1986).

Intrusive activity has also affected the shale below the limestone within the Pioche Formation. The shale is strongly phyllitic, which indicates a higher grade thermal metamorphism than seen in the shale in other parts of the area.

Tactite deposits probably do not occur in any other part of the study area, for although carbonate rocks are widespread in the study area, none shows signs of having been affected by intrusive activity. The Prospect Mountain Quartzite is the country rock in contact with the igneous intrusive body as delineated by geophysical studies (see anomaly G, fig. 4) north of the tactite body in the study area. There are no carbonate rocks in the Prospect Mountain Quartzite.

Hydrothermal Vein Deposits

Hydrothermal vein deposits occur in a wide variety of geological environments. Conditions required for these deposits are hydrothermal metal-bearing fluids and a system of fractures through which the fluids travel. Deposition occurs under favorable conditions, which range from high temperature and pressure near magmatic sources to low temperature and pressure in near-surface conditions. Most metals can be carried in solution under certain specific conditions. Vein deposits can occur in any type of rock; however, the most favorable are brittle rocks that fracture readily and whose fractures remain open. Hydrothermal vein deposits commonly are spatially and genetically associated with magmatic activity. Regional geophysical signatures are not generally associated with vein deposits but may indicate a plutonic source that supplied metals and heat for the mineralizing fluids.

The geologic environment of the Mount Grafton Wilderness Study Area is structurally favorable for the occurrence of small veins and stockworks in the clastic and nonclastic Paleozoic rocks. The study area is tectonically active. Fracturing of the Paleozoic rocks—quartzite, shale, and carbonate—has been intense. Many of the north-south-trending faults, border faults included, are nearly contiguous the length of the study area. These faults are, in turn, connected by a network of crosscutting faults providing a fairly thorough system of interconnected fractures. It is conceivable then, if any metal-bearing fluids were available, they would be dispersed and the metals deposited within this mature fracture system.

Metal-bearing hydrothermal veins exist within and in proximity to the study area. Known occurrences were explored in mines and prospects. Studies based on the geology and mines and prospects of the area indicate that veins occur in both quartzite and carbonate host rocks.

The quartzite host is Lower Cambrian and Late Proterozoic(?) Prospect Mountain Quartzite; it crops out in the northwestern part and in the southern half of the study area (pl. 1). Mines and prospects on veins in the quartzite are characterized by one or more of the following metals: tungsten, silver, lead, zinc, and gold. The Lake Valley mine (Geyser mine) (no. 6, pl. 1), outside the study area along the eastern boundary, was probably the most important deposit of this type. There the vein follows a major north-trending fault that has dropped the terrane down on the west, placing the middle part of the Pioche Formation in juxtaposition with massive white quartzite of the Prospect Mountain Quartzite (Prospect Mountain Quartzite along the fault is too small to be shown on plate 1). This fault extends south into the study area; however, there are no indications of the quartz vein. Huebnerite- ($MnWO_4$) and fluorite-bearing quartz veins are present at this site. Silver and tungsten were mined. Exploration by drilling outside the study area in 1983 indicated silver in the fault near the Lake Valley mine (Chatman, 1986). The Deer Trail mine, about 2 mi north of the Lake Valley mine, explored and exploited a huebnerite-bearing quartz vein in fractures in the Prospect Mountain Quartzite. Identified tungsten resources (2,000 tons of 0.1 percent WO_3) are estimated for the Deer Trail mine (Chatman, 1986).

Detectable amounts of tungsten, lead, silver, gold, and antimony were found in heavy-mineral concentrates of stream-sediment samples (see pl. 1, sample localities 20–48). Intrusive activity may have supplied the metals to the deposit at the Lake Valley mine and to other deposits along fractures in this area. The source of magnetic anomaly G (fig. 4) approaches the surface near the southern study area boundary and may extend at depth as far north as the Lake Valley mine.

The area in the southeastern part of the study area (pl. 1) was assigned a moderate potential, with a certainty level of C, for the occurrence of tungsten, lead, zinc, silver, gold, and fluorite in veins and replacement deposits. This assessment is based on the presence of favorable structures, on finding traces of metals in all stream sediments draining the favorable area and in mines and prospects nearby, and on the presence of a nearby buried intrusive. The area of mineral potential to the north, which contains the Deer Trail mine (no. 3, pl. 1) and the North Creek Spring prospect (no. 15, pl. 1) was assigned a moderate mineral resource potential, with a certainty level of B, for tungsten and silver in vein deposits. This assessment is based on the occurrence of tungsten at the Deer Trail mine, on the presence of tungsten and silver in stream sediment derived from the area, and on the presence of faults that may host vein deposits.

Weakly mineralized veins containing traces of silver (5–7 ppm) and zinc (50 ppm) (Day and Barton, 1986) follow fractures in Cambrian limestone at the Marich claims, about 1 mi outside the study area, near Robbers Roost Spring. Several prospects test the veins, and the USBM has identified low-grade silver resources there (no. 1, pl. 1 and table 1). A major structure there continues south from the Marich claims for about 6 mi; part of it crosses the study area. Little evidence of mineralization was found along the fault within the study area, nor were stream sediments collected below the prospects enriched in metals. Rock samples collected from this area and analyzed by the USBM were reported to be weakly mineralized (see Chatman, 1986, for localities of samples 259, 264, and 293). Gold and silver were detected in a panned concentrate (sample locality 63, pl. 1) collected from a stream south of the Marich claims, just outside the study area. This stream crosses the major north-trending fault that contains silver-bearing veins identified by the USBM. Another sample (sample locality 60, pl. 1) collected farther southwest contains both gold and silver. Although there are no geophysical anomalies suggesting intrusive activity as a possible source of metals nearby, favorable structures and a few geochemical anomalies suggest the likelihood of mineral deposits in this area. On the basis of the criteria given above, this area is assigned a moderate mineral resource potential for gold and silver in veins, with a level of certainty of B (pl. 1).

Hydrothermal veins and related replacement (non-tactite) deposits hosted in carbonate rock are important silver and tungsten deposits in the Patterson mining district, which is south of the study area. Host rocks there are limestone of the Pioche Formation and the overlying Pole Canyon Limestone and younger dolostone of Silurian and Ordovician age. The study area contains only a small amount of limestone in the southern part; it crops out along the southern study area border adjacent to the Patterson district.

The Patterson district, the most productive district near the study area, contains silver, tungsten, lead, and zinc in veins and replacement deposits. Replacement deposits here are probably not due to contact metasomatism that formed the previously described tactite. Production in the Patterson district came from several small mines in the area south of the study area and continued to the southern edge of the area shown on plate 1. These deposits are localized along the east-trending Patterson Pass fault and other northerly trending faults that dissect the limestone as far north as the tactite body. This mineralized rock may be related to the intrusive that formed the tactite body. Lead and tungsten were found in most of the heavy-mineral concentrates collected from this area. Silver was not detected; however, some of the mines there were known for high-grade silver ore.

Core drilling was carried out to test a magnetic anomaly about 1 mi southeast of the study area. According to Grigsby (1981), dacite porphyry was encountered below the dolostone there. The porphyry was described as intrusive by Grigsby (1981); however, according to Tschanz and Pampeyan (1970), the igneous rock may have actually been extrusive rock that was structurally covered by older rocks along a low-angle fault. Tungsten occurs in this area (Cinch mine, locality 2 on pl. 1) in brecciated quartz-scheelite veins in dolostone. The mine is near the intersection of the Patterson Pass fault and either a north-trending high-angle fault or a low-angle fault. Geophysical studies suggest that the Patterson Pass fault extends easterly along the north side of anomaly J (see fig. 4), about 1 mi southeast of the study area.

Other vein and replacement deposits in carbonate host rock occur outside the study area boundary in Cave Valley. The Cave Valley and the Streator mines (Ag, Pb, Zn, W, and Cu) are in Cambrian limestone outliers in Cave Valley just west of the Cave Valley fault. These rocks are not known east of the Cave Valley fault in the western part of the study area. In the study area, rocks east of the Cave Valley fault are quartzite of the Prospect Mountain unit.

The likelihood of quartzite-hosted hydrothermal vein deposits (Au, Ag, Pb, Zn, and W) within the western part of the study area is low, with a certainty level of C. Little altered rock is associated with fractures, and a dearth of metals was found in the stream sediments from this area. About 2 mi southwest of the study area, an east-west fracture in the Prospect Mountain Quartzite is host to a vein that contains estimated resources of tungsten and silver (Eagle Rock mine; see no. 4 on pl. 1; also Chatman, 1986). Personnel of the Eagle Rock mine tested the vein but production is unknown. The fracture does not extend into the study area; it is terminated by a major north-south fault.

Carbonate rocks underlie a large part of the northern half of the study area. Approximately 12,000 ft of dolostone and limestone overlie the Pole Canyon Limestone. However, none contains anomalous amounts of metals or altered rocks suggestive of mineralization. There are no mines and prospects in this area.

Except for the areas of moderate and high mineral resource potential described above, the wilderness study area has a low mineral resource potential for all metals in tactite and vein deposits. This assignment is made with a certainty level of C (pl. 1).

Uranium and Thorium

The mineral resource potential for uranium and thorium in the study area is low. This assignment is made with a certainty level of C. Aerial gamma-ray surveys flown for the U.S. Department of Energy provide a partial geochemical representation of the near-surface concentration of potassium and equivalent concentrations of uranium and thorium. The Mount Grafton Wilderness Study Area has overall low radioactivity. Potassium ranged from 0–1.8 percent, equivalent uranium (eU) 0–2.5 ppm, and equivalent thorium (eTh) 2–10 ppm. There are no radiometric anomalies within the boundaries of the study area or in the immediate vicinity (Joe Duval, written commun., 1986).

Oil and Gas

A low energy resource potential for oil and gas was assigned with a certainty level of C. The geologic setting of the terrane in the study is well known, and it does not fit the current model for oil and gas accumulations in the Great Basin.

All known oil and gas fields in the Great Basin are located within Neogene–Quaternary basins that are adjacent to the ranges formed during the Neogene Basin and Range block-faulting episode (Poole and Claypool, 1984). Source rocks and structural traps in oil fields about 50 mi to the west in Railroad Valley, west of the Grant Range, are buried beneath several thousand feet of Quaternary valley fill.

The major source rocks for the generation of oil and gas in the Great Basin are Mississippian Chainman Shale and the much younger Sheep Pass Formation of Paleogene age (Poole and Claypool, 1984). Known reservoirs are in both Paleozoic and Tertiary rocks (McCaslin, 1984).

The geologic setting of the study area does not compare favorably to the present model used to define oil and gas accumulations in east-central Nevada. The study area consists only of an uplifted fault block between Cave and Lake Valleys; the valley fills may have possibilities for oil and gas. Little is known about occurrences in this region other than those within the valley fills. The possibilities here for oil and gas, using other models, for example accumulations within the uplifted fault block or from below along detachment structures, are not known. Accumulations in the study area seem unlikely in that the prolific system of high-angle faults present would not be effective in trapping oil and gas. Favorable low-angle faulting occurred along the northeast boundary; however, it is mostly outside the study area. Low-angle faults are more likely to form structural traps for oil and gas, whereas high-angle faults can provide channelways for migration of oil and gas but little means of trapping it. Oil seeps or oily stains on spring waters were not found in the study area. The southern part of the area in proximity to the shallow intrusive is unfavorable because heat supplied by the intrusion could have destroyed any hydrocarbons that might have accumulated nearby.

The Mount Grafton study area was assigned a medium potential for oil and gas by Sandberg (1983); however, this assignment was made for an area much larger than the present study area. The larger area included parts of Cave and Lake Valleys that may have possibilities for oil and gas within the valley fill. These areas in Cave and Lake Valleys are leased for oil and gas. The large leased block of land in Cave Valley includes a small fraction (about 130 acres) of the study area (see fig. 3).

Geothermal Resources

Geothermal resources are not currently known within the study area, in which there are currently no geothermal leases. Six warm springs are on the Geyser Ranch, east of the area boundary within 3.2 mi (fig. 1). Waters at the springs range from 65 °F to 75 °F and are used for irrigation purposes (Garside and Schilling, 1979, p. 45–46, pl. 1).

The warm springs are roughly aligned with the north-northeasterly geophysical trends in the Schell Creek Range at Patterson Pass and continuing into Cave Valley. This structure is outside the study area.

Temperatures of spring waters throughout the study area ranged from 42 °F to 56 °F and averaged approximately 45 °F. Due to the consistently low temperatures of the spring waters, no attempt was made to further evaluate the temperatures geochemically, such as testing to see whether any warm water is present but diluted by surface water.

On the basis of the available evidence, the Mount Grafton Wilderness Study Area is assigned a low potential for geothermal resources. This assignment is made with a certainty level of C.

Clay

High-grade clay was mined in the early days from a large cave in Cave Valley, about 1 mi west of the study area. A large, nearly horizontal cavern, formed in Pole Canyon Limestone, extends for some distance to the northeast toward the study area. The cave was nearly filled during the Paleocene with a reddish-brown clay. Analysis of the clay indicates its mineral content to be smectite, illite, and kaolinite (Paul Blackmon, written commun., 1985). Hematite in the clay imparts the reddish color. Clay has been removed from the first several hundred feet of the cave. The cavern lies west of, and is probably terminated by, the Cave Valley fault. It probably does not extend into the study area. Although carbonate units in the study area are cavernous in places, extensive dissolution and clay deposition has not occurred. The mineral resource potential for clay in the Mount Grafton study area is low. This assignment is made with a certainty level of B.

REFERENCES CITED

Chatman, M. L., 1986, Mineral resources of a part of the Mount Grafton Wilderness Study Area (NV–040–169), Lincoln and White Pine Counties, Nevada: U.S. Bureau of Mines Open File Report MLA 29–86, 77 p.

Cordell, Lindrith, Keller, G. R., and Hildenbrand, T. G., 1982, Complete Bouguer gravity anomaly map of the Rio Grande Rift, Colorado, New Mexico, and Texas: U.S. Geological Survey Geophysical Investigations Map GP–949, scale 1:1,000,000.

Day, G. W., and Barton, H. N., 1986, Geochemical data for the Mount Grafton Wilderness Study Area, Lincoln and White Pine Counties, Nevada: U.S. Geological Survey Open-File Report 86–463.

Garside, L. J., and Schilling, J. H., 1977, Wells drilled for oil and gas in Nevada through 1976: Nevada Bureau of Mines and Geology Map 56, scale 1:1,000,000.

———1979, Thermal waters of Nevada: Nevada Bureau of Mines and Geology Bulletin 91, 163 p.

Garside, L. J., Weimer, B. S., and Lutsey, I. A., 1977, Oil and gas developments in Nevada, 1968–1976: Nevada Bureau of Mines and Geology Report 29, 32 p.

Goudarzi, G. H., compiler, 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report 84–787, 42 p.

Great Basin GEM Joint Venture, 1983, Egan/Mount Grafton G–E–M resources area (GRA no. NV–14), technical report (WSA's NV 040–168, 040–169, and 040–172), contract YA–554–RFP2–1054: Great Basin GEM Joint Venture (Reno), 47 p.

Grigsby, R. N., 1981, Circus Project (Fred claims comments), Lincoln County, Nevada: Grand Junction, Colo., Union Carbide Corporation, unpub. internal report, 9 p.

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

Hill, J. M., 1916, Notes on some mining districts in eastern Nevada: U.S. Geological Survey Bulletin 648, 214 p.

Hose, R. K., Blake, M. C., Jr., and Smith, R. M., 1976, Geology and mineral resources of White Pine County, Nevada: Nevada Bureau of Mines and Geology Bulletin 85, p. 1–35.

Jones, R. B., and Papke, K. G., 1984, Active mines and oil fields in Nevada—1983: Nevada Bureau of Mines and Geology Map 84, scale 1:1,000,000.

Kellogg, H. E., 1963, Paleozoic stratigraphy of the southern Egan Range, Nevada: Geological Society of America Bulletin, v. 74, no. 6, p. 685–708.

———1964, Cenozoic stratigraphy and structure of the southern Egan Range, Nevada: Geological Society of America Bulletin, v. 75, no. 10, p. 949–968.

Ketner, K. B., 1976, Map showing high-purity quartzite in California, Nevada, Utah, Idaho, and Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF–821, scale 1:1,000,000.

Lincoln, F. C., 1923, Mining districts and mineral resources of Nevada: Reno, Nevada Newsletter Publishing Co., 295 p.

McCaslin, J. C., 1984, Oil exploration in Nevada: Oil and Gas Journal, v. 82, no. 28, p. 119–120.

Poole, F. G., and Claypool, G. E., 1984, Petroleum source-rock potential and crude-oil correlation in the Great Basin, *in* Woodward, Jane, Meissner, F. F., and Clayton, J. L., eds., Hydrocarbon source rocks of the greater Rocky Mountain region: Denver, Colo., Rocky Mountain Association of Geologists, p. 179–229.

Raymond, R. W., 1872, Statistics of mines and mining in the states and territories west of the Rocky Mountains, for the year 1870: Washington, D.C., U.S. Government Printing Office, 566 p.

Sandberg, C. A., 1983, Petroleum potential of wilderness lands, Nevada: U.S. Geological Survey Miscellaneous Investigations Map I–1542, scale 1:1,000,000.

Schrader, F. C., 1931, Notes on ore deposits at Cave Valley, Patterson district, Lincoln County, Nevada: University of Nevada Bulletin, v. 25, no. 3, June 1, 1931, Bulletin of Nevada State Bureau of Mines and Mackay School of Mines (Reno), 16 p.

Smith, F. T. A., 1926, Report on the Lake Valley mine of the Banner Exploration Co., Ely, Nevada: Banner Exploration Co. unpublished internal report, 6 p.

Smith, R. M., 1976, Mineral resources—Part 2, *in* Geology and mineral resources of White Pine County, Nevada: Nevada Bureau of Mines and Geology Bulletin 85, p. 36–105.

Tingley, J. V., and Bentz, J. L., 1982, A mineral inventory of the Egan resource area, Ely district, Nevada, contract #YA–553–CTO–78: Nevada Bureau of Mines and Geology (Reno) unpublished manuscript.

Tschanz, C. M., and Pampeyan, E. H., 1970, Geology and mineral resources of Lincoln County, Nevada: Nevada Bureau of Mines Bulletin 73, 188 p.

U.S. Geological Survey, 1985, Aeromagnetic map of Mount Grafton and vicinity, eastern Nevada: U.S. Geological Survey Open-File Report 85–736, scale 1:62,500.

Van Loenen, R. E., 1987, Geologic map of the Mount Grafton Wilderness Study Area, Lincoln and White Pine Counties, Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF–1938, scale 1:50,000.

White, A. F., 1871, Third biennial report of the state mineralogist of Nevada for the years 1869 and 1870: Carson City, Nev.

Williams, Albert, Jr., 1883, Mineral resources of the United States, 1882: Washington, D.C., U.S. Government Printing Office, 813 p.

Wood, R. H., II, 1985, Mineral resources of the Worthington Mountains study area (NV–040–242), Lincoln County, Nevada: U.S. Bureau of Mines Open File Report MLA 69–85, 47 p.

GEOLOGIC TIME CHART

Terms and boundary ages used by the U. S. Geological Survey, 1986

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.

Mineral Resources of Wilderness Study Areas— East-Central Nevada and Part of Adjacent Beaver and Iron Counties, Utah

This volume was published
as separate chapters A–F

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CONTENTS

[Letters designate the chapters]

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.

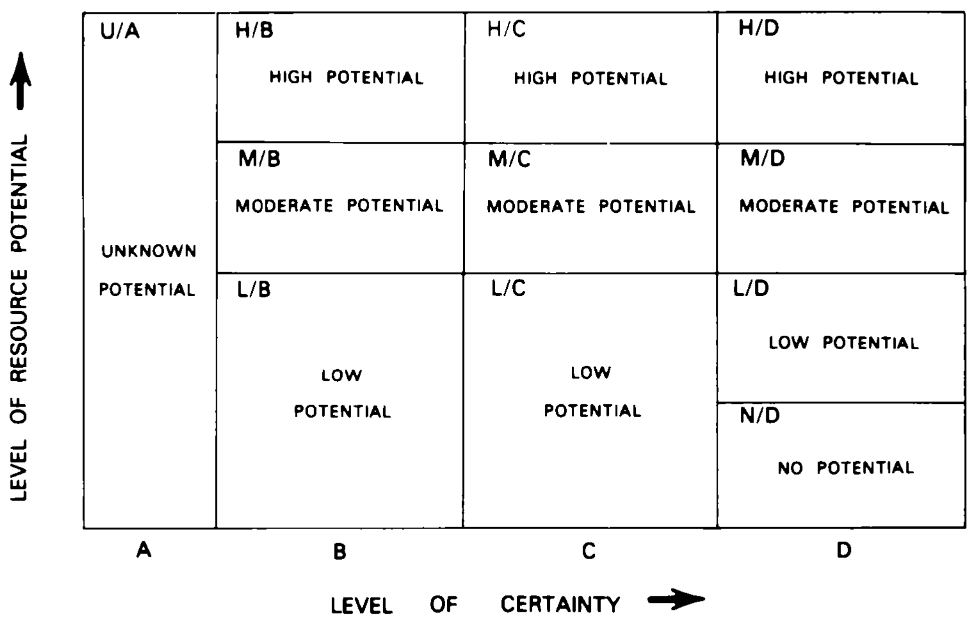
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application 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



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.

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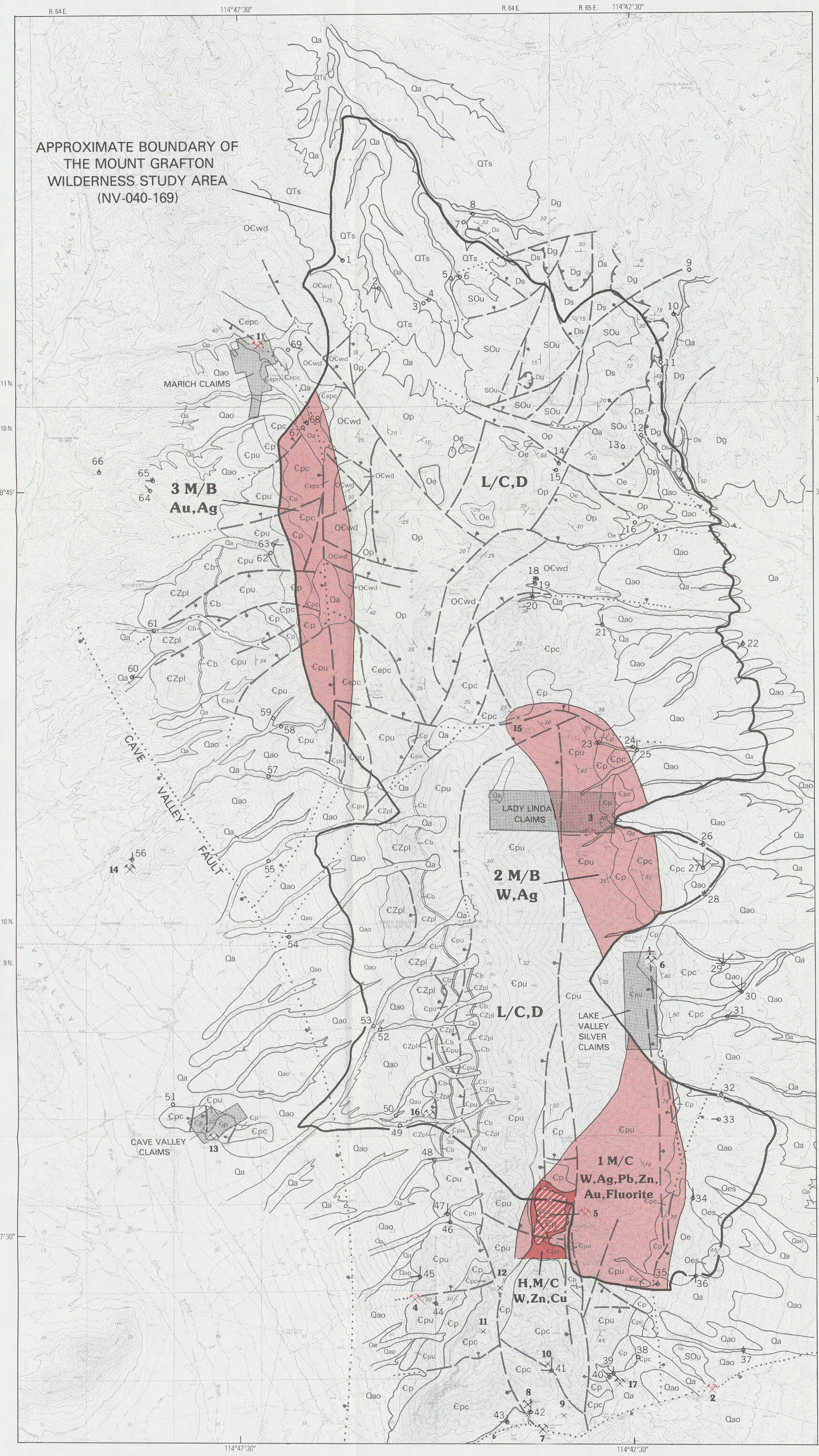
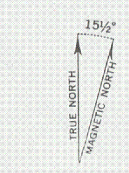


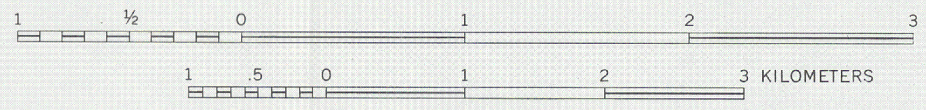
Base from U.S. Geological Survey, 1:24,000 Parker Station, Shingle Pass, 1969; Cattle Camp Spring, 1973; Bullwhack Summit, 1977; Milk Ranch Spring, Mount Grafton, 1978

Geology from Van Loenen (1987)



APPROXIMATE MEAN DECLINATION, 1978

SCALE 1:50 000



CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

EXPLANATION OF MINERAL RESOURCE POTENTIAL

Area of identified resources of zinc in low-grade deposits and geologic terrane having high resource potential for tungsten and copper in a tactite deposit, with certainty level C

Mine or prospect having identified resources—
1. Marich claims (silver)
2. Cinch mine (tungsten)
3. Deer Trail mine (tungsten)
4. Eagle Rock mine (tungsten, silver)
5. Workings at the head of Schwartz Canyon (zinc)

H, M/C Geologic terrane having high resource potential for tungsten, zinc, and copper in a tactite deposit, with certainty level C, and moderate resource potential for tungsten, lead, zinc, silver, gold, and fluorite in hydrothermal veins and replacement deposits, with certainty level C

1 M/C Geologic terrane having moderate resource potential for tungsten, lead, zinc, silver, gold, and fluorite in veins and replacement deposits, with certainty level C

2 M/B Geologic terrane having moderate resource potential for tungsten and silver in vein deposits, with certainty level B

3 M/B Geologic terrane having moderate resource potential for gold and silver in veins, with certainty level B

L/C, D Geologic terrane having low resource potential for (1) tungsten, lead, zinc, silver, and gold in tactite, hydrothermal vein, and replacement deposits (applies to all uncolored areas), and (2) uranium and thorium, oil and gas, and geothermal resources (applies to entire study area), with certainty level C; and for clay (applies to entire study area), with certainty level D

CORRELATION OF MAP UNITS

- Qa, Qao — QUATERNARY
- QTs — TERTIARY

UNCONFORMITY

- Dg — UPPER DEVONIAN
- Ds — MIDDLE DEVONIAN, LOWER DEVONIAN
- SOu, Oes — UPPER AND MIDDLE SILURIAN, UPPER ORDOVICIAN

UNCONFORMITY

- Oe — MIDDLE ORDOVICIAN
- Op — LOWER ORDOVICIAN
- O€wd — UPPER CAMBRIAN
- €epc, €pc — MIDDLE CAMBRIAN
- €p, €pu, €b — LOWER CAMBRIAN
- €Zpl — LOWER CAMBRIAN, LATE PROTEROZOIC(?)

DESCRIPTION OF MAP UNITS

Qa **Younger alluvial deposits (Quaternary)**—Stream deposits of clay, silt, sand, and gravel

Qao **Older alluvial deposits (Quaternary)**—Alluvial fans of silt, sand, and coarse gravels

QTs **Younger sedimentary rocks (Quaternary and Tertiary)**—Conglomerate, sandstone, and siltstone

Dg **Guilmette Limestone (Upper and Middle Devonian)**—Limestone and dolostone

Ds **Simonson Dolostone (Middle Devonian) and Sevy Dolostone (Middle and Lower Devonian), undivided**—Simonson is alternating brown and light-gray dolostone; Sevy is light-gray, aphanitic dolostone

SOu **Laketown Dolostone (Upper and Middle Silurian) and Ely Springs Dolostone (Upper Ordovician), undivided**—Laketown in upper part is medium-grained, light-gray, cherty dolostone; lower part is fine-grained brown dolostone. Ely Springs is medium-dark-brownish-gray, fossiliferous, fine-grained dolostone

Oes **Ely Springs Dolostone (Upper Ordovician)**

Oe **Eureka Quartzite (Middle Ordovician)**—Massive, fine- to medium-grained, white quartzite

Op **Pogonip Group (Middle and Lower Ordovician)**—Fossiliferous limestone; locally cherty

O€wd **Whipple Cave Formation (Lower Ordovician and Upper Cambrian) and Dunderberg Shale (Upper Cambrian), undivided**—Whipple Cave is massive limestone and dolostone, some chert. Dunderberg is limestone and shale

€epc **Emigrant Springs Limestone of Kellogg (1963) (Upper and Middle Cambrian) and Pole Canyon Limestone (Middle Cambrian), undivided**—Emigrant Springs is light-gray limestone, some siltstone and mudstone. Pole Canyon is mainly massive, medium-light-gray and dark-gray limestone

€pc **Pole Canyon Limestone (Middle Cambrian)**

€p **Pioche Formation (Lower Cambrian)**—Dark-greenish-gray argillaceous shale with minor amounts of quartzite and limestone

€pu **Upper part of Prospect Mountain Quartzite (Lower Cambrian)**—White to reddish-brown, fine- to medium-grained quartzite and minor dark-greenish-gray argillite

€b **Basalt flow (Lower Cambrian)**—Dark-greenish-gray, vesicular olivine basalt

€Zpl **Lower part of Prospect Mountain Quartzite (Lower Cambrian and Late Proterozoic?)**—Grayish-purple to reddish-brown, medium- to coarse-grained quartzite; minor amounts of conglomerate

Contact

High-angle fault—Bar and ball on downthrown side; dashed where approximate; dotted where concealed

Thrust—Sawteeth on upper plate

Strike and dip of inclined bedding

Mines and prospects not having identified resources—See list below; numbered workings are described in table 1

Large mine or prospect workings

Lesser mine or prospect workings

Area of mining claims

Geochemical sample locality (heavy-mineral concentrate)—Showing sample locality number and the amounts of selected elements determined to be present, if any. Each point on the eight-sided star represents a specific element, and the length of the point indicates the amount of that element that is present in the sample, in parts per million. A range of values is shown for each element rather than a specific amount.

W, Ag, Au, Zn, Bi, Mo, Pb, Sb

Element	Smallest star (ppm)	Second star (ppm)	Third star (ppm)	Largest star (ppm)
Tungsten (W)	100, 150, 200	300, 500, 700	1000, 1500, 3000	Greater than 3000
Silver (Ag)	1.5, 2, 3	5, 7, 10	15, 20, 30	50, 70, 100, 150, 200, 300
Gold (Au)	20	50	100	200
Zinc (Zn)	300, 500	700	1000	1500
Bismuth (Bi)	70, 100	150, 200, 300, 500	700-1000	1500-2000
Molybdenum (Mo)	15, 20	30, 50	70-100	150-200
Lead (Pb)	50, 70, 100	150, 200	300, 500	700-1000
Antimony (Sb)	200, 300, 500	700, 1000, 1500	2000	3000, 5000, 7000

Mines and prospects shown on plate 1

1. Marich claims
2. Cinch mine
3. Deer Trail mine
4. Eagle Rock mine
5. Workings at the head of Schwartz Canyon
6. Lake Valley (Geyser) mine
7. Unnamed workings at Patterson Pass
8. Unnamed workings at Patterson Pass
9. Unnamed Patterson district workings on a northwest-trending fault zone
10. Unnamed Patterson district workings on a northwest-trending fault zone
11. Unnamed Patterson district workings on a northwest-trending fault zone
12. Unnamed Patterson district workings on a northwest-trending fault zone
13. Cave Valley mine
14. Streator mine
15. North Creek Spring prospect
16. Lanter mine
17. Pip mine

LEVEL OF RESOURCE POTENTIAL ↑ / LEVEL OF CERTAINTY →

	A	B	C	D
High	U/A UNKNOWN POTENTIAL	H/B HIGH POTENTIAL	H/C HIGH POTENTIAL	H/D HIGH POTENTIAL
Moderate		M/B MODERATE POTENTIAL	M/C MODERATE POTENTIAL	M/D MODERATE POTENTIAL
Low		L/B LOW POTENTIAL	L/C LOW POTENTIAL	L/D LOW POTENTIAL
None				N/D NO POTENTIAL

LEVELS OF RESOURCE POTENTIAL

- **H** High mineral resource potential
- **M** Moderate mineral resource potential
- **L** Low mineral resource potential
- **U** Unknown mineral resource potential
- **N** No known mineral resource potential

LEVELS OF CERTAINTY

- **A** Available data not adequate
- **B** Data indicate geologic environment and suggest level of resource potential
- **C** Data indicate geologic environment, give good indication of level of resource potential, but do not establish activity of resource-forming processes
- **D** Data clearly define geologic environment and level of resource potential and indicate activity of resource-forming processes in all or part of the area

Diagram showing relationships between levels of mineral resource potential and levels of certainty. Shading shows levels that apply to this study area

MAP SHOWING MINERAL RESOURCE POTENTIAL, GEOLOGY, MINES AND CLAIMS, AND GEOCHEMICAL SAMPLE SITES, MOUNT GRAFTON WILDERNESS STUDY AREA AND VICINITY, LINCOLN AND WHITE PINE COUNTIES, NEVADA