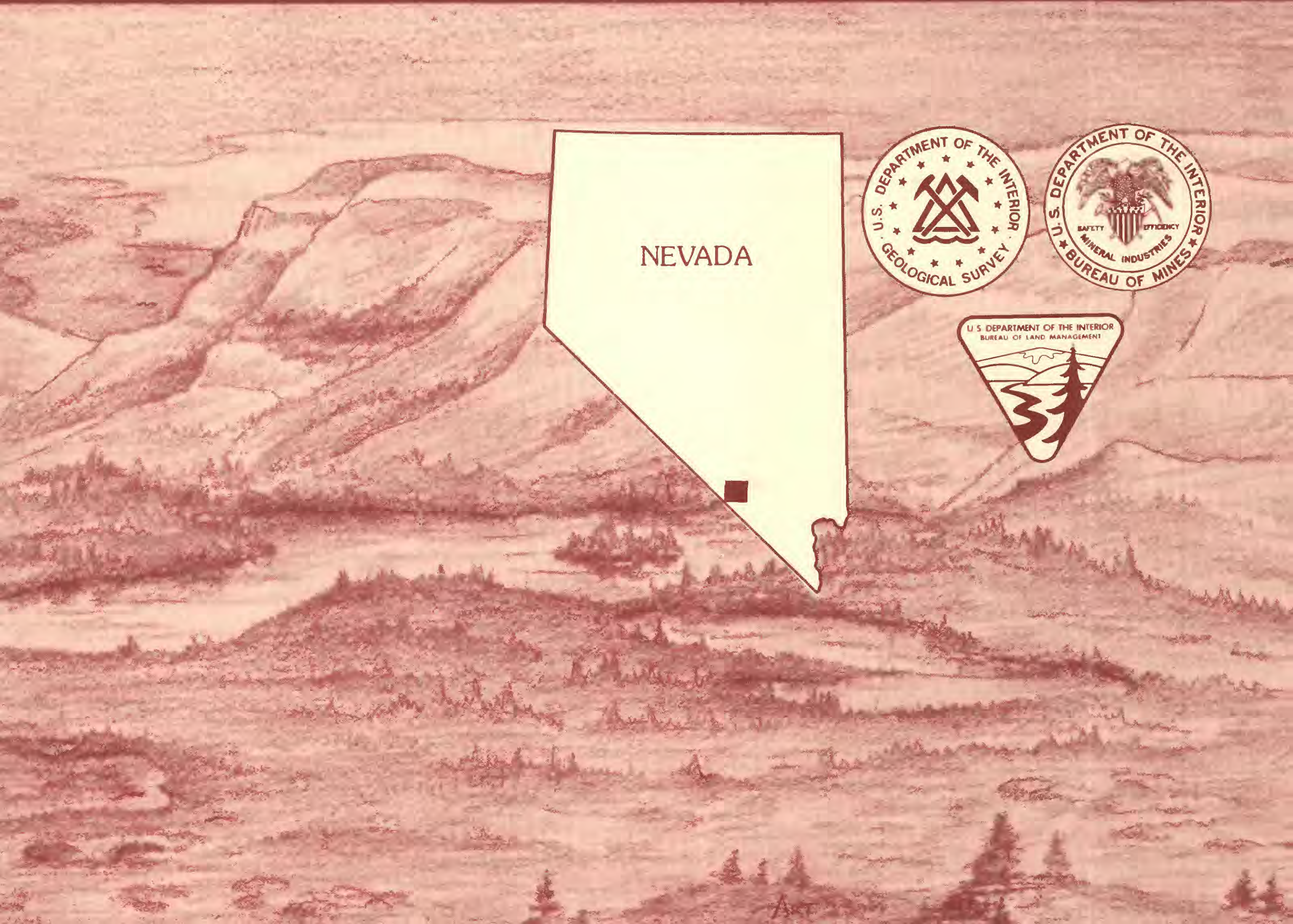
Mineral Resources of the Mt. Stirling Wilderness Study Area, Clark and Nye Counties, Nevada

U.S. GEOLOGICAL SURVEY BULLETIN 1730–B



Chapter B

Mineral Resources of the Mt. Stirling Wilderness Study Area, Clark and Nye Counties, Nevada

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U.S. GEOLOGICAL SURVEY BULLETIN 1730

MINERAL RESOURCES OF WILDERNESS STUDY AREAS: SOUTHERN NEVADA

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

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

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1987

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

Library of Congress Cataloging-in-Publication Data

Mineral resources of the Mt. Stirling Wilderness Study Area, Clark and Nye Counties, Nevada

U.S. Geological Survey Bulletin 1730–B
Bibliography
Supt. of Docs. No.: I 19.3:1730–B
1. Mines and mineral resources—Nevada—Mount Stirling Wilderness. 2. Geology—Nevada—Mount Stirling Wilderness. 3. Mount Stirling Wilderness (Nev.) I. Madrid, Raul J. II. Series.
QE75.B9 No. 1730–B 662 s 87–600018
[TN24.N3] [553'.09793'13]

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 part of the Mt. Stirling Wilderness Study Area (NV-050-401), Clark and Nye Counties, Nevada.

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Mineral Resources of the Mt. Stirling Wilderness Study Area Clark and Nye Counties, Nevada

By Raul J. Madrid, Robert Turner, David W. Brickey, *and* H. Richard Blank
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SUMMARY

Abstract

Mineral surveys were requested on 40,275 acres of the Mt. Stirling Wilderness Study Area (NV 050-401) located 50 mi northwest of Las Vegas and 8 mi south of Mercury, in the northern Spring Mountains of Nevada. Geologic, geochemical, geophysical, and mineral surveys of the wilderness study area conducted by the U.S. Geological Survey and the U.S. Bureau of Mines between 1983 and 1985 aided in evaluating the identified mineral resources and the mineral resource potential (undiscovered) of the area. Mines outside the study area that have produced gold, silver, and base metals are located along major faults and fracture systems that are present in the study area. An extensive and locally intense zone of alteration developed in siliclastic and minor carbonate rocks is associated with the Grapevine fault system on the western flank of the Spring Mountains and extends northward through the Johnnie mining district, one-half mile west of Grapevine Spring. Rock, stream, and soil samples from the zone of alteration associated with the Grapevine fault system are consistently anomalous in gold that is associated with arsenic, mercury, thallium, and antimony. Within the zone of alteration along this fault system the geologic setting and the assemblage of anomalous elements are similar to those at known sediment-hosted disseminated gold deposits elsewhere in Nevada. This zone of alteration has a high mineral resource potential for gold in this type of deposit. Another area of high mineral resource potential for gold occurs at Gold Spring (fig. 1) where anomalous amounts of gold are contained within shear zones in quartzite. An area of moderate resource potential for gold is present along part of the Wheeler Pass thrust where gold is associated with silicified limestone of the lower plate parallel to, and just below the thrust fault. One area that crosses the range north of Gold Spring has a low mineral resource potential for lead and zinc; another area along the crest of the range south of Mt. Stirling has a low mineral resource potential for manganese and zinc; both are associated with quartz-hematite vein systems in metamorphic rocks. A third area of low mineral resource potential for copper, lead, and zinc is present at Big Timber Spring where alteration is associated with the spring. An area south of Big Timber spring has an unknown mineral resource potential for gold along a poorly exposed normal fault system.

Character and Setting

The Mt. Stirling Wilderness Study Area encompasses 40,275 acres in the northern part of the Spring Mountains in southern Nevada (fig. 1). The northern Spring Mountains, have rugged terrain and high relief and are composed of Late Proterozoic to Permian (about 700 to 280 Ma; see appendix for geologic time chart) siliciclastic and carbonate sedimentary strata that were deposited on the Proterozoic and Paleozoic continental margin. These rocks were compressively folded and thrust faulted during the Mesozoic (about 240 to 66 Ma) and were subjected to high-angle normal faulting prior to and as part of extensional tectonism during the Tertiary (66 to 1.7 Ma). Quaternary alluvial deposits occur within the wilderness study area.

Major mineralized and altered zones postdate Mesozoic metamorphism and thrusting and are related to high-angle normal faulting of Tertiary and (or) Quaternary (about 2 Ma to present-day) age. Metamorphic quartz-hematite veins, however, are pre- or syn-thrusting, occur along fairly discrete zones, and trend at high angles to the later high-angle normal faults. Extensive and locally intense acid leach zones

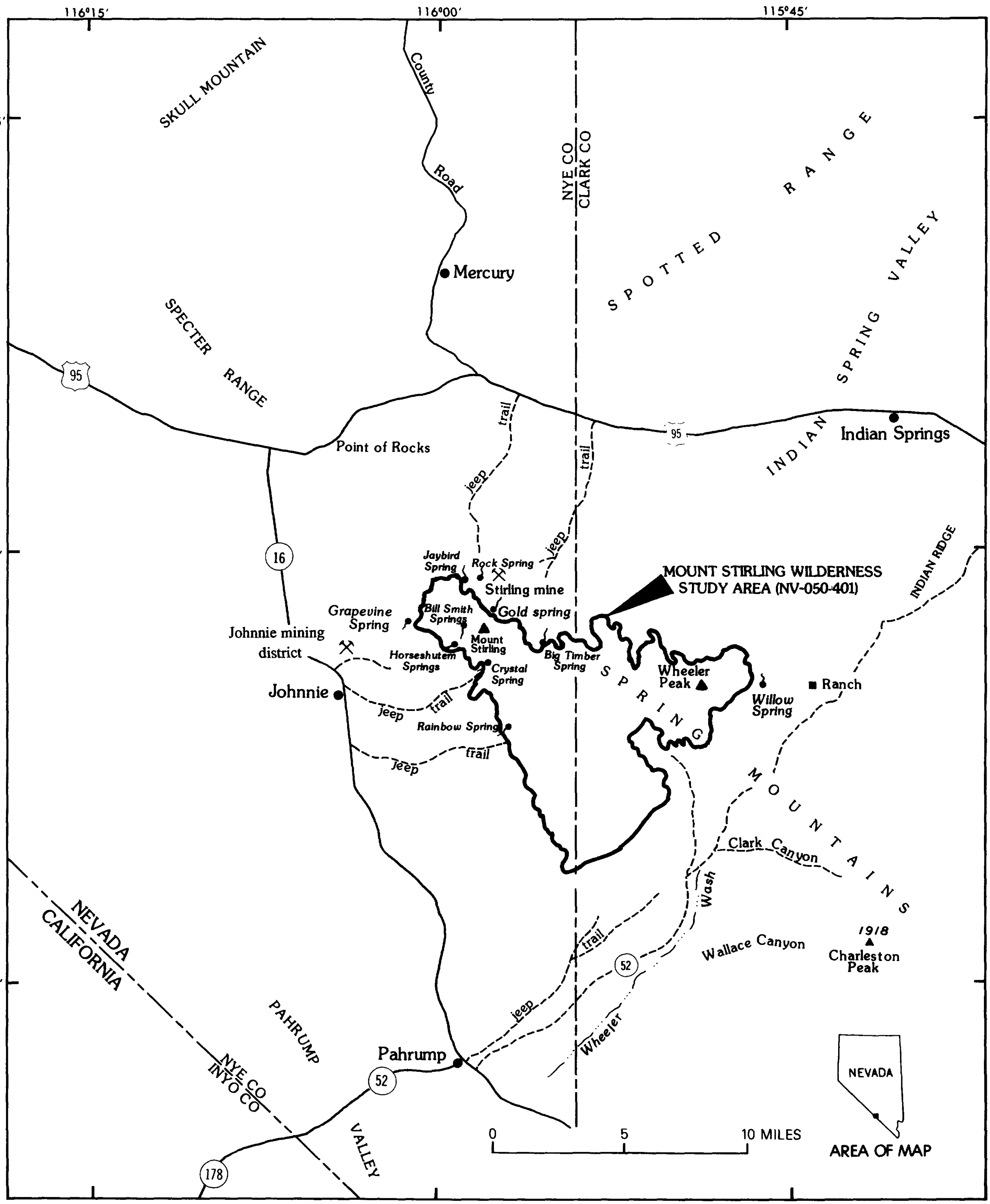

Figure 1. Index map showing location of the Mt. Stirling Wilderness Study Area, Clark and Nye Counties, Nevada.

are present parallel to the Grapevine fault system which bounds the southwestern flank of the northern Spring Mountains along the western boundary of the study area. The Grapevine fault, and associated acid leach zone, is also present in the Johnnie mining district (fig. 1).

Mineral Resources and Mineral Resource Potential

Mining and mineral exploration at the Stirling mine and in the Johnnie mining district (fig. 1) adjacent to the Mt. Stirling Wilderness Study Area occurred intermittently in the late 1800's and early 1900's and resulted in the production of 91,266 oz of gold. Small-scale production is underway in the Johnnie mining district. Fractures and quartz veins host the gold in these mines, and major workings follow the trend of these structures. Similar veins and related altered zones in the study area may represent the continuation of these veins. High resource potential for gold is assigned to the Grapevine fault system, along which are several prospects within an extensive altered area. Shear zones in an area south of the Stirling mine are also assigned a high resource potential for gold. Moderate resource potential for gold is assigned to the altered area along the Wheeler Pass thrust fault southwest of Willow Spring. Along the southwest extension of the Wheeler Pass thrust, outside the study area, the El Lobo prospect (table 1, fig. 2, No. 13) lies outside the altered area; the altered area contains no known prospects.

Two areas contain major mineralized metamorphic vein systems. One area north of Mt. Stirling is assigned a low resource potential for lead and zinc while the other is south of Mt. Stirling and assigned a low resource potential for manganese and zinc. At Big Timber Spring an altered area is assigned a low resource potential for copper, lead, and zinc.

An area south of Big Timber spring has an unknown mineral resource potential for gold along a poorly exposed normal fault system. No identified resources were found within the study area.

INTRODUCTION

Location and Physiography

The Mt. Stirling Wilderness Study Area (NV-050-401) contains 40,275 acres and encompasses the northern part of the Spring Mountains approximately 40 mi northwest of Las Vegas, Nev., in Clark and Nye Counties (fig. 1). It lies approximately 15 mi south of the town of Mercury. Access to the study area is provided by several unimproved roads leading into the northern and southern parts of the study area. Other areas, especially major springs (fig. 1), are accessible via rough jeep trails and livestock trails that traverse low-lying areas adjacent to the study area. There are few roads or trails within the study area, which includes relatively inaccessible mountainous terrain ranging in elevation from about 4,750 ft at the southwest corner to 9,168 ft at Wheeler Peak in the eastern part. Mt. Stirling (elevation 8,217 ft), in the northwestern part of the study area, is a prominent physiographic feature and the highest point of the western flank of the range. Vegetation includes sagecovered areas in the lower elevations with pinon and juniper woodland in higher elevations.

Methods and Sources of Data

The U.S. Bureau of Mines (USBM) studied prospects and mineralized areas within the study area and investigated the history of mining and production within and adjacent to the study area. Their study included a literature search, field examination of prospects and mines, and assaying of samples collected during their study. Mining claim information was obtained from the U.S. Bureau of Land Management, and production statistics were obtained from the USBM (Conyac, 1985).

The U.S. Geological Survey (USGS) compiled a 1:62,500-scale geologic map (pl. 1) based largely on previous mapping (Vincelette, 1964; Secor, 1962; and Hamil, 1966). Detailed mapping of altered and mineralized areas (not shown in this report) was conducted in order to assess the extent of their distribution and their association with rock type and (or) structures. Seventy rock samples and 75 stream sediment samples were analyzed so that assessments of chemical variations reflecting concentrations of ore-related elements and the distribution of ore-related minerals could be determined for the study area. The USGS also used digitally processed data from the Landsat Thematic Mapper (TM) augmented by field checks to assess the occurrence of hydrothermally altered rocks. Observations in the mineralized areas, geochemical data, and analyses of samples collected from prospects and mines provided by the USBM were used to assess the potential for undiscovered mineral resources in the study area.

The mineral resource potential classification system of Goudarzi (1984) is used throughout this report. Also see appendix, this report.

Previous Work

The earliest geological work in the Spring Mountains was by G.K. Gilbert, who served as a geologic assistant for the Wheeler expeditions of 1871-1872. In 1919, C.R. Longwell began mapping in southeastern Nevada and his work, along with others, led to the first regional maps of southeastern Nevada and of the Spring Mountains (Longwell and others, 1965; Burchfiel and others, 1974, p. 1013). The earliest geological work specifically in the study area was done by T.B. Nolan (1924). Previously, only small parts of

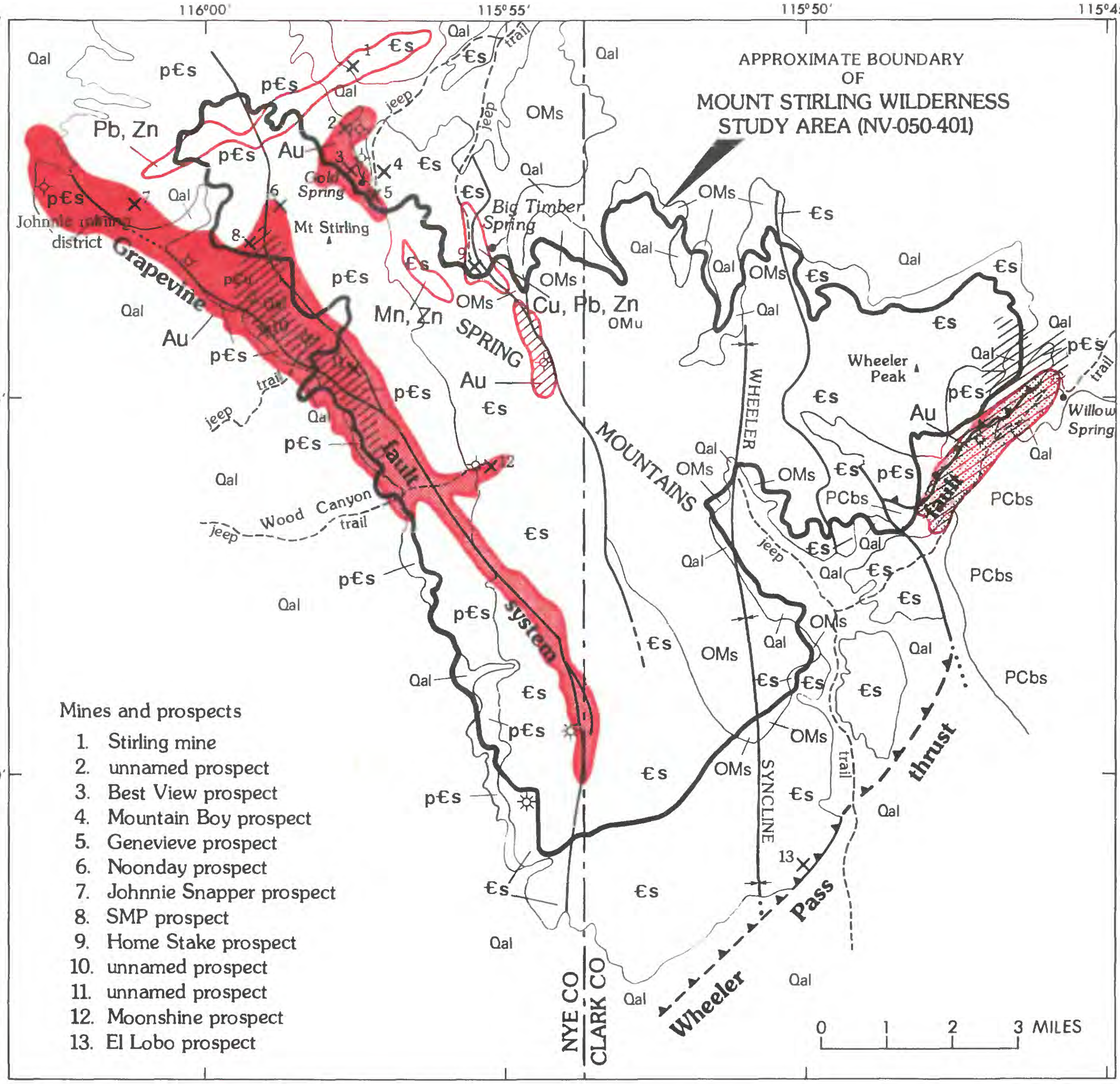

Figure 2. Map showing mineral resource potential and generalized geology of the Mt. Stirling Wilderness Study Area, Clark and Nye Counties, Nevada.

the area had been included in regional reconnaissance reports (Spurr 1903; Ball, 1906). Reports on nearby mines and mining districts were published by Higgins (1909), Gregory (1910), Heikes (1916), Hale (1918), Labbe (1921), and Kral (1951). In recent years the general geology of the region has been described by Secor (1962), Stewart (1970, 1974), Cameron (1977), Carr (1977, 1979, 1983), Burchfiel and others (1981), and Burchfiel (1982). Mineral deposits near the area were described by Bonham (1967), Garside (1973), Johnson (1973), Ivosevic (1976, 1978), Garside and Schilling (1979), Longwell and others (1965), and Cornwall (1972). A preliminary mineral resource assessment for the study area was reported by Great Basin GEM Joint Venture (1983) The most recent work covering the entire Mt. Stirling Wilderness Study Area was a structural geology study of the Mt. Stirling quadrangle (Vincelette, 1964).

Acknowledgments

Personnel of the U.S. Bureau of Land Management in Las Vegas kindly provided current information on the land status in the study area. David Lipton provided field assistance to Martin Conyac of the U.S. Bureau of Mines.

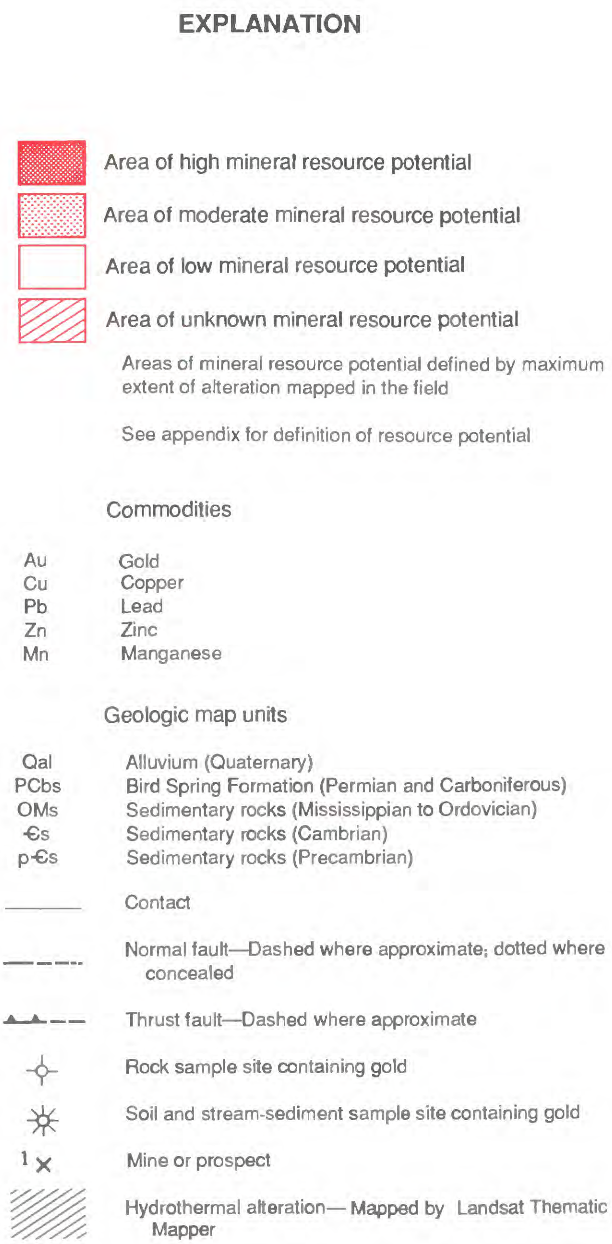

Figure 2. Continued.

APPRAISAL OF IDENTIFIED RESOURCES

By Martin Conyac, *U.S. Bureau of Mines*

History and Production

A library search and examination of courthouse records of Clark and Nye Counties, Nev., was conducted to identify and locate mines and prospects within and adjacent to the study area. The USBM notified claim owners of the study and requested permission to examine their claims. USBM files were checked for additional information on known mines and prospects, and regional offices of the Bureau of Land Management (BLM) were consulted to determine if any current claims or mineral and fuel leases were in the study area.

Field work was conducted in May and June 1984. Work consisted of searching for mines, prospects, and claims that library and courthouse research indicated were either in or near the study area. All mineralized outcrops and workings were sampled and mapped.

The USBM collected 73 mineralized rock samples that were analyzed for gold and silver by fire-assay methods. When indicated, quantitative values of other elements were measured by atomic absorption analysis, colorimetry, fluorimetry, cold-vapor atomic absorption, or inductively coupled argon spectrometry. At least one sample from each mineralized feature was checked by semiquantitative emission spectroscopy for content of 40 elements (Conyac, 1985).

In the late 1800's and early 1900's, more than 100 claims were located outside the boundary of the study area immediately to the northwest. The earliest claim (Mountain Boy, fig. 2) was located about 0.5 mile northeast of Gold Spring in September 1887.

In November 1983, current claims adjacent to the study area consisted of five small groups, totaling 26 claims. Two groups (containing 11 claims) are on the study area boundary. The nearest active mine is the Overfield mine in the Johnnie mining district, where gold-bearing quartz veins are intermittently mined (figs. 1 and 2). Oil and gas leases nearly surround the area and six extend as far as 1 mi into the study area.

There has been no mineral production from the study area. The site of the Stirling mine, about 1 mi from the northwest boundary, was worked for gold prior to 1892 by local Indians and later by ranchers residing at Indian Springs (fig. 1). During the same period, gold was discovered in the Johnnie mining district (Nolan, 1924, p. 105; Ivosevic, 1976, p. 73).

The Johnnie, Congress, Overfield, and other mines in the Johnnie district may have produced as much as 91,266 oz gold valued at $1,966,049 (Ivosevic, 1976, p.76) from quartz veins. Most of the gold production was prior to 1915, although small amounts were produced during the 1920's (Ivosevic, 1976, p. 73-74). As much as 48,500 oz gold are estimated to have been produced by the Johnnie mine alone to 1913 (Ivosevic, 1976, p. 76). Also 3,645 oz of silver and 6,017 lb of lead were reportedly produced between 1908 and 1932, probably from galena-calcite veins in the Johnnie Formation (Ivosevic, 1976, p. 75).

In the late 1920's, the Charleston mining district, about 10 mi southeast of the study area, produced oxidized lead-zinc ore valued at $5,000 from replacement deposits in dolomite. Eleven oz of silver and 18,300 lb of lead valued at $2,574 were produced in 1953 and 1954 (Longwell and others, 1965).

Mineral Deposits and Identified Resources

Sites examined for this study are shown on figure 2 and in table 1. Four of the 13 properties examined are located inside the study area (fig. 2, Nos. 6, 8, 11, 12). No mineral resources were identified at these prospects; however, the geologic settings may be significant. Copper-silver occurrences similar to those associated with deposits in the Johnnie mining district and elsewhere in the region are at the Noonday, SMP, and Moonshine prospects (fig. 2, Nos. 6, 8, and 12). The host formation at these prospects, the Stirling Quartzite, is extensive throughout the west side of the study area.

Quartz veins in the Wood Canyon Formation at the Stirling mine (fig. 2, No. 1) and mines of the Johnnie mining district locally have high gold concentrations; veins at prospects in and near the study area contain traces of gold (fig. 2). The Wood Canyon Formation is extensively exposed throughout the study area and is considered a favorable exploration target (Ivosevic, 1978, p. 104).

Sand, gravel, and limestone suitable for construction materials are abundant in the study area. However, transportation cost is a major factor in producing these high-bulk/low unit-value commodities, and similar materials are available closer to major markets. Therefore, occurrences in the study area are not classified as resources.

Recommendations for Further Work

Further detailed mapping and sampling of rock, soil, and stream sediments is warranted to evaluate copper and silver occurrences in the vicinity of the Noonday, SMP, and Moonshine prospects. Test drilling would be required to confirm any anomalies. This exploration program should be designed to include evaluation of gold-bearing quartz veins and disseminated gold occurrences near prospects along the west edge of the study area in the Late Proterozoic and Lower Cambrian formations. Targets of highest interest are the intersections of faults with these formations.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

By Raul J. Madrid, Robert Turner, David W. Brickey, *and* H. Richard Blank, *U.S. Geological Survey*

Geology

Geologic Setting

The Mt. Stirling Wilderness Study Area is comprised predominantly of Late Proterozoic and Lower Cambrian siliciclastic strata and minor limestone deposited on the continental shelf and overlain by Upper Cambrian to Permian carbonate strata. Most of the altered and mineralized areas occur in the Proterozoic and Cambrian siliciclastic units. The northern Spring Mountains contain a complexly faulted, easterly dipping homoclinal section of these Proterozoic and Paleozoic rocks, which is folded into the broad Wheeler syncline in the southern and eastern parts of the study area. The siliciclastic rocks are exposed predominantly on the southwestern side of the range and the carbonate section is exposed on the northeastern flank in the core of the Wheeler syncline. These rocks extend southward into the southern Spring Mountains where they are overlain by Mesozoic terrigenous rocks.

The Late Proterozoic rocks consist of the Johnnie Formation and the overlying Stirling Quartzite. The Johnnie Formation is predominantly shale, siltstone, and sandstone. Siltstone makes up the basal part of the section and grades upward into coarse sandstone. Sporadic thin beds of slightly dolomitic sandstone and thin dolomite beds occur in the middle and upper parts of the formation. Dolomite forms several oolitic marker beds toward the top of the formation. The Johnnie Formation contains abundant mesoscopic folds and thrust faults and a number of internal map-scale folds. The section is therefore tectonically thickened. Despite this, the estimated undeformed thickness is 3,000 to 4,500 ft in the study area and is in agreement with other estimates for the thickness of the Johnnie (Nolan, 1924; Hamil, 1966; Stewart, 1970) in nearby areas.

The Late Proterozoic Stirling Quartzite is a sequence of quartzite and minor shale, dolomite, and siltstone. It usually crops out in large bluffs to low ledges and forms prominent razorbacks on most ridges. Many quartzite beds are characteristically pink due to the presences of a hematitic matrix. The grain size in the quartzite generally ranges from granule to fine sand with a mode of coarse sand. The quartzite consists of quartz and minor detrital muscovite, microcline, plagioclase, and rare hornblende. Preferred metamorphic fabrics are present in the quartzites and are displayed by the formation of aligned metamorphic mica and minor chlorite and quartz within the matrix of these rocks. These minerals reflect a low greenschist grade of metamorphism.

Cambrian rocks in the study area consist of shale, siltstone, and quartzite with limestone and dolomite increasing up section and include the Wood Canyon Formation of Burchfiel and others (1974) and the overlying Carrara Formation, which are overlain with slight angular unconformity by the Bonanza King Formation. The Wood Canyon and Carrara Formations consist of shales, siltstones, and dolomites in their lower parts, grade upward to dolomitic siltstones, and are capped in their upper parts by dolomitic sandstones and dolomite. The Carrara Formation is a Lower and Middle Cambrian transitional sequence between the more siliclastic Wood Canyon Formation and the overlying massive limestones of the Bonanza King Formation. This latter formation constitutes the basal part of the thick carbonate section that was deposited in this area throughout most of Paleozoic time. Capping the Paleozoic carbonate sequence is the Carboniferous and Permian Bird Spring Formation. In the study area this formation is overthrust by the Wheeler Pass thrust nappe.

Tertiary rocks are not exposed within or adjacent to the study area. Quaternary alluvial fans on the east and west flanks of the range are composed of clasts of rocks eroded from the Precambrian and Paleozoic formations exposed in the higher parts of the range.

Metamorphism

The Late Proterozoic and Lower Cambrian rocks of the study area are metamorphosed to the greenschist facies displayed in thin section by the development of a planar fabric of chlorite+quartz and minor albite. This metamorphism is best expressed in the Johnnie, Carrara, and Wood Canyon Formations where slaty and phyllitic cleavage are developed parallel or subparallel to the bedding within these rocks. The slaty cleavage cuts premetamorphic or synmetamorphic veins that consist of quartz ± hematite, talc, minor barite, and manganiferous minerals. Thus, premetamorphic or synmetamorphic mineralization and alteration are associated with these veins. The metamorphism is not well expressed in the younger Paleozoic rocks of the study area and is seen as locally developed stylolitic cleavage in the predominantly carbonate section. The metamorphic fabric and accompanying mineral assemblages were used during this study to delineate postmetamorphic altered and mineralized zones within these units. The degradation of the metamorphic minerals was enhanced by hydrothermal fluids, resulting in alteration that cuts preexisting premetamorphic or synmetamorphic veins and alteration.

Structural Geology

The rocks within the study area constitute the highest of three thrust nappes present in the Spring Mountains and are floored by the Wheeler Pass thrust. This thrust nappe system was emplaced from west to east over the Carboniferous and Permian Bird Spring Formation along the Wheeler Pass thrust (Burchfiel and others, 1974) near the south boundary of the study area (pl. 1). A map-scale fold affecting the entire Wheeler Pass thrust nappe, is represented by the Wheeler syncline (pl. 1), which developed prior to or synkinematically with the Wheeler Pass thrust. Mesoscopic folding, secondary cleavage, and two dominant sets of through-going vein and fracture systems in the Proterozoic and Paleozoic strata developed prior to the emplacement of the thrust sheets. One of the vein systems is folded by mesoscopic or outcrop-scale folds into approximate parallelism to the bedding of most of the units. The second is a late metamorphic quartz-hematite vein system that cuts across all previous metamorphic fabrics and extends from the Stirling mine west to about 0.6 mi east of the Johnnie mining distict. All structures older than and including the Wheeler Pass thrust fault are cut by high-angle normal faults; an older set trends north to northeast and a younger set related to basin and range formation trends northwest. The northwest-trending faults that flank the range created the high mountainous relief of the Spring Mountains.

This study indicates that the high-angle Grapevine fault on the west flank of the Spring Mountains has vertically displaced the Wheeler Pass thrust nappe 800 ft in the south to 1.6 mi in the north, within the study area, and has an estimated maximum vertical displacement of 2.2 mi outside the study area (Burchfiel and others, 1983). This fault is the major conduit for hydrothermal solutions that have altered a large area along the west flank of the range. Other faults, generally parallel to the Grapevine fault system, have less intense but persistent alteration spatially associated with them. The Spring Mountains block is the footwall of the Grapevine fault, and only small parts of the hanging wall are preserved in the vicinity of Rainbow Spring and Wood Canyon (pl. 1).

Alteration and Mineralization Mapping

Detailed mapping was undertaken in order to place practical limits on the sizes of areas affected by alteration and mineralization and to provide a better basis for delineating areas from which anomalous geochemical values were obtained. The extent of these altered areas served as the basis for delineation of tracts with resource potential (fig. 2; pl. 1).

Within altered zones associated with the Grapevine fault system some exposures were mapped in detail. It was found that the intensity of the alteration is directly correlated with the degree of degradation of the metamorphic minerals in these rocks, and usually is most intense adjacent to the faults. As examples, chlorite becomes progressively more bleached and, 30 to 100 ft from the fault, it and muscovite are totally altered to clays; feldspar becomes cloudy and also is completely altered to clays close to faults.

In places within the altered zones, where thin beds of calcareous rocks of the Johnnie Formation are present, the development of jasperoid characterizes the alteration. Associated with the jasperoid are calcite veins and veinlets that contain minor jasperoid fragments and exotic mixtures of rock fragments (with respect to the rock in which they are found). These calcite-jasperoid-breccia veins (following terminology of Madrid and Bagby, 1986) cut the jasperoids but are cut by later coarsely crystalline calcite veins and veinlets that sporadically contain small jasperoid fragments. These vein relations are best exposed closest to minor normal faults within the altered areas delineated during this study.

Similar alteration and vein relations are commonly associated with sediment-hosted gold deposits (Madrid and Bagby, 1986), which are also developed along major high-angle normal fault systems. The alteration of metamorphic minerals and the jasperoid development and vein relations like those seen in the study area were described in detail for the Preble disseminated gold deposit in north-central Nevada (Madrid and Bagby, 1986). The study area has less abundant reactive calcareous rocks in the Johnnie Formation and Stirling Quartzite compared to units associated with gold deposits in north-central Nevada. In the absence of reactive calcareous rocks, which commonly are replaced by jasperoid, siliciclastic rocks, such as those of the Johnnie Formation, Stirling Quartzite, and Wood Canyon Formation, are also commonly replaced by silica. This silicification in disseminated gold deposits in north-central Nevada and in altered zones of the study area is more cryptic and most commonly expressed by well-developed, very fine, drusy, quartz-lined fractures that cut the rock. At Rainbow Spring (fig. 1; pl. 1), thick quartzites of the Johnnie Formation are partly to throughly silicified and, in part, brecciated and resilicified. In all silicified zones where high concentrations of relict sulfide minerals occur, they are accompanied by pockets of intense leaching and by goethitic alteration of the sulfide minerals. It was not conclusively determined in this study, whether the sulfides minerals were deposited from hydrothermal solutions or whether they were preexisting metamorphic segregations. The percentage of the rock containing metamorphic segregation sulfide minerals in unaltered ground is minor. Therefore, the sulfide minerals observed at Rainbow Spring are probably hydrothermal in origin.

The most intense alteration occurred within 400 to 800 ft of the Grapevine and associated faults, but alteration effects are seen as far as 2,500 ft from the Grapevine fault. Although most of the length of the Grapevine fault zone appears to have been hydrothermally altered, alteration was most intense in an area 4 mi long between Horseshutem Spring and Wood Canyon (pl. 1).

The area at Big Timber Spring, on the northeast flank of the range, is still being altered by waters from the spring. There, rocks, soils and talus, in a zone 75 ft across, have been intensely altered to clay. Additional altered ground may be buried by slope wash and talus. Rock Spring, north of the study area (fig. 1), is similarly associated with alteration.

Small bodies of jasperoid and partly silicified limestone of the Bird Spring Formation are found within the Wheeler Pass thrust zone, southeast of the study area. Minor goethite alteration of sulfide minerals imparts a reddish-brown stained appearance to the rocks. The altered zone is discontinuous and pod like, and is exposed in a 30-ft by 1-mi area along the trace of the thrust. It may however, be as wide as 2,500 ft based on the areal extent of altered rock fragments present in alluvium, soil, talus, and slope wash material.

On the ridge south of Rock Spring, a discontinuous set of quartz-specular hematite veins resemble those found at the Stirling mine and the Johnnie mining district. These veins cut the Stirling Quartzite, Wood Canyon, and Carrara Formations. Vein width does not exceed more than 4 in. at the surface. The zone in which they occur is 60 ft wide in one place on the surface but may be as wide as 600 ft elsewhere within the zone. Normal faulting has offset the veins in many places at the north end of the range.

One additional vein system cuts the Wood Canyon and Carrara Formations on the ridge top west of Big Timber Spring (fig. 1). These veins are clearly synmetamorphic or premetamorphic because they are folded and are cut by phyllitic, axial-plane cleavage. Some veins have clay-altered selvages that now are muscovite phyllite indicating that the alteration developed prior to metamorphism. The veins consist of quartz, talc, and clots of massive manganese oxide minerals. The veins are generally less than 4 in. thick, discontinuous, folded, and occur in a narrow zone, about 200 ft wide. The vein density is low, perhaps 1/yd^2.

Geochemistry

Methods

The USGS collected 67 stream-sediment samples and 18 rock samples in the spring of 1984, at a density of 1 sample/mi^2 to characterize the regional geochemistry. The sites selected for stream-sediment sampling are along the range front at elevations high enough in the mountains to assure that the samples would not be diluted with valley fill. The individual drainage basins represented by samples cover approximately 0.5 to several mi^2. For large drainage basins, tributaries of the main stream were sampled to make the density represented by the sample site close to 1 sample/mi^2.

The heavy-mineral-concentrate samples were collected from the active alluvium in the stream channels. The nonmagnetic fraction of each sample that contains the nonmagnetic ore-related minerals, zircon and sphene, was analyzed for 31 elements using a six-step semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). The precision of the analytical technique is approximately plus or minus one reporting interval at the 83 percent confidence level (Motooka and Grimes, 1976). The rock samples were also analyzed for arsenic, bismuth, antimony, and zinc using a modified analytical technique by Viets (1978).

An additional 52 rock samples and 8 stream-sediment and soil samples were collected to characterize the major altered areas mapped during this study and were analyzed to low detection limits for gold (0.05 parts per million, ppm), mercury (0.02 ppm), arsenic (2 ppm), antimony (2 ppm), and thallium (0.05 ppm); these elements are commonly associated with sediment-hosted gold deposits. In these deposits, the overall range in concentration for these elements is commonly wide, but most concentrations are low: below 100 ppm for arsenic, the low 10's of ppm for elements like silver, antimony, and thallium, and commonly in the parts per billion (ppb) range for gold and mercury.

Reconnaissance Geochemical Survey

Anomalous concentrations of elements from heavy-mineral concentrates occur in three areas: along the southwest flank of the Spring Mountains, along the northeastern trend of the Wheeler Pass thrust fault, and in the north-central to northeastern part of the study area.

The area along the southwest flank of the Spring Mountains is characterized by anomalous amounts of barium, scandium, yttrium, lead, and zinc with one anomalous copper site and two sites with anomalous tin. Along the southwest flank of the Spring Mountains, the drainage basins are in the Johnnie Formation, Stirling Quartzite, Wood Canyon, and Carrara Formations that are cut by the Grapevine fault system. There are numerous north-northwest- trending faults in this area, and many of the sample sites that have anomalous values for various elements are along some of these faults.

The anomalous zone delineated by the Wheeler Pass thrust fault is characterized by the elements barium, lead, yttrium, and scandium. The sites with anomalous values are spatially associated with the Late Proterozoic and Cambrian formations above the thrust and the Carboniferous and Permian Bird Spring Formation immediately below the Wheeler Pass thrust. It is difficult to correlate the source of anomalies to individual formations within the Late Proterozoic and Cambrian section.

The anomalous zone in the north-central to northeastern part of the study area is characterized by lead, copper, zinc, and barium. The anomalous sites are spatially associated with rocks of Ordovician through Mississippian age.

Eighteen rock samples were taken at sixteen sites throughout the study area for the reconnaissance geochemical survey. Twelve have anomalous values, half of which are clustered in the southeast corner of the study area. The remainder of the samples with anomalous values are scattered in the northwestern part of the study area. The anomalous geochemistry from rock samples is characterized by elevated concentrations of antimony (10 of 12 samples), cadmium, and arsenic.

Geochemistry of Altered Areas

Anomalous concentrations obtained from samples collected during detailed mapping of altered areas occur in several places. Lower detection limits for gold (0.05 ppm), mercury (0.02 ppm), arsenic (2 ppm), antimony (2 ppm), and thallium (0.05 ppm), which are the main target elements used in the exploration for precious-metal deposits, were used to establish anomalies relative to background values from unaltered rocks. Typically, elements associated with precious-metal deposits (and most ore deposits) are distributed log normally with a few high values directly associated with the most altered areas and ore grade rocks, but the most abundant values are for samples with low concentrations of metals. For example, mercury and arsenic in a typical sediment-hosted disseminated gold deposit have values of 0.1 to 0.2 ppm, and 25 to 125 ppm, respectively. These values are generally higher than the range in values established for rock samples collected during this study. Despite this, the values are still anomalous and are similar to some sediment-hosted disseminated gold deposits.

Twenty-four rock and four stream-sediment and soil samples were collected from the alteration zone associated with the Grapevine fault system. Of those, five rock and two stream-sediment samples contain gold at the detection limit (0.05 ppm). One rock sample was collected from the Johnnie mine west of the study area; all others were collected from within the study area, or, in the case of two of the stream-sediment samples, close to the study area. Most of the rock samples contain anomalous mercury, arsenic, and antimony. Thallium is the most ubiquitous element and concentrations correspond to those typically obtained from areas peripheral to a typical sediment-hosted gold deposit such as the Preble deposit (Bagby, Madrid, and Kretschmer, written commun., 1986; Madrid, Bagby, and Kretschmer, written commun., 1987). Although these anomalous values are uniformly low, the geologic environment is favorable and similarities in alteration, mineralization, and geochemistry between the Grapevine fault system and the Preble sediment-hosted disseminated gold deposit make these low concentrations more significant in terms of that kind of deposit. Silver is conspicuously absent.

Both vein systems discussed in previous sections yielded rock samples that contain no anomalous values of gold or silver and only a few of these samples were anomalous in base metals, such as copper, lead, or zinc. The quartz-specular hematite vein system north of Mount Stirling includes the Stirling mine. Although some anomalous base-metal, and possibly some precious-metal values were expected, the most anomalous element is iron along with zinc, though some zinc values only slightly exceed background values. Gold is concentrated at the Stirling mine, but may be related to mineralization and alteration that postdates formation of the quartz-specular hematite veins. The vein system west and south of Big Timber Spring is clearly anomalous in manganese (as much as 1500 ppm) and zinc (as much as 280 ppm), but the poor density and great lateral extent of these veins is not supportive of significant concentrations of ore-related elements.

Detectable gold (.05 ppm) was found east of Big Timber Spring in a fault zone that trends parallel to the Grapevine fault system. Unfortunately, poor exposures precluded a thorough assessment of this area. The single detectable gold-bearing sample was collected from the fault zone exposed in an associated fault sliver that crops out high on the fault scarp 1.6 mi south-southeast of the spring. A shallow soil horizon within the fault zone contains arsenic, mercury, antimony, and thallium values close to the detection limit.

Geophysics

Aeromagnetic and gravity anomalies on the northwest flank of the Spring Mountains are believed to be the expression of a broad uplift of Precambrian basement rocks that form the core of the range. The basement is probably at a depth of at least 8 km beneath the study area, on the basis of these geophysical data. Aeromagnetic and gravity indications of structure or lithologies that can be interpreted as related to mineral resource potential were not identified. Several aeroradiometric traverses were made across the study area as part of the National Uranium Resource Evaluation (NURE) program. The NURE data were studied by J. S. Duval of the U.S. Geological Survey, who reports overall low radioactivity with values of 0 to 1.0 percent potassium, 0.7 to 2.0 ppm equivalent uranium, and 0 to 4 ppm equivalent thorium; anomalies do not occur within the study area or in the immediate vicinity (J.S. Duval, written commun., 1985).

Landsat Thematic Mapper

The Mount Stirling Wilderness Study Area was also examined independently using computer-processed data from the Landsat Thematic Mapper (TM) to locate hydrothermally altered rocks. This was augmented by field checks, rock-chip sampling, and laboratory analysis to verify the anomalies found during the imaging process. Several areas were found within or adjacent to the study area that were confirmed to be hydrothermally altered.

The Johnnie mining district, which contains epithermal gold, silver, lead, zinc, and copper vein and replacement deposits, is characterized by extensive sericitically altered and limonitically stained rocks of the Johnnie, Wood Canyon, and Carrara Formations and the Stirling Quartzite similar to those found in the study area. These types of alteration and mineralization were detected using TM processing and the characteristics of the image anomalies were used for comparative interpretation of the images within the study area.

Band ratioing of selected TM channels provides information on mineral content of rocks and soil (Rowan and others, 1974; Podwysocki and others, 1985) by increasing spectral contrasts present in the data and by decreasing the effects of illumination due to topographic differences. Proper selection of channels to be ratioed allows the user to identify hydrated sheet silicate minerals such as clays and micas, carbonate minerals, and ferric iron-bearing minerals (limonite). These are represented by different colors on the derivative color infrared images. When found in sandstone, quartzites, and carbonate rocks as secondary minerals associated with argillic, sericitic, and limonitic alteration, they may indicate hydrothermal mineralization. Field checks allowed an evaluation of the ratios selected to differentiate the alteration types, and to insure that anomalies are due to alteration and not to other factors.

Two anomalies that indicate alteration were recognized on the images of the study area or close to the study area, and field-checked for confirmation. The first of these, between Willow Spring and Wheeler Pass, is characterized by rocks altered to hematite and sericite that are part of the hanging and foot walls of the Wheeler Pass thrust. This anomaly coincides with the alteration and partial development of jasperoid mapped for this study and described above. The total width of the altered zone is wider on the images than actually mapped, but thick talus covers some areas that contain abundant altered rock.

The second anomaly, on the southwest flank of the Spring Mountains, is within and just outside the study area. The anomaly is characterized by hematitically and sericitically altered rocks of the Horseshutem Spring area (pl.1). This anomaly, although smaller, corresponds well to the field-mapped alteration zone discussed above. The TM anomaly extends into the alluvial fan material which consists, in part, of altered rock fragments derived from the range.

The Thematic Mapper was not successful in defining the two major copper, lead, zinc, and manganese vein systems found during this study. The veins are small, discrete features and are not associated with penetrative alteration. Thus it is suspected that the resolution of the images was insufficient for detection.

Mineral and Energy Resources

Lithologic compositions, structural relations, geochemistry, and significant alteration and mineralization criteria suggest that two deposit types occur in the Mt. Stirling Wilderness Study Area: sediment-hosted disseminated gold and copper-, lead-, zinc-, and manganese-bearing veins.

Sediment-hosted Disseminated Gold

Sediment-hosted disseminated gold is mined from low-grade, high-tonnage (generally greater than 7 million tons of ore) deposits, commonly with a cut-off of 0.02 oz/ton (approximately 0.6 ppm) and average grades of approximately 0.096 oz/ton (2.7-3.3 ppm) gold (Bagby, 1984). The host rocks are most commonly sedimentary carbonate rocks, but siliclastic rocks also are hosts. Early decalcification of the host rock is accompanied by silicification, in the form of jasperoid development in carbonate rocks and penetrative silicification in noncarbonate rocks. This is accompanied by the formation of a vein paragenesis characterized by vein stages associated with silicification accompanied by main stage gold, followed by vein stages associated with calcification (Madrid and Bagby, 1986). Penetrative leaching and argillization of host rocks are commonly associated with the deposit, but its temporal relation to main-stage gold mineralization is largely unknown. A common geochemical signature of this deposit type is the association of gold+silver+arsenic+mercury+silicon+tellurium+antimony+iron ±thallium. Gold is most highy correlated with silica, tellurium, arsenic, and to a limited extent, mercury. Silicification, calcification, the vein sequence, and metallization are most commonly spatially and perhaps genetically related to high-angle normal fault systems, where the economic mineralization is largely confined to the hanging wall. In the largest deposits, footwall mineralization is not as extensive and is commonly characterized by lower ore grades. Despite this, the above vein and geochemical relations hold and their limited development can be used to define higher grades in the hanging wall of the fault.

Exploration for sediment-hosted disseminated gold deposits is difficult, partly because the overall absolute values of geochemical anomalies are very low, and because they encompass small areas where ore-grade rock is present. The ore bodies are typically 100 to 200 ft thick, 800 ft long and extend down dip for unknown distances. Hundreds of samples are commonly necessary to establish viable prospects for further exploration and delineation. In some cases, many exploration companies have sampled the same area or even the same outcrop before gold is detected and more detailed exploration proceeds. The presence of detectable gold at sub-ppm levels, especially accompanied by the elements listed above, is the main factor in proceeding with a larger systematic sampling program. Inasmuch as gold is detectable, and alteration and mineralization features in the study area meet the above geologic criteria, the number of samples collected in the study area is sufficient to establish limits for resource potential but their number is insufficient for more detailed exploration.

All of the geologic relations defined above for sediment-hosted disseminated gold deposits are present in the Grapevine fault system. The compelling correlations supporting this include: (1) the presence of penetrative alteration associated with a major fault system; (2) the presence of silicification in the form of jasperoid development in reactive carbonate rocks, and spotty silicification of nonreactive rocks; and (3) a vein paragenesis analogous to that found associated with economic and currently productive sediment-hosted disseminated gold deposits. The general geochemical signature is also compelling. These relations define the criteria necessary to assign the Grapevine fault system a high mineral resource potential for gold (certainty level D). This assignment is highly dependent on (1) the large area affected by alteration and veining; (2) the geologic and geochemical attributes that correlate with similar features and signatures in areas where sediment-hosted disseminated gold deposits are mined or occur; and (3) importantly, the presence of detectable gold in several samples. Alteration in the hanging wall of the Grapevine fault exposed near Rainbow Spring displays slightly more intense alteration and mineralization than the footwall and thus warrants more detailed sampling and mapping.

North of Gold Spring, sheared zones associated with high-angle normal faults are assigned a high resource potential for gold (certainty level C). This assignment is based upon the presence and disseminated nature of the gold, along fractures within these shear zones, and the silicification and sulfide-mineral development along these fractures. In the Preble gold deposit in north-central Nevada much of the gold occurs along similar fractures, especially in nonreactive rocks similar to the shales and quartzites of the Stirling Quartzite, which are the hosts for the gold in the shear zones in this altered portion of the Mt. Stirling study area.

The altered area associated with the Wheeler Pass thrust zone also indicates a sediment-hosted disseminated gold deposit environment. Part of this altered area may extend into the study area as suggested by the presence of altered clasts in talus and by the TM imagery. Minor jasperoid development, partial silicification of the carbonate rocks of the Bird Spring Formation, and localized leaching, along with a clear geochemical signature, are consistent with a sediment-hosted disseminated gold model. However, without more detailed mapping and a more extensive geochemical sampling program, we can only assign a moderate mineral resource potential for gold (certaintly level C) to the area presently defined by alteration mapping.

Base-metal Vein Systems

A low mineral resource potential for lead and zinc (certainty level C) is assigned to the area containing the vein system in the northern part of the study area. There, the low intensity of veining, low lead-zinc (base metals) content of the veins relative to background, and the lack of clearly definable criteria associated with a base-metal vein system does not warrant a higher resource potential. The fact that this vein system in the study area appears to be the extension of the vein systems associated with the Stirling mine and Johnnie mining district is also insufficient to establish a higher resource potential. At the Stirling mine these veins are altered and crosscut by fractures that carry silica and sulfides. Therefore we suspect that gold may postdate the vein system.

A low mineral resource potential for zinc and manganese (certainty level C) is assigned to the area containing the vein system on the ridge west of Big Timber Spring. Low density, metamorphic, manganese- and zinc-bearing veins occur in narrow zones generally parallel to the ridge and to bedding. The low density and low concentrations of manganese and zinc within these veins are the basis for the assignment of a low resource potential.

The altered zone at Big Timber Spring affects modern sediments and the prospect yielded samples that have trace amounts of copper, lead, and zinc. The prospect is outside the study area and the alteration extends into the study area. However, the relation of the altered area to the prospect is not clear. Therefore, the altered area is assigned a low mineral resource potential (certainty level B) for copper, lead, and zinc.

The fault zone south-southeast of Big Timber Spring and subparallel to the Grapevine fault system is assigned an unknown mineral resource potential (certainty level A) for gold. Only a small number of samples, one of which yielded gold, were collected from limited exposures and alteration could not be mapped except at the sampled outcrop because of the presence of talus over the fault zone.

RECOMMENDATIONS FOR FUTURE WORK

The Grapevine fault system is assigned a high mineral resource potential for gold. Most of the area so assigned occurs within the footwall of the fault system. The potential for more intensive mineralization in the hanging wall (common in most sediment-hosted gold deposits) is largely unknown because alluvial fan deposits cover most of the hanging wall. Detailed geochemical sampling and additional alteration mapping of the limited exposures of the hanging wall west of Wood Canyon and Rainbow Spring may provide more definitive geochemical signatures. The Wheeler thrust zone is also an area that needs more systematic sampling to determine the extent of alteration and to characterize the geochemical anomalies more definitively. The fault zone assigned an unknown resource potential east of Big Timber Spring needs additional work in order to establish a clearer resource potential assessment.

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APPENDIXES

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 permissive. This broad category embraces areas with dispersed but insignificantly mineralized rock as well as areas with few or no indications of having been mineralized.

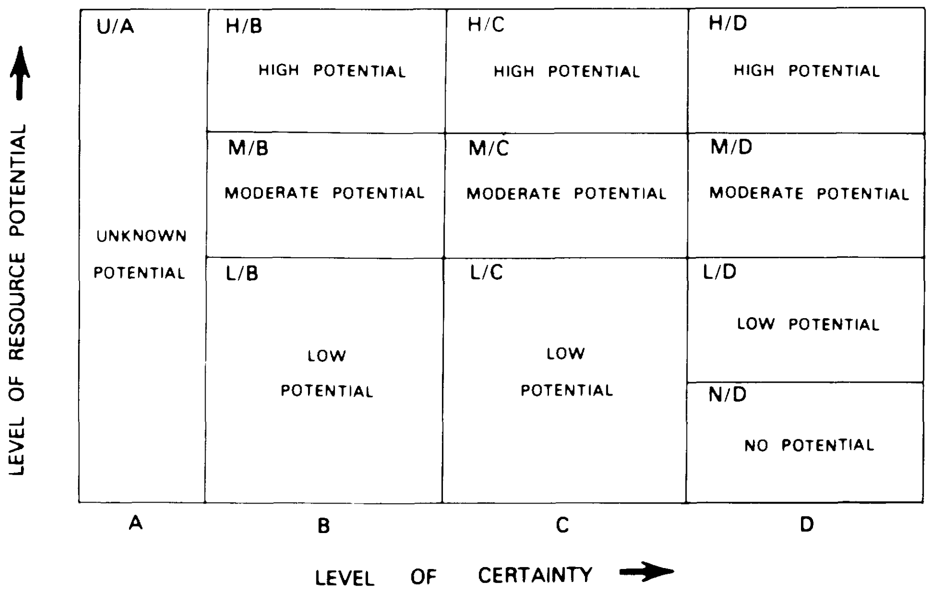
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate reasonable likelihood of resource accumulation, and (or) where an application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

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

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

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

Levels of Certainty



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

Abstracted with minor modifications from:

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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.

TABLE 1. *Mines and prospects in the Mt. Stirling Wilderness Study Area and vicinity*
[*, outside study area]

Map No. (pl. 1)	Name (commodity)	Summary	Workings	Sample and resource data
1	Stirling mine* (gold)	At least two main quartz veins as much as 10 ft thick strike northeast, have various dips, and are traceable for at least 1,000 ft in metasedimentary rocks, probably of the Wood Canyon Formation. Quartz veins are parallel and about 800 ft apart. Quartz is locally brecciated, iron oxide stained, and contains traces of malachite, chalcopyrite, and galena. Nolan (1924) stated that main quartz vein is traceable for several miles.	Main workings, at east end of south vein, include a 23-ft-long adit in quartz and a 58-ft-deep shaft. Shaft was inaccessible but appeared to have drifts at two levels. Also on south vein are 16 small surface pits. Two shafts, 13 and 28 ft deep, and 11 small pits are on north vein. Stockpiles of a few hundred pounds of quartz near most of pits.	38 samples were taken; 35 from small stockpiles and from veins exposed in pits and 3 from adit. All samples were of either massive or brecciated vein quartz with iron and manganese oxide stains. Three chip samples of vein quartz from adit contained trace, 0.01, and 0.09 oz/ton gold. Four select samples contained: 0.05 oz/ton gold with 0.1 oz/ton silver, 0.08 oz/ton gold with 0.5 oz/ton silver, 0.18 oz/ton gold with 0.3 oz/ton silver, and 0.10 oz/ton gold. A trace of gold was found in 17 other samples and a trace of silver was found in two samples. Eleven samples assayed for copper, lead, and zinc contained from trace to 0.29 percent copper, trace to 0.26 percent lead, and trace to 0.02 percent zinc. Nine samples had no significant mineral values.
2	Unnamed prospect* (copper)	Iron oxide stained argillite and phyllite country rock has traces of malachite, siderite, and calcite.	1 10-ft-diameter pit 2 ft deep is in an area of malachite-stained argillite. Small stockpile has phyllite containing siderite and calcite.	A select sample of malachite-stained argillite contained trace gold and silver and 0.77 percent copper; a select sample of phyllite with calite and siderite from small stockpile contained no significant mineral values.
3	Best View prospect* (copper-silver)	Light-gray to white quartzite layer of the Stirling Quartzite contains iron oxide stains and malachite. Malachite is disseminated throughout the rock and also present as radiating crystals along fractures.	Workings consist of an upper bulldozer scraping about 85 ft in diameter. About 400 ft downslope north-northeast is another bulldozer cut about 70 ft long and 10 ft wide, a pit 15 ft long and 7 ft deep, and a 23-ft-long adit. All surface workings in white quartzite with disseminated malachite; no malachite was in adit.	Four select samples and three chip samples were taken. A select sample of white quartzite with disseminated malachite at south pit contained 0.01 oz/ton gold, 6.8 oz/ton silver, and 7.5 percent copper. Three samples (two select, one chip) of white quartzite with disseminated malachite and veinlets of iron oxides from north pit assayed 2.2 oz/ton silver with 3.7 percent copper, 0.5 oz/ton silver with 1.48 percent copper, and 4.9 oz/ton silver with 4.0 percent copper. Of two chip samples taken from the adit, one along north rid in quartzite contained 0.1 oz/ton silver. Select sample of quartzite with disseminated malachite from dump contained 9.6 oz/ton silver and 9.9 percent copper.
4	Mountain Boy prospect* (iron)	Irregular pods 10 ft long of vuggy, hard, dark-brown to yellow, iron-rich rock highly altered to limonite in limestone country rock striking N. 10° E, and dipping 33° E.	A 4-ft-deep pit has a 10-ft-long extension at bottom, About 300 ft north is another pit 8 ft deep, 9 ft long, and 5 ft wide, with a 100-lb stockpile.	One chip and two select samples of iron-rich rock taken. Three samples contained from 44 percent to 51 percent iron, 0.018 percent to 0.049 percent copper, 0.058 percent to 0.135 percent lead, and 0.064 percent to 1.3 percent zinc.

TABLE 1. *Mines and prospects in the Mt. Stirling Wilderness Study Area and vicinity*—Continued

Map No. (pl. 1)	Name (commodity)	Summary	Workings	Sample and resource data
5	Genevieve prospect* (gold)	Sand and gravel fills creek bottom	Ten-ft diameter pit is about 6 ft deep.	One grab sample of sand and gravel taken from side of pit contained no significant mineral values.
6	Noonday prospect (copper-silver)	White quartzite of the Stirling Quartzite strikes N. 6° W., dips 26° NE., and has some malachite stain. White quartz in randomly oriented stringers and in pods to 1 ft diameter.	Two shafts: one inclined shaft full of water is estimated to be driven 15 ft into the malachite-stained quartzite; about 1/2 mi south, a 19-ft inclined shaft driven on a shear zone in quartzite exposes numerous quartz stringers and pods.	Three select samples were taken. One of malachite-stained quartzite from dump of the northernmost shaft contained 7.4 oz/ton silver and 0.49 percent copper. Two samples of quartz from wall and portal of 19-ft shaft contained no significant mineral values.
7	Johnnie Snapper prospect* (copper-gold)	White quartz pods with traces of hematite, malachite, azurite, and pseudomorphs of limonite after pyrite in phyllite and sandstone of the Johnnie Formation. Pods of quartz are as much as 11 ft long and 1 to 2 ft thick.	One pit is 26 ft long, 10 ft wide, and 4 ft deep; another is 5 ft in diameter; another is 6 ft deep with a 6-ft extension at the bottom.	Three select samples taken. One of quartz with hematite and limonite from largest pit contained trace gold and 0.1 oz/ton silver. Quartz sample with malachite and azurite from the 6-ft-deep pit contained trace gold, 0.6 oz/ton silver, and 1.17 percent copper. A pod with intermixed quartz, limonite, and phyllite from the smallest pit contained trace copper and zinc.
8	SMP prospect (copper-silver)	White quartz veins with thin stringers of specularite, and malachite and chrysocolla disseminated in the Stirling Quartzite.	Two pits, 4 ft and 7 ft in diameter, are about 1/2 mi apart. Stockpile of about 300 lb of iron oxide-stained quartz containing specularite is at westernmost pit.	A select sample of quartzite with stringers of specularite contained trace silver and 0.016 percent copper. A select sample of malachite- and chrysocolla-stained quartzite from easternmost pit contained 1.4 oz/ton silver and 1.48 percent copper.
9	Home Stake prospect* (gold)	Vein quartz with limonite and calcite in phyllite.	One pit is 10 ft long, 4 ft wide, and 3 ft deep.	A select sample of vuggy, limonite-stained quartz float from pit contained trace copper, lead, and zinc.
10	Unnamed prospect* (gold)	Well-fractured, heavily iron oxide-stained quartz vein 1.7 ft thick strikes N. 20° E., and dips 26° SE. in shale of the Johnnie Formation.	One small sloughed pit and an 18-ft-long inclined shaft.	A select sample of quartz from dump at shaft and a chip across quartz vein in shaft contained no significant mineral values.
11	Unnamed prospect (copper-silver)	Fractured quartz pods with moderate iron oxide stains and traces of malachite and chalcopyrite in limestone and phyllite country rock. In adit, a slump block of limestone appears to have slid over the soil mantle covering phyllite bedrock.	An adit 28 ft long along a limestone-phyllite contact. A 15-ft-long pit nearby.	A select sample of malachite and iron oxide-stained quartz from dump contained 0.1 oz/ton silver and 0.91 percent copper. A chip across a 5.7-ft-wide quartz pod with abundant limonite stains had 0.1 oz/ton silver and 0.018 percent copper.

TABLE 1. *Mines and prospects in the Mt. Stirling Wilderness Study Area and vicinity*—Continued

Map No. (pl. 1)	Name (commodity)	Summary	Workings	Sample and resource data
12	Moonshine prospect (copper-silver)	Light-gray quartzite unit of the Stirling Quartzite is 9 ft thick and contains disseminated chalcopyrite with some malachite along fractures. Quartzite is bounded above and below by red siltite, strikes N. 10° W., dips 55° E., and is mineralized for 185 ft along strike.	A water-filled inclined shaft about 15 ft in diameter and three pits about 5 ft in diameter.	A chip across malachite-stained quartzite at inclined shaft contained 0.3 oz/ton silver and 0.88 percent copper. Two select samples of malachite-stained quartzite from pits contained 4.3 percent copper with 0.7 oz/ton silver, and 2.23 percent copper with 0.3 oz/ton silver and trace gold.
13	El Lobo prospect* (gold)	Gray quartzite country rock contains a white quartz vein as much as 20 ft thick exposed for 300 ft. Prospect along trace of Wheeler Pass thrust fault.	A trench 5 ft deep and 15 ft long, and a 6-ft diameter shallow pit in quartzite country rock. Four pits, the largest 15 ft wide, 25 ft long, and 6 ft deep, in or near the 20-ft-thick quartz vein. A caved 300-ft adit reportedly on property was not found. A 300-lb stockpile of iron oxide-stained quartz and quartzite near pit.	Two select samples were taken of vein quartz and quartzite from the pits in country rock; one sample contained 0.1 oz/ton silver. Three select samples of quartz were taken from 20-ft-thick quartz vein. One contained a trace of gold and 0.1 oz/ton silver; another contained 0.1 oz/ton silver.

GPO 785-048/77395