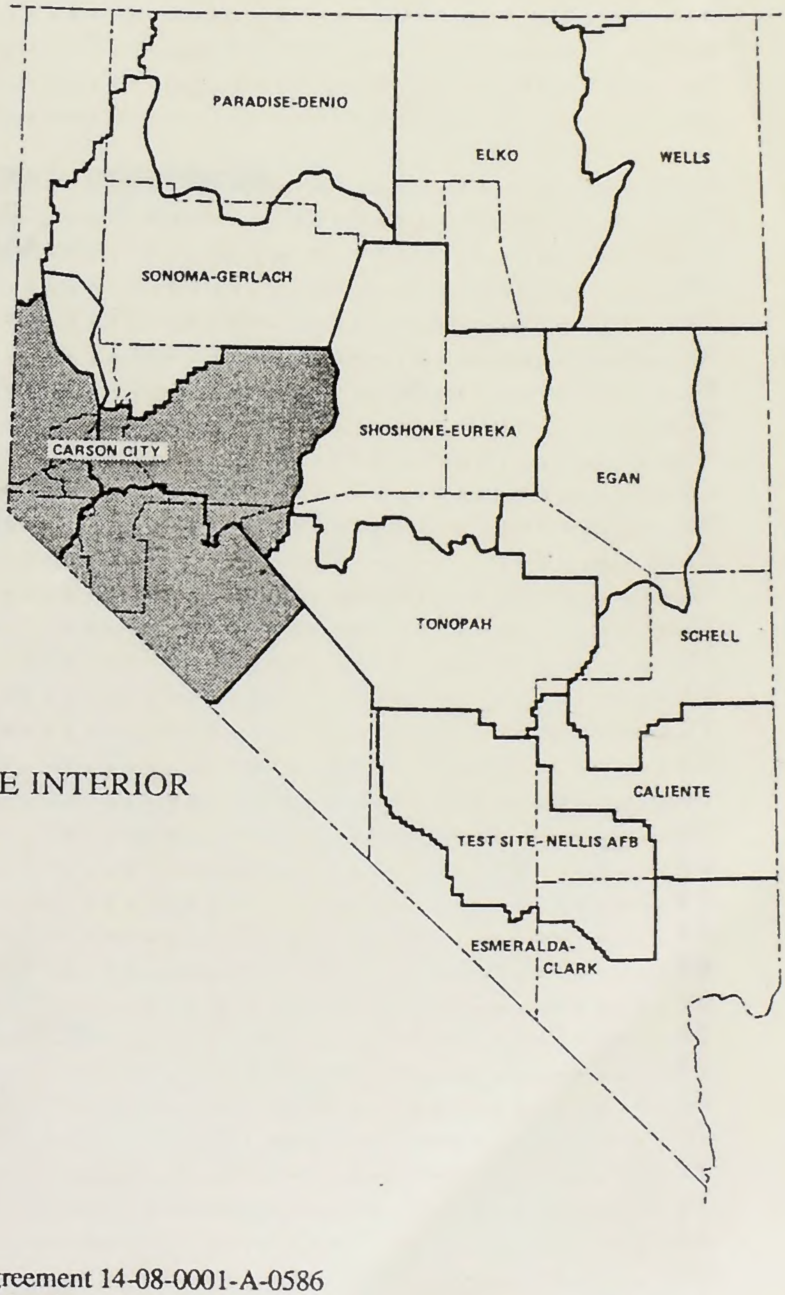
Mineral Resource Inventory
Bureau of Land Management, Carson City District, Nevada



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(supplied under separate cover)

SUMMARY

The Bureau of Land Management, Carson City District, includes in the order of 5 million acres of public lands in west-central Nevada. The district includes all of Mineral, Lyon, Douglas, Storey, and Carson City counties, all but the northern portions of Washoe and Churchill counties, and a small part of western Nye County.

The portion of western Nevada included within the Carson City BLM district has had a long and complex geologic history that includes major episodes of sedimentation, igneous activity, and orogenic deformation. The oldest rocks in the district are Precambrian schists. Paleozoic rocks are present in areas, but the most extensive outcrops of pre-Tertiary rocks within the district consist of Triassic and Jurassic metasedimentary and metavolcanic rocks and Jurassic and Cretaceous granitic rocks. In most parts of the district, the granitic and metamorphic rocks are overlain by an extensive sequence of Cenozoic volcanic and interbedded sedimentary rocks; voluminous rhyolitic ash-flow tuffs overlie the older rocks in a large area in the central and eastern part of the district. About 17 m.y. ago, extensional faulting began in the area and the major basins and ranges that characterize the present-day physiography of the western part of Nevada were formed.

Precious metals deposits were discovered in the western part of the present Carson City district in 1850, and exploitation of these deposits dominated mining in the area into the early 1900's. Copper deposits, many with associated values in precious metals, were exploited in many areas within the Carson City district during the first decades following 1900 and one area, Yerington, produced copper into the late 1920's, again between the mid-1950's and the mid-1970's, and is presently producing small amounts of copper. Several tungsten mines within the Carson district generated small to moderate production during periods of high tungsten prices, mainly during World Wars I and II, and the Korean War.

At the present time, mining and prospecting activity in western Nevada is largely confined to precious metals. Within the Carson City district, one open-pit silver mine and several large open-pit gold mines are presently in operation or are in the process of starting operations. Other large deposits of low-grade, bulk-minable gold and silver have been developed and additional deposits will, no doubt, be discovered and developed as the result of the many exploration ventures now active in the district. A small-scale copper leach plant is in operation at the site of the former copper mine in Yerington and, if the copper market continues to improve, other copper mines in the Yerington district may open within the next year or two.

Presently, the largest industrial mineral mining operations within the district are of sand and gravel, diatomite, limestone, and rhyolite aggregate. Small amounts of zeolite are being mined from one deposit, clay is mined from several small deposits, and salt, for road and livestock use, continues to be mined on a small scale from playa deposits east of Fallon.

Geothermal resources exist in several areas within the Carson City district, and power plants are in operation at sites in Dixie Valley and near Soda Lake in Churchill County, and at Steamboat Springs south of Reno in Washoe County.

Oil and gas resources are not known to exist within the Carson City district.

INTRODUCTION

PURPOSE AND METHODOLOGY

The need for an updated and expanded mineral inventory has been recognized by the BLM, Carson City District, in anticipation of planning requirements for land utilization in the 1990's. A low-level of mineral inventory was conducted within the district in the mid-1970's. Drastic changes in mineral economics and mineral exploration concepts and methods have taken place since that time, however, requiring that a new, district-wide inventory be made. The object of the current mineral inventory is to describe the mineral resources of the public lands within the District and to comments on the potential for the occurrence and development of these resources.

Work within the Carson City District was completed in three complementary stages.

First, records of all mineral occurrences within the district on file within the U.S. Geological Survey's Mineral Resource Data Set (MRDS) were obtained and examined. Deposit locations were plotted on topographic maps for field use, and additional literature search was done in some areas to augment information obtained from MRDS. Folios were prepared for each mining district within the study area which included MRDS forms, notes on mineral activity, and pertinent references.

Second, mining districts within the area were visited and individual properties were examined and described. Outlying prospects, as well as major mines, were examined in order to provide more complete and accurate information on occurrences than was found in literature sources. In each area examined, photos were taken to document activity, type of mine workings present, and to record geologic relationships. In addition, samples of typical ore mineralization were collected for analysis to investigate trace element associations in the ores. These samples were "high-graded" and usually collected from dumps, ore piles, or mineralized outcrops. The samples were prepared for analysis by the Nevada Bureau of Mines and Geology analytical laboratory, and were analyzed by the Branch of Geochemistry, U.S. Geological Survey through a cooperative agreement between that agency and the Nevada Bureau of Mines and Geology.

The third stage of this project consisted of evaluation of the data collected during the field examinations, study of geochemical associations, and the preparation of an inventory report.

Information collected as part of the BLM Carson City District inventory project is presented in this report in the following form:

1) Summary report, which includes sections on geologic setting, description of energy and mineral resources, potential for the occurrence of mineral resources, recommendations, references and selected bibliography, and appendices.

2) Mining district folios, which include descriptions of each property examined in the field, copies of MRDS and/or CRIB forms (older version of MRDS) from NBMG files, and copies of samples descriptions and geochemical results for each district.

3) Topographic map set, consisting of a set of 7 1/2' and 15' topographic maps showing locations of properties examined and sampled, plus locations from the MRDS files. The set is organized by each 30' by 60' quadrangle in the district, and an index map is provided.

4) Slide album, consisting of color 35mm slides taken during field examinations. The slides are organized by mining district or mining area.

5) Mineral assessment map set, consisting of overlays for each 30' by 60' quadrangle map in the district showing names of mining districts and generalized areas of inferred mineral potential. Three sets of overlays have been prepared: 1) Metallic mineral resources, including uranium (involves overlays for 13 of the 14 quadrangle maps within the district); 2) Industrial mineral resources, including salines and brines (involves overlays for 13 of the 14 quadrangle maps within the district); and 3) Coal, oil and gas, and geothermal resources (involves 10 of the 14 quadrangle maps within the district).

This report is mainly an inventory of metallic mineral occurrences within the BLM Carson City district; industrial mineral resources, geothermal resources, and oil and gas are referred to in the report but are not covered in detail.

Generalizations regarding mineral potential are included with the report, but they are presented only to satisfy the terms of the contract and, while these generalizations represent the highest level of assessment that can be done with the data that is available, they are, at best, educated guesses and not statements of fact. Potential is discussed both by specific mineral commodity and by area (30' by 60" quadrangle). In the first section, every commodity that has documented occurrences within the BLM Carson City district is mentioned--some in detail,

some only generally, and depending on the level of information available, potential ratings have been assigned. In the second section, the potential discussion is mainly limited to metallic mineral resources.

LOCATION

The Bureau of Land Management, Carson City District, consists of approximately 5 million acres of public land in west central Nevada. The district extends east from the California-Nevada state line to the eastern border of Churchill County, and extends from the Esmeralda-Mineral county line on the south to the northern boundary of Churchill County on the north. The district includes all of Mineral, Lyon, Douglas, Storey, and Carson City counties, all but the northern portions of Washoe and Churchill counties, and a small part of western Nye County. The Walker River Indian Reservation, while entirely enclosed within the Carson City District, is not managed by the BLM. There are also large areas, especially along the California-Nevada state line that are National Forest lands managed by the U.S. Department of Agriculture.

DESCRIPTION OF GEOLOGY

PHYSIOGRAPHIC SETTING

Almost all of the BLM, Carson City District is within the Great Basin region of the Basin and Range physiographic province, a region characterized by a series of generally north-trending mountain ranges separated by alluviated valleys. A small area along the westernmost part of the district, along the Nevada-California state line, lies within the mountainous Sierra Nevada province (Stewart, 1980, p. 7).

Mountain ranges within the Great Basin are typically elongate. The ranges can be 5 to 15 miles wide and valleys between the ranges are generally of the same width. Many ranges extend for more than 50 miles in a north or northeast direction and rise 1,000 to 5,000 feet above adjoining valleys; others are either irregular in shape or almost equidimentional. A zone of very irregular topography, the Walker belt, extends in a northwest direction along the western border of the district. (Stewart, 1980, p. 7).

All of the Carson City district is an area of internal drainage. The major rivers that traverse the district, the Truckee, Carson, and Walker rivers and their various branches, all have headwaters to the west, in California. These rivers, however, terminate in desert lakes and sinks within the Carson City district, in western Nevada. The Truckee flows to its terminus in Pyramid Lake, the Walker River ends in Walker Lake, and the Carson is mostly dissipated into a network of irrigation canals and lakes near Fallon. The natural terminus of the Carson River is the Carson Sink, northeast of Fallon. Many of the valleys in the central part of the district are floored by flat, mud-surfaced playas that are flooded by runoff from the mountains during times of high precipitation (Stewart, 1980, p. 7-9). Some of these basins are relics of more extensive lake beds formed during the latter part of the last ice age. Pyramid Lake and Walker Lake are, in fact, remnants of glacial Lake Lahontan which covered a large area of western Nevada during Pleistocene time.

GEOLOGIC SETTING

The portion of western Nevada included within the Carson City BLM district has had a long and complex geologic history that includes major episodes of sedimentation, igneous activity, and orogenic deformation.

The oldest rocks exposed in the district crop out along the Mineral County-Esmeralda County line and consist of Precambrian phyllite and schist. These rocks are interpreted to be

continental shelf deposits laid down along what was then the western margin of North America. Siliceous and volcanic rocks of Ordovician and Devonian age also crop out in this area; these rocks are within the Roberts Mountains allochthon, which was, during Late Devonian and Early Mississippian time, thrust eastward over the continental shelf deposits (Stewart, 1980, p. 5, 14). Permian rocks are found within a slightly larger area within the district, but outcrops are mainly restricted to southeastern Mineral County.

The most extensive outcrops of pre-Tertiary rocks within the district consist of Triassic and Jurassic metasedimentary and metavolcanic rocks and Jurassic and Cretaceous granitic rocks. In the western part of the district, the Triassic and Jurassic rocks occur mainly as roof pendants of various sizes included within granitic rocks of the Sierra Nevada batholithic complex.

In most parts of the district, the granitic and included metamorphic rocks are overlain by an extensive sequence of Cenozoic volcanic and interbedded sedimentary rocks. Voluminous siliceous ash-flow tuffs were erupted about 34 to 17 m.y. ago in and east-trending belt across the central part of Nevada; this belt extends into the eastern part of the district (Stewart, 1980, p. 5).

About 17 m.y. ago, a major change occurred in the tectonic setting of Nevada with the onset of extensional faulting and the eruption of basalt or bimodal assemblages of basalt and rhyolite. During this time, the major basins and ranges that characterize the present-day physiography of the western part of Nevada formed by extensional block faulting, and continental sediments were trapped in fault-related basins (Stewart, 1980, p. 5).

GEOPHYSICS

Regional magnetic and gravity data on Nevada have been compiled at a scale of 1:750,000 (Hildenbrand and Kucks, 1988a and b; and Saltus, 1988a and b). In addition, aeromagnetic maps compiled at a scale of 1:250,000 are available for the Reno and Walker Lake 2^0 sheets (Nevada Bureau of Mines and Geology, 1977; Plouf, 1986). Bouguer gravity maps, at 1:250,000 scale, are available for the Reno, Goldfield-Mariposa, Tonopah, and Walker Lake 2^0 sheets (Erwin and Berg, 1977; Healey, Wahl, and Currey, 1980; Healy, Snyder, and Wahl, 1981; Plouf, 1984); and a gravity map, at a scale of 1:125,000, has been published for the Yerington, Como, Wabuska, and Wellington quadrangles (Erwin, 1970).

Information contained on these maps was used in a very general way in the preparation of this report. Both magnetic and

gravity data can be used to project geologic structures and rock type beneath alluvial cover and important regional structural trends can sometimes be developed.

GEOCHEMISTRY

Regional geochemical surveys have been completed for the Walker Lake and Tonopah 2^0 sheets (Chaffee, Hill, and Sutley, 1988 a-d; Chaffee, 1988 a-c; Nash and Siems, 1988). In addition, geochemical studies of ores and mineralized rocks have been made for areas within the Pilot Mountains (Nash, Siems, and Budge, 1985) and Cedar Mountains (Nash, Siems, and Hill, 1985). These studies were undertaken by the U.S. Geological Survey as part of their work on CUSMAP projects on the Walker Lake and Tonopah 2^0 sheets. A CUSMAP project is now underway for the Reno 2^0 sheet but no data are available from this project. Published data from these surveys were studied during the planning stage of the Carson City project. Data from the studies of the two mining areas was especially helpful, and was compared with results of sampling done specifically for the Carson City project.

As part of the examination procedure used during the accomplishment of work for this project, samples of ores and mineralized rocks were collected from essentially all of the prospects examined. Slightly over 900 individual sample descriptions and analyses are included in our compilation; about 200 of these were collected and analyzed as part of an earlier project (Quade and Tingley, 1987) but some 700 samples were specifically collected during work on the Carson City project. The results of this sampling was used during the mineral assessment stage of our study. Sample descriptions and analytical results are found in the appendix of this report.

DESCRIPTION OF ENERGY AND MINERAL RESOURCES

The first mineral discoveries in Nevada were made within the area of the present Carson City district when the silver and gold deposits on the Comstock Lode were found in 1850. Exploitation of precious metals from the Comstock dominated Nevada mineral production into the 1870's and Virginia City and the surrounding mining districts were among the most active in the state during this time. Discovery of silver and gold in the camps of Aurora and Candelaria added to the volume of production from the western part of the state for a few years prior to 1900. Declining production from the Comstock and discovery of major metal deposits in the eastern and central parts of the state, however, combined to shift the bulk of Nevada's mineral activity away from lands now included within the Carson City district after about 1900. Copper deposits, many with associated values in precious metals, were exploited in many western Nevada mining districts during the first decades following 1900 and one, the Yerington district, produced copper into the late 1920's and again between the mid-1950's and the mid-1970's. Production, on a small scale, recently resumed at the Yeringtion mine and several hundred thousand pounds of copper were produced from the deposit during 1989. Tungsten deposits occur in many of the mining districts within the Carson City district, and several districts generated small to moderate production during periods of high tungsten prices. A very large deposit of tungsten ore was discovered in the Pilot Mountains district of Mineral County in the late 1960's. The deposit was carried to development stage and will, no doubt, be mined during some future period of more favorable tungsten market conditions.

At the present time, mining and prospecting activity in western Nevada, as well as in most of Nevada and other western states, is confined to precious metals. Within the Carson City district, one large open-pit silver mine, at Candelaria, and large open-pit gold mines in the Aurora, Lucky Boy, Rawhide, Santa Fe, and Shady Run districts are presently in operation or are in the process of starting operations. Other large deposits of low-grade, bulk-minable gold and silver have been developed within the Bell Mountain, Ramsey, Talapoosa, and Comstock districts and additional deposits will, no doubt, be discovered and developed as the result of the many exploration ventures now active in the Carson City district.

Nonmetallic, or industrial mineral, activity within the area of the BLM, Carson City District began in the early 1860's with the exploitation of salt deposits from playa lakes at various locations in Churchill and Mineral counties. Borate minerals were later discovered at these same locations, and small amounts of borax were produced. Gypsum has been produced from three localities within the district, and fluorite has been produced from two locations; gypsum continues to be produced from one

deposit but there has been no production of fluorspar since 1957. Small deposits of clay have been mined in several areas within the district, and some intermittent mining of clay still occurs.

Presently, the largest industrial mineral mining operations within the district are of diatomite, limestone, and rhyolite aggregate. Diatomite is mined from deposits near Clark Station, east of Reno, and from deposits near Hazen, in Churchill County. Limestone is currently being mined from one location southeast of Fernley in Lyon County, and is used to manufacture cement at the cement plant at Fernley. Rhyolite is mined from locations east of Carson City and southeast of Reno and is used mainly in the local construction industry for aggregate. Small amounts of zeolite are being mined from one deposit, near Eastgate in Churchill county, and salt, for road and livestock use, continues to be mined on a small scale from playa deposits east of Fallon.

Geothermal resources exist in several areas within the Carson City district. Most of these areas have been examined for power generation potential and power plants are in operation at sites south of Reno, in Dixie Valley northeast of Fallon, and at Soda Lake, west of Fallon. Geothermal resources at other of the sites have been considered for use in space heating and for other uses, such as vegetable drying and hydroponic gardening. The U.S. Naval Air Station, Fallon, has spent considerable time and money studying the use of geothermal resources present within the boundaries of the Naval Air Station; their use would probably be for electrical power generation and space heating within their facility.

Oil and gas resources are not known to exist within the Carson City district. Drilling for these resources has been done in locations near Fallon but no oil or gas deposits were found.

MINING DISTRICTS AND AREAS

ALLEN HOT SPRINGS AREA

Location

The Allen Hot Springs area, Churchill County, is on the northwest margin of the Blow Sand Mountains about 18 miles south of Fallon. Allen and Lee hot springs are about 1 mile east of U.S. Highway 95 and the only two known mining prospects in this area are a little over 1 mile to the east of the hot springs. The largest of the two prospects is less than one mile north of the boundary of a U. S. Naval bombing range (Range B-19). True to the name of the mountains, roads in this area are difficult to travel due to drifting sand.

History

Nothing is known of the mining history of this small area. It is possible that the area, in the past, has been included in the Holy Cross district.

Geologic Setting

The rocks exposed in the area of the two prospects are Tertiary rhyolitic welded ash-flow tuffs. These rocks overlie Jurassic-age dioritic rocks that crop out north of Allen Springs and are themselves overlain by extensive basalt flows to the south in the Blow Sand Mountains. Large areas of dune sand cover the northern flanks of the Blow Sand Mountains and extend east into Diamond Field Jack wash.

Ore Deposits

The one major prospect in this area explores a prominent zone of silicification, brecciation, and iron-oxide staining along a northwest-striking fracture system in a welded ash-flow tuff. Alteration here is similar to that found at prospects in the Barnett Hills several miles to the southeast.

ALPINE DISTRICT

Location

The Alpine district, Churchill County, is located in the central Clan Alpine Mountains about 40 miles west of the town of Austin. A small area on the western flank of the Desatoya Mountains near Cold Springs is also included in the district. The historic mines of the district are located in the upper drainage basin of Cherry Creek and Starr Canyon and near the mouth of Florence Canyon; these canyons drain the northeast flank of Mount Augusta, the highest peak in the Clan Alpine Mountains. The mines in Florence Canyon are accessible by good gravel and dirt roads that lead north from U.S. Highway 50. Access to the mines on the upper flanks of Mount Augusta, however, are dependent on the condition of the road up Cherry Creek Canyon; they are accessible mainly by foot.

Mines further to the northeast, along the eastern slope of the Clan Alpine Mountains near the foot of Mount Grant, are sometimes included in the Alpine district. Those deposits are now, however, included in the Tungsten Mountain district. The prospects at Cold Springs were included by Willden and Speed (1974, p. 71) in the Eastgate district.

History

The Clan Alpine (Alpine) district was organized in January, 1864, and many claims were staked at that time (Thompson and West, 1888, p. 366). A 10-stamp mill was constructed at Clan Alpine, at the mouth of Cherry Creek, in 1866. Mining in the area was short lived, however, and the mill was soon abandoned after producing only a few thousand dollars (Vanderburg, 1940, p. 20).

The Cold Springs area may have been prospected as early as 1907 but very little work was done at that time. The area was promoted in 1921 for a short time and some ore is reported to have been shipped from the property to the railroad in Fallon in 1948 (Bruner, F., 1974, p. 39)

Subsequent mining in the district has been on a small scale and sporadic, but deposits in lower Florence Canyon and at Cold Springs continue to sustain mining interest. Both of these areas were under claim when they were visited in 1989 and both show evidence of recent exploration drilling.

Geologic Setting

Tertiary volcanic rocks make up the entire area of this district. These volcanic rocks are related to two major eruptive centers. Oligocene quartz-latite tuff and rhyolite tuff, and Miocene(?) and Oligocene rhyolite flows and intrusions make up all of the Clan Alpine Mountains part of the district. These rocks are related to the Railroad Ridge collapse feature which occupies the central part of the mountain range generally south of War (Cherry Creek) Canyon (Hardyman and others, 1988, p. 6). At Cold Springs, on the eastern edge of the district, rock outcrops are composed of quartz latite and rhyolite ash-flow tuffs (Tuff of Desatoya Peak) erupted from the Desatoya Mountains eruptive center (McKee and others, 1987, p. 5-6). The mine area at Cold Springs may lie along structures related to the margin of the Desatoya Mountains eruptive center.

Ore Deposits

In the Clan Alpine Mountains portion of the district, prospecting and mining for silver and gold has been done in an area extending northwest from Florence Canyon on the south to the Cherry Creek drainage on the north. Schrader (1947, p. 324-330) reported that small amounts of gold and silver were produced from this area and that most of the deposits were predominantly silver-bearing. Most of the deposits are contained in epithermal quartz veins and silicified shear zones in rhyolitic volcanic rocks. Ore minerals include cerargyrite, argentite, and native gold. Quartz and adularia are common gangue minerals. Studies

by the U. S. Geological Survey (Hardyman and others, 1988, p. 13) report that gold-silver mineralization and associated hydrothermal alteration occur in a zone trending northwest from the mines near the mouth of Florence Canyon, across Starr Canyon, and extending north to Cherry Creek. In this zone, rhyolitic wall rocks show weak to locally intense argillic alteration and locally strong silicification along faults and shear zones; open-space mineralization and brecciation are common along with bleaching of the wall rock and iron- and manganese-oxide staining (Hardyman and others, 1988, p. 13). Recent work in this area includes underground work at the lower Florence Canyon adit and claim staking, road building, and drilling in the area north and south of Florence Canyon.

At the Cold Springs prospect, on the west flank of the Desatoya Range, silicified shear zones in a lithic-rich ash-flow tuff have been explored by a number of adits and shafts. Bands of white, chalcedonic quartz with some lamellar quartz which has replaced calcite follow the northwest-trending shear zone. This area has recently been explored by Phelps Dodge Corporation and ASARCO.

Geochemistry

Samples of ores collected from this district show silver and gold associated with moderately high arsenic and antimony values. Base metal values are very low, but beryllium and molybdenum values are moderately anomalous.

AURORA DISTRICT

Location

The Aurora district, Mineral County, is located about 3 miles east of the California border a little over 20 miles southwest of the town of Hawthorne. The district is situated east of Aurora Creek in an area of small hills bounded by Brawley Peaks to the south, Aurora Peak to the east, and Aurora Crater to the north. Most of the mines of the district are grouped on four of the hills, locally known as Silver Hill, Middle Hill, Last Chance Hill, and Humboldt Hill. Principal access to the district is by well-maintained gravel roads from Hawthorne via Lucky Boy Pass.

History

The Aurora district, originally known as the Esmeralda district and also called the Cambridge district, was discovered in August 1860 by J. M. Braly, J. M. Corey, and E. R. Hicks, three prospectors who, since about July of that year, had been working their way south from Virginia City on an extended

prospecting tour. While out hunting for camp meat one morning, Hicks made the discovery of rich, gold-bearing quartz on what was named the Old Winnemucca Ledge located near the brow and on the western slope of Esmeralda Hill (Angel, 1881, p. 415). Corey named the site Esmeralda, and the Esmeralda mining district was formed (Leigh, 1964, p. 81). The townsite was moved about 1 mile to the north shortly thereafter and renamed Aurora; Aurora became the county seat of Esmeralda County, Nevada and, for about two years, also served as the county seat of Mono County, California. This dual role came about as the result of confusion concerning the location of the Nevada-California boundary. Following the boundary survey of 1864, Aurora and the Aurora mines were determined to be in Esmeralda County, Nevada. Esmeralda County, one of Nevada's original 9 counties, was divided into two counties in 1911 and the Aurora district became part of the newly-created Mineral County (Carlson, 1974, p. 109, 168).

During its peak production years of 1861 to 1869, Aurora is credited with producing nearly $29,500,000 in gold and silver. The district was intermittently productive into the early 1900's and, from 1914 to 1918, enjoyed a brief resurgence when $1,850,000 in gold and silver were produced by Goldfield Consolidated Mines Co.; much of this production was probably from reworking dumps and tailings (Ross, 1961, p. 79). Siskon Corporation acquired Goldfield Consolidated Mines Co.'s holdings in the district and mined about 10,000 tons of ore grading better than 1 oz/ton gold from the Juniata veins in the late 1940's. Following this activity, the district was idle until 1982 when a small Canadian company, Electra Northwest Ltd., began a small heap-leach operation at the northern edge of the district (Osborne, 1987, p. 245). In 1985, Nevada Goldfields Inc. entered into a partnership with Siskon Corp. and began a concentrated drilling program in the district. The program was successful and, in 1989, Nevada Goldfields, Inc. was producing from and open-pit, heap-leach operation at what they have named the new Aurora mine. Announced mine reserves at this property are 1.5 million tons of 0.129 oz gold and 0.3 oz silver per ton (Bonham, 1988, p. 23); in June, 1989, the mine was producing at a rate of 1000 to 1500 tons per day of 0.08 oz/ton gold.

Geologic Setting

Tertiary volcanic rocks cover most of the Aurora area; exceptions are small areas southeast of Aurora where small windows of Triassic metavolcanic rocks and Cretaceous (?) granitic rocks are exposed (Ross, 1961, p. 65). At least three series of flows overlie and, in some cases, cut pre-Tertiary rocks in the Aurora area: Miocene porphyritic to nonporphyritic andesitic flows, breccias, and intrusive rocks; Miocene and Pliocene porphyritic to nonporphyritic rhyolite and rhyodacite plugs, cumulo domes, dikes, and flows; and Pliocene and Pleistocene andesitic and basaltic rocks related to Aurora crater

(Hill, 1915, p. 143; Kleinhampl and others, 1975, p. 4-15). The Aurora district has been defined by Kleinhampl and others (1975, p. 17-18) as a complex volcanic center in which volcanism was sporadic throughout a long period beginning in the Miocene and ending with the formation of Aurora Crater about 250,000 years ago.

Ore Deposits

Major production of gold and silver at Aurora came from conspicuous north- and northeast-striking steeply dipping quartz-filled fissure veins that cut 13.5- to 15.4-m.y.-old Miocene andesitic lavas and breccias (Kleinhampl and others, 1975, p. 24). The ore bodies occurred in branching quartz veins a fraction of an inch to 80 feet thick in the Miocene volcanic rocks over an outcrop area 2 miles by 1-1/4 miles. At least 14 major veins were mapped by Hill (1915, map) in this area. The high-grade ore generally was within 200 feet of the surface and appears to have developed along the veins where cut by north-striking faults (Green, 1964, p. 29-33). The veins consist mostly of finely granular white quartz which, in some places, has a milky-white porcelain-like appearance. The veins are commonly composed of layers of quartz of different grain sizes, and all the veins contain cavities lined with clear quartz crystals (Ross, 1961, p. 79). Hill (1915, p. 148) described the rich ore as containing wavy streaks of quartz, adularia, argentiferous galena, small amounts of pyrite and chalcopyrite, and a soft bluish-gray mineral supposed to be a combination of gold and possibly silver with selenium. Free gold was found in the richer ore. Adularia from one of the largest and most productive veins was dated by Kleinhampl and others (1975, p. 24) at 10.3 m. y. Altered zones associated with the vein system carry mineral assemblages characteristic of potassic, argillic, and propylitic alteration. Pyrite is commonly disseminated in the veined wallrock (Kleinhampl and others, 1975, p. 23).

Geochemistry

All samples of ore taken from the district during our examination contained detectable gold and silver; gold values ranged from 0.10 to 1.40 parts per million (.003 to .041 oz/ton) and silver ranged from 5 to 30 parts per million (.15 to .87 oz/ton). The ratio of gold to silver in our samples ranged from 1 to 10 to 1 to 60. This is quite different from the 1 to 2, 1 to 5, and 4 to 2 ratios given by Hill (1915, p. 150). Hill's values, however, probably reflect recovered metal ratios rather than metal ratios occuring in the ores. Our samples contained little else but precious metals; base metals, arsenic, and antimony were all very low to nil. Molybdenum values, however, were very anomalous in one sample from Silver Hill and in another from Middle Hill.

BELL DISTRICT

Location

The Bell district, Mineral County, also known as the Cedar Mountains district, is located in the Cedar Mountains in eastern Mineral County near the Nye County border. The central part of the district is about 18 miles east of Mina on U.S. Highway 95 and is accessible via gravel and dirt roads that lead east across a low pass in the Pilot Mountains to Stewart Valley and the Cedar Mountains. Mines in the eastern part of the district are accessible via gravel and dirt roads extending from Gabbs, 18 miles to the north in Nye County. Mines in Nye County, in the eastern foothills of the Cedar Mountains, are sometimes included in the Bell district; we include these mines in the Athens district of Nye County and do not discuss them in this report.

History

The Simon mine, in the central part of the district, was discovered in 1879 and small quantities of lead ore were mined from the gossan outcrop and shipped. In 1919, silver-bearing lead-zinc ores were discovered in the sulphide zone beneath the gossan outcrop. A 100-ton flotation mill, later enlarged to 250-tons, was erected and, between 1921 and 1927, $741,278 in silver, lead, and zinc was produced (Vanderburg, 1937, p. 72).

The Olympic (Omco) mine, at the north end of the Cedar Mountains, was located in 1915 and a 70-ton cyanide mill was erected on the site in 1917; this mill burned in 1919, another was built in 1920 but closed in 1921. The mine was then operated by various lessees until 1929 when it was sold at a tax sale. In 1932, the mine workings were caved by a severe earthquake (Vanderburg, 1937, p. 72-73). Total production from the Omco mine, through 1940, is about $800,000, mainly in gold (Couch and Carpenter, 1943, p. 104).

Tungsten deposits have been prospected at several localities south of Cedar Summit in the southern part of the district. The major tungsten properties, the Blue Bird, Cedar Chest, and Cedar Summit mines have together produced about 700 units of WO3 between 1953 and 1956 (Stager and Tingley 1988, p. 114-115).

Geologic Setting

The oldest rocks in the Cedar Mountains area are dark limestone and subordinate shale of the Triassic Luning Formation. Several granodiorite to monzonite stocks of probable Cretaceous age intrude the Triassic rocks (Ross, 1961) and have caused aureoles of thermal metamorphism to develop in the sedimentary rocks near their contacts with the exposed stocks (Nash and

others, 1985, p. 4). The sedimentary and intrusive rocks crop out mainly in the central portion of the Cedar Mountains. The northern and southern ends of the range are covered by Tertiary andesite, quartz latite, dacite tuff that are, in turn, overlain by lacustrine sediments of the late Eocene Esmeralda Formation (Knopf, 1922).

The Luning Formation is gently folded, and faults as young as Cenozoic are indicated by tilted or displaced Tertiary rocks, most notably along the west flank of the mountains (Nash and others, 1985, p. 4).

Ore Deposits

The most notable mineral deposits in the district are those in the Simon mine where two large, irregular, chimney-like shoots were developed. The ore bodies were replacement deposits in Luning limestone localized along an alaskite dike; ore minerals were galena and sphalerite which were enclosed in a jasperoid mass (Knopf described the ore as an argentiferous lead-zinc jasperoid). Associated minerals were pyrite and arsenopyrite in a gangue of calcite and limestone. The outcrop of the ore shoots were composed largely of siliceous gossan containing considerable plumbojarosite and locally some galena and cerrusite. The dike rock has been silicified and sericitized; it locally contains sulfides and quartz veining but did not contain sufficient metal to constitute ore. A belt of silicated rock consisting of garnet, diopside, actinolite, and calcite, lies parallel to the dike rock in the limestone adjacent to the mine (Knopf, 1921, p. 370-372).

The other major deposits located in this district, gold-bearing quartz veins in Tertiary volcanic rocks, occur in the north end of the range. The largest of these deposits is the Olympic (Omco) mine located about 4 miles north of Simon. The ore at the Olympic mine consists of fine-grained white quartz, much of it clearly pseudomorphic after platy calcite, containing a gold-silver alloy so finely divided as to be invisible. Pyrite in traces is the only sulfide present. The quartz vein had an unusual concave upward form and was hosted in highly argillized rhyolite flows just below Miocene lacustrine beds (Knopf, 1921, p. 377).

Tungsten-bearing skarn deposits have been prospected at many localities near the stocks where garnet and other calc-silicate minerals are developed in limy rocks of the Luning Formation. Most of these occurrences are in the south end of the district, south of Cedar Summit. Properties of this type include the Blue Bird, Cedar Summit, and Cedar Chest mines.

Recent activity in the district includes exploration for tungsten near the Cedar Chest mine (between 1980-85), exploration

for gold in the area of volcanic rocks southwest of Simon, and most recently, road building and drilling near the Cedar Summit mine. Companies active in the district in 1989 included American Gold Resources (Simon mine), Battle Mountain Exploration Co. and Bond Gold Corp. (Cedar Mountains), Cominco American Resources (Omco Wash), and FMC (Simon West).

Geochemistry

Samples of ores collected in the district show generally clear associations of elements within the three types of deposits mined. Replacement ores at Simon show high silver, lead, and zinc and moderate copper associated with high arsenic, antimony, and cadmium. Gold ores north and east of Simon were moderately anomalous in arsenic, but low in base metals and most other elements. Skarn tungsten ores from the south part of the district, in addition to tungsten, were anomalous in tin and molybdenum; base metals in the skarn ores were very low.

BELL MOUNTAIN DISTRICT

Location

The Bell Mountain district, Churchill County, includes Bell Mountain and the surrounding low hills lying generally northeast of Bell Flat. The district is centered around the Bell Mountain mine in Sections 10 and 11, T15N, R34E, but also includes prospects to the east in the eastern half of T15N, R35E. The Bell Mountain mine is about 6 miles southeast of Fairview Peak and can be reached by a moderately well-maintained gravel road that leads south from U.S. Highway 50 at a point just east of Drumm Summit.

History

The Bell Mountain deposit was located in March 1914 by W. W. "Billy" Stockton who did the original development on the property. Exploration was conducted by the Nevada Wonder Mining Co. between 1916 and 1919 but they were not successful in developing ore of sufficient grade to mine at that time, and work on the property ceased (Schrader, 1947, p. 135). According to A. L. Payne (quoted in Garside, 1984, p. FT4 11), 39 tons of ore with a grade of 0.5 oz/ton gold and 16.4 oz/ton silver was produced from the property in 1927. After many years of inactivity, Bell Mountain Mining Co. obtained the property in the late 1970's and commenced exploration for large-tonnage deposits that could be mined using heap-leaching methods. The company was successful in defining over 2 million tons of material grading from 0.022 to 0.14 oz gold/ton and 1.0 to 3.3 oz silver/ton (Bonham, 1983, p. 15). Plans were made in 1981 to place this property into operation but the plans were not carried out. In 1989, when the property was visited, there were no indications of

recent activity. N. A. Degerstrom has recently acquired the property and intends to begin production in 1991 at a rate of 2 million tons per year (personal comm., D. Jacquet, 1990).

Geologic Setting

The Bell Mountain district is underlain entirely by extrusive rhyolite to rhyodacite units of Miocene age that occur as flows, tuffs, tuff breccias, and welded ash-flow tuffs (Willden and Speed, 1974, p. 46). The rocks are cut by a dominant sheeting that strikes N750E and dips 800NW, and by another sheeting that strikes N250W and dips 700E.

Ore Deposits

The Bell Mountain deposit described by Schrader (1947, p. 137-139) is a quartz-calcite vein of known extent of more than 3,000 feet. The vein varies from 10 feet to more than 50 feet in width and does not outcrop prominently. In places, the wall rock, especially the hanging wall, contains quartz stringers up to 2 1/2 inches wide paralleling the main vein. The vein is coarsely banded, much of it has been brecciated and re-cemented with fine-grained silica, and consists of quartz, calcite, and partially-replaced country rock stained with oxides of manganese and iron. The best ore in the vein was generally associated with almost pure quartz, especially quartz stained an apple-green tinge; the ore always panned considerable silver sulfide as well as gold and, on weathering, it turned bluish due to oxidation of the silver sulfides. Some calcite in the ore has been replaced by quartz and the more siliceous ore is reported to contain small vugs lined with crystalline quartz and adularia (Schrader, 1947, p. 138). Payne (in Garside, 1984, p. FT4 11) reports that the principal hypogene minerals at this property are believed to be electrum and argentite, probably accompanied by small amounts of base metal sulfides and silver sulfosalts. Supergene oxidation has produced native silver, cerargyrite, and possibly fine-grained acanthite.

Recent exploration on the Bell Mountain property follows an east-west-trending, quartz stockwork zone in silicified ash-flow tuff and tuff breccia. The zone is up to about 600 feet wide in its central part; rock in the zone is laced with white, vuggy quartz veins, fracture surfaces are coated with clear, manganese- and iron-oxide-stained quartz crystals. Some lamellar quartz replacing calcite is present and areas of hydrothermal brecciation parallel the east-west structures. Old shafts on the west end of this structure (part of the original Bell Mountain mine) were sunk on a massive, white calcite vein about 20 feet thick. The massive vein is cut by later quartz veinlets and surfaces of fractures in the calcite vein are coated with drusy quartz crystals.

The only other property included in this district, the Cye Cox prospect, is about 4 miles east-northeast of the Bell Mountain mine. At this property, two or three parallel fault zones in silicified rhyolite have been trenched and explored by limited underground workings. The fault zones are expressed as rubble zones that appear to follow older fractures and veins in the silicified rhyolite. This property has been recently trenched and drill roads have been constructed. Remains of a leach pad at a camp below the mine indicate an attempt has been made to leach ore from the property; the attempt does not appear to have been successful.

BENWAY DISTRICT

Location

The Benway district, Lyon County, is located in Sections 11, 12, 13, and 14, T14N, R28E and Sections 7 and 18, T14N, R29E. The mines and prospects are located on the south end of Painted Mesa, a 2-mile wide, southwest-trending lobe of the Desert Mountains. The district is about 10 miles north of Schurz and 1 mile west of U.S. Highway 95; the area is entirely within the Walker River Indian Reservation.

History

Schrader (1947, p. 292) believed discoveries of gold-bearing veins in this area predated discoveries in the nearby Terrell (Holy Cross) district. In 1916, the district was active and a shaft was being sunk on one of the properties. Production, if any, is small and no record of it is available. The district was apparently inactive until the late 1950's when it and the surrounding region was extensively prospected for iron and copper deposits. An aeromagnetic anomaly possibly related to disseminated or skarn copper deposits was detected as early as 1956 and ground follow-up work by Idaho Mining Co. began in 1963. Drilling by Walker-Martel Mining Co. was carried out between 1965 and 1967 and in 1974. Results of this work were not encouraging and the property has been idle since that time (Satkoski and others, 1985, p. 76).

Geologic Setting

Rocks in the district consist of Mesozoic schist, slate, quartzite and limestone which were intruded and metamorphosed by Cretaceous intrusive rocks. The intrusive rocks have been divided into several units ranging in composition from diorite and gabbro to granodiorite, quartz monzonite, and aplite. The contact-metamorphosed rocks consist of recrystallized limestone, calc-silicate rock, and skarn. In places, the intrusive rocks are intercalated with calc-silicates and skarn and variations in the

intrusive rocks may be partially due to assimilation of country rock (Satkoski and others, 1985, p. 78).

Tertiary volcanic units, consisting of tuffs, andesite, rhyolite, and intrusives and Quaternary units consisting of basalt, trachybasalt, andesite, and intrusives also occur throughout the area (Satkoski and others, 1985, p. 78).

Structurally, the area lies along a right-lateral, strike-slip fault system that strikes N20OW to N40OW. These faults are, in places, offset by a system of northeasterly faults which may have step-faulted the granitic rocks downwards to the east (Satkoski and others, 1985, p. 78).

Ore Deposits

Two types of ore deposits have been explored in the Benway district; copper-silver-gold-bearing quartz veins, and disseminated sulfide deposits in silicated zones associated with various intrusive contacts.

The vein deposits, described by Schrader (1947, p. 293-296), consist of a series of 10 or more veins that strike nearly east-west, dip steeply south, and cut both intrusive rocks and limestone. The veins are up to 20 feet wide and some extend for up to a mile along strike. Vein filling is mostly crushed or sheared and altered rock, quartz, and argillaceous gangue-like material stained with iron and manganese oxides. Tourmaline is reported to be present. Metallic minerals present include argentite, chalcopyrite, and pyrite along with minor molybdenite and stibnite. Cerargyrite, malachite, hematite, limonite, manganese oxides, gold, and silver are present in the oxidized portions of the veins. Apparently prospecting of these occurrences was restricted to the oxidized portions of the veins where supergene enrichment concentrated gold and silver values. Vein deposits include the Eureka mine, Copper King prospect, Riovista prospect (Schrader, 1947, p. 294-295), and the Afterthought shaft (Satkoski and others, 1985, p. 75).

The magnetic anomaly explored in the 1960's for copper by Idaho Mining Co. and Walker-Martel Mining Co. is centered around the old Afterthought shaft. Quartz veins containing hematite and traces of copper carbonates are exposed at surface in this area. The magnetic anomaly is centered on a diorite-quartz monzonite contact and follows a northeast-trending fault. Drilling of an induced-polarization anomaly in this area revealed extensive disseminated pyrite with some minor, near-surface chalcopyrite mineralization; fill-in drilling revealed only trace amounts of copper, with no associated gold values, to be present. Minor amounts of base metal mineralization were encountered in the drilling, but were too deep and too low grade to be of economic interest (Satkoski and others, 1985, p. 80).

BERNICE DISTRICT

Location

The Bernice district, Churchill County, is on the west slope of the Clan Alpine Mountains about 60 miles east-northeast of Fallon. The district extends from Shoshone Canyon on the north to Dyer Canyon on the south; the mines of the district, however, are concentrated in an area about 5 miles square that lies between Dyer Canyon and Hoyt Canyon. Access to the district is best from the west side via the Dixie Valley road.

History

Silver-gold-antimony mineralization was first discovered at what is now the Bernice mine in 1886; a 10-stamp mill was built on the property and more than half a million dollars in silver and gold is said to have been produced between 1886 and 1890 (Schrader, 1947, p. 319-320). The ores contained considerable arsenic in the form of arsenopyrite and the mill was equipped with two White-Howell roasters (Vanderburg, 1940, p. 16). In 1892, some of the deposits began to be worked for antimony and they have been operated periodically since when the price of the metal has warranted. Shipments of antimony ore were made during 1893-1896, in 1906, and considerable production was made during World War I (Schrader, 1947, p. 320). Several mines were active in the 1940's and one property was operating in the spring of 1967 (Willden and Speed, 1974, p. 61). Total antimony production of the district, through 1963, is estimated to be about 300 tons of metal (Lawrence, 1963, p. 21-32). No mines were in operation when the district was visited in 1989. Many new lode mining claims covered portions of the district, however, and geologic mapping and sampling were in progress. This work is probably for precious metals, not antimony.

Geologic Setting

Rocks cropping out in the Bernice district consist mainly of thin-bedded black slate, gray slate and shale, brown to gray sandstones, some interbedded limestone, and minor quartzite of Triassic age (Schrader, 1947, p. 320; Willden and Speed, 1974, p, 61). These sedimentary rocks generally trend northwest and dip to the southwest. Andesite and rhyolite extrusive rocks unconformably overlie the sedimentary rocks; several basalt and andesite dikes cut the other rocks. Two felsite sills, striking northerly and dipping to west, crop out in the area of the mines. The sills are roughly parallel and are approximately 300 feet apart. The sills were porphyritic, although alteration has obscured the original texture; phenocrysts of feldspar are

sericitized, and the fine-grained groundmass commonly is silicified (Lawrence, 1963, p. 21).

Ore Deposits

Ore in the district occurs as veins in the Triassic sedimentary rocks. Some of the better antimony ore occurs in or near the felsite sills.

At the Bernice (Williams) mine, the vein varies from 1 to 6 feet or more in width and consists of quartz and crushed, altered rock or fault breccia. Sulfides present in the vein include pyrite, arsenopyrite, stibnite, sphalerite, galena, and minor tetrahedrite and jamesonite (Schrader, 1947, p. 321-322).

Mines in the district exploited mainly for antimony, such as the Hoyt, Arrance, Antimony King, and Lofthouse mines, are essentially the same as the precious metals mines with the exception being the predominance of stibnite over other metal sulfides. Veins range from a few inches up to several feet in width and contain pods and lenses of massive stibnite with quartz, pyrite, and minor amounts of other metallic sulfides. Locally, stibnite in the veins is partially oxidized to yellow and white antimony oxides. At the Antimony King mine, the exposed vein roughly parallels a felsite sill and stibnite occurs with quartz as pods, blebs, and veinlets in the fractured sill (Lawrence, 1963, p. 23).

BOVARD DISTRICT

Location

The Bovard district, Mineral County, includes the northwestern Gabbs Valley Range and extends generally from Wildhorse Canyon on the southeast to Copper Mountain on the northwest. Nugent Wash bisects the district; mines on Copper Mountain lie to the northwest of the wash, the Rand and Golden Pen deposits lie to the southeast of it. In this report, the Bovard district is defined to include the Rand, Bovard, and Copper Mountain mining districts of Schilling (1976) and is the same area as the Rand district of Schrader (1947, p. 237). Vanderburg (1937, p. 55) also used the term Rand district, but included in it only those areas to the southeast of Nugent Wash and did not discuss the Copper Mountain area in his coverage of Mineral County.

History

The first mineral discoveries in this district were made at Copper Mountain, in the northern part of the district in June,

1906. In 1907, discoveries were made at the Bovard mine, about 1/2 mile southeast of what is now known as the Golden Pen mine. The original discovery was made by a group of prospectors from Rawhide headed by Albert J. Bovard and the area came to be known as the Bovard district. Deposits to the northwest of Bovard, including the Golden Pen, Lone Star, and Rand properties were made soon after this. Production of the district, mainly from the Golden Pen, Copper Mountain, and Nevada Rand mines, amounted to about $530,000 through 1919 (Schrader, 1947, p. 237). Couch and Carpenter (1943, p. 101) credit the district with additional of $60,000 for 1921 through 1939; the district has recorded no production since that time.

Walker-Martel Mining Co. and later Idaho Mining Co. intermittently performed exploration work on the Copper Mountain property from 1960 to 1975 but the property is now inactive. Recent bulldozer work and drilling has been done in the area of the Bovard, Golden Pen, and Last Hope mines. No activity was noted, however, at the time these properties were visited in May 1989.

Geologic Setting

The district is underlain principally by rhyodacitic to quartz latitic ash-flow tuffs and lavas of late Oligiocene to Miocene age that have been intruded in some areas by dioritic rocks of Miocene age (Ekren and Byers, 1986). Small outcrops of pre-Tertiary rocks occur in two general localities the district. Copper Mountain, at the north end of the district, is composed of a triangular-shaped, fault-bounded block of limestone of the Upper Triassic Luning Formation that has been intruded by a Middle to Late Jurassic granodiorite body. Near the granodiorite contact, the limestone is recrystallized to light-gray and white marble (Ekren and Byers, 1986). On the southeast end of the district, Luning limestone crops out in small windows formed in a detachment fault surface and in an elongate fault-bounded block along the east side of a ridge north of Wildhorse Canyon.

The area is structurally complex, with dominantly northwest to west-northwest trending high-angle faults being the major structural features.

Ore Deposits

Two distinct types of mineralization occur in the Bovard district.

In the Copper Mountain section of the district, replacement lenses of copper sulfide ore occur mainly in garnet-rich skarn formed along a granodiorite-limestone contact zone. Quartz latite porphyry dikes cut and have displaced mineralized portions of the deposit (Satkoski and others, 1985, p. 100). The

1960s. In 1961, [illegible] were [illegible] of the [illegible] mile [illegible] of what is now known as the [illegible] mine. The original discovery was made by [illegible] headed by [illegible] and [illegible] as the [illegible] district. [illegible] including the Golden Sun, [illegible] were made soon after this. [illegible] the Golden Sun [illegible] to about $150,000 through 1919 [illegible] and Carpenter (1949, p. 103) credit the district with [illegible] of $60,000 for 1911 through 1939; [illegible] production since [illegible].

[illegible] intermittently [illegible] exploration work on the Golden Sunlight property from 1958 to 1979 [illegible] the property [illegible] of the [illegible] 1980.

GEOLOGIC SETTING

The district is [illegible] predominantly by [illegible] rocks of [illegible] age that have been intruded [illegible] rocks [illegible]. The [illegible] Golden Sunlight [illegible] is composed of a [illegible] of the [illegible] along the east side of a [illegible].

The area is structurally complex, with [illegible] northeast-trending [illegible] structural features.

ORE DEPOSITS

The district [illegible] types of [illegible] deposits in [illegible] district.

In the [illegible] deposits [illegible] of copper [illegible] and [illegible] of [illegible] Golden Sunlight [illegible] of the [illegible] (1949, p. [illegible]). The garnetized, contact metamorphic zone though not always present is a characteristic feature of the deposits, much of the ore ran about 6 percent copper with minor values in gold and silver (Schrader, 1947, p. 272). Tabular bodies of replacement ore also occurred in the quartz latite dikes along the contact. These bodies were a foot or more wide and were composed of dark gray sulfide and chalcopyrite; much of this ore ran more than 30 percent copper. The quartz latite is intensely altered and, in areas, contains sulfide minerals as disseminated grains and streaks (Schilling, 1968, item 17). Oxidized portions of the ore bodies cropped out as heavy, iron-bearing gossans, in some areas containing chrysocolla and malachite. Native copper occurred along with chalcocite and cuprite in enriched areas beneath surface leached zones. Native gold and silver were also reported to be present. Molybdenite occurs disseminated in the porphyry and as coatings on fracture surfaces in deeper levels of the mine (Schrader, 1947, P.275).

Quartz veins containing gold, silver, and some copper cut rhyolite ash-flow tuffs and intermediate volcanic rocks in the southern part of the district. The Golden Pen, Lone Star, and Bovard mines are developed along the Golden Pen vein which is emplaced along a northwestward-trending fault that offsets the ash-flow tuff sequence. The faulted and brecciated zone dips vertically and is 20 to 200 feet in outcrop. Within this structure, the mineralized veins are 3 to 8 feet thick and consist of broken and brecciated quartz cemented by sheets and pods of fine-grained alunite. Veinlets of alunite extend into the wall rocks and alunite appears to be a primary replacement mineral that extends some distance from the vein. Prospect pits and small adits trace the vein outcrops for at least one mile along strike. Northwest of the Golden Pen mine, the fault bends, or splits, and continues across the range with a more westerly trend. Numerous prospects, adits, and shafts, including those of the Rand and Nevada Rand mines, are developed along this section of the fault.

Ore seen on dumps at these mines is mainly banded quartz containing fine-grained pyrite, chalcopyrite, and minor free gold; the quartz is sometimes vuggy and is heavy with manganese-oxide stainings and coatings. Some of the quartz is pseudomorphic after calcite. Other minerals reported in veins at the Rand mine include hematite, electrum, cerargyrite, argentite, minor tetrahedrite, calaverite (?), malachite, chrysocolla, tenorite, argentiferous cerussite, pyargyrite, and polybasite; selenium is reported to be present. Wulfenite occurs in the veins as disseminated, white or yellowish, platy crystals (Schilling, 1968, item 18). Alteration in the vicinity of the Golden Pen mine is of the advanced argillic type with veins of alunite, quartz, limonite, and kaolinite (?) replacing wall rock minerals. Near the Rand and Nevada Rand mines, alteration appears to be sericitic and phyllic (Silberman, 1977).

silicified, contact metamorphic zone though not always present is a characteristic feature of the deposit. Most of the ore runs about 6 percent copper with minor values in gold and silver (Schrader, 1947, p. 217). Skarn, a product of replacement, has also occurred in the granite inlier along the contact. These bodies were a dark or more wine and were composed of dark gray calcite and andradite garnet as well as the ore minerals of pocket copper. The granite inlier is intensely altered and in areas, contains calcite, epidote, is disseminated pyrite and minerals (Schrader, 1947, p. 217). Gold-bearing portions of the ore had been enriched and are such as the vein, in some areas containing chalcopyrite along with chalcocite and covellite in what were commonly surface leached zones. Native gold and silver have also reported to be present. Malachite, azurite, chrysocolla in the gossan and as coatings on fractures are found in upper levels of the mine (Schrader, 1947, p. 217).

Quartz veins containing gold, silver, and some copper and sulfide minerals occur in metamorphic rocks exposed in the southern part of the district. The veins are quite small, and several mines are developed along the veins and trend northeast to northwest along a northeast-trending fault that offsets the adjoining rock sequence. The veins, and a few lower ones dip vertically and 14 to 30 cm thick in places. Outside this structure, the mineralized veins are 3 to 5 feet thick and consist of quartz and specularite which is replaced by pyrite and some of chalcopyrite and siderite. Particles of visible native gold are small and are found to occur in near surface vein-related mineral that extends some distance from the vein. Oxidation zones and sulfide zones are more persistent on the vein with heavy sulfide. Wall rocks at the surface are vuggy, and the black, or white, and vein and other rocks contain a more oxidizing stage. Silicified greenstone, schist, and sulfides, including those of the Reed and others have fault, with some that lie on the east segment of the fault.

The zone of quartz veins known as Copper, Carbonate quartz containing disseminated pyrite, chalcopyrite, and minor free gold; the quartz is fine-grained, and is cut by calc-carbonate veinlets and sulfides. Pyrite is the most abundant as porphyroblastic after calcite. Other minerals reported in the zone are tetrahedrite, bornite, chalcocite, argentite, gold, sphalerite, galena, barite, and molybdenite, and ankerite, siderite, magnetite, and hematite. Considerable alteration is confined to the vein, with the main ore minerals located in the veins and chalcopyrite, chalcocite, pyrite, ..., and argentite (Jones, 1950, p. 200). Mines in the district on the ... of the ... and the mine is at the channel where the south end of ... granite, quartz, porphyry, and ... in the vein and ... Zones, then this zone and ... mines ... of ... ... to be associated with ... of ... ... lead, zinc.

Sericite from altered volcanic rocks at the Golden Pen mine has been dated and gives a potassium-argon age of 22.6 ma. Alunite from the same vein reports a potassium-argon date of 4.7 ma (Weaver, 1982, p. 56).

BROKEN HILLS DISTRICT

Location

The Broken Hills district, Mineral County, includes the southern Broken Hills, a low range that defines the north end of Gabbs Valley, as well as small area on the east slope of the northern Monte Cristo Mountains. The district is confined to the narrow eastern prong of Mineral County, here only 2 to 4 miles wide, that separates Churchill and Nye counties. The Quartz Mountain part of the Lodi district is across the Nye county line to the southeast and the King district, Mineral County, is directly west of the district, on the west slope of the Monte Cristo Mountains. State Highway 361, which follows Gabbs Valley Wash, divides the Broken Hills district; fluorite mines lie to the west of the highway in the Monte Cristo Mountains and the silver mines lie east of the highway in the southern Broken Hills.

History

Silver deposits at Broken Hills were discovered in 1905 by James M. Stratford; iron-stained, oxidized float containing silver chloride and lead carbonate lead him to outcrops of one of the veins near the site of the Broken Hills mine. Nothing resulted from this discovery but, in 1913, Stratford returned with others and was successful in discovering commercial silver ore in the main Broken Hills vein. By 1920, about $70,000 worth of silver-lead ore had been shipped from the property (Schrader, 1947, p. 125). Couch and Carpenter (1943, p. 101) credit the silver-base metal mines of the district with about $180,000 between 1935 and 1940. The total metallic production, through 1940 totals about $250,000.

Fluorspar was discovered in the Monte Cristo Mountains on the west side of the district in 1922 by V. S. Baxter. Fluorite mining began in 1928 and continued until 1957; Baxter mined the property from 1928 through 1951 and Kaiser Aluminum and Chemical Co. operated from 1952 through 1957 (Papke, 1979, p. 29). During this time, nearly $6,000,000 worth of fluorspar was mined from the property (Ross, 1961, p. 80).

The only signs of activity in the district in 1989 consisted of evidence of sampling and bulldozing at the Broken Hills mine. Dumps at the mine have been trenched and sampled; some material has possibly been removed for testing or processing elsewhere.

Geologic Setting

Rocks cropping out in the district consist mainly of Tertiary volcanic rocks of intermediate composition, chiefly rhyodacite to andesite flows, tuffs, and breccia. Rhyolite and quartz latite crystal-rich, welded ash-flow tuffs cover parts of the district. Andesite and basalt dikes and irregular bodies intrude the andesite volcanic rocks. The andesite wall rocks near these intrusions has been extensively hydrothermally altered. Granite, probably of Cretaceous age, is reported to crop out both north and south of the district (Schrader, 1947, p. 127).

Ore Deposits

Silver-lead deposits in the Broken Hills occur in quartz veins which cut andesite tuff breccia. The deposits are associated with 6 or more veins which are contained in a zone of mineralization about 400 feet wide. In general, the veins are not large; they range up to about 2,000 feet in length, 9 feet in width, and extend to a depth of at least 350 feet. They have well-defined walls, but are accompanied by little or no gouge and are not associated with croppings of silicified wall rock. Most veins, in fact, do not outcrop but were discovered by cross trenching, though the position of some of them is indicated by bands of prominently mineral-stained rock debris, weathered even with the adjacent surface. The principal veins, the Broken Hills veins and the Belmont vein, strike northwesterly and dip steeply to the west but there are other cross veins of various attitudes. The veins are composed chiefly of hydrothermally altered andesite tuff breccia and minor quartz; the ore minerals mainly replace the altered wall rock. Oxidation in the veins extends to about 150 feet, oxide mineral present include gypsum, cerargyrite, cerussite, anglesite, limonite, plumbojarosite, and jarosite. Primary sulfides, consisting of argentiferous galena, jamesonite, pyrite, chalcopyrite, sphalerite, and rare molybdenite, begin to appear at about 120 feet. Proustite and pyargyrite are reported in both oxide and sulfide zones (Schrader, 1947, p. 129-130).

In the Broken Hills fluorite district, in the Monte Cristo Mountains about 5 miles west of the silver mines, fluorite veins occur in Tertiary andesitic rock and in rhyolite ash-flow tuff. Veins are localized in northeast-striking, northwest-dipping faults and shear zones and show characteristic features of open-space filling. Fluorite forms botryoidal and drusy coatings or veins within the andesite and rhyolite tuff; cockade structure is common. The fluorite is mainly white, pale green, or lavender, and ranges from very fine-grained, layered aggregates to euhedral crystals up to 1 inch across. At the Baxter (Kaiser) mine, the major producing property, the mineralized zone occurred in

andesitic rocks and has been traced for about 2000 feet along strike and 700 feet down-dip; the vein averaged only 1.5 feet in thickness (Archbold, 1966, p. 10). The Spardome property, southwest of the Baxter, is developed on a fluorite-cemented breccia formed along a shear zone in a rhyolitic lithic-rich, crystal tuff. The shear zone strikes northeast and is about 600 feet wide in outcrop north of the Spardome shaft.

Geochemistry

The precious metals-bearing deposits at the camp of Broken Hills contain silver and gold associated with very high arsenic, antimony, lead, and zinc, some high molybdenum, and low but anomalous tin. Copper values are moderately high, but are relatively low compared to lead and zinc.

BRUNER DISTRICT

Location

The Bruner mining district is located in the northern end of the Paradise Range a short distance south of Burnt Cabin Summit. The major mines are in Nye County but a few small prospects near the head of Lodi Valley on the east side of the Paradise Range in adjacent Churchill County are included in the district.

History

The first work reported in the district was at the Black Mule mine (later known as the Paymaster mine) in July 1906 and other discoveries were made during the following year. The townsites of Phonolite and Duluth were established in 1907 to serve the new mines but the boom was brief and both towns had folded by late 1908 (Paher, 1970). Activity resumed in the district in 1915 and a mill was built on the Paymaster property in 1919. The mill ran only a few years, however, with limited success (Kleinhampl and Ziony, 1984). The major mine in the district, the Penelas, was discovered before World War I but did not provide significant production until the mid-1930's; in the period between 1936 and 1940 the Penelas mine is credited with $898,629 in gold and silver (Couch and Carpenter, 1943). In 1981, a small mill was in operation at the Paymaster mine; some ore also may have been hauled to the mill from the nearby Derelict mine. In early 1989, the properties in central Bruner district were controlled by Newmont Exploration Co. Other companies reported to have been active in this district in the past few years include Kennecott (1985), Corn and Ahern (1986), and Marshall Earth Resources (1989).

Geologic Setting

The largest part of the Bruner district is underlain by Tertiary volcanic rocks, chiefly silicic domes, plugs, and irregularly shaped intrusive bodies. Kleinhampl and Ziony (1984, p. 66-67) believe that a small volcanic center is coincident with the district; the Bruner center lies on the southeastern periphery of what may be a genetically related much larger center, possibly a caldera, immediately to the northwest in Churchill County.

Ore Deposits

The ore deposits in the Bruner district are free-gold bearing quartz veins that formed along fractures, faults, and breccia zones in rhyolitic volcanic rocks. Sugary adularia crystals coat fracture surfaces in some of the open breccias. The mineralized breccia zones are probably, in part, hydrothermal breccias which were later silicified and filled with drusy to chalcedonic quartz vein material containing pyrite and free gold. In two of the properties examined, multiple stages of hydrothermal brecciation were noted. The wall rocks are silicified and locally argillized; biotite in the rhyolites is converted to sericite near the veins. some quartz-vein matter exhibits a platy or lamellar texture which is believed to represent a pseudomorphic replacement of calcite. Iron-oxide minerals and jarosite are present in the oxidized vein material found on most of the dumps. Most of the mine workings are in the oxidized zone. From exposures seen at the properties visited, many of the mineralized structures are high-angle and are generally northerly trending. Rhyolitic porphyry that is probably equivalent to the mineralized rhyolites in the mines has been dated by K-Ar methods at 19.3 m.a. (Kleinhampl and Ziony, 1984, p. 66). The mineral deposits are probably younger than that date. When the district was visited in July 1989, adularia for age-dating was collected from vein material at the Duluth mine but the results are not yet available.

Geochemistry

Ore samples collected from mines in the district showed values in silver and gold associated with anomalous beryllium and moderately high barium and manganese. Base metal, antimony and arsenic values are very low in samples from this district.

BUCKLEY DISTRICT

Location

The Buckley district, Mineral County, occupies most of the northern Gillis Range and extends from the drainages of Wildhorse

Canyon, Wovoka Wash, and Hidden Wash on the southeast to the northern flanks of the range. Most of the northern part of the district and many of the mines and prospects are included within the Walker River Indian Reservation.

History

Very little is known of the mining history of this area. The name Buckley derives either from a 1907-era town on Walker Lake that served as access to prospects in the Dutch Creek area of the Wassuk Range or from the Buckley mine and associated camp located on the south side of Buckley Flat in the Gillis Range. Neither of these two areas is included in the present Buckley district.

Activity in the district no doubt dates from the 1906-1907 prospecting rush triggered by discoveries at Rawhide to the north of this area. Several of the mines appear to have produced small amounts of gold and copper ores (Satkoski and others, 1985), but the only recorded production is about 800 units of WO_3 from the Lucky Four tungsten mine (Stager and Tingley, 1988, p. 132).

Areas within the district were explored for copper deposits, both porphyry and skarn-related in the late 1960's and 1970's. Considerable geophysical work and drilling was done at the Copper Hill prospect but the results of this work are not known. In the early 1960's, Idaho Mining Co. discovered the Hottentot iron-copper deposit in the Hu-Pwi Wash area on the north end of the district. Follow-up exploration was successful in defining a reserve of iron-copper ore but no mining has been done on the property.

Companies reportedly active in the district in 1989 included Atlas Precious Metals, Inc., and Strato Geological Engineering, Ltd.

Geologic Setting

This portion of the Gillis Range is composed of Triassic metasedimentary and metavolcanic rocks which have been intruded by Jurassic and Cretaceous intrusive rocks. These rocks have been complexly faulted, eroded, and overlain by a thick sequence of Tertiary volcanic rocks. The Gillis Range and the adjacent Gabbs Valley Range are cut by several northwest-trending strike slip faults of regional extent. In addition, thousands of moderate-angle normal and oblique-slip faults occur that, in general, parallel the strike-slip faults and greatly extend the Tertiary strata. Detachment and bedding plane faults occur at several stratigraphic horizons in the Tertiary section which generally displace younger strata over older; a detachment fault separates the bulk of the Tertiary section from the underlying Mesozoic basement (Ekren and others, 1980, p. 3).

The outcrop pattern in the part of the northern Gillis Range included in the Buckley district is one an elongate, northwest-trending, fault-bounded trough with fault slices of Tertiary volcanic rocks filling the trough and faulted Mesozoic rocks forming its margins (Hardyman, 1980).

Ore Deposits

The mines and prospects in this district are confined to outcrops of Mesozoic rocks. Prospects are found along Gillis and Wildhorse canyons on the west side of the district and in the areas of the Red Granite and Centipede mines on the north end of the district. Mineralization at most of the properties consists of sulfide-bearing skarns associated with intrusive-limestone contacts. The deposits typically contain small amounts of gold and silver as well as copper and skarn at one property was mined for tungsten. The extensive faulting in the range complicates relationships at the mines.

From literature reports, copper skarn deposits at the Copper Hill prospect have received more exploration attention over the years than any others in the district. At the Copper Hill Prospect, quartz veining containing pyrite, minor chalcopyrite, and trace amounts of silver, lead, zinc, and molybdenum occur in a quartz monzonite pluton and massive andraditic skarn. Drilling of the prospect did not outline minable reserves of copper or molybdenum but large areas of silication and alteration were encountered. After examination of reports and drill information on this property, the U.S. Bureau of Mines (Satkoski and others, 1985) recommended further study of the area.

The Lucky Four (Gentry) tungsten mine has provided the only recorded production for the Buckley district. In a production period extending from 1937 to 1956, an estimated 800 units of WO_3 were produced from the property. Scheelite mineralization at the Lucky Four mine occurs in irregular skarn bodies formed at the contact of limestone of the Triassic Luning Formation with a Cretaceous quartz monzonite porphyry. The grade of ore from the property is estimated to have averaged about 1.5 percent WO_3 (Stager and Tingley, 1988, p. 132).

At two separate properties on the north end of the district, the Red Granite and the Centipede, work has been directed at gold-bearing quartz veins that cut granitic rocks.

The Hottentot deposit, lying generally between the Red Granite and Centipede mines, is a contact metasomatic iron-copper deposit similar to others which occur in a northwest-trending belt that extends toward the Calico Hills. At the deposit, magnetite and hematite are hosted in a fine-grained, silicified and albitized intrusive that ranges from gabbro to

quartz monzonite in composition. The magnetite occurs as pods and irregular lense-shaped bodies of endoskarn in the intrusive rock. Other minerals present include pyrite, chalcopyrite, and traces of galena.

Considerable surface exploration and diamond drilling was done on this property by Idaho Mining Co., Walker-Martel Mining Co., Occidental Minerals Corp., Bear Creek Mining Co., and United States Steel Co. between 1963 and 1975. Based on this work, estimated ore reserves on the property are approximately 625,000 tons averaging 46.2 percent iron and 0.1 to 0.15 percent copper (Satkoski and others, 1985, p. 59-73). This deposit was not mined and, due to variable metal prices, its economic potential is uncertain.

Several other areas of rock alteration and associated copper-gold mineralization are described in this district by Satkoski and others (1985). None of these areas, however, have received exploration attention in the last few years.

BUCKSKIN DISTRICT

Location

The Buckskin district lies in the Buckskin Range near the eastern border of Douglas County. Most of the district is in Douglas County but the northern and southern tips of the district fall into adjacent Lyon County. The Yerington district, Lyon County, is to the east in the Singatse Range and the Como district, Douglas County, is to the west in the Pine Nut Range. The best access to the district is via the old, paved Minnesota mine road that leaves U.S. Alt. 95 at Wabuska and passes through Gallagher Pass into the northeast end of the district.

History

Gold was discovered in surface croppings at the Buckskin mine, for which the district is named, in 1904. Copper sulfide bodies were soon discovered beneath the oxidized outcrops and small-scale leasing operations were carried out in the district until 1907. Depressed metal markets due to the 1906 San Francisco earthquake caused operations to be suspended at that time and work did not resume in the district until about 1916. A flotation mill was constructed at the Buckskin mine in 1936 but the property remained operation only until 1938 (Overton, 1947, p. 21-22). Couch and Carpenter (1943, p. 36) record a production of slightly over $79,000 for the mine through 1937. Production at the property was intermittent to 1950; activity ceased until about 1970 when exploration resumed. Extensive diamond drilling was done in the early 1970's and, in 1978, an estimated 10,000 tons of ore was produced. In 1983, Pacific Silver Corp. announced

mine reserves of 400,000 tons of ore averaging 0.2 oz/ton gold, 0.4 oz/ton silver and 0.9 percent copper and revealed plans to construct a 300 tons-per-day flotation and leaching plant on the property. The mill was constructed but production plans were canceled, apparently due to low metal prices. There is currently no mining activity at the property.

In the north end of the district, claims were staked on the Minnesota Copper Lode in 1906. This claim became the center of the Minnesota-Nevada Copper Mines Co. property and a little copper ore was shipped during World War I. Extensive development did not begin, however, until a large iron-ore body was developed on the property in 1917. In 1943, this property was acquired by Strategic Minerals, Inc., leased to Standard Slag Co. and large-scale mining of the iron ore began (Overton, 1947, p. 46-47). Iron mining continued at the Minnesota mine into 1971 and it has been the largest mine to operate in Douglas County. Through 1966, the mine produced about 3,7000,000 tons of iron ore (Moore, 1969, p. 29), mainly for shipment to Japan. This production, valued at nearly $17,000,000, accounted for 99.5% of the mineral production of the Buckskin district through 1966 (Oriel, 1978, p. 10).

Exploration for deposits of porphyry copper in the Buckskin district began in the late 1960's. Several major corporations, including Phelps Dodge Corp., Anaconda, Bear Creek Mining Co., and Conoco conducted extensive mapping, sampling, and drilling programs in the area of the original Buckskin mine in the southern part of the district. Following closure of the Minnesota iron mine in 1971, the northern part of the district also came under examination for both copper and molybdenum porphyry deposits. Work in the southern area defined a large sulfide-bearing porphyry system, but economic copper mineralization was not found. Exploration programs in the district were terminated when copper prices fell in the late 1970's. Copper exploration, however, will no doubt resume in this area if metal prices again rise.

Geologic Setting

The oldest rocks in the Buckskin district are Triassic and Jurassic metavolcanic and metasedimentary rocks which crop out mainly in the north, northeast, and southeast parts of the range. These rocks are cut by Jurassic intrusive rocks and all are, in turn, overlain by a thick sequence of Tertiary volcanic rocks.

The thick section of Mesozoic rocks exposed in the Buckskin Range is composed of Triassic metavolcanic rocks superseded by carbonate and clastic sedimentary rocks of the Upper Triassic Oreana Peak Formation and by carbonate and sedimentary rocks of the Lower Jurassic Gardnerville Formation. In places, these rocks have been overthrust by andesitic metavolcanic rocks of the Lower Jurassic Artesia sequence and dacitic to quartz latitic

metavolcanic rocks of the Lower Jurassic to Lower Cretaceous Churchill Canyon sequence (Oriel, 1978, p. 15).

In the central part of the district, between the two areas of mining, Oligocene tuffs, ash-flow tuffs, and Miocene andesites overlie the Mesozoic rocks.

The Lower Mesozoic rocks are intruded by Jurassic granodiorite and quartz monzonite. Numerous varieties of Miocene andesite dikes and mineralized dacitic and latitic porphyry dikes and stocks intrude the older rocks. Most of the rocks in the Buckskin Range were hydrothermally altered to propylitic, sericitic, or aluminophyllic alteration facies by Miocene and, to a lessor extent, by Mesozoic alteration events (Oriel, 1978, p. 15).

Structure in the district is dominated by gently-dipping Basin and Range (?) faults which were originally steeply-dipping normal faults. These faults underlie steeply westward-dipping Tertiary ash-flow tuffs and Mesozoic metavolcanic rocks (Oriel, 1978, p. 17). Mesozoic thrusting is also documented in the northern and southeastern Buckskin Range (Hudson and Oriel, 1979).

<u>Ore Deposits</u>

Mineralization at the Buckskin mine occurs as replacement filling along a N60OW-striking, 65ONE-dipping shear zone in altered Mesozoic meta-andesite. Copper sulfide ore occurs in lenses and veinlets of quartz in the shear zone. The gossan outcrop of the system was the site of the original 1904 gold discovery in the district. Recent exploration on the property has traced the vein system for at least 1000 feet along strike.

The magnetite orebody at the Minnesota iron mine occurs in a dolomitized limestone member of a series of steeply-dipping Triassic metasedimentary and metavolcanic rocks. The sedimentary section has been intruded by Cretaceous granodiorite and quartz monzonite; the later quartz monzonite has altered both sedimentary rocks and granodiorite and is probably responsible for the formation of the large replacement bodies of magnetite. The main magnetite orebody dips to the west and cuts across bedding in the replaced dolomite. Magnetite is the principal ore mineral. Sulfide minerals, mainly pyrite and minor chalcopyrite, occur with the magnetite, principally near the borders of the deposit. The principal gangue mineral is unreplaced dolomite associated with small amounts of magnesite and serpentine minerals. Locally, veinlets of chlorite cut meta-andesite wall rocks adjacent to the ore body; sericite has formed along the contact between dolomite and magnesite in a few places (Reeves and others, 1958, p. 55-56).

In a large area in the northwestern part of the Minnesota mine pit, both granodiorite and quartz monzonite have been silicified and are cut by northwest- and northeast-striking quartz veins containing molybdenite. Drilling in the central part of the pit by Standard Slag in the 1970's revealed that highly silicified rocks containing disseminated pyrite and cut by molybdenite-bearing quartz veins were present at depth beneath the pit (Tingley, 1970).

Exploration for porphyry copper deposits in the Buckskin district has been concentrated mainly in the southern part of the district, north and east of the old Buckskin mine. Surface showings of turquoise and altered rocks drew attention to the area; follow-up sampling defined areas of surface geochemical anomalies that were further tested by geophysical methods and, eventually, by drilling. Work by several companies in the area has apparently defined the presence of a large, complex sulfide system related to porphyritic dikes, plugs, and sills. These rocks are latitic to dacitic in composition, they cut rocks as young as late Oligocene to Miocene, and both dikes and the intruded rocks are strongly altered. Copper mineralization was encountered in drilling, but no economic concentrations were defined by this work (Oriel, 1978, p. 3).

The Blue Metal deposit, about 1 1/2 miles northwest of the Buckskin mine, has been explored for abrasive-grade corundum and alumina refractories. Corundum-andalusite bodies occur scattered in a shear zone in weakly-metamorphosed Mesozoic andesite that has been cut by lamprophyre dikes. The andesite shows widespread silicification and sericitization. Most of the sericite is confined along shear zones and the corundum-andalusite mineralization is confined to the sericitized zones (Moore, 1969, p. 36). The U.S. Bureau of Mines studied this deposit in detail in 1945 (Binyon, 1946). There has been no production from the property.

CALICO HILLS AREA

Location

The Calico Hills area is located in the Calico Hills, Mineral County, east of U. S. Highway 95 about 6 miles north of Schurz. The Calico Hills are entirely within the Walker Lake Indian Reservation.

History

No prospecting activity is recorded in the Calico Hills until an aeromagnetic survey by Columbia Steel Co, a subsidiary of U.S. Steel Corp., revealed a magnetic anomaly over the area. Subsequent exploration work by Idaho Mining Co., Walker-Martel

Mining Co., and Occidental Petroleum Co. between 1963 and 1978 outlined a iron-copper deposit of approximately 200 million tons containing 40 percent iron and 0.08 percent copper. At this point, problems with lease negotiations between the mining companies involved and the Walker Lake Tribal Council arose and no additional work has been done on the property (Satkoski and others, 1985, p. 40).

Geologic Setting

Rock outcrops in the Calico Hills are dominated by Tertiary volcanic rocks, mainly varicolored rhyolite to quartz-latite ash-flow and ash-fall tuffs. The tuff sequence has been intruded by flows and plugs of basalt and basaltic andesite (Satkoski and others, 1985, p. 41). Several small outcrops of Jurassic (?) quartz diorite to quartz monzonite intrusive rocks and one outcrop of Triassic or Jurassic metasedimentary rocks occur along the northeast flank of the hills. The area is structurally complex and is cut by numerous northwest-trending strike-slip faults related to the Walker Lane system as well as by normal to listric Basin and Range faulting.

Ore Deposits

The Calico iron-copper deposit is known only by descriptions of drill core logged by the various exploration companies that have worked on the prospect. It consists of calcic iron skarn formed both in Triassic or Jurassic metasedimentary rocks and endoskarn formed in quartz diorite and quartz monzonite that have intruded the sedimentary section. Iron and copper sulfides occur in the skarn associated with wollastonite, diopside, epidote, zoisite, and tremolite; contained gold and silver values are very low. The subsurface skarn deposits are covered by Tertiary volcanics that range from 400 to 2,000 feet in thickness. Drill information indicates that the deposit is open at depth.

CANDELARIA DISTRICT

Location

The historic camp and mining district of Candelaria are located in the Candelaria Hills in southeastern Mineral County. Historically, at the time Candelaria was first operating, all of the Candelaria Hills extending to Columbus Salt Marsh on the southeast, were in the original boundaries of Esmeralda County. In this report, however, the district is restricted to the area between U.S. Highways 6 and 95, State Route 360, and the present Mineral-Esmeralda County lines.

History

Other than a few small deposits of barite located north of Miller Mountain in the southern part of the district, the mines of the district are centered around the camp of Candelaria. The history of the district is essentially that of Candelaria and its mines.

Silver-bearing veins in the Candelaria Mountains were discovered by a band of roving Spanish prospectors in May 1863. Organized as the Columbus mining district, development began at the Northern Belle and other mines. Exploitation on a large scale did not begin until 1873, however, when a 20-stamp mill was erected by the Northern Belle Company at Belleville, 8 miles west of the mines (Paher, 1970, p. 444). A second 20-stamp mill was completed in 1876 and, beginning in 1875, the Northern Belle produced a million dollars annually for a period of 10 years (Lincoln, 1923, p. 141).
Production entered into decline in 1892 and, with the exceptions of short revivals in 1916 and 1923, production from the camp was insignificant until the current revival began in 1980. Total recorded production of the district, 1870 through 1940, is slightly less than $14,000,000 (Couch and Carpenter, 1943, p. 101).

Exploration for reserves of bulk-minable silver ores began in the Candelaria district in the late 1960's; exploration extended into the 1970's and, in 1980 operation began on what is now known as the Candelaria mine. An open-pit operation, the mine is developed on near-surface, oxide mineralization related to the old, underground mines. Bulk-minable reserves developed at the Candelaria mine, including ore mined to date, are 27 million metric tons averaging 50 g/ton silver and 0.19 g/ton gold (Moller, 1987, p. 240).

Barite has been mined from several deposits in the south part of the district, about 8 miles southwest of Candelaria. These mines were active in the late 1970's and early 1980's. Two properties, the Giroux and the Noquez No. 2, have produced somewhere between 1000 and 25,000 tons of barite. A third property, the Noquez, has produced between 25,000 and 100,000 tons of barite (Papke, 1984, p. 108-109).

Geologic Setting

Basement rocks at Candelaria consist of chert, argillite, and dolomite of the Ordovician Palmetto Formation. These rocks are overlain unconformably by Permian sandstone (the Diablo grit), and siltstones and mudstones of the Lower Triassic Candelaria Formation. The Mississippian-Triassic(?) Pickhandle Gulch complex, which consists of serpentine, mafic volcanics, and tectonically intercalated sediments, is in contact with the

Candelaria formation along the Pickhandle Gulch thrust fault. Cretaceous (?) intrusives ranging from diorite to granite in composition form a dike-sill complex within the Candelaria formation and along formation contacts and thrust faults Moller, 1987, p. 240). Tertiary felsic welded tuff and Quaternary mafic volcanic rocks overlie much of the district (Ross, 1961, p. 59).

Thrust faulting associated with the Lower Triassic Sonoman orogeny emplaced the Pickhandle complex and developed a broad shear zone parallel to bedding in the lower part of the Candelaria Formation. A series of east-northeast trending normal faults offsets all stratigraphic units and the Mesozoic thrusts (Moller, 1987, p. 240).

Ore Deposits

Alteration and mineralization at Candelaria show an association with areas of thrust related structural preparation and with the Cretaceous intrusive sequence. Alteration in Candelaria Formation sediments and dikes is a district-scale sericitization associated with pyrite, quartz, and carbonate. This alteration is best developed within the lower Candelaria shear (thrust); mafic and ultramafic rocks of the Pickhandle Gulch complex show pervasive, pre-mineral silica-carbonate replacement and irregular silicification in a thick zone above this thrust (Moller, 1987, p. 240). High-grade ore bodies mined in the historic period of activity at the camp occurred in an east-trending vein system that paralleled the shear fabric. The principal ore bodies were 10 to 20 feet thick and, in highly oxidized, near-surface ores, contained silver averaging 60 oz/ton. Lower-grade, primary ores averaged 10 to 15 oz/ton silver and consisted of jamesonite and pyrite with some chalcopyrite and galena in a manganeferous ferrodolomite gangue (Ross, 1961, p. 81).

Most of the open pit reserves of the new Candelaria mine are hosted by the basal member of the Candelaria Formation, within the lower Candelaria shear (thrust fault). Where unoxidized, the ore is hosted by carbonaceous, calcareous, silty mudstones and contains abundant veinlets of quartz with disseminated pyrite, sphalerite, and galena. Oxidized ores contain abundant iron and manganese oxides which contain the bulk of the leachable silver. Cerargyrite and argentite are present but are not economically important. About 25 percent of the ore is hosted by serpentine and mafic volcanic rocks of the Pickhandle Gulch complex within the thrust zone. Ores hosted within the Candelaria Formation are characterized by a silver-gold ratio of 400:1 and contain 1 to 3 percent combined lead-zinc along with anomalous copper, antimony and arsenic. Ultramafic-hosted ore has a slightly lower silver-gold ratio (Moller, 1987, p. 240-241).

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

In the southern part of the Candelaria district, small replacement deposits of barite are hosted in Ordovician chert and in thin-bedded limestone of the Luning Formation. These deposits have produced small amounts of barite, but have not been active for the past several years.

CARSON CITY DISTRICT

Location

The Carson City district, includes several mining prospects that border Carson City's urban area. The district, in what was historically Ormsby County, includes the southern slope of the Virginia Range, north of the city, and the sandstone quarry and other small prospects on Prison Hill, south of the city.

History

Beginning as early as 1859, the area around Carson City was actively explored for croppings of quartz and indications of metal. This activity, an overflow of effort from the nearby Comstock lode discoveries, resulted in many locations but no specific activity is recorded until 1876 when work was done at the North Carson mine, 2 1/2 miles north of Carson City (Thompson and West, 1881, p. 537). The mine was abandoned shortly thereafter, but a small amount of copper-lead-silver ore was apparently sold from the property in 1925 (Overton, 1947, p. 41). The only other mining of note in the Carson district has been the quarrying of building stone from the Prison quarry for use in many of the historic buildings in Carson City. The quarry was apparently in use as late as the 1940's (Overton, 1947, p. 40).

Geologic Setting

The Virginia Range, north of Carson City, is underlain by Triassic and Jurassic metasedimentary and metavolcanic rocks which have been intruded and metamorphosed by Cretaceous granodiorite. To the south, Prison Hill is composed of Triassic metavolcanic rocks and Jurassic dacite porphyry (Trexler, 1977). Prison Hill is skirted by deposits of older Quaternary alluvium which include the bedded sandstone quarried for building stone.

Ore Deposits

Mining prospects north of Carson City explore erratic copper and tungsten mineralization localized near the intrusive contact of granodiorite and limy metasedimentary rocks. At the North Carson mine, mineralization is contained in quartz veins that cut granodiorite. The veins contain chalcopyrite, galena, and possibly silver-antimony sulfides. Small prospects to the east of the North Carson mine explore small scheelite-bearing skarn zones that occur along the granodiorite-metasedimentary rock

contact. No production has been recorded from any of these prospects (Stager and Tingley, 1988, p. 29).

CASTLE PEAK DISTRICT

Location

The Castle Peak district, Storey County, is located in the Virginia Range about 8 miles north of Virginia City. Access to the mine area is via a road leading north from State Route 341 at Six Mile Flat.

History

Cinnabar was discovered at the site of the Castle Peak mine in 1927. The Castle Peak Quicksilver Co. was organized in 1929, production of mercury from the property began in 1929, and between 1929 and 1943, 2,576 flasks of mercury were produced from the mine (Bonham, 1969, p. 99). Cinnabar was discovered at Washington Hill, about 3 miles north of Castle Peak, in 1941 but only a few flasks of mercury have been produced from this property. There has been no production of mercury from either of these properties since the early 1940's. In the past few years, however, the district has come under investigation for precious metals deposits and several major companies have conducted exploration programs in the Washington Hill area.

Geologic Setting

The oldest rocks in the district are Mesozoic argillites which crop out a short distance south of the Castle Peak mine. The Mesozoic rocks are overlain by andesite flows and breccias of the Miocene Alta Formation and rhyodacite to andesite flows, breccias, and intrusions of the Miocene-Pliocene Kate Peak Formation. At Washington Hill, the rocks of the Kate Peak Formation have been intruded and overlain by rhyolite of the Washington Hill flow dome complex (Bonham, 1969, p. 99). Quaternary andesite and basalt flows cover areas in the central part of the district, east of Castle Peak.

Ore Deposits

Cinnabar at the Castle Peak mine occurs in tabular to pipelike bodies localized along steeply-dipping joints and as disseminations along a gently-dipping, north-trending fault in argillized and alunitized andesite of the Alta Formation. The principal ore mineral is cinnabar, although native mercury and calomel also occur. Crystalline cinnabar fills fractures as veinlets and is disseminated in the wall rocks. Gangue minerals include pyrite, barite, calcite, ankerite, gypsum, and dolomite (Bonham, 1969, p. 99).

deposit. No production has been recorded from any of these prospects (Bonham and Tingley, [illegible], p. [illegible]).

CASTLE PEAK PROSPECT

Location

The Castle Peak district, Storey County, is located in the Virginia Range about [illegible] miles north of Virginia City. Access to the site area is via a road leading north from State Route 341 at [illegible] mile [illegible].

History

Cinnabar was discovered on the site of the Castle Peak mine in [illegible]. The Castle Peak quicksilver Co. was organized in [illegible], production of mercury from the property began in [illegible], and between [illegible] and [illegible], [illegible] flasks of mercury were produced from the mine (Bonham, [illegible], p. [illegible]). Cinnabar was discovered in [illegible] Hill, about [illegible] miles north of Castle Peak, in [illegible] and only a few flasks of mercury were produced from this property. There has been no production of mercury from either of these properties since the early [illegible]. In the last few years, however, the district has come under renewed scrutiny for precious metals potential and several major companies have conducted exploration programs in the Washington Hill area.

Geologic Setting

The oldest rocks in the district are Mesozoic argillites which crop out a short distance south of the Castle Peak mine. The Mesozoic rocks are overlain by andesitic flows and breccias of the Alta Formation and rhyolitic to dacitic [illegible] flows, breccias, and intrusives of the Kate Peak-[illegible] Formation. In Washington Hill, the rocks of the Kate Peak Formation have been intruded and altered by intrusions of the Washington Hill [illegible] (Bonham, [illegible], p. [illegible]). [illegible] altered and [illegible] rocks occur in the [illegible] part of the district, east of Castle Peak.

Site Geology

[illegible]

Mineralization at the Washington Hill mine occurs in bleached and altered andesite flows, tuffs, and breccias of the Kate Peak Formation. Cinnabar occurs as fine-grained disseminated crystals and as irregular veinlets in altered andesite tuff and agglomerate along north-trending faults. Barren lenses and pods of opalite also occur along north-trending fractures. The suite of alteration minerals present in the Washington Hill area, including opalite and alunite, is indicative of hot-springs-type gold mineralization and this area is currently being explored for precious metals deposits.

CHALK MOUNTAIN DISTRICT

Location

The Chalk Mountain district, Churchill County, encompasses Chalk Mountain, which is just north of U.S. Highway 50 at Drumm Summit, about 45 miles east of Fallon. The mountain, named for its conspicuous light color, is about 3 miles long by 2 miles wide and rises some 1,000 feet above the surrounding terrain. Chalk Mountain is on the east side of Dixie Valley, about midway between the old mining camps of Fairview and Wonder. Access is from the south via Highway 50 or from the west from the Dixie Valley road (State Route 121).

History

Miners from the early days of the Comstock were aware of the lead-silver mineralization at Chalk Mountain, but ore was of insufficient grade to be shipped and the district was not developed (Schrader, 1947, p. 116). Prior to 1921, production was sporadic with occasional carload shipments running 60 percent lead and 60 ounces silver to the ton. Major activity began in 1922 with the formation of the Chalk Mountain Lead-Silver Mining Co. to develop mines located about mid-way down the eastside of the mountain. By 1925, the company was reported to be shipping 12 tons daily of $100/ton ore (Schrader, 1947, p. 116). At least five other mining operations, mostly on the west side of the mountain, were active during the same 1920's period. The most notable of these was the Nevada Chalk Mountain Mining co. which produced small quantities of ore for several years. The most productive years for the district were from 1923 to 1929, but the exact dollar amount produced is not known as part of the production was credited to the nearby Fairview district. The Chalk Mountain mine continued to operate sporadically until the 1950's (Willden and Speed, 1974, p. 64).

Geologic Setting

Four major rock types crop out at Chalk Mountain; highly folded limestone and dolomite of possible Triassic age, volcanic

and sedimentary rocks of Triassic or Jurassic age, massive quartz porphyry that intrudes the carbonate rocks, and a younger granodiorite (Willden and Speed, 1974, p. 64). The northern half of Chalk Mountain is made up of the quartz porphyry which is itself intruded by several smaller bodies of granodiorite. The quartz porphyry is bounded on the south by an irregular, approximately east-west striking contact with carbonate rocks that make up most of the southern half of the mountain. A large body of granodiorite intrudes the carbonate rocks and crops out along the southwestern flank of Chalk Mountain; the carbonate rocks are highly folded and narrow skarn zones occur along their contact with the granodiorite.

Ore Deposits

Mineralization at the Chalk Mountain Lead-Silver mine follows a northeast-trending structure in limestone along the east side of the mountain for approximately 1-1/2 miles. The deposits occur as veins and irregular replacement bodies in fractures and preferred bedding in the limestone. The deposits are highly oxidized; ore minerals consist of cerussite anglesite, cerargyrite, wulfenite, vanadinite, and argentiferous galena in a porous gangue consisting of quartz, calcite, altered limestone, and iron oxides. At one small property on the northeast end of the mountain, massive magnetite occurs in a skarn associated with jasperoid. On the west side of Chalk Mountain, shallow, often caved workings follow irregular gossan-like zones along narrow fissures or contact zones in carbonate rocks. Mineralization is similar to that on the east side of the district, but not as intense. Other than iron- and copper-oxide minerals, very little metallic mineralization is visible in the western workings.

Geochemistry

On the east side of the district, ore samples from the Chalk Mountain Lead-Silver mine dumps contained fair gold and low silver values associated with very high lead, zinc, and arsenic values; moderate to high cadmium, tin, molybdenum, antimony, and copper values; and moderate to low bismuth values.

Samples from mine workings on the west side of Chalk Mountain reported low gold values for five out of eight samples, and sporadic values for silver (ranging from 2 ppm to 1,500 ppm). The samples reported very high values for lead and zinc, lower values for arsenic, and sporadic but high values for tin, antimony, and bismuth. Samples from the properties on the west side of the mountain reported tungsten present in low to moderate, but consistent, amounts.

CHURCHILL DISTRICT

Location

The Churchill district, Lyon County, includes the area of Churchill Butte and a small part of the northwestern Desert Mountains immediately south of the Carson River. Most of the mining properties lie on the southwest flanks of Churchill Butte, west of U.S. Highway 95A and north of the Carson River.

History

The earliest record of production from this district is in 1915 when tungsten ore was produced from properties on Churchill Butte; additional tungsten production between 1934 and 1940 resulted in a total production of $101,412 for the district(Couch and Carpenter, 1943, p. 92). Stoddard and Carpenter (1950, p. 75) state that bentonite clay was being produced from a deposit about 3 miles south of the Carson River; production, at a rate of about 1,000 to 2,000 tons a year had been underway since 1936.

Geologic Setting

On the northeast side of Churchill Butte, a fairly large area of Mesozoic siltstone, argillite, and slate intruded by Cretaceous granodiorite is exposed. Andesite and younger basalt on top of the pre-Tertiary rocks are warped and cut by numerous faults. The dominant west dip of the volcanic rocks, as well as the predominance of pre-Tertiary rocks of the east side of the butte, indicates that Churchill Butte is the exposed part of a west-tilted fault block. The small part of the Desert Mountains included in this district is underlain mainly by Tertiary andesitic rocks which are, in places, overlain by Tertiary lacustrine and fluvial sedimentary rocks.

Ore Deposits

Most of the small mines and prospects on the flanks of Churchill Butte expose lenses of scheelite-bearing skarn that has formed between limy rocks in the Mesozoic section and granodiorite. The skarn lenses are very small but are locally well mineralized with scheelite. At two prospects in the district, one on the north in section 10 and one south of the Ruth mine in section 22, explore quartz veins in granodiorite, probably for gold and silver. There has been no activity at any of these properties for many years.

At the Juniper clay pit, on the west side of Highway 95A about 3 miles south of Buckland's, montmorillonite-type clay has been mined from a shallow pit some 700 feet long by about 120

feet wide. Clay crops out over an area about a quarter of a mile across. The country rock is andesite porphyry of probable Miocene-Pliocene age; the clay was formed from hydrothermal alteration of the andesite (Papke, 1970, p. 23).

CLARK-DERBY AREA

Location

The Clark-Derby area, Storey County, is located in the portion of the northern Virginia Range that lies south of the Truckee River, generally between Clark Station on the west and the Lyon County line on the east. The only mining area is accessible by road from Clark Station.

History

The first recorded mining activity in this area was in 1918 when claims were located on diatomite croppings at what is now the Celatom mine, south of Clark Station. Production from this deposit was small and intermittent until 1943 when the Nevada Celatom Co. was organized and a small crushing plant was built at Clark Station. Eagle-Pitcher leased the property in 1945 and constructed the present plant (Papke, 1969, p. 116). The operation has been expanded over the years and is now one of the largest diatomite plants in the state.

Metallic mining activity in the area is restricted to one small mercury property, the Taylor-Branch prospect, located south of Clark Station. This occurrence was discovered in 1931 and a small amount of mercury was produced from a 2-pipe retort constructed on the property (Bonham, 1969, p. 102).

Geologic Setting

All of the rocks cropping out within this area consist of porphyritic rhyodacite, dacite, and andesite flows and intrusives of the Miocene-Pliocene Kate Peak Formation. Locally, this formation contains sedimentary lenses of diatomite, shale, sandstone, conglomerate, and waterlain tuff (Bonham, 1969).

Several northeast-trending faults with left-lateral displacement have been mapped in the area by Rose (1969).

Ore Deposits

The major ore deposit in this area is the large deposit of diatomite which is being mined at the Celatom mine. Diatomite occurs within the Kate Peak Formation associated with thin interbeds of diatomaceous shale and a few thin beds of volcanic tuff. The total stratigraphic thickness of the sequence is about

350 feet; the sequence dips northward at an angle of about 30^0 and is cut by faults that cause local offsets to the productive bed (Papke, 1969, p. 116). Mining is by open pit methods and the material is trucked to the Clark Station plant for treatment.

The Taylor-Branch mercury prospect occurs along one of the major northeast-trending faults which transect the district. Cinnabar, associated with pyrite, gypsum, and jarosite, occurs as disseminated crystals and narrow stringers in argillized and locally silicified andesite tuff and breccia (Bonham, 1969, p. 102). Small hydrothermal breccias are reported to be visible in exposures at the prospect.

COMO DISTRICT

Location

The Como district, Lyon County, is in the northern Pine Nut Mountains about 7 miles southeast of the town of Dayton. The main mines of the district are located on the upper west slope of the range, on the west side of the saddle between Lyon and Rawe peaks. Numerous other prospects are located east of this saddle and to the south along the east flank of Lyon Peak. The district is reached by unpaved road from Dayton.

History

The Como district, first know as Palmyra, was discovered in the early 1860's during the Comstock boom period. The first mill was moved into the district in 1863; it proved to be a failure and was dismantled and removed in 1865 with no reported production (Angel, 1881, p. 500). Desultory mining efforts were carried out at Como for the next half century, with small, unrecorded production. The Como Consolidated Mines Company was organized in 1916 and considerable effort was expended driving exploration and development tunnels; a mill was built and some mining was done. The venture ultimately closed in 1920 with only minor production. In 1929, the assets of Como Consolidated Mines Co. were acquired by Como Mines Co., and the Boyle drainage tunnel was completed under workings on the main veins. Como Mines Co. constructed a 500-tons per day flotation mill and began mine and mill operations in June 1935; this operation, as all those before it, also lost money and closed in 1936 (Stoddard, 1950, p. 76-77). Total recorded production from all operations in the Como district, 1900 to 1940 is $511,540 (Couch and Carpenter, 1943, p. 92).

The district has been quiet from the 1940's up to very recently when prospecting was renewed around several of the larger mines. Numerous drill roads and drill sites as well as new trenching is in evidence. An open pit and associated heap-

leach pads at the Hully-Logan mine are evidence of recent mining at that location; no production information is available, however. Companies reported to be active in the Como district in 1989 included Horizon Gold Shares, Amax Mineral Resources Co., and U.S. Borax.

Geologic Setting

The Como district is entirely underlain by Tertiary volcanic rocks, mainly andesitic flows and flow breccias of the Alta and Kate Peak formations (Moore, 1969).

Ore Deposits

To prospectors of the Comstock era, the prominent croppings of vein quartz in the Como district closely resembled those in Virginia City. The Como veins cut altered andesite and strike east-westerly with varying dips. Surface and near-surface ores contained silver, as chloride, with free gold and traces of copper in a quartz gangue. At fairly shallow depths, however, silver-bearing tetrahedrite began to appear in the ores (Stoddard, 1950, p. 76). At lower levels, where intersected by the Boyle drainage tunnel, the large Rapidan vein was not rich and consisted only of clay with small quartz lenses (Moore, 1969, p. 25). Vein masses at the Hully-Logan mine consist of massive quartz, fine-grained pyrite, and breccia; much of the breccia has a matrix of fine-grained pyrite. Alteration near the major veins is intense; the host andesite is bleached and argillically altered and some outcrops appear to have been alunitized.

COMSTOCK DISTRICT

Location

In this report, the Comstock district includes all of the mining areas generally between Gold Canyon and Sixmile Canyon on the east slope of the Virginia Range. The district extends from Dayton and Silver City in Lyon County to Virginia City in Storey County and includes districts described elsewhere as the Dayton, Silver City, Gold Hill, Gold Canyon, Flowery, Comstock Lode, and Washoe districts.

History

Discoveries of placer gold in Gold Canyon in 1849 or 1850 led to discovery of the rich croppings of the Comstock Lode in early 1859. By 1863, the mines of the Lode had produced about $10 million of gold and silver from near-surface ores largely by crude mining and milling methods. During the late 1860's, the Comstock developed into a major mining district with a number of large mining companies. Several large, high-grade, bonanza ore [illegible] at the [illegible] site are [illegible] of [illegible] at most [illegible] as [illegible] information [illegible] available, however. Companies reported to be active in the Cove district in [illegible] included [illegible] Coates, [illegible] Minerals, [illegible] Co., and R.B. [illegible]

[illegible]

The Cove District is entirely underlain by Tertiary volcanic rocks [illegible] lines and [illegible] of the [illegible] formation ([illegible], 1984).

[illegible]

[illegible] of the [illegible] the [illegible] of [illegible] in the Cove district [illegible] Virginia City. [illegible] and [illegible] silver, [illegible] gold and [illegible] however, [illegible] in the [illegible] (1979, p. [illegible]). [illegible] the [illegible] gold [illegible] only [illegible] with [illegible] quartz [illegible] [illegible] the [illegible] of [illegible] pyrite, [illegible] near the [illegible] the [illegible] and [illegible] altered [illegible].

COMSTOCK DISTRICT

[illegible]

In this report, the Comstock district includes all of the mining areas generally between Gold Canyon and [illegible] the east slope of the Virginia Range. The district extends from Dayton and Silver City in Lyon County to Virginia City in Storey County and includes [illegible] the [illegible] Silver City, Gold Hill, [illegible] Canyon, Flowery, [illegible] and [illegible]

HISTORY

[illegible] in Gold Canyon [illegible] the [illegible] of the Comstock [illegible] By [illegible] of gold and silver [illegible] Comstock [illegible] bodies were found during this period and mining, milling, and transportation facilities were improved and expanded. In the 1870's huge bonanza ore bodies were discovered in the Crown Point and Consolidated Virginia mines and the Comstock entered its period of highest production; nearly $200 million was produced from 1871 to 1880 from about four million tons of ore. Production from the Lode sharply declined after 1880, however, and total production from the district between 1880 and 1900 was about $49 million. During the period 1900 to 1930, deep mining below the Sutro Tunnel level was attempted but was finally abandoned due to excessive pumping costs. Elsewhere on the Lode, mining was confined to old stope fill and low-grade ore in upper levels. Production for this period was about $12 million in gold and silver. Between 1920 and 1950, various attempts were made to mine large tonnages of low-grade ore from open pits and from underground by block-caving. Although some $28 million was produced during this time, the operations were largely not successful and all mining on the Comstock virtually ceased by 1950. The total recorded production for the Comstock Lode, 1859 through 1965, is $393,963,725 in gold and silver (Bonham, 1969, p. 102-104). In 1968, the Natural Resources Division of Union Pacific Railroad began an exploration program in the Gold Hill area with the objective of developing sufficient low-grade ore to support an open-pit operation. Their program was not successful but later work in the same area by Houston Oil and Minerals Co. resulted in the development of a large open-pit mine at the site of the old Consolidated Imperial pit west of Greiner's Bend on State Route 341. Various technical difficulties, including engineering problems with rock-slope stability, public relations problems with the residents of adjacent Gold Hill, and low contained values in the ore caused this operation to close in 1981. Small exploration and mining projects continue to reactivate on the main Lode, but none are active at the present time.

East of the main lode, in the Flowery portion of the district, exploration by several major companies has been undertaken in the past ten years and a moderate tonnage of low-grade ore has been blocked out at the Flowery deposit (Bonham, 1989, p. 25). The property was not active in 1988, however. In the southern end of the district, near Silver City, leach operations have been attempted on old tailings at the Dayton mine and on low-grade, open-pit ores at the Haywood-Santiago mine. The Haywood-Santiago mine was active in 1988 (Fleming and Jones, 1989, p. 39).

Geologic Setting

The oldest rocks exposed in the Comstock district are argillite and limestone of the early Jurassic Gardnerville Formation which have been overthrusted by meta-andesite, metadiorite, and metagabbro of the Mesozoic Peavine Sequence.

several mines opened during this period and mining, milling, and transportation facilities were improved and extended. In the [illegible] the region [illegible] and the Comstock, [illegible] the period of highest production: nearly $200 million was produced from 1875 to 1890 from about four million tons of ore. Production from the Lode sharply declined after 1880, however, and total production from the district between 1890 and 1919 was about $40 million. During the period 1907 to 1919 deep mining below the 2700 foot level was attempted and was finally abandoned due to excessive pumping costs. Elsewhere on the Lode, mining was confined to old stope fill and low-grade ore in upper levels. Production for this period was about $14 million in gold and silver. Between 1920 and 1950, various attempts were made to mine large tonnages of low-grade ore from open pits and ores concentrated by cyanidation. Although over $24 million was produced during this time, the operations were largely not successful and all mining on the Comstock virtually ceased by 1950. The total recorded production for the Comstock Lode, 1859 through 1950, is $386,000,000 in gold and silver (Bonham, 1969, p. 113-114). In 1960, the [illegible] conducted an exploration program in the Gold Hill area with the objective of developing sufficient low-grade ore to support an open-pit operation. Their program was not successful but later work in the same area by Houston Oil and Minerals Co. resulted in the development of a large open-pit mine at the site of the old Consolidated Imperial pit [illegible]. Various technical difficulties, including engineering problems with overburden [illegible] problems with the residents of adjacent Gold Hill, and low [illegible] values in the ore caused this operation to close in [illegible]. [illegible] exploration and mining projects continue in [illegible] of the main Lode, but none are active at the present time.

[illegible] the main Lode, is the [illegible] of the [illegible] and [illegible] in the past [illegible] has been [illegible] of the [illegible] (Bonham, 1969, p. [illegible]). [illegible] however, in the [illegible] have been [illegible] at the [illegible] of the [illegible] as a [illegible] and the [illegible] (Bonham, 1969, p. 1[illegible])

[illegible]

The [illegible] in [illegible] the [illegible] and [illegible] of the [illegible] and [illegible]

These rocks have been intruded by late Mesozoic granodiorite and diorite (Hudson, 1987, p. 413). The metavolcanic and metasedimentary rocks crop out in the southern part of the district around American Flat and Silver City; the main outcrops of granodiorite are located along the west flank of the Virginia Range, several miles to the west of to the Comstock Lode (Bonham, 1969, p. 104). The Mesozoic rocks are unconformably overlain by a series of silicic ash-flow tuffs which range in age from 28 to 20 Ma. Unconformably overlying the tuffs and Mesozoic rocks are over 3000 feet of andesitic flows, flow breccias, mudflow breccias and lacustrine sediments of the early Miocene Alta Formation. Rocks of this formation are the main host rock for orebodies in the Comstock district. All of these rocks are intruded by hornblend andesite porphyry dikes and stocks of the Davidson Diorite; this rock, which ranges in composition from diorite to granodiorite to andesite, has been dated at about 17 Ma. Overlying the Alta Formation are andesitic to dacitic flows, dikes, and stocks of the Kate Peak Formation; the upper member of the Kate Peak has yielded dates of 12.6 to 13.7 Ma. Late Miocene or Pliocene andesite and Pliocene basalt flows cover parts of the district (Hudson, 1987, p. 413).

The most conspicuous structural features in the district are the Comstock and Silver City faults; the Silver City fault is apparently a branch of the Comstock fault. The main Comstock fault trends north-northeast and dips about 45^0 east; the Silver City fault, which joins the Comstock fault south of Gold Hill, trends southeast-ward and dips about 45^0 east. Estimates of offset across the Comstock fault range from 3450 to 2500 feet of dip-slip displacement (Bonham, 1969, p. 105). The Occidental fault, located about 2 miles east of the Comstock fault, is similar in both strike and dip. A number of northeast- and northwest-trending faults occur in the district; some of these intersect and displace the main Silver City fault (Bonham, 1969, p. 105).

Ore Deposits

The valuable ore deposits of the Comstock Lode are epithermal precious-metal veins that occur in and adjacent to the major faults of the district. The Comstock Lode is essentially a stockwork zone and consists of a large body of brecciated vein quartz and highly altered andesite formed along the Comstock fault and in nearly vertical hanging wall fractures connected with the main fault. The bonanza ores consisted of quartz and sparse to abundant calcite containing abundant sphalerite, galena, chalcopyrite and pyrite accompanied by lessor amounts of argentite, gold, and polybasite (Bonham, 1969, p. 105). Gianella (1936, p. 91-92) reported that the veins in the Silver City portion of the Lode contained significantly less base metals than the Comstock portion. Hudson (1987, p. 415) describes a vertical zoning in the vein mineralogy that varies from a deep quartz zone

to an intermediate quartz-adularia zone to a shallower calcite-quartz-adularia zone; the higher-level calcite-quartz-adularia veins are rarely preserved on the Comstock but crop out extensively on the Occidental and Silver City lodes. Hudson (1987, p. 415-416) states that the ore horizon on the lodes is located in the upper portion of the quartz-adularia zone and extends into the calcite-quartz-adularia zone. The veins are often banded but rarely contain more than four stages of gangue mineral deposition.

Within the Comstock mines, the vertical extent of orebodies rarely exceeded 500 feet, strike lengths were up to 1000 feet, and mining widths were up to about 150 feet. Grades of ore from the main lode deposits averaged about $50 per ton during the peak production years of 1871-1880 but dropped to about $10 per ton for waning years of 1900-1920 (Bonham, 1969, p. 102).

COPPER KETTLE DISTRICT

Location

The Copper Kettle district, Churchill County, includes the area of Grimes and Copper Kettle canyons, and extends to the canyons west of Anderson Ranch along the west flank of the northwestern Stillwater Range. Most of the prospects in the district are clustered in the low hills at the mouth of Copper Kettle Canyon and in the southern tip of the Buena Vista Hills, north of Copper Kettle Canyon. A number of other prospects occur about 4 miles to the northeast, west of Anderson Ranch. Copper deposits prospected early in the history of the district are located somewhere in upper Grimes and Copper Kettle canyons. These areas are not accessible at the present time and the locations of the prospects are not known.

History

Copper deposits were discovered in the Grimes Canyon part of this district in 1908 and, in 1917, several carloads of copper ore were shipped. In 1929, 11 tons of copper ore was shipped from the Copper Kettle mine, in the upper reaches of Copper Kettle Canyon (Vanderburg, 1940, p. 50-51). No production has been recorded from the district since that time. Iron deposits at the mouth of Copper Kettle Canyon were discovered about the same time (1888-1898) similar deposits were discovered to the north in the Buena Vista Hills, Mineral Basin district. Schrader (1947, p. 312-314) describes two iron deposits, the South Group and the North Group in this area; only one of these, the South Group, is in the Copper Kettle district, the other is now known as the Buena Vista mine, Mineral Basin district.

Geologic Setting

Rocks in the general area of Copper Kettle Canyon consist of Middle Jurassic albitized quartz arenite that is conformably overlain by lapilli tuffs, volcanic sandstone, and basalt flows similar to rocks near the Buena Vista mine to the north. The arenite is intruded by albitite, diorite, and anorthositic gabbro, facies characteristic of the Humboldt gabbroic complex. Bodies of fine- to medium-grained albitic rocks similar to those near the Buena Vista mine intrude the layered volcanic rocks. Albitization and dolomitization are widespread in the volcanic rocks but are concentrated near the fine-grained intrusive rocks. Veins of magnetite-calcite-chlorite occur in breccias and shears in the intrusive rocks and altered volcanic rocks (Willden and Speed, 1974, p. 64).

Ore Deposits

The copper occurrences in the district are known only by their descriptions in old literature. Lincoln (1923, p. 2) states that "The ore contains chalcocite and copper oxides and carbonates and occurs near a contact of diorite with overlying altered porphyry". Vanderburg (1939, p. 51) adds cuprite and some silver to the list of minerals present and Schrader (1947, p. 312) confuses the description slightly by describing the deposits as "...occurring near the contact of diorite porphyry intruded into limestone".

Iron deposits are associated with the contact of intrusive diorite porphyry and Jurassic quartz arenite. The body of ore exposed on the deposits at the mouth of Copper Kettle Canyon (South group of Schrader) varies from 4 to 50 feet in width and averages about 6 feet; it dips westward toward the Carson Sink valley (Schrader, 1947, p. 312-313). The iron ore consists of magnetite and hematite associated with calcite and apatite as gangue minerals.

CORRAL CANYON DISTRICT

Location

Corral Canyon district, Churchill County, is located in the vicinity of the mouth of Corral Canyon on the east side of the Stillwater Range about 6 miles southwest of Boyer Ranch. The mining properties of the district are located at the mouth of Corral Canyon and along the range front to the southwest.

History

Beal (1963, p. 9) mentions that small gold deposits in the district were worked in the 1920's and 1930's. In 1938, 25 tons

of gold ore averaging $40 per ton were shipped from claims near Corral Canyon (Vanderburg, 1940, p. 50). In the 1950's and 1960's, the area was examined for lode and placer titanium deposits. No minable deposits were apparently encountered, however, and no further exploration for titanium has been reported. In 1989, the area showed evidence of recent exploration for precious metals. Santa Fe Pacific Mining Co. holds mining claims in the Corral Canyon area and drilling has been done from several sites along the range front.

Geologic Setting

Lower Corral Canyon lies entirely within the Humboldt gabbroic complex of gabbro and basalt. The rocks at the canyon mouth are gabbro that contains dikes of albitite and albitized shear zones. The roof of the gabbro occurs about a quarter of a mile upstream, where the gabbro is separated from overlying basalts by a body of massive albite several hundred feet thick (Willden and Speed, 1974, p. 64-65).

Ore Deposits

Gabbro near some of the albite bodies is serpentinized, and gold-bearing quartz bodies occur within and along the contacts of the albite-calcite bodies and the county rock. Ferguson (1939, p. 19) reported that the quartz mined for its gold content occurs as elongate lenticular bodies a few feet in width that may be traced for an extent of 100 feet. The gold occurs free in the quartz but is so fine grained that it can only be seen upon panning. The mineralized quartz zone, in outcrop, is highly brecciated an the breccia contains chunks of silicified wall rock as well as quartz. Fractures in the zone interconnect and grade into anasmotizing breccias. Hot spring-type alteration is in evidence in the Last Chance Claim area and opaline and chalcedonic silica coat fracture surfaces associated with a dike contact zone.

Titanium minerals occur in the albite bodies and prospecting during the 1950's and 1960's was focused on these occurrences. Titanium minerals present are anatase, ilmenite, luecoxene, and rutile (Beal, 1963, p. 9). Churn drilling by E. I. duPont de Nemours & Co. on placer claims in 1951 encountered placer debris containing 4.5 to 30 percent ilmenite. No minable bodies were encountered, however, and no work has been done on the titanium occurrences since that time.

DEAD CAMEL MOUNTAINS AREA

Location

The Dead Camel Mountains lie along the Churchill County-Lyon County border on the southwest edge of Lahontan Valley. The only known mining area, Camp Gregory, is located in Churchill County along the northeast slopes of the mountains about 11 miles southwest of Fallon. Mining activity near Camp Gregory has been confined to two small areas: one southeast of Red Mountain, north of the road that leads west into Churchill Valley, and a second in the low hills south of this road.

History

Nothing is known of the mining history of this area. There are two deep, vertical shafts at the site of the Camp Gregory mine. The shafts are not accessible but large dumps at each of the shaft collars provide evidence of fairly extensive underground workings. The remains of a camp are present in the wash northwest of the mine; rusting cans and other debris present at the site hint that activity here, probably gold prospecting, may have occurred sometime in the 1920-1935 era. There is, however, no recorded mineral production from these mines. In the past few years, the area has again been prospected for gold and silver. Noranda Exploration, Inc., staked claims covering Camp Gregory in 1982. Grayhill Exploration, Arvada, Colorado held claims in the area in 1986.

To the southeast of Camp Gregory, a group of claims cover outcrops of diatomite which are exposed through shallow gravel cover at the edge of the range. These claims date from the 1950's but little evidence of activity, save minor trenching, was seen. One large diameter bore hole, marked by a shaft symbol on the topographic map, was found within the claim block. This hole was probably drilled to test the extent of the diatomite deposit.

Geologic Setting

Most of the Dead Camel Mountains are underlain by young basalt flows. Rhyolite and andesite flows which locally crop out from beneath basalt and alluvial cover may be correlative with the Tertiary Kate Peak and Alta Formations exposed to the west. Tuffaceous sedimentary rocks, including some diatomite lenses, of the Truckee Formation crop out along the southern edge of the mountains.

In the Camp Gregory, area along the northeastern flank of the Dead Camel Mountains, a sequence of unwelded lithic tuffs is overlain unconformably by an andesitic to basaltic composite unit

containing flows, flow-breccias, lahars, phreato- magmatic surge and air-fall debris, fallback breccia, and minor siliceous sinter. These rocks were cut by faulting then overlain by a later sequence of rocks which included tuffaceous siltstones, bedded fallback breccias, siliceous sinters and undifferentiated, mixed sinter and fallback breccia. The fallback breccia deposits and sinters are evidence of hot-spring activity, probably associated with steep, northeast-trending faults which cut the volcanic rocks. Two rhyolite flow domes were emplaced in the southern part of this area, probably late in the sequence of hot-spring activity. Alteration associated with the hot-spring activity includes silicification of fallback breccia and tuffaceous sediments, argillization of tuffaceous sediments, rhyolite tuff, andesite, and basalt, and propylization of andesite and basalt (Dilles, 1983).

<u>Ore Deposits</u>

Two types of ore deposits have been prospected within this portion of the Dead Camel Mountains. A large area of hydrothermal alteration associated with an extensive fossil hot spring system located along the northeastern margin of the mountains has been prospected for precious metals. The earliest prospecting was done along steeply-dipping, silicified breccias and fault zones such as that exposed at the Camp Gregory mine. In the early 1980's, these same areas were prospected for large-tonnage gold-silver deposits similar to those found at Paradise Peak in Nye County, Nevada and at the McLaughlin mine in northern California.

The only other known mineral deposits within the eastern Dead Camel Mountains are found about 3 miles southeast of the area of hydrothermal alteration surrounding Camp Gregory. Here, Tertiary lake sediments have been prospected for diatomite. The diatomite deposits have been know for many years and are currently being held by mining claims. There has been no activity here, however, for many years.

DELAWARE DISTRICT

<u>Location</u>

The Delaware district, Carson City and Douglas County, is in the northwestern Pine Nut Range directly east of Carson City. The district is east of the Carson River along both sides of Brunswick Canyon. Most of the mining properties are in Carson City but several properties are in the upper reaches of Brunswick Canyon, north of Lebo Springs in Douglas County. Access to the district is via unpaved roads through Brunswick Canyon from the north or Johnson Lane from the southwest.

History

Discoveries of free gold in croppings in the Pine Nut Range east of Carson City were made in 1859-1860 during the early Comstock prospecting rush. Organized as the Sullivan district, a considerable amount of work was done in the summer and fall of 1860. Efforts were not successful, however, and most claims were subsequently abandoned. In 1866, iron and copper ores were discovered in the same general area but no mines developed (Angel, 1881, p. 537-538).

Trial shipments of iron ore are reported to have been made from the Bessemer mine, in Brunswick Canyon in 1907 and in 1919-1920 and small amounts of gold ore are reported to have been treated at a 5-stamp mill erected in the district in the 1920's (Overton, 1947, p. 42). This production was apparently not recorded, however, as Couch and Carpenter (1943, p. 122) show no production from this district. In the period between 1944 and 1954, less than 1,000 tons of iron ore were mined from the Bessemer mine. Some of this was used for concrete ship ballast; some was later mined for its iron content (Reeves and others, 1958, p. 61).

Tungsten was discovered at several locations in the district in the early 1940's and, between 1944 and 1977, about 250 units of WO_3 were produced (Stager and Tingley, 1988, p. 30-31).

The skarn iron occurrences in Brunswick Canyon were extensively explored in the late 1950's and early 1960's U.S. Steel Co. and others but no development occurred. In the early 1970's, the area around Lebo Springs was staked and explored for copper by Continental Oil Company. No discoveries were made, and the properties are now quite. The only activity noted in the district in the spring of 1989 was geologic mapping at the Utopian mine. Companies recently active in the Delaware district include Gold Bond Mines, Inc. (Lebo Springs, 1987) and Billiton Minerals USA, Inc. (June Ellen area, 1989).

Geologic Setting

Large areas of the district, especially west of Brunswick Canyon, near the head of Brunswick Canyon, and in the area near Lebo Springs, are underlain by Mesozoic metasedimentary and metavolcanic rocks. Cretaceous granitic rocks intrude the Mesozoic rocks and possibly underlie many of the Mesozoic outcrops; granitic outcrops occur along the lower flanks of the Pine Nut Range east of the Carson River, between Brunswick and Eldorado canyons, and in the vicinity of Lebo Springs in the south part of the district. Tertiary andesitic rocks, including both the Alta and Kate Peak formations, cover the lower parts of Brunswick Canyon and the peaks north of Lebo Springs.

Ore Deposits

Mineralization in the Delaware district occurs as quartz vein deposits in Tertiary andesite flows and all of the older rocks, and as iron and tungsten skarn deposits associated with contacts between Cretaceous granitic intrusive rocks and Mesozoic metamorphic rocks.

The quartz vein deposits are reported to carry limited gold and silver along with copper and iron sulfides. In the area of the Bidwell mine, in Sec. 28, T15N, R21E, several prospects explore quartz veins carrying chalcopyrite, pyrite, and galena that occur along a quartz monzonite-granodiorite contact. In other areas, vein deposits also occur in Triassic metasedimentary and metavolcanic rocks and these also have been prospected for gold, silver, and copper. The veins usually outcrop as iron-oxide-rich gossans locally stained with copper oxide minerals.

According to Reeves and others (1958, p. 61) the largest iron occurrence in the district occurs along a fault zone in Tertiary andesite flows. There is some question about the age of the host andesite, however, and the deposit may actually be a scarn-related occurrence in Mesozoic meta-andesite (?). The several small tungsten occurrences on McTarnahan Hill are scheelite-bearing skarns developed in Mesozoic rocks; some have replacement bodies of hematite associated with them (Moore, 1969, p. 31). One tungsten occurrence, the Dixon Brothers prospect (Stager and Tingley, 1988, p. 30-31) is a manganese-tungsten breccia in Tertiary rhyolitic tuffs.

Geochemistry

Most of the samples taken in this district contained trace to moderate amounts of gold associated with copper, arsenic, and occasionally, anomalous tungsten, antimony, and zinc.

DESERT MOUNTAINS AREA

Location

In this report, the Desert Mountains area, Lyon County, includes the southern slope of the Desert Mountains and extends from the general area of U.S. Highway 95A, north of Wabuska, to the low summit of the range east of Cleaver Peak. The prospects in this area are a diverse lot and have been grouped together more for descriptive purposes than for geologic similarities. The Juniper clay deposit, on the north side of the Desert Mountains, should logically be included in this area but, following tradition, it is included in the Churchill district to the north.

History

Little is known of the mining history of this area; diatomite prospects in the canyons south of Cleaver Peak were known as early as 1931 but no production is reported from them (Stoddard and Carpenter, 1950, p. 95). There is no record of production from the few metallic prospects north of the Thompson smelter site north of Wabuska or from those east of Cleaver Peak. The prospects appear to be old, however; those near the smelter site probably date from the early 1900's while those on the east end of the area may date to the late 1880's.

Geologic Setting

Rocks cropping out in the western part of the area include Jurassic-Triassic metavolcanic rocks which have been overlain by Miocene volcanic including rhyolitic tuffs, flows, and intrusions. In the eastern and northern part of the area, the overlying Tertiary rocks are mainly Miocene-Pliocene sedimentary rocks including lacustrine and fluvial sediments, and Pliocene or Pleistocene basalt flows and interbedded diatomaceous sediments.

Ore Deposits

Prospects in the hills north of the Thompson smelter site are along a shallow-dipping fault which separates thin-bedded hornfels in the hanging wall from meta-andesite in the footwall. Mine workings follow gossany, brecciated quartz veins containing specular hematite which occur as lenses in fault gouge. No information on these deposits is available but the work was probably for gold and silver.

Prospects in the low hills about 2 miles east of Cleaver Peak explored brecciated quartz veins in chloritized metavolcanic rock. The metavolcanic rocks have been intruded by a coarse-grained granitic porphyry and narrow aplite dikes. The vein material contains limonite, galena, and possible silver sulfide minerals. Work at this location may date to the late 1800's but the last work appears to have been in the 1920's or 1930's.

Diatomite crops out along a canyon on the south side of Cleaver Peak, about 3 miles north-northwest of Wabuska. Several bulldozer cuts expose the diatomite and interbedded tuffaceous rocks at intervals for an estimated 2,000 feet. The diatomite, however, appears complexly faulted and is probably at the surface only in small fault blocks. Younger basalt overlies much of the area and talus covers most of the slopes, thus obscuring the actual extent of the diatomite (Archbold, 1969, p. 32).

DIXIE VALLEY DISTRICT

Location

The Dixie Valley district, Churchill County, is a composite of two districts, the Dixie Marsh district of Vanderburg (1940, p. 49-50), and the Dixie Valley district of Willden and Speed (1974, p. 67. The only mine in Willden and Speed's Dixie Valley district, the Dixie Comstock, was included by Vanderburg (1940, p. 48) within his Table Mountain district.

In this report, the Dixie Valley district covers the east flank of the Stillwater Range from the area of Dixie Hot Springs on the south to the site of the old camp of Dixie on the north and, in addition, includes all of Humboldt Salt Marsh in Dixie Valley, between the Stillwater and Clan Alpine ranges. The only lode mines in the district are located low on the range front south of Dixie; the saline deposits are confined to Humboldt Salt Marsh.

History

From 1861 to 1868, Humboldt Salt Marsh produced a large amount of salt which was hauled by mule team to the silver mills of Virginia City, Austin, Belmont, Unionville, and even as far away as Silver City, Idaho. With the decline of silver milling by the Washoe and Reese River pan processes, the production of salt ceased and, owing to the isolation of the deposit from consuming centers, no attempts have been made to mine salt for any purpose since that time (Lincoln, 1923, p. 3; Vanderburg, 1940, p. 49). If production began from this deposit in 1861 as reported, Dixie Marsh was the earliest commercial source of salt in Nevada (Papke, 1976, p. 11).

Some 10 cars of borax were produced from the north end of the marsh in the early 1870's but there has been no subsequent production. In 1916, the marsh was tested for potash but grades encountered were too low to be of commercial interest (Vanderburg, 1940, p. 49).

Schrader (1947, p. 318) describes a promotional and "ephemeral boom camp" of Marvel that must have been near or at the later site of Dixie. Promotional activities were in progress here 1912-1913 and were centered on gold discoveries made in 1907. These discoveries were probably the same that were later rediscovered in as the Dixie Comstock deposit.

According to Vanderburg (1940, p. 48) the Dixie Comstock mine, the only lode mine in the district, was discovered in 1934. An amalgamation mill was constructed on the property in 1935 and production of about $293,000 in gold and silver was made by 1942 when operations ceased (Willden and Speed, 1974, p. 67).

DIXIE VALLEY DISTRICT

Location

The Dixie Valley district, Churchill County, is a composite of two districts: the Dixie Marsh district of Vanderburg (1940, p. 19-20), and the Dixie Valley district of Willden and Speed (1974, p. 67). The only mine in Willden and Speed's Dixie Valley district, the Dixie Comstock, was included by Vanderburg (1940, p. 54) within his Table Mountain district.

In this report, the Dixie Valley district covers the east flank of the Stillwater Range from the area of Dixie Hot Springs on the south to the site of the old camp of Dixie on the north and, in addition, includes all of Humboldt Salt Marsh in Dixie Valley, between the Stillwater and Clan Alpine Ranges. The only lode mines in the district are located low on the range front south of Dixie; the saline deposits are confined to Humboldt Salt Marsh.

History

From 1861 to 1868, Humboldt Salt Marsh produced a large tonnage of salt which was hauled [illegible] to the silver mills of Virginia City, Austin, Belmont, Unionville, and even as far away as Silver City, Idaho. With the decline of silver milling by the Washoe and Reese River pan processes, the production of salt ceased and, owing to the isolation of the deposit from consuming centers, no attempts have been made to mine salt for any purpose since that time (Lincoln, 1923, p. 8; Vanderburg, 1940, p. 20). If production began from this deposit in 1861 as reported, Dixie Marsh was the earliest commercial source of salt in Nevada (Papke, 1976, p. 11).

Some 15 tons of borax were produced from the north end of the marsh in the early 1870's but there has been no subsequent production. In 1915, the marsh was tested for potash but reported concentrations were too low to be of commercial interest (Vanderburg, 1940, p. 20).

Schrader (1947, p. 195) describes a prospect and [illegible] that [illegible] 1912-1913 [illegible]. [illegible] mentioned in the Dixie [illegible].

According to Vanderburg (1940, p. 54), the Dixie Comstock mine, the only lode mine in the district, was discovered in 1933. An amalgamation mill was constructed at the property in 1935 and production of about $100,000 in gold and silver was made by 1940 [illegible] (Willden and Speed, 1974, p. 67).

Recent exploration at the Dixie Comstock mine has consisted of underground rehabilitation, possibly for mapping and sampling, and surface trenching and drilling. According to claim notices on the property, work has been done by the Santa Fe Pacific Mining Co. Horizon Gold has recently approached the BLM regarding a plan to develop the Dixie Comstock property (personal comm., D. Jacquet, 1990).

Geologic Setting

The lower flank of the Stillwater Range west of the Dixie Comstock deposit is composed of Tertiary rhyolite which uncomformably overlays Jurassic gabbroic rocks of the Humboldt lopolith complex. The contacts of the two formations are shown by Willden and Speed, 1974) as faults but the rhyolite is described as a dike or plug that intrudes the gabbroic body (Willden and Speed, 1974, p. 67). Humboldt Salt Marsh, to the east of the lode mine area, is a playa lake bed; deposits of saline minerals in the lake are probably Pleistocene age.

Ore Deposits

The mineralized zone at the Dixie Comstock mine is a large silicified breccia that occurs along a northeast-striking, northeast-dipping shear zone in silicified rhyolite. Most stoping at the mine appears to have been done in the area of an intersection of northwest-trending structures with the northeast structure where a large outcrop of silicified, vuggy breccia occurs; from production records, gold and silver occur in about equal amounts in the ore but the only metallic minerals seen in outcrop were iron oxides and minor disseminated pyrite. Vanderburg (1940, p. 48) reported that mining at the Dixie Comstock was hindered by intense heat and that large quantities of hot water were encountered less than 75 feet from the surface.

The Dixie (Humboldt) marsh was formerly the site of a shallow lake, the evaporation of which produced a mixture of salts including sodium chloride, sodium sulfate, and sodium carbonate, with smaller amounts of sodium borate and potash salts associated with silt and mud. Sodium chloride occurs as an efflorescence in the lowest parts of the basin, covering an area of about 9 square miles. The surface salt is underlain by a series of salt and saline mud strata to a maximum depth of probably several hundred feet. When the salt deposit was mined, it was simply hoed into piles and shipped without refining. The borate mineral was chiefly ulexite or "cotton balls" that occurred at surface as aggregates of acicular crystals (Vanderburg, 1940, p. 50).

EAGLEVILLE DISTRICT

Location

The Eagleville district, Mineral County is centered around the old camp of Eagleville, a little less than 4 miles east of the Nevada Scheelite mine camp. According to Schrader (1947, p. 223) the district was also known as the Hot Springs district and included the all of the area between Rawhide Hot Springs, in Gabbs Valley about 8 miles south of Eagleville, and the Churchill County line, about 3 miles north of Eagleville. Schrader also included the camp of Sunnyside just east of the Nevada Scheelite camp, in the Eagleville district; Sunnyside is now included in the Leonard district.

In this report, the Eagleville district is restricted to the area beginning at the intersection of State Route 839 and the Churchill-Mineral county line and extending southeast to the camp of Eagleville, then south to the northern edge of Gabbs Valley.

History

According to Schrader (1947, p. 223) mineral deposits in this district were discovered in the early 1870's, or before, at the site of the Harry Mann mine, 3 miles northwest of Eagleville. A mill was built 5 miles to the southeast, on the edge of Alkali Flat but, due to the "basic" nature of the ore from the Mann mine, the mill was not a success and operated only in 1874.

In 1882, mineral was discovered at what is now the site of the Eagleville mine. The Eagleville Mining Co. was formed and, between 1884 and 1895, about $28,000 worth of gold ore was shipped from the property (Schrader, 1947, p. 224). In 1913, additional work was done on the property and ore worth $280,000 was reported to have been blocked out in the mine; no production was made, however. Couch and Carpenter (1943, p. 24) show about $35,500 in production from the district in 1932-1933. Much of this amount, however, probably represents barite production from the Highland barite deposit (Papke, 1984, p. 104-105).

Geologic Setting

All of the southern portion of the Eagleville district, from the south margin of Little Bell Flat south, is underlain by Upper Triassic volcaniclastic and volcanic rocks and limestone which have been intruded by Jurassic and Cretaceous granodiorite. The area north of Little Bell Flat is underlain by intermediate volcanic rocks probably correlative with the Tuff of Gabbs Valley (Eckren and Byers, 1986b).

The Triassic rocks are mainly rhyolitic and andesitic rocks that have been metamorphosed to the extent that they have a quartzitic appearance. On Eagle Hill, east of Eagleville, the andesitic rocks are so coarse-grained that they are dioritic in character (Archbold, 1966, p. 17). Within outcrops of the Triassic rocks in the western and southern parts of the district, some fine-grained clastic rocks and thin-bedded, clastic limestone units up to 100 feet thick are present. Granodiorite intrusive rocks crop out in the western and southern parts of the district and small exposures occur locally throughout the Triassic outcrop area. Archbold (1966, p. 17) believes the entire region (Eagleville area) is underlain by the granitic rock at shallow depth.

Tertiary volcanic rocks, mainly rhyolitic tuffs and flows, cover the older rocks west of Eagleville as well as to the north, on the northern margin of the district. No mineral deposits in the district are known to occur in the younger volcanic rocks; the deposits are associated with Triassic metasedimentary and metavolcanic rocks and granodiorite.

Ore Deposits

Eagleville is best known for its production of gold from quartz veins. The veins strike northwesterly, dip steeply, and are concentrated in the area between the old camp of Eagleville and Eagle Hill. The veins contain altered, brecciated meta-andesite, quartz, crystalline barite, fine-grained pyrite, and, in the oxidized portions, free gold. The vein outcrop near the top of Eagle Hill is composed of a 3- to 4-foot-wide vein of crystalline barite with an iron-oxide-stained zone of silica-cemented quartz rubble on its footwall; a sample from this vein contained 8 ppm gold. The vein barite deposit mined at Eagleville is adjacent to but separate from the vein gold deposits. Barite was mined from one vein which crops out over 3000 feet along strike; the vein strikes northeast, has a near-vertical dip, and is up to 8 feet in thickness (Papke, 1984, p. 105). Papke infers that the barite vein may be older than the granodiorite intrusive rocks in the district. The quartz-cemented shear zones containing gold are later in age than the barite vein and may be genetically related to the granodiorite; Archbold (1966, p. 18), in fact, mentions that the barite vein appears to be cut and offset by the shear zones in which the gold veins are localized.

Schrader (1947, p. 229-231) describes several small gold properties in the area between Sunnyside camp (probably near the current Nevada Scheelite mine camp) and Eagleville. Some of these occurrences, such as those at Sunnyside, are now included in the adjacent Leonard mining district. Others, such as the Gold Reef mine, are probably within the area of the Eagleville district; no information beyond that given by Schrader, however, is available on any of these properties.

The Triassic rocks are mainly rhyolites and andesitic rocks that have been metamorphosed to the extent that they have a schistose appearance. On [illegible] many of [illegible], the andesitic rocks are so [illegible] that they are [illegible] (Ferguson, 1933, p. 17). Within outcrops of the Triassic rocks in the western and northern parts of the district, some fine-grained clastic rocks and thin-bedded, [illegible] limestone units up to 100 feet thick are present. Granodioritic intrusive rocks crop out in the western and southern parts of the district and small, [illegible] dikes [illegible] locally throughout the Triassic volcanic rocks. Ferguson (1933, p. 17) believes that [illegible] is underlain by the granitic rock at shallow depth.

Tertiary volcanic rocks, mainly rhyolitic tuffs and flows, [illegible] the older rocks west of Rawhide as well as [illegible] in the northern part of the district. No mineral deposits in the district are known to occur in the [illegible] Tertiary rocks [illegible] are associated with Tertiary [illegible] and [illegible].

Ore Deposits

Rawhide is best known for its production of gold [illegible]. The [illegible] quartz veins [illegible] are concentrated in the area between the [illegible] of Rawhide and [illegible] Hill. The veins [illegible] quartz, [illegible], fine-grained pyrite, and, in the oxidized portions, free gold. [illegible]

[illegible]

EASTGATE DISTRICT

Location

In this report, the Eastgate district, Churchill County, includes a large area on the southwest end of the Desatoya Mountains lying generally south of Eastgate and west of Buffalo Summit on the Churchill-Lander county line. The district covers an outlying ridge of the Desatoya Range that merges with the Broken Hills to the southwest in the area of the Churchill-Mineral county line. Mines and prospects in the district are in clusters near the Eastgate mine on the north, near Buffalo Summit on the southeast, and near Tri-County well and Mud Spring on the southwest.

Willden and Speed (1974, p. 68) included prospects at Cold Springs, several miles north of Eastgate, in the Eastgate district. In this report, those properties are included in the Alpine district.

History

The first recorded activity in the district was in 1906 when locations were made on the Gold Ledge group of claims, site of the present Double Eagle mine (Vanderburg, 1940, p. 20). The nearby Eastgate mine was located at the same time. Individuals and small companies worked these two properties intermittently through 1940; recorded production from the properties for this time period is about $61,000 (Couch and Carpenter, 1943, p. 24). The Buffalo Hump mine, in the southeast part of the district, was discovered sometime later than the properties to the north. Extensive prospecting has been done in the mine area but it is credited with production of only a few carloads of shipping ore in 1936 (Vanderburg, 1940, p. 21-22).

Recent prospecting activity for precious metals is in evidence throughout the Eastgate district. Drilling has been done on claim blocks surrounding the Eastgate-Double Eagle mine area and wide-space drilling has been done on large claim blocks in the southwestern part of the district. Companies reported to have been active in this district recently include Dome Exploration, Ltd., Freeport McMoran Gold Co., U.S. Borax, and Cache Creek Exploration Co.

Deposits of zeolites were discovered in 1959 in the low pediment area west of Eastgate, south of the point U.S. Highway 50 turns north from its junction with old Highway 50. Subsequent exploration has been done in the area but, with the exception of a small operation producing kitty litter, there has been no zeolite production.

Geologic Setting

This portion of the Desatoya Mountains are made up largely of volcanic rocks, mainly rhyolitic flows, tuff, and welded ash-flow tuffs, of early Miocene to probable Pliocene age. Sedimentary deposits of Miocene age consisting largely of tuffaceous and diatomaceous shale and pebbly mudstone are exposed along Buffalo Canyon. Dacite flows crop out over a large area along the Lander and Nye county borders in the southernmost part of the district (Willden and Speed, 1974). Mudstone, tuff, slightly consolidated ash, and conglomerate, all of lacustrine origin, crop out in low hills in the narrow valley west of Eastgate. These rocks, of early to middle Pliocene age, host the zeolite deposits in this area (Papke, 1972, p. 14).

Pre-Tertiary rocks consisting of coarse-grained quartz monzonite which intrudes a complex of Mesozoic metavolcanic rocks are exposed along the Lander county line in the southeastern part of the district. This area is within a large caldera, centered to the north in the main portion of the Desatoya Range, and the Pre-Tertiary rocks are large, intracaldera blocks and are not in place (H.F. Bonham, Jr., personal comm.).

Ore Deposits

The Eastgate district contains several small silver-gold deposits which occur as quartz veins in altered rhyolitic rocks or as irregular disseminations in altered and silicified rhyolite. At the Double Eagle and Eastgate mines in the northern part of the district, quartz veins follow northeast-striking structures in wide breccia zones in welded ash-flow tuff. The veins show evidence of multiple stages of hydrothermal brecciation and lamellar quartz-after-calcite replacement textures. In the area of the Gold Trail group, east of Buffalo Canyon, prospecting has been done on a large area of kaolinization in volcaniclastic rocks adjacent to intracaldera blocks of granitic rocks. No obvious metallic mineralization can be seen but there is a large area of iron-oxide-stained clay alteration present. Workings at the Buffalo Hump mine explore a large area of iron-oxide staining in kaolinized, silicified, non-welded, lithic tuff. Brecciation and silicification follow a northwest-striking fault zone in the altered rhyolite ass-flow tuff. In the basin west of the Buffalo Hump mine and extending west into the low northern part of the Broken Hills, several small mines and prospects explore areas of kaolinization, silicification, and local hydrothermal brecciation in rhyolite ash-flow tuffs. Most of these prospects appear to be related to northwest-trending faults which are locally marked by silicified ribs and sheeted zones in the altered tuffs.

The zeolite deposits east of Eastgate occur in a sequence of lacustrine sediments of early to middle Pliocene age. Zeolite-

rich beds occur within a stratigraphic thickness of about 15 feet and are underlain by montmorillonitic-illitic mudstones, friable ash, and some tuff and gritty sandstone (Papke, 1972, p. 13-16). The zeolite sequence is exposed for as much as 1,400 feet along strike in parts of the area. Zeolite minerals present are clinoptilolite, erionite, chabazite, mordenite, and phillipsite. At one area, the zeolite unit has been quarried on a small scale for building stone (walls of two of the buildings at Eastgate are constructed of this material). The zeolite deposit has been tested by several companies, including Union Carbide Corp. and Shell Development Co. but no large-scale commercial development has taken place. In 1987, construction began on a small plant to treat mordenite for use as cat litter and oil and grease absorbent. When placed into operation, this plant will have a capacity to produce 30,000 tons/year (Castor, 1989, p. 30).

Of more casual than commercial interest is a reported occurrence of gold-bearing petrified logs found in tuffaceous sediments somewhere in the southern part of the district. This occurrence, described by Palmer (1935, p.335) is "...in the Aspen district of Churchill County...at the eastern end of the Broken Hills range and northwest of the Bruner or Phonolite district... The gold-bearing wood is found about 1/4 mi. southwest of the camp known as Nigger or Tucker Wells...In size the logs seen range up to 2 ft. in diameter...About ten to fifteen gold-bearing logs have been found, and only parts of two that carry gold are now exposed. The others have been mined and either milled or screened and sacked for shipment". Gold in these logs occurs as discrete crystals, sometimes attached to quartz, associated with crystalline and chalcedonic silica, carbon, and calcite. Assays up to 18.26 oz of gold and 10.8 oz of silver were obtained from specimen samples. The Aspen district is in Lander County, but the sketchy description of the location places this occurrence probably somewhere in the vicinity of either Tri-County well, Big Buffalo, or Little Buffalo well in the Eastgate district.

Geochemistry

Ore samples collected from mines in the district showed values in silver and gold associated with anomalous beryllium and moderately high barium and manganese. Base metal, antimony and arsenic values are very low in samples from this district.

EASTSIDE AREA

Location

The Eastside area, Mineral County, is located in the low hills northwest of Basalt and south of Teels Marsh. The major property in the area, the Eastside mine, is 2 miles west of the State Route 360 and about 7 miles northwest of Basalt.

History

The Eastside mine was located during World War I for copper, and it is reported that approximately 4000 tons of ore averaging over 5 percent copper was shipped (Grauberger, 1971, p. 2). Turquoise was discovered on the Blue Gem claims by Lee Hand in 1931, and production has been intermittent from the property up through about 1970 (Morrissey, 1968, p. 24). In about 1940, cinnabar was discovered in the southwestern part of the area by J. G. H. Noguez and a few flasks of mercury have been produced from the property (Bailey and Phoenix, 1944, p. 131-132).

In 1971, the Eastside area came under consideration as a porphyry copper prospect and several major companies conducted exploration in the district. Conoco leased the property in 1972 and carried out a program of sampling, mapping, and drilling which was not successful in developing economic quantities of mineralization. There was no activity in the area in 1989.

Geologic Setting

In the vicinity of the Eastside mine, metamorphosed sedimentary rocks of the Ordovician Palmetto Formation are cut by Jurassic-Cretaceous age quartz monzonite dikes. The remainder of the area is mantled by Tertiary volcanic rocks, mostly rhyolite and quartz latite welded tuffs. Basin and range faulting has produced a series of northeast-trending horst and graben structures consisting of Ordovician rock horsts alternating with grabens capped with Tertiary volcanic rocks (Roman, 1973, p. 1.). All of the mines and prospects in the district visited during this project, including the Noguez mercury prospect, are hosted in the Ordovician rocks.

Ore Deposits

Outcropping mineralization at the Eastside mine consists of several quartz veins, 1- to 4-feet thick, that occur within a 100-foot wide zone of brecciation in chert, limy sandstone, and limestone of the Ordovician Palmetto Formation. The north-south striking, near vertical vein outcrops are stained with iron and copper oxide minerals. Visible copper minerals associated with the veins include azurite, chalcocite, cuprite, malachite, tenorite, turquoise, and rare blebs of chalcopyrite. Molybdenite is present in highly siliceous rocks in some areas. The vein mineralization occurs within a larger area, about 1 1/2 miles in length and 1 mile wide, of intense hydrothermal alteration. Altered rocks are silicified, sericitized, contain disseminated pyrite, and are laced with quartz-sericite-sulfide veinlets.

Historic production from the Eastside mine was of secondary-enriched copper ores from the near-surface portion of the main

vein. Porphyry copper-molybdenum exploration in the early 1970's was focused on the larger area of quartz-sericite-sulfide veining. Induced polarization studies in the stockwork vein area indicated the possible presence of a broad pyritic halo interpreted to be related to a buried, mineralized intrusive mass (Roman, 1973, p. 1-3). Diamond drilling failed to intersect mineralization and reinterpretation of data from the property led to the conclusion that any potential for porphyry copper-molybdenum would be very deep, beyond current economic interest. Additional work was not done, and the property is now idle.

At the Noguez mine, in the western part of the area, cinnabar occurs associated with gypsum and pyrite in a high-angle fault cutting Ordovician limestone, chert, and shale. The description of this property in Bailey and Phoenix (1944, p. 131-132) places the mine in silicified Tertiary tuff, not at all the setting found at the mine site.

ELDORADO DISTRICT

Location

The Eldorado district, Lyon County and Carson City, is restricted to the drainage of Eldorado Canyon in the northern Pine Nut Range. The canyon drains to the north from Mineral Peak and connects with the Carson River at Dayton. At a point about 3 miles south of Dayton, the canyon forms the boundary between Carson City, to the west, and Lyon County, to the east. The only known prospect in the district is at the canyon mouth on the north end of the district; the coal occurrence, for which the district was formed, is located several miles up the canyon along the northeast slope of Bismark Peak. The coal deposit is immediately west of the stream in Eldorado Canyon and the old workings are, therefore, in Carson City rather than Lyon County.

History

Stretch (1866, p. 18) reported that "About two years ago there was considerable excitement about reported discoveries of coal on El Dorado Canyon. Considerable work was done on the Newcastle Co.'s location...the coal, which was of a dull, black color, and shaly in its appearance, being an inferior lignite, probably of Triassic age; but work has been suspended for many months". It is reported that 9,800 tons of coal were mined from the deposit prior to 1865 and, following formal organization of a mining company in 1872, an additional 31,400 tons were mined. Two shafts were sunk, one 420 feet deep and the other 85 feet deep. An examination of the area in the early 1960's (?) indicated that, in general, it appeared that no work had been done on the area since 1900; the shafts were caved and the dumps were badly weathered and covered with sagebrush (U.S. Geological

Survey and Nevada Bureau of Mines and Geology, 1964, p. 52). In 1976, there was evidence of recent exploration in the vicinity on placer claims and the old dumps had been bulldozed (Garside and Papke, 1980). Santa Fe Mine, located in section 34 & 35, was evaluated by Anaconda Mining Co. during the firms active period in Yerington. The property was reactivated in the mid-1970's by Santa Fe Mines, Inc. which attempted to leach copper from mineralized volcanics (personal comm., D. Jacquet, 1990).

Geologic Setting

Rocks in the area are Miocene-Pliocene andesites of the Alta or Kate Peak Formations. These formations locally contain interbeds of tuff and coal-bearing sediments.

Ore Deposits

At the Eldorado Canyon coal deposit, the coal-bearing formation consists of alternating layers of marl, soft gray sandstones, shales, fire-clay, carbonized vegetable matter, and beds of weathered lignite. There are three beds of lignite which are, counting from the surface, 16 feet, 15 feet, and 6 to 8 feet in thickness (U.S. Geological Survey and Nevada Bureau of Mines and Geology, 1964, p. 52). The beds strike north-south (?), and dip 20^0 west. An analysis of coal from the dump reported about 19 percent moisture, 34 percent ash, 28 percent volatile hydrocarbons, and 19 percent fixed carbon (Garside and Papke, 1980).

No information is available on the single metallic prospect in the district. It appears to be a hot spring deposit and may have been prospected for mercury.

FAIRVIEW MINING DISTRICT

Location

The Fairview district, Churchill County, is located about 45 miles east-southeast of the town of Fallon and encompasses an area on both sides of Fairview Peak extending from U.S. Highway 50 on the north to Crown (Bell) Canyon on the south. An unimproved dirt road following the bottom of Crown Canyon provides the only public access to the southern part of the district. Crown Canyon can be reached by driving east from State Highway 31 at a point about 8 miles south of Highway 50. The eastern portion of the district is accessible by a dirt road that leads south from Highway 50 east of Drumm Summit and parallels the east side of Fairview Peak. Access to mines north of Crown Canyon on the west side of the district is possible either by road through restricted bombing range from the west or by foot from the Nevada Fairview mine north of Crown Canyon. On the north end of the district, the major mining area southeast of the

old townsite of Fairview is accessible by a poorly-maintained dirt road that leads south from U.S. Highway 50 about 4 miles east of Frenchman. This route crosses the Naval bombing range but is open to public access.

History

Silver deposits on the northwest side of Fairview Peak were discovered in the summer of 1905 by F. O. Norton in the summer of 1905. By July 1906, prospectors and miners has staked close to 400 claims covering 12 square miles. Early work in the district was done mainly by small operators and lessees; by 1911, however,

the Nevada Hills Mining Company consolidated most of the properties in the district, including those of the Fairview Eagle Mining Company, and formed the nucleus of properties thereafter known as the Nevada Hills Mines (Schrader, 1947, p. 65-66). The Nevada Hills Mine was the major producer in the Fairview district from the time of consolidation until 1917 when it closed for lack of ore. From 1906 to 1922 the camp produced over 48,000 ounces of gold and over 4,700,000 ounces of silver, most of which was credited to the Nevada Hills Mine (Vanderburg, 1940, p. 25). The mine was opened to a depth of 1,100 feet and was mined on 9 levels from more than 43,000 feet of workings. The years of peak production were 1906 to 1916; the highest yearly production was achieved in 1912.

During this same time period (1906-1916) a number of smaller properties were located along the west-central and southern portions of the district. The most notable of these include the Mizpah, Grand Central, and Jelinek mines in the west-central area and the Nevada Crown, Nevada Fairview (Snyder or Gold Coin) and Bluff Mines to the south. Although some of these mines have very sizeable workings, no production is recorded from any of them.

Following the closure of the Nevada Hills mill in 1917, the district rapidly declined. Claims in the Fairview district have been maintained over the years, however, and sporadic prospecting continues in the area. Recently, several major mining companies have examined the district searching for bulk-mineable deposits of gold and silver. In the late 1960's, patented mining claims covering a large portion of the Fairview district were acquired by the Howard Hughes organization. When the Hughes company, Summa Corporation, later divested itself of its mineral holdings, the Fairview properties were sold to Houston Oil and Minerals Company. Houston was later acquired by Tenneco Minerals. Tenneco Minerals, in late 1986, was purchased by Echo Bay Mines, a large Canadian gold mining company with extensive holdings in Nevada. Houston explored its holdings at Fairview and South Fairview in the late 1970's but these properties are not active at the present time.

Geologic Setting

The oldest rocks exposed in the Fairview district are schist, limestone, shale, and slate of Triassic age. The limestone and shale crop out in a narrow belt on the northwest side of the district, west of Fairview Peak. The schist, shale, and slate crop out both north and south of Crown Canyon. Schist is exposed at the Nevada Crown shaft just north of Crown Canyon while both schist and slate are exposed along the margin of a granitic outcrop west of the Nevada Crown adit. According to Schrader (1947, p. 73), quartz monzonite forms the core of Fairview Peak and the northern part of the range. It is exposed on the north slope of Fairview Peak and at the foot of the mountain about 2 miles south of the peak. Granite crops out just north of Crown Canyon and also due west of Fairview Peak where it is in contact with metasedimentary rocks.

Fairview Peak and most of the surrounding district are covered by a thick sequence of welded and non-welded, largely silicic, tuffs of Miocene age. All of the tuffaceous rocks, according to Willden and Speed (1974), are sufficiently quartz-rich to be classified as rhyodacite, quartz latite, and rhyolite rather than dacite as described by Schrader (1947). The so-called "lode andesite" of Schrader is classified as dacite by Willden and Speed, also on the basis of its quartz content. Both pre- and post-ore faults are numerous throughout the district; some of the mineralized veins follow the pre-ore faults.

Slates and limestone in contact with granodiorite are exposed along the southeast flank of the mountain in the vicinity of the Slate Mine (Midday Mine).

Ore Deposits

Two types of mineral occurrences have been mined within the Fairview mining district. The most important of these, precious metal-bearing quartz vein deposits, occur mainly along the west side of Fairview Peak. The vein deposits were developed in three general areas: on the northwest slopes of Fairview Peak (the Nevada Hills, Eagle, Dromedary Hump and adjacent mines); on the lower, west slopes of Fairview Peak (the Mizpah, Big Ledge or Jelinek, and Grand Central Mines); and on the southwest slopes of Fairview Peak, near Crown Canyon (the Nevada Fairview or Gold Coin, Bluff. and Nevada Crown Mines). The Crown Canyon area is sometimes referred to as the South Fairview district.

South of Crown Canyon, on the southern slopes of Slate Mountain, small contact deposits of tungsten have been prospected and mined. These deposits were discovered in the 1940's and their production is insignificant in comparison to the precious metal production recovered from the vein deposits to the north.

The major productive quartz veins in the Fairview district trend northwesterly in or along the margin of a dacite intrusive (the lode porphyry of Schrader, 1947) which cuts silicic tuffs. The vein systems are cut by numerous faults which acted, in part, as conduits for three separate stages of mineralization. Although the veins occur in or near fractures, they are largely replacement veins consisting of quartz and altered wall rock which has been partly or wholly replaced by quartz, adularia, and other gangue minerals. The veins are mostly massive or brecciated and show fine-grained replacement quartz and ore grading laterally into the silicified wall rock. Large parts of the veins are well banded and crustified, recording deposition in successive layers on the walls of open fissures (Schrader, 1947, p. 83). The ore minerals, which are selectively distributed in both the quartz ore and some of the adjoining wall rock, are: acanthite, cerargyrite, embolite, ruby silver, bromyrite, polybasite, pyrite, sphalerite, stephanite, tetrahedrite, and native gold.

In general, the veins pinched out with depth or became too low grade to justify further mining. The drastic reduction in ore grade with depth is exemplified by conditions recorded at the Nevada Hills Mine. At this deposit, outcrops and near-surface ore shoots contained as much as 92 ounces gold and 4,300 ounces silver per ton. During 1906 to 1910, the average grade of ore from the upper workings ranged from 1 to 3 ounces gold per ton and to over 100 ounces silver per ton. Later, during the period of maximum production from 1914 to 1916 when ore was being mined from the lower levels of the mine, grades dropped to 0.08 ounces gold per ton and 7.8 ounces silver per ton (Vanderburg, 1940, table 3).

The veins, or vein groups, are accompanied by zones or masses of hydrothermally altered, highly silicified, pyritic andesite porphyry wall rock; such rock is generally most abundant along the wider parts of the veins. In all cases, for both veins and adjacent wall rocks, silicification was reported to decrease with depth (Schrader, 1947, p. 84).

Geochemistry

Two general groupings of geochemical associations are apparent within the Fairview district: 1) Southern Fairview District (Jelenik-Mizpah-Gold Crown area); silver, gold with anomalous beryllium, some anomalous molybdenum, low arsenic, antimony and low to nil base metals, and 2) Main Fairview district (Nevada Florence-Nevada Hills area): silver, spotty gold associated with high copper, lead, zinc, and anomalous molybdenum, moderately anomalous beryllium.

Molybdenum seems to be anomalous in samples from both areas, but higher in the base-metal-rich area. Arsenic and

antimony values are anomalously low in the entire district. The base metal association is found in the part of the district closest to outcrops of pre-Tertiary rocks (west of Fairview in the Nevada Florence mine area) and in the area of the main Fairview mines on the north end of the range. This metal association is similar to that found in samples from the Chalk Mountain district, north of Fairview. The base metal association and possible relationship to pre-Tertiary rocks may indicate that base-metal (polymetallic) replacement deposits, skarns, or porphyry copper-molybdenum deposits may be present beneath Tertiary outcrops on the west side of the Fairview district or under alluvial cover in Fairview valley to the west of the mountain front.

FITTING DISTRICT

Location

The Fitting district covers the southeastern Gillis Range and a small portion of the Gabbs Valley Range in central Mineral County. The district lies generally north of the section of U.S. Highway 95 between Hawthorne and Luning. In this report, the boundaries used for the district are Ryan Canyon on the northwest, Win Wan Valley on the north, U.S. Highway 95 on the south, and State Highway 361 on the southeast. Most of the mines in the district are located on both sides of Paymaster Canyon, northwest of the old railroad siding of Acme.

History

The district apparently dates from about 1906 when a large, silicified outcrop in Ryan Canyon was found to contain gold and silver. Discoveries must have been made in Paymaster and Montreal canyons about the same time as Paher (1970, p. 437) mentions that the camp of Acme had developed in 1907 at a railroad siding by that name to service the mines in the Fitting district, 7 miles to the north. The prospects apparently did not prove valuable and the town was soon abandoned. Lincoln (1923, p. 143) credits the Montreal mine in Montreal Canyon with $1.5 million in gold production and the Silver King mine in Paymaster Canyon with $.5 million in silver and lead, but there is no record of this production. Andalusite and corundum were found in an area south of Ryan Canyon in 1929, and a few hundred tons of andalusite were mined from the deposits (Ross, 61, table 6.2). In the period following World War II, the district was prospected for iron and tungsten in skarn deposits and, later, for uranium. No deposits were developed, however. Some parts of the district either currently or very recently have been explored, probably for precious metals. New bulldozer roads and drill sites were noted on claims in Ryan Canyon and in areas in Paymaster Canyon. There was, however, no activity at the time the district was

visited in the late spring of 1989. Companies reported to be active in this district in 1988-89 included American Gold Resources, Coca Mines, Inc., Combined Metals Reduction Co., Placid Oil Co., Westley Exploration, Inc., Bond Gold, Inc., and Corona Gold, Inc.

Geologic Setting

Rocks exposed in the portions of the Gillis and Gabbs Valley Ranges included in the Fitting district are mainly Triassic and Jurassic metavolcanic and metasedimentary rocks that have been intruded by Cretaceous and Jurassic quartz monzonite. The eastern part of the district, in the Gabbs Valley Range, is covered by Tertiary volcanic rocks, mainly rhyolitic ash flow tuffs.

Most of the mines in the district have been developed in the metavolcanic and metasedimentary rocks and along the contacts of these rocks with the quartz monzonite intrusive rocks.

Ore Deposits

The discovery outcrop of the district, on the Hawaiian group of claims in Ryan Canyon, is a silicified dike 150 to 600 feet wide that can be traced along strike for over a third of a mile. Part of the structure is occupied by a silicified breccia and the outcrop is variably stained with iron, manganese, and copper oxide minerals (Vanderburg, 1937, p. 33).

At the Silver King and Montreal mines, mineralization occurs along vein systems that cut Triassic metavolcanic rocks. At Silver King, the veins trend north-south, at the Montreal, the veins strike N30^{0}E and dip to the northwest. Vein material in samples collected from these mines contained quartz, calcite, and oxide minerals of lead, copper, and silver. Numerous other prospects in the district explore similar vein occurrences.

Skarn minerals, garnet, epidote, and other silicate minerals, were noted on dumps in Ryan Canyon and at a prospect about 2 miles to the south of Ryan Canyon. At two locations north of Kinkaid, barite occurs as lenses and veins in Triassic metavolcanic rocks associated with copper mineralization.

At the Dover and Green Talc mines, on the south flank of the Gillis Range east of Thorne, andalusite, corundum, quartz, sericite, and probably a little dumortierite occur as replacement masses in Triassic metavolcanic rock. A small quantity of andalusite was shipped from this deposit prior to World War II, but the property has been inactive since that time.

In the eastern part of the district, in the Gabbs Valley Range, several prospects explore iron-stained shear zones in

altered rhyolite ash-flow tuff units. Some of these properties appear to have had minor production, but no record of production exists. On the Red Hills claims, fissure veins containing minor copper mineralization are exposed in numerous small prospects in massive ash-flow tuff units. Pits, bulldozer cuts, and roads on this prospect cover over a square mile .

Geochemistry

Ore samples collected from mines in the district showed low but anomalous gold values and spotty, high silver associated with high copper values. Lead, zinc, antimony and arsenic are high in a few but not all samples. A number of samples are high in molybdenum.

FREDS MOUNTAIN AREA

Location

Freds Mountain area, Washoe County, is in the vicinity of Antelope Valley, about 8 miles north of Stead. The area includes both Freds Mountain and the western part of Hungry Mountain.

History

No information is available on the mining history of this area. Prospects in the area are marked by small diggings on copper-stained quartz outcrops; these could be very old workings dating to the time of early work in the Peavine area in the 1860's. There is, however, no recorded production from the area. Titanium occurrences on the southern tip of both Freds Mountain and Hungry Mountain were prospected in the 1950's, and the entire area was actively searched about the same time for uranium. No economic occurrences of either commodity were found, however. There is no activity in the area at the present time.

Geologic Setting

The area including Freds Mountain and Hungry Mountain consists largely of Mesozoic metamorphic and granitic rocks unconformably overlain by small erosional remnants of Tertiary volcanic rocks. The north-trending ranges are fault blocks bounded by normal faults which locally cut deposits of Pleistocene age. The ranges have been tilted to the northwest (Bonham, 1969, p. 52).

Ore Deposits

Most of the copper and copper-gold prospects in metamorphic rocks at the north end of Freds Mountain are small lenses of disseminated copper sulfides in schistose metavolcanic rocks

(Bonham, 1969, p. 93). The outcrops of these deposits are commonly marked by narrow limonitic and hematitic gossans and boxworks with sparse vein quartz. The quartz, with and iron- and copper-copper-oxide staining, occurs along shear zones cutting metavolcanic and intrusive rocks. Narrow zones of sericitic, and rarely, potassium-feldspar alteration border the mineralized shear zones.

Titanium-bearing quartz and feldspar pegmatites and greisen zones in Mesozoic granitic rocks have been explored at localities in the southwestern and southern part of Hungry Mountain. At these occurrences, sparse red rutile commonly occurs as disseminated crystals in greisen-like rocks associated with sparse iron- and copper-oxide minerals.

GABBS (DOWNEYVILLE) DISTRICT

Location

The Gabbs district, Nye County, covers the western portion of the Paradise Range and extends from Downeyville on the north to the Cottonwood Canyon area on the south and from the western front of the range near the town of Gabbs east to include prospects near Craig Station in the eastern part of the range. The northern part of the district, which includes the mines at Downyville, is west of the Toiyabe National Forest boundary and is within the Carson City BLM district; the southeastern part of the district, which includes the magnesite deposits at Gabbs, is east of the Forest boundary and is within the Tonopah BLM district. Only those areas within the Carson City BLM district are covered in this report.

History

The earliest mining activity in this district was at Carbonate Point, now Downeyville, in 1875 or 1877 (Kleinhampl and Ziony, 1984, p. 98). According to Paher (1970, p. 377), silver-lead discoveries were made here in May 1877. Production records for the Downeyville mines, however, show production for the years beginning with 1875 (Couch and Carpenter, 1943, p. 118), indicating that the district must have been discovered sometime prior to 1875. A lead smelter was built at Downeyville shortly after 1881, but activity at the mines had ceased by about 1901 (Paher, 1970, p. 377). The only mining reported from Downeyville since that time has been the shipment of all the old slag dumps and some oxidized ore dumps to smelters sometime prior to 1951 (Kral, 1951, p. 109). Recorded production from the Downeyville mines, 1875 to 1878, is about $120,000 in silver, lead, zinc, and minor gold (Kleinhampl and Ziony, 1984, p. 100).

Several small copper properties have been explored in the area extending from Craig Station northwest to the Big Chief mine. Nothing is known of the discovery or production history of these deposits.

There was no evidence of recent work in the district when it was examined in 1986 and 1989.

Geologic Setting

Rocks exposed in the Downeyville-Craig Canyon portion of the Gabbs district consist of complexly folded and thrust-faulted limestones and dolomites of Triassic age, limestones and limy clastic rocks of Triassic-Jurassic age, and sandstones of Jurassic age. These rocks are intruded by bodies of granodiorite of inferred Cretaceous or Jurassic age (Silberling and John, 1989). With the exception of a curving range-front fault along the southeast margin of Lodi Valley, most of the faults cutting rocks in the district follow a north-northwest trend. Thrust faults are interpreted to separate large structural blocks, each with distinct deformation characteristics. Major thrust faults mapped in the Downeyville area include the Holly Well fault, an overturned thrust fault that crops out east of Downeyville in the Lodi allochthon, and the Big Chief fault, an inferred thrust fault (possibly also overturned) that separates the Lodi allochthon from the Quartz Mountain allochthon to the east (Silberling and John, 1989). Two generally distinct bodies of granodiorite occur in the Downeyville area; a strongly sericitized biotite granodiorite porphyry near the Big Chief mine, and a locally porphyritic hornblende-biotite granodiorite that crops out several places in the low hills east of Downeyville. Large areas of bleaching and recrystallization occur in the carbonate rocks near these intrusive bodies and extend for considerable distances into the carbonate outcrops. No skarn mineralization, however, was noted in the district.

Ore Deposits

Deposits of silver-lead-zinc are clustered in the low hills within about a one-mile radius of the old camp of Downeyville. Ore occurs in replacement bodies in bleached, recrystallized carbonate rocks of mainly Triassic age. From what can be seen in surface exposures, mining was done along pipes and shoots that followed bedding plane-fracture intersections in the host limestone. The limestone outcrops display a mottled appearance with bleached marble zones occurring both along bedding and as random patches in the rock. The ore deposits are oxidized at surface and outcrop as limonite- and hematite-rich gossans. The gossans contain lenses of jasperoid; vugs commonly contain clear quartz crystals, barite crystals, hemimorphite crystals, cerussite, and occasional wulfenite. Specimens of sulfide ore, seen on the Downeyville mine dump, from deeper in the mine

workings consist of massive galena, sphalerite, and pyrite. Silver, and some gold, is contained in the lead-zinc minerals. A small patch of altered granodiorite crops out northwest of the main shaft of the Downeyville mine; alteration in the limestone at Downeyville as well as the silver-base-metal mineralization is inferred to be related to a body of intrusive rock which may underlie this portion of the Gabbs district.

Several small copper-silver occurrences are located north and south of Craig Station along the eastern border of the mining district. These deposits fall along a northwest-southeast trend that generally coincides with the Big Chief fault of Silberling and John (1989). The deposits extend from the area of the Big Chief mine on the northwest to the prospects near Fowler Spring on the southeast. At the Big Chief and Chukar properties, oxide and sulfide copper mineralization occurs along shear zones cutting silicified limestone. Further southeast, prospects near Fowler Spring expose northwest-trending, tetrahedrite-bearing quartz veins in shear zones in meta-andesite.

GABBS VALLEY AREA

Location

The area is not a recognized mining district but, in this report, is used to include mines and prospects scattered throughout several groups of low hills surrounding and included within southern Gabbs Valley. The area is generally along the Nye-Mineral county line, west of the town of Gabbs and southeast of the camps of Rawhide, Nevada Scheelite, and Eagleville. Prospects in Mineral County west of the Paradise Peak mine, between the county line and State Route 361, are included in this area along with prospects further to the west near Ramsey Spring and in the Black Hills along the southwestern edge of Gabbs Valley. Occurrences east of Rawhide Hot Springs, in Nye County within the southwestern part of the Monte Cristo Mountains, are also placed in this area. Access to many of the prospects is difficult to the presence of dune sand which hampers travel.

History

Very little information is available on the mining history of this area and no production has been recorded from any of the properties. Bailey and Phoenix (1944, p. 132) note that the Poinsettia mercury property, west of Ramsey Spring, may have been discovered in 1929. Schrader (1947, p. 29) mentions that, in 1936, the Rovada Mining Co. made four small shipments of gold ore from a property 4 miles south of Rawhide Hot Springs. This could have been either the Lithia mine, the Rita mine, or the Black Hills prospect, north of the Rita mine. Several of the properties, including the Rex mercury prospects and the Rita and

Lithia mines, have extensive workings and no doubt produced some amount of ore. The remains of mercury retorts at several locations on the Rex claims indicate some production of mercury from that area. Many of the mine areas are now under claim but most of the present prospecting activity is located in the southeastern part of the area, adjacent to the active Paradise Peak gold mine. Companies active in this area in 1989 included Adwest Gold, Inc., FMC, Glamis Gold, Inc., and Hecla Mining Co.

Geologic Setting

The oldest rocks in the area are Triassic volcaniclastic and volcanic rocks which crop out on Mystery Ridge and in the Black Hills in the western part of the area. These rocks have been intruded by Cretaceous-Jurassic granodiorite; the granodiorite crops out in the Black Hills and in the southern Monte Cristo Mountains to the northeast of the Black Hills. Ekren and Byers (1986) have mapped an inferred cauldron boundary that trends northeasterly along the eastern side of Fissure Ridge in the southwestern Monte Cristo Mountains. Several northeast-trending faults cut Fissure Ridge and the Black Hills to the west; these faults may be cauldron boundary faults. To the east of the cauldron boundary, outcrops consist of Tertiary rhyolites, rhyolite tuffs, and tuff breccias. These rocks would be within the inferred cauldron of Ekren and Byers (1986). All of the lower portions of Gabbs Valley are covered by Tertiary fluvial and lacustrine sediments and by Quaternary alluvium and dune sand.

Ore Deposits

Mercury prospects in the eastern part of the area, immediately west of the Paradise Peak gold mine, are located within areas of kaolinization, silicification, and alunitization associated with hydrothermal breccias in Tertiary rhyolitic ash-flow tuff. Alteration and sparse mercury mineralization follows northwest- and northeast-striking shear zones in the silicified ash-flow tuffs. Native sulfur was noted in outcrops along with alunite veinlets and some marcasite. Slopes below some of the silicified outcrops are littered with crystalline gypsum. Mining claims held by FMC cover much of this area and drilling and surface exploration for precious metals was underway at the time the properties were visited in July of 1989.

Mercury mineralization at the Poinsettia mine, in the western part of the area, is also hosted in silicified tuffs and the alteration is similar. The Ball Bearing mine, east of the Poinsettia near Ramsey Spring, is located within a pipe-like breccia mass in altered tuff. Other than hematite staining, however, there is little evidence of metallic mineralization at this property.

Mines and prospects south of Rawhide Hot Springs in the Black Hills and on the west side of Fissure Ridge all explore mineralized shear zones in Triassic metavolcanic rocks or granitic rock which cuts the Triassic rocks. At the Rita mine, on the east side of the Black Hills, oxide copper mineralization occurs along a northeast-trending shear zone in fine-grained diorite. North of the Rita mine, at the Black Hills prospect, an extensive area has been recently worked, by hand and light equipment, probably for gold. Small trenches and pits expose thin quartz veins containing galena, cerussite, and oxide copper minerals. A dozen or more 50-gallon cyanide drums, filled with hand-sorted chunks of mineralized vein material, remain on the property.

GALENA DISTRICT

Location

The Galena district, Washoe County, is located in the area of Pleasant Valley, about 10 miles south of Reno. The major mines in the district are in the Steamboat Hills, on the west side of Pleasant Valley, but several prospects also occur on the lower flanks of the Virginia Range, on the east side of the valley.

History

The Galena district was organized in the spring of 1860 following discoveries of galena-rich ores at the site of the present Union mine. A smelting furnace, the first one on the east side of the Sierra's, was built but the ores were found to be "too base" and to contain too little silver to be worked profitably and the mines were abandoned (Angel, 1881, p. 643).

Interest in the district was renewed in 1906 and 1907 when a new concentrating plant was built at the Union mine by the Commonwealth Mining and Milling Co; this venture ceased operations about 1911 (Overton, 1947, p. 64-65). Other attempts to operate the Union (now referred to as the Commonwealth) mine in the 1920's and 1930's and, in 1939 the Union Lead Mining & Smelter Co. reopened the property and began shipping ore. Between 1943 and 1947, about $400,000 in zinc, copper, lead, and silver was produced from the property; total recorded production from the Galena district, 1907 to 1966, is $414,690 (Bonham, 1969, p. 61). Essentially all of the production has been from the Union mine. The Union mine property is now owned by the Mackay School of Mines, University of Nevada Reno, and is used as a training site for students in the mining engineering program at the school. The only mining activity in the district at the present time is rock quarry on the site of the Galena mine in the north part of the district.

Geologic Setting

Rocks cropping out in the district are mainly Mesozoic metamorphic rocks which have been intruded by Cretaceous granodiorite. The metamorphic rocks consist of hornfels, marbleized limestone, slate, metasandstone, and metaconglomerate. The pre-Tertiary rocks are overlain unconformably by andesitic volcanic rocks of the Alta and Kate Peak Formations of Tertiary age. Along the contact between the metamorphic rocks and granodiorite, local areas of skarn have formed.

Ore Deposits

At the Union mine, the major deposit in the district, ore occurs in a northeast-striking, mineralized fault zone up to 30 feet in width that cuts metamorphic rocks. Mineralization apparently consisted of lenses and pods of galena, sphalerite, chalcopyrite, pyrite, and arsenopyrite which occurred in sheared metamorphic rocks along the fault. At surface, the ore was oxidized and consisted of cerussite, smithsonite, calamine, and oxide mineral of copper, iron, and arsenic (Bonham, 1969, p. 61). Wall rock in the mineralized zone is both silicated and silicified and contains considerable chlorite.

On the lower slopes of the hills east of Pleasant Valley, several prospects explore quartz veins cutting metavolcanic rock. The veins contain iron- and manganese-oxide rich gossans and are reported to have been prospected for tungsten; no scheelite was seen in samples from this area.

Other old mine workings and prospects occur in the hills southeast of Pleasant Valley, northeast of New Washoe City. Little is known of these workings and they may be related to the Jumbo district located higher in the range to the east. The old workings explore lenses of quartz that occur along shear zones in a small pendant of hornfels enclosed in granodiorite. The vein material contains sparse pyrite and galena and, in areas, considerable tourmaline.

Geochemistry

Samples taken in the district reflect the high base-metals association, and show the presence of anomalous arsenic, antimony, bismuth, and cadmium along with copper, lead, zinc, and silver. Boron is very high in most samples, as is indicated by the association of tourmaline-bearing veins and dikes with the ores.

GARDNERVILLE DISTRICT

Location

The Gardnerville district, Douglas County, is located on the western slope of the Pine Nut Mountains, approximately 10 miles southeast of Gardnerville. Most of the mines and prospects are located along Pine Nut Creek and to the west, between Pine Nut Creek and U.S. Highway 395.

History

Indications of mineral were found in the lower hills of the Pine Nut Mountains in the fall of 1859 and many claims were located at that time. The following year, however, more encouraging prospects were found higher up in the range (Mount Siegel district) and the earlier discoveries were abandoned (Angel, 1881, p. 374). The Mammoth lode (now known as the Veta Grande mine), was discovered in 1860 and, along with the Peck lode, was explored for the following several years (Overton, 1947, p. 27). No other activity is recorded in the Gardnerville district until the early 1900's when the Pine Nut Consolidated mine was discovered; a 5-stamp mill was installed on this property in 1907. The Ruby Hill copper mine was discovered in 1908 and has had a small production. In 1921, the Veta Grande Mining Co. took over the old Mammoth mine and began active exploration work (Lincoln, 1921, p. 34). Tungsten deposits were discovered in the central part of the district about 1930 and several small properties in this area have had a combined production of slightly over 15,000 units of WO_3 through 1958 (Stager and Tingley, 1988, p. 46-48). The most recent activity in the district has been production of small amounts of gold and silica from the Veta Grande mine and small amounts of gold from the Monarch mine, in the north end of the district.

The area west of Pine Nut Creek, near the old tungsten properties, was extensively explored for molybdenum in the mid- and late 1960's by Climax Molybdenum Co. A large, low-grade deposit of porphyry-type molybdenum was found but it is, at this time, not economic.

At the time of our examination, in 1988 and 1989, the only mining activity in the district was a small gold mining venture at the site of the old Monarch mine and minor activity at the Veta Grande mine.

Geologic Setting

The oldest rocks in the district are Triassic metasedimentary and metavolcanic rocks that are locally intruded by masses of Cretaceous granitic rocks. Irregular masses of

skarn and silicated rocks have formed on the contact of the Triassic rocks and the Cretaceous intrusive rocks. Small patches of Tertiary andesitic rocks cover the older rocks in local areas, and form extensive outcrops both east and west of the district.

Ore Deposits

Numerous small gold prospects in the area of the Monarch mine, north of Pine Nut Creek in the northern part of the district, occur in shear zones that cut poorly-developed skarn. The skarn lenses occur in limy lenses in Triassic metasedimentary and metavolcanic rocks where they are cut by small granitic to dioritic intrusive masses. Brecciated, lenticular masses of white vein quartz occur along the shear zones, and the wall rocks are typically chloritized and silicified; vein material commonly contains clots of chlorite and large, hematite-after-pyrite casts along with minor manganese oxides. Many of the workings at these locations appear to be very old and they are probably the sites of the 1859 prospecting activity.

At the Ruby Hill mine, oxidized copper ore occurs in fractured, sericitized and silicified meta-andesite breccia near a major northward-trending fault. Calcite, quartz, and minor pyrite are present along with a variety of oxide and sulfide copper minerals.

The Veta Grande mine occurs in a large quartz vein, in places over 50 feet thick, that cuts metavolcanic rocks. The vein is composed of vein quartz, some chalcedonic quartz, quartz breccia, and streaks of argentite, stefanite, and minor gold (Moore, 1969, p. 30). Lawrence (1963, p. 41) reports stibnite to be present in the quartz vein material. Originally worked for its sparse precious metals content, the Veta Grande deposit has produced small quantities of silica powder of high purity and brightness (from the old mill tailings)(Archbold, 1969, p. 40).

Tungsten deposits in the district are located in the hills between Pine Nut Creek and Buffalo Canyon to the west. At these properties, scheelite occurs disseminated in thin beds of skarn that have replaced impure limestone interbedded with metavolcanic rocks, and replaced more massive, silicated limestone and dolomite in the metasedimentary section. In the southern part of the district, in the vicinity of the Gardnerville tungsten mine, a broad zone of molybdenite mineralization has been encountered by drilling. The molybdenite occurs in a stockwork of quartz veins generally related to an underlying quartz monzonite stock.

Geochemistry

Samples of ores collected in this district display two general geochemical groupings: 1) small skarns and quartz-calcite occurrences in the north part of the district are generally low

in all metallic elements; spotty gold values are present, and most deposits show traces of tungsten, and one sample from the largest gold deposit contained very high bismuth values; 2) samples collected from the area of the Ruby Hill copper mine to the south, in addition to high copper, contained high arsenic and antimony, but only low amounts of lead and zinc. Samples collected from the tungsten skarns, located generally between the other two areas, are anomalous in zinc and contain trace amounts of tin and molybdenum as well as tungsten.

GARFIELD DISTRICT

Location

The Garfield district, Mineral County, is located in the vicinity of Mable Mountain in the eastern Garfield Hills about 20 miles east of Hawthorne. The district lies between Black Dyke Mountain on the north and Garfield Flat on the south; the Pamlico mining district is to the west of the Garfield district, the Santa Fe district lies to the east, and Silver Star is to the south, south of Garfield Flat. Mines in the district are located on mainly on the southern slope of Mable Mountain.

History

According to Vanderburg (1937, p. 33), silver-gold ore was discovered in the area in 1882 and the Blue Light, or Garfield, copper deposits are credited with production of 128 tons of ingot copper in that year (Burchard, 1883, p. 514). From 1882 to 1887, the Garfield mine is said to have produced several million dollars in shipping ore (Vanderburg, 1937, p. 33). In 1890, a 10-stamp mill was erected at Garfield Springs to treat ore from the mine and Vanderburg (1937, p. 33) estimated that about 5000 tons of ore were treated by this mill. Between 1922 and 1940, about $745,000 in silver, gold, and lead were produced from the Mable mine, located to the northwest of the Garfield mine (Couch and Carpenter, 1943, p. 105). Small skarn deposits located about 3 miles southeast of the Garfield mine were mined for copper during 1915-1917. Tungsten was discovered on these properties in 1943 and a small amount of tungsten ore was produced from them between 1953-1955 (Stager and Tingley, 1988, p. 116).

In May of 1989, plans were being made to reopen the Mable mine and new roads were being constructed in the mine area.

Geologic Setting

The portion of the Garfield Hills included within this district is comprised mainly of Triassic and Jurassic metasedimentary and metavolcanic rocks which have been intruded by Cretaceous granitic rocks. In the vicinity of the Garfield,

Blue Light, and Mable mines, rocks exposed are limestones and shale of the Luning Formation and felsic metavolcanic rocks. Skarn deposits in the district occur southeast of the Garfield mine where the Luning Formation has been cut by Cretaceous quartz monzonite.

Ore Deposits

At the Garfield mine, an interconnected system of three quartz veins carried values in silver, gold, and lead. The veins cut Triassic limestone and metavolcanic rocks. The Mable mine workings follow a nearly east-west-striking, near-vertical quartz vein system cutting Triassic chert, limestone, and quartzite. The veins contain native silver, and oxide lead and copper minerals and are complexly faulted (Ross, 1961, table 6.3).

Southeast of the Garfield mine area, at the Bataan mine, small deposits of skarn and gossan occur along a fault contact between quartzite and limestone; copper mineralization and sparse scheelite occur in garnet-diopside skarn formed in sheared limestone along the contact. East of this area, copper-bearing quartz veins and quartz breccia occur along the contact between silicified conglomerate of the Dunlap Formation and Cretaceous granite. This area is currently being explored for precious metals.

Geochemistry

Ore samples taken in the district show only slightly different associations in the two deposit types present. Samples collected from the polymetallic vein occurrences show high silver and spotty but generally anomalous gold associated with high arsenic, lead, antimony, and zinc. The skarn deposits are similar, but copper values are very high, zinc and lead are low to moderate and occasional values in molybdenum were detected. Bismuth was not detected in the skarn samples, but is present in low amounts in the vein occurrences.

GENOA DISTRICT

Location

The Genoa district, Douglas County, lies west of the town of Genoa on the east slope of the Carson Range. Old descriptions of prospects in this district place the workings about 1 mile south of town, possibly in the drainage of Genoa Canyon or the next drainage to the south. The exact locations are not known.

History

The Genoa mining district was organized in 1860 (Angel, 1881, p. 375) following the discovery of gold-bearing quartz

veins 1 mile south of the town of Genoa. Several tunnels were started, one of which was run some 1,800 feet. The quartz ledges proved to be largely barren, and the district was abandoned about 1865 (Overton, 1947, p. 28). A small amount of placer gold was produced from the district in 1916 (Vanderburg, 1936,p. 68) but there has been no placer activity since that time. The lode prospects were again prospected in the 1920's but no production resulted and the district has been inactive since then.

Geologic Setting

The area of the Genoa district is underlain by Triassic felsic schist and metavolcanic rocks; in areas the Triassic rocks are cut by masses of Jurassic diorite (Pease, 1980). All these rocks are intruded by Cretaceous granodiorite. Most of the area between Genoa Canyon and the next canyon to the south is underlain by Triassic rocks; the major granodiorite outcrops are to the south and west of the district.

Ore Deposits

The only information on the deposits in this district is given by Overton (1947, p. 27-28) who states: "The ore occurs in erratic bunches or lenses of quartz, epidote, garnet, actinolite, and tourmaline as gangue minerals, with minor amounts of chalcopyrite associated with small values of gold and silver". The deposits are said to be both veins and replacement deposits; from the description, however, they may be skarn deposits cut, in places, by sulfide-bearing quartz veins.

GOLD BASIN DISTRICT

Location

The Gold Basin district, Churchill County, includes several small mines and prospects located in the low hills east of Fairview Peak. The Gold Bug mine and several surrounding prospects are located in Sections 26 and 35, T16N, R34E; the Shamrock mine lies to the northeast, in Section 19, T16N, R35E. All of the area between these two centers of activity is included within the Gold Basin district.

History

According to Schrader (1947, p. 123) the Gold Bug mine was discovered in 1924; Vanderburg (1940, p. 28) credited the property with a few small shipments of ore made to the Dayton custom mill in Silver City but noted that the mine was inactive in 1939. Judging from the appearance of camp remains in the mine area, there has been no work since that time. Schrader (1947, p. 124) also mentions that the wash below (west) of the mines in

Branch Canyon (probably what we call the Gold Basin adit area) was prospected for placer gold by dry-washing.

In 1936, placer gold was discovered in the northern part of the district by Cye Cox, and the source of the gold was traced to what is now known as the Shamrock mine. The Shamrock mine is not active at the present time, but the property looks as if small-scale mining activity has taken place there intermittently over the years since its discovery.

Although the Gold Basin district appears to have been quiet for many years, a large group of mining claims had recently been staked in the vicinity of the Gold Bug mine in June, 1989. Companies reported to be active in the district in 1989 included Kennecott and Pegasus Gold Corp.

Geologic Setting

The rocks cropping out within the Gold basin district are composed entirely of Tertiary rhyolite, quartz latite, and rhyodacite flows, tuffs, and welded ash-flow tuffs. Quaternary alluvial fan and pediment gravels cover the volcanic rocks around the margin of the district and fill internal basins.

Structurally, the Gold Basin district lies to the east of the Fairview Peak fault and between two large volcano-tectonic centers, the Desatoya-Clan Alpine volcanic center to the north, and a caldera centered around the Gabbs Valley area to the south.

Ore Deposits

At the Gold Bug mine, workings follow a N60^{0}W-striking, 50^{0}NE-dipping shear zone in moderately-kaolinized, silicified ash-flow tuff. The silicified rock is laced with quartz veins and a fine-grained, gray sulfide mineral occurs with the quartz. According to Schrader (1947, p. 123) the ore panned free gold and contained a little argentite and cerargyrite. Some of the dumps contain fragments of hematite-stained, kaolinized andesite, indicating that there may be an andesite dike along the mineralized shear zone. North of the Gold Bug mine, in Branch Canyon, old workings follow N20 to 30°E-striking shear zones in silicified ash-flow tuff. The wall rock adjacent to the prospects is kaolinized, silicified, and stained with iron- and manganese-oxide minerals. A locked, iron grating blocks access to the main adit at the largest workings in this area. All of the area surrounding Branch Canyon was staked in June 1989 by Kennecott Exploration but no work was in progress on the claims when the property was examined in July, 1989.

The Shamrock mine area in the northern part of the Gold Basin district has been the scene of extensive, but very small scale, mining activity over the years since its discovery in

1936. Several shallow shafts, adits, and dog-holes connect with small stopes and pits within a wide zone of alteration associated with a group of northwest-trending faults that cut rhyolite ash-flow tuffs. The rhyolite tuff units are silicified, brecciated, and kaolinized in an exposure about 500 feet wide by 1000 feet long, along strike. The only mineralization noted consisted of iron- and manganese-oxide staining within fractured rock along the main fault zones.

HOLY CROSS DISTRICT

Location

The Holy Cross district, Churchill County, is centered around Rawhide Flat, about 25 miles south of Fallon. The district includes mining areas in the Terrill Mountains, southwest of Rawhide Flat and in the Barnett Hills northeast of Rawhide Flat. The major mines are located near Camp Terrill in the Terrill Mountains and the district is sometimes referred to as the Terrill district. All of the mines in the Terrill Mountains and the southern properties in the Barnett Hills are within the Walker River Indian Reservation; access to all properties in the district is by gravel roads which pass through the Reservation.

History

The first gold-silver discoveries in this district were made in the mountains southwest of Rawhide Flat in 1910 by J. B. Terrell and George Pollinger. The original discovery was on the Silver Star claim, near what is now known as Camp Terrell. Other discoveries were made nearby and, by 1913, the district was quite active (Schrader, 1947, p. 262). The district did not record much production during this early period, however, and the Holy Cross mines are only credited with $40,000 for the period 1911 through 1940 (Vanderburg, 1940, p. 30). Production was intermittent up through 1965, and a total production of $72,262 for the period 1934 through 1965 is given by Willden and Speed (1974, p. 74). Recent activity in the Camp Terrell area has been centered at the Gee Shaft, south of the old Pyramid mine. Some underground work appears to have been done at this property within the past two or three years; no production has been recorded, however, and there was no activity at the time the mine area was visited (July 1989).

To the north, in the portion of the district in the Barnett Hills, the first recorded activity was in 1932 when gold was discovered by A. L. Robinson (Vanderburg, 1940, p. 32). The discovery was made on what became known as the Bimetal property, located just south of the northern boundary of the Walker River Indian Reservation. The Cinnabar Hill mine, in the hills to the

north of the Bimetal mine was discovered in 1938; this mine has been developed by a small amount of underground workings and, although there is no mercury production credited to it, a small burned-ore pile on the dump suggests that there has been some production. Several other shallow mine workings on the low hills northwest of Cinnabar Hill are probably mercury prospects and also date from the 1938 period of activity. There is no recorded production from any of the properties in the Barnett Hills.

The most recent activity in this part of the district dates from 1984 when a large claim block was staked by Coeur Exploration Co. of Sparks, Nevada.

Geologic Setting

Camp Terrell Area:

The Terrill Mountains, near Camp Terrell, are made up largely of Tertiary rhyolitic tuffs that rest on a body of Jurassic gabbro; the gabbro is exposed in two places at the northeast front of the range. The rhyolitic tuffs are unconformably overlain by dacite flows, which make up the crest of the range, and are cut by dacite plugs and dikes. A dacite plug exposed near the front of the range northeast of Camp Terrell has been dated at 21.2 m.a. but the dacite flows may be substantially younger than the dacite intrusives and are correlated with similar rocks in other parts of Churchill County that are late Miocene or early Pliocene age (Willden and Speed, 1974, p. 41). High-angle faults cut most of the rocks. Ore deposits are found in altered rhyolitic tuffs near dacite intrusives and in some altered intrusives. The pre-Tertiary rocks are not mineralized (Willden and Speed, 1974, p. 75).

Barnett Hills Area:

Rocks cropping out in the western portion of the Barnett Hills include Cretaceous granodiorite, Tertiary rhyolite tuffs, dacite flows, and basalts. The granodiorite body crops out in an elongate, north-south pattern and dominates the central portion of the area. The granodiorite is capped on its eastern side by Tertiary rhyolite tuffs. The tuffs are unconformably overlain by dacite flows, which are in turn unconformably overlain by basalt. High angle faults cut most of the rocks (Willden and Speed, 1974, p. 74). Cinnabar Hill is located to the northeast of the northern boundary of granodiorite, and is underlain by brecciated, silicified rhyolite tuff. To the northwest of Cinnabar Hill, two small rhyolite intrusive domes crop out as conical-shaped hills. The domes are locally brecciated and silicified and display evidence of hot spring-type alteration. Most of the area north and west of Cinnabar Hill and the rhyolite domes is covered with basalt, dune sand, and alluvium.

Ore Deposits

Camp Terrell Area:

The deposits near Camp Terrell are mostly silver- and gold-bearing small veins that occur in altered dacite near its contact with rhyolitic tuffs. The veins follow steep shear zones that cut kaolinized dacite; the shear zones are brecciated and cemented with hematite, limonite, and manganese oxides. One property in this area, the Scocia mine, is credited by Schrader (1947, p. 262) with producing a few tons of manganese ore. At the Black Butte mine, west of Camp Terrell, mineralization follows the margin of an altered dacite intrusive but the intruded rhyolitic tuffs are also altered and mineralized. Rock along the contact zone has been highly silicified and is brecciated and recemented with silica. Free gold occurs in quartz veinlets that cut the silicified rock. Further to the west at the Gee Shaft (Pyramid mine), galena, sphalerite, and pyrite occur in thin quartz veins cutting silicified, moderately-welded ash-flow tuff.

Although the veins mined near Camp Terrell are reported to be very narrow, the zones of shearing, brecciation, and associated alteration appear to be wide and have considerable linear extent. This fact is noted by Schrader (1947, p. 265) who writes: "The larger veins occur in the andesite [dacite] and lie about parallel with the andesite-rhyolite contact, but they are not so rich as the stringers in the rhyolite which are obliquely, at angles 20° to 30° to the contact. Some stringer zones are as much as 200 feet wide and 1,000 feet long." Some of the wide altered zones may have potential for the development of bulk-minable gold-silver ore.

Barnett Hills:

Mines and prospects in the western Barnett Hills have explored two types of ore occurrences; gold-silver bearing quartz veins in granodiorite and mercury-bearing, silicified shear zones in rhyolitic welded tuffs and shallow rhyolite domes.

The quartz veins in granodiorite occur along the northern boundary of the Walker Lake Indian Reservation; the largest of these occurrences, the Bimetal mine, is within the Reservation. At the Bimetal property and nearby Sand Mountain claims, the veins strike to the northwest. Veins exposed at the Wall Street prospect, to the north, strike northeast. Willden and Speed (1974, p. 75) state that the veins generally parallel a prominent set of aplite dikes in the granodiorite, and they believe the some of some of veins may be quartz-rich pegmatites rather than true hydrothermal veins.

The deposit at the Cinnabar Hill mine is the largest of the several silicified shear zones in rhyolitic rocks that have been

prospected for mercury in the central part of the area examined. The shear zones at Cinnabar Hill, and at other smaller prospects to the northwest, strike northwest and are marked by wide zones of hydrothermal brecciation and silicification. The shear structures are stained with hematite and local areas along the structures contain veinlets and fracture coatings of alunite. Jarosite is sometimes present and barite was seen in one prospect along with specks of galena. The Cinnabar Hill deposit is contained within a rhyolitic welded ash-flow tuff; the several small occurrences to the northwest are within silicified rhyolite intrusive rocks. All of these volcanic-hosted occurrences display hot-spring type alteration suggesting that the area may have potential for the discovery of bulk-minable hot-spring gold deposits similar to the Paradise Peak deposit in Nye County.

HUNTOON VALLEY AREA

Location

Huntoon Valley, Mineral County, lies along the southwest side of the Excelsior Mountains about 25 miles south of Hawthorne. The prospects included in this area are located on the lower slopes of the Excelsior Mountains on the west side of the valley and in the low hills that separate Huntoon Valley from Teels Marsh on the east. In the fall of 1988, the best access into the area was from the north over unimproved roads leading south from State Highway 359 through Whisky Flat and Rattlesnake Well.

History

There are no records of early mining activity in this area. Camp remains at the mine in the south end of the valley may date to the late 1890's but the most recent occupation probably was in the 1930's or 1940's. Many areas around the old mines have recently been sampled and existing claims are being maintained, but no other activity was seen in 1988.

Geologic Setting

Triassic metasedimentary and metavolcanic rocks crop out along the western and eastern sides of Huntoon Valley. On the north, toward Whisky Flat, the Triassic rocks have been intruded by Cretaceous granitic rocks. Tertiary rhyolitic tuffs cover the older rocks around the margins of the valley and Quaternary felsic volcanic rocks cover the higher country to the west, along the California state line (Ross, 1961). The mines and prospects in this area mainly occur in the Triassic rock outcrops.

Ore Deposits

Workings at the two mines along the west side of Huntoon Valley, the Hontone mine and the Hardrock mine, explore quartz veins containing galena, tetrahedrite, and pyrite which follow northeast-trending shear zones in metavolcanic rocks. At the Hontone mine, the shear zone is several hundred feet wide in outcrop and is cut by pods and lenses of aplitic material. The setting at the Hardrock mine is similar but the veins are more prominent and the metavolcanic wall rocks are brecciated, silicified, and laced with quartz veinlets. At the Moon Glow prospect, across the valley to the east, prospecting has exposed quartz veins in Triassic quartzite. Limy units in the section appear to have been silicified along a shear zone and copper oxide minerals occur along the zone.

Geochemistry

Ore samples collected in the area displayed high silver and gold values associated with anomalous arsenic, antimony, lead, and copper. Zinc values were low.

I.X.L. DISTRICT

Location

In this report, the I.X.L. district includes the portion of the central Stillwater Range surrounding the peak known as Silver Hill. Deposits in Cox Canyon, on the west slope of the range, and in the area extending from I.X.L. Canyon to Alameda Canyon, on the east slope of the range are included in the I.X.L. district. Schrader (1947, p. 301-305), and Willden and Speed (1974. pp. 66 and 76) divide this area into two separate districts, Cox Canyon on the west, and I.X.L. on the east. Vanderburg (1940, p. 32-35), however, views both areas as one district, I.X.L.; we will describe the area as one district.

At the present time, none of the mining areas, save those along the low parts of the range at the mouths of Cox and Silver Hill canyons, are accessible by road.

History

Silver ledges were discovered at Silver Hill, in I.X.L. Canyon on the east flank of the Stillwater Range, in 1860 (Stretch, 1867, p. 29). In the spring of 1861, a townsite was laid out which soon had 200 inhabitants and an express stage line to Virginia City; by June of that year, however, the locators had rushed off to chase reportedly richer finds elsewhere, and the camp was deserted (Paher, 1970, p. 108).

In 1878, the deposits at Silver Hill, in the upper part of I.X.L. Canyon, were rediscovered and several properties were worked in a small fashion (Angel, 1881, p. 364). The last reported production from the properties in the vicinity of I.X.L. Canyon was made about 1908 and total production from the area has been estimated at about $20,000 (Vanderburg, 1940, p. 33).

Early mining activity on the west side of the range, in and around Cox Canyon, is largely undocumented. Schrader (1947, p. 364-365) refers to an old smelter in Cox Canyon, which may date to the 1878 era of activity, and notes that some work was being done in the canyon in 1913. Most activity in Cox Canyon, however, began in 1938 when deposits of fluorite were discovered at the Revenue mine, on the upper north side of the canyon. About 1,900 tons of fluorite was mined from this deposit in 1942 and between 1952-1957 (Papke, 1979, p. 14).

There has been no mining activity for several years in the Cox Canyon area; roads are washed out and access is difficult. New claim posts were in evidence near I.X.L. Canyon, and the Silver Hill area was being examined and sampled in the summer of 1989. ASARCO was reported to be active in the district in 1989.

Geologic Setting

Rocks cropping out in the portion of the central Stillwater Range included within the I.X.L. district are mainly a sequence of Upper Triassic slate and phyllite which locally contains thin interbeds of feldspathic quartzite and intervals of gray-weathering limestone up to 5 feet thick (Page, 1965). These rocks are intruded by Tertiary granite which crops out on the east side of the range from I.X.L. Canyon south and in a small area north of Alameda Canyon. Many dikes and small, irregular intrusive bodies of white felsite also cut the Triassic rocks near Cox Canyon, in the canyon south of Silver Hill, and near the margins of the granitic body, north of Alameda Canyon (Page, 1965).

Complex folds and imbricate thrust faults have been mapped in the Triassic slates and phyllites in the Stillwater Range. South of Cox Canyon, brecciated shale overlies a quartzite unit of unknown age. This contact may represent the footwall of a thrust sheet interpreted by Page (1965) to underlie much of the entire slate terrain in the Stillwater Range. The age of the thrusting was probably Middle or Late Jurassic but could have been Cretaceous; the Tertiary pluton in I.X.L. Canyon postdates the thrusting (Page, 1965).

Ore Deposits

The mines and prospects in I.X.L. Canyon are developed in metamorphosed limestone and quartzite near the contact of these

rocks with the Tertiary granitic body. The deposits are nearly all contained in a belt about 3,000 feet wide by 2 1/2 miles long, extending from the crest of the range easterly down the slope into I.X.L. Canyon (Schrader, 1947, p. 302). Mineralization at the Black Prince mine consists of sphalerite, chalcopyrite, and galena in a gangue of epidote, garnet, pyrite, quartz, calcite, and abundant magnetite. At the nearby Bonanza group, ore occurs in several quartz and calcite veins in limestone which carry native silver, horn silver, gold, and lead (Vanderburg, 1940, p. 34). Low on the eastern range front, between James Canyon and I.X.L. Canyon, prospecting has been done on a massive jasperoid gossan in silicated limestone and weak skarn containing epidote and magnetite. In the granitic outcrop to the west, lenses of siliceous gossan occur along shear zones in the granite. This area had recently been covered with mining claims and, when visited in July, 1989, sampling of some of the old mines was in progress.

Page (1965) mentions that "...mineralized skarn is conspicuous at the north margin of the Tertiary quartz monzonite in the vicinity of I.X.L. Canyon, but no appreciable amount of tungsten as been found there as yet." Tungsten deposits still are not known in this area, but the presence of skarn, magnetite, and base-metal sulfides indicate that the area could contain gold mineralization.

On the west side of the range, near the mouth or Cox Canyon, several small prospects expose narrow quartz veins containing pods of limonitic gossan that follow shear zones in phyllite. In the upper reaches of Cox Canyon, prospecting has been done along a massive white marble lens that has formed in gray limestone; no evidence of metallic mineralization was seen in this area and the prospecting may have been done for fluorite.

At the Revenue fluorite mine, in the northern branch of Cox Canyon, fluorite occurs in a vein located along portions of a north-northeastward-trending fault zone that cuts slate and thin-bedded limestone. Fluorite also occurs in small, irregular masses, veinlets, and partially filled vugs in brecciated, silicified rock occurring along bedding in the slate (Papke, 1979, p. 14). The area of the fluorite deposits has been extensively trenched and explored by bulldozing, but there has been no activity for many years. Roads in the canyons have been obliterated by flooding, and the upper reaches of the canyons are accessible only by foot.

JUMBO DISTRICT

Location

The Jumbo (West Comstock) district, Washoe County, is located on the western crest of the Virginia Range, about 3 miles

directly west of Gold Hill. The mines of the district are accessible from Washoe Valley via the Jumbo Grade road leading east from New Washoe City or from the Comstock area by the Jumbo road leading west from Gold Hill.

History

Angel (1881,p.538-539) describe an Argentine district which "...was located in the summer of 1859, lying in the range of mountains to the east of Washoe Valley, and west of Virginia, and immediately north of Eagle Valley, in which Carson City is situated". This description fits the general area of the Jumbo district but the descriptions of the deposits, veins in granitic rock, applies only to small prospects much lower in the range to the west, not to the main deposits at Jumbo which are veins in volcanic rock.

The earliest recorded production from the Jumbo district was in 1909 when the Wild Goose, Pandora, and Red Top mines produced $5,000 in gold and silver (Overton, 1947, p. 66; Couch and Carpenter, 1943, p. 141). Intermittent production is recorded from the district between 1909 and 1948, the last year of recorded production. Total production from the district is slightly over $31,000 (Bonham, 1969, p. 65).

Geologic Setting

Mesozoic metavolcanic and metasedimentary rocks, intruded by granodiorite, crop out to the west and south of the Jumbo area. The Mesozoic rocks are overlain unconformably by a series of Tertiary volcanic rocks including rhyolitic ash flows of the Hartford Hill Rhyolite and andesite flows and breccias of the Alta Formation all of which, in turn, are overlain unconformably by andesitic and dacitic flows and breccias of the Kate Peak Formation (Bonham, 1969, p. 66).

Ore Deposits

All of the gold and silver produced from the Jumbo district came from mines located on veins cutting the Alta Formation. The mineralization occurs along two intersecting faults systems; one trending northeast and dipping northwest, and the other trending northwest and dipping northeast. Mineralization does not occur in well-defined veins, but rather in small isolated shoots in highly-brecciated andesite. Most of the ore in the district was oxidized, consisting of free gold associated with stringers and lenses of quartz, calcite, and zeolites (Bonham, 1969, p. 66). Volcanic wall rock near the deposits is silicified, and contains some disseminated pyrite; larger areas of propylitic alteration surround the mineralized areas.

At the Empire mine, near the old camp of Jumbo, mineralized quartz stringers occur in a shear zone in Triassic metavolcanic rocks near a granodiorite contact. These workings are very old and may be some of the original discoveries described in the Argentine district of Angel (1881, p. 538-539).

There was no evidence of recent exploration in the district when it was examined in May, 1989.

KING DISTRICT

Location

The King mining district lies on the western slope of the Monte Cristo Mountains in the narrow, eastern point of Mineral County. The King mining camp and adjacent mine workings are about 4 miles southwest of the Baxter fluorite mine and about 12 miles east of Rawhide.

History

Early activity in this area is undocumented but the district was no doubt prospected around 1907 when the nearby camp of Rawhide became active. Activity resumed years later when a small stringer of rich gold ore was discovered in an old shaft in September 1926. Additional discoveries were made within the next two years and one car of gold ore was shipped from the district in January of 1927. Prospecting has been carried out in the district over the years since the original activity in 1926, but no additional production has been recorded. In 1989, the area was under claim (J. Prochnau & Co., Reno), and exploration drilling had been carried out along the trend of the old mine workings.

Geologic Setting

The western slope of the Monte Cristo Mountains is underlain by Mesozoic metavolcanic rocks, mainly andesites, that have been intruded, in the mine area, by a rhyolite dike. To the east, beyond the limits of the mining district, the older rocks are overlain by Tertiary rhyolite tuffs.

Ore Deposits

All of the mining properties in the district occur along the sheared contact between the older metavolcanic rocks and a silica-flooded rhyolitic dike. The metavolcanic rocks are silicified and contain chlorite and epidote; the rhyolite dike is fractured and iron-oxide- and manganese-oxide-stained. The silicified rock along the contact contains disseminated sulfide minerals, possibly jamesonite, as well as pyrite. Old reports on

the mines mention that the chief mineralized zone was composed of numerous veins and stringer zones in the altered rhyolite. The rhyolite is up to 300 feet wide and, in its leached outcrop, contained gold, silver, lead, and copper values in an iron-rich gossan (Wren, 1963). There were apparently pods of enriched ore within the oxidized shear zone that were rich enough to have been mined and shipped during the early period of activity, but no large tonnage of shipping ore was ever developed. Vanderburg (1937, p. 39) noted that the individual mineralized seams were too small and irregular to be mined separately, but thought that they might be numerous and rich enough to carry the intervening rock, making low-grade ore. This low-grade potential is, no doubt, the object of the current exploration program on the property.

LA PLATA MINING DISTRICT

Location

The La Plata (Mountain Wells) mining district, Churchill County, is located on the eastern slope of the Stillwater Range about 25 miles due east of Fallon. The area of mining activity is concentrated in La Plata and Elevenmile Canyons, eastward draining canyons which lead into Fairview Valley. Access to the mines in La Plata canyon is by good gravel road leading north from U.S. Highway 50 at a point just west of Frenchman Station. The mines in Elevenmile Canyon are reached by a gravel road which turns west from the Dixie Valley road and travels up Elevenmile Canyon. During recent mining exploration in the district, a road was constructed east from La Plata canyon to connect with Elevenmile Canyon, facilitating access between the two parts of the district.

History

Vanderburg (1940, p. 38) summarized the history of the La Plata district as follows: "The La Plata district, discovered in 1862, attained considerable prominence as a boom camp during the middle 1860's, but there is little evidence to show that any appreciable amount of ore was produced. The town of La Plata, established about 1863, was the county seat of Churchill County from 1864 to 1868. In 1863 and several years afterward many claims were located, many of which were sold to eastern capitalists, who did considerable prospecting, but the general results were discouraging. The county seat was moved to Stillwater in 1868, and the following year most of the miners deserted the district for the White Pine boom in the eastern part of the State. In 1864, the Silver Wave Mining Co. erected a 10-stamp mill at La Plata at a cost of $150,000. but little evidence, such as tailings or extensive mine workings, exists to indicate a large production. This mill was removed subsequently

to the Ellsworth district in Nye County. Another mill was built in Elevenmile Canyon...about 1864, which was likewise unsuccessful, presumably for lack of ore."

The remains of the stone building which housed the 10-stamp mill in La Plata Canyon can still be seen at the old townsite. The site of the old mill in Elevenmile Canyon, southeast of Black Knob Spring, is marked by stone foundations, piles of bricks from walls and old boilers, and fragments of rusting iron and purple glass.

Fluorite was discovered in the district in 1939 (Vanderburg, 1940) but there has been no recorded production of that commodity. More recently, several major mining companies have conducted exploration in the district for various commodities. Continental Oil Company did reconnaissance work for copper and molybdenum in La Plata Canyon in 1970, Freeport Exploration and Phelps Dodge Corporation explored for molybdenum between La Plata and Elevenmile Canyons in the early 1980's. Some exploration for tungsten has also been recently done northeast of the old site of La Plata. There is no activity at the present time in this district, but several blocks of mining claims are still maintained.

There is no recorded production from the La Plata district although Schrader (1947, p. 300) reports that several thousand dollars worth of bullion, mainly silver, was produced from the old mines.

Geologic Setting

Rocks exposed in the La Plata district range in age from Upper Triassic to Recent and include metasedimentary and metavolcanic rocks which have been intruded by a Tertiary-Cretaceous granitic pluton and at least two younger dike systems. The eastern portion of the district, including the lower reaches of both La Plata and Elevenmile Canyons, is marked by exposures of Tertiary ash-flow tuffs and sediments.

At least two periods of structural deformation are recorded in rock outcrops in the district. The first, associated with a Jurassic-Cretaceous orogeny, involved the juxtaposition of Triassic limestone above autochthonous Triassic phyllite along northeastward-trending thrust plates. Thrusting was followed by the intrusion of the granitic pluton. The younger, Cenozoic, period of deformation involved development of north-south trending folds in Tertiary sedimentary rocks and the onset of high-angle normal faulting. Activity on some of these younger, normal faults continues to the present time. Mineralization in the La Plata district is associated with contact zones and quartz veins related to the granitic bodies and younger aplitic and andesitic dike rocks.

to the Silverton district in the [illegible] county. [illegible] in Placerville [illegible] [illegible]

The remains of the [illegible] mill [illegible] the site of the [illegible] mill in Placerville [illegible] walls and old boilers. [illegible] glass.

[illegible] was discovered in the district in [illegible] but there has been no [illegible] production of this commodity. More recently, however, [illegible] exploration in the district for [illegible] Company [illegible] Phelps Dodge Corporation explored for [illegible] Placerville [illegible] in the [illegible] district, [illegible] maintained.

There is no recorded production [illegible] although [illegible] reports that [illegible] was produced from the mines.

GEOLOGIC SETTING

Rocks exposed in the [illegible] district [illegible] volcanic rocks which have been intruded by a [illegible] The surface [illegible]

At least two periods of [illegible] in the district. The first [illegible]

Ore Deposits

Mineral occurrences in the La Plata district can be generally grouped into three broad categories: silver-copper bearing quartz veins developed in shear zones; molybdenum-tungsten-copper bearing skarn zones related to the granitic intrusive and to later aplite and andesite dikes that cut the intrusive rock; and fluorite deposits in shear zones associated with aplitic dikes and sills. These deposits are all felt to be related both spatially and genetically; all are basically related to the multi-staged intrusive activity within the district.

The original discoveries within the La Plata district were of copper- and silver-sulfide bearing quartz veins which cut both the granitic rocks and intruded Triassic metasedimentary rocks. These veins follow mainly northeast trends although some trend north-south and northwest. The veins sometimes form bold outcrops of milk-white bull quartz which contain scant patches of green and blue copper-oxide staining formed on clots of oxidizing tetrahedrite and chalcopyrite. These veins are up to several feet thick and locally contain flecks of molybdenite.

The skarn deposits occur along the margins of the irregular-shaped granitic intrusive which cuts Triassic rocks. The intrusive and Triassic rocks crop out in a northwest-trending band which nearly bisects the Stillwater Range at this point. The major skarn zones, however, trend northeast, paralleling the southeast contact between granite and sedimentary rocks, and north-south, associated with a large pendant of sedimentary rocks in the central part of the intrusive. Aplitic and andesitic dikes cut the contact area along northwest and northeast trends. In many areas, zones of endoskarn within the granitic rock, the silicated border zones of the granitic contacts, the aplite and andesite dikes and their associated zones of silication all blend into a large zone of fine-grained, silicated rock which has been locally brecciated and silicified. These zones, where also mineralized with trace amounts of molybdenite, chalcopyrite, and scheelite, have been the focus of the most recent exploration activity within the district. Exploration for tungsten has been confined to skarn zones northeast of the old La Plata townsite, east of La Plata Canyon. Molybdenum- copper exploration has occurred in a broad, east-west trending area extending from La Plata into Elevenmile Canyon with the area of highest interest being located south and east of Black Knob Spring. Here, an area of greisen (a muscovite-rich, brecciated, kaolinized granitic rock as described by Phelps Dodge Corp.) and skarn was sampled and drilled.

A small fluorite deposit has been explored on the east side of La Plata Canyon about two miles southeast of La Plata. The

workings explore irregular contact zones adjacent to aplite sills and dikes that cut phyllite and limestone. The fluorite occurs as small masses and veinlets along the contact. A considerable amount of trenching has been done here, but there is no recorded fluorite production.

Geochemistry

Two general geochemical groupings were found in ore samples collected in the La Plata district. One grouping, found in samples collected from polymetallic veins and skarns from the main part of the district, displays high silver-copper-lead-zinc-bismuth-antimony with some molybdenum and tin, generally low lead, and no zinc. The second group, found in quartz veins in volcanic rocks in the Eleven Mile Canyon area, contains the same general association but are generally low in lead, zinc, molybdenum, and tin. Some of the volcanic-hosted vein deposits contain variable amounts of gold.

LEONARD DISTRICT

Location

The Leonard district, Mineral County, includes a small area south of Big Kasock Mountain in the southern Sand Springs Range. The gold-barite district of Eagleville is a few miles east of Leonard, and the Rawhide gold-silver district is about 3 miles west of Leonard. The Nevada Scheelite mine camp, in the center of the district, is at the end of the pavement on State Route 839, about 20 miles south of U.S. Highway 50. Mines in the district are the Nevada Scheelite mine and other adjacent tungsten mines, and gold-silver prospects near the old camp of Sunnyside, about 1 mile southeast of Nevada Scheelite camp.

History

The first mineral discoveries in what is now included in the Leonard district were made at Sunnyside, less than 1 mile southeast of the present Nevada Scheelite mine, in about 1874; the first discovery in the area was named the Sunnyside, the second the Great Eastern. Since 1882, the Great Eastern group is credited with about production of about $5,000 in gold (Schrader, 1947, p. 223).

Tungsten ores were discovered at the site of the present Nevada Scheelite mine in 1926 by Frank Channing. The deposits were developed by W. H. Leonard who began opening them up early in 1930 (Schrader, 1947, p. 234). During World War II, the district produced about 70,000 units of WO_3, most of which came from the Nevada Scheelite mine. The Nevada Scheelite mine became one of the major tungsten producers in Nevada and was in

operation almost continuously from it time of discovery until 1960 when it closed due to falling tungsten prices. Operations resumed between 1972 and 1976, and 1980 to 1982. Total tungsten production of the district is about 315,000 units of WO_3 (Stager and Tingley,1988, p. 123). There was no mining activity in the district in 1989.

Geologic Setting

The Leonard district is underlain by Triassic metavolcanic rocks which contain interbedded limestone units up to 500 feet in thickness. These rocks are intruded by a granitic stock of probable Tertiary age, about 1 mile square in outcrop, and by numerous small granitic dikes and sills. The contact between the stock and the sedimentary rocks is generally sharp and concordant. A major pre-granite fault cuts the district and is directly related to ore formation. This fault displaces limestone and locally controlled the emplacement of the granite (Stager and Tingley, 1988, p. 123-126).

Ore Deposits

Deposits at the original camp of Sunnyside occurred in small quartz veins in a diorite porphyry associated with its contact with the Tertiary granitic intrusive. The veins contained free gold, horn silver, argentite, chrysocolla, and malachite in a quartz gangue. Outcrops were a rusty, dark brown or black from iron- and manganese-oxide staining of the vein quartz (Schrader, 1947, p. 229-230).

At the Nevada Scheelite mine, skarn bodies were formed where intruding granite followed a major pre-mineral fault and cut limestone beds. Scheelite occurs as small, disseminated crystals widely distributed in the skarn associated with garnet, epidote, diopside, wollastonite, quartz, calcite, and sulfide minerals. The sulfide minerals are pyrite, chalcopyrite, and molybdenite. The skarn is 2 to 50 feet wide along the contact in an irregular zone about 1,800 feet long; drilling has shown the skarn zone to persist for at least 600 feet in depth. Ore mined from the deposit has averaged about 1.0 percent WO_3.

There is no activity at either of these areas at the present time, although a watchman is maintained at Nevada Scheelite camp to protect buildings and equipment on the property.

LITTLE VALLEY DISTRICT

Location

Little Valley is located in the Carson Range, Washoe County, about 6 miles east of Washoe Lake. Placer gold prospects in

Little Valley area located along Franktown Creek in the south end of the Valley.

History

Discovery of placer gold in Little Valley is not well documented. Vanderburg (1936, p. 163) states that the placer deposits were worked "in the early days", but an article by Reid (1908, p. 522-525) is written as if the discoveries were contemporary with the article. Whatever the case, the district was being worked in 1908 and was still being prospected in 1935. Vanderburg (1936, p. 163) credits the placer mines with a production of about $100,000. There has been no lode mining in Little Valley.

All of Little Valley was under private ownership for many years and no mining activity is documented after about 1935. The northern half of Little Valley now belongs to the University of Nevada, Reno and is used as a biological research station; this part of the valley is managed more or less as a wilderness area and no activity is allowed that will disturb it natural setting. The southern part of the valley, location of the gold prospects is managed by the U.S. Forest Service.

Geologic Setting

Little Valley is underlain by granitic rocks of the Sierra Nevada batholith complex. The valley is down-dropped fault block, or graben, within the granitic rocks. Stream gravels fill the bottom of the valley which is now occupied by Franktown Creek.

Ore Deposits

The placer deposits in Little Valley occur in gravels in a Tertiary river channel that passed in a northeasterly direction across the area prior to the formation of the present-day valley. According to Vanderburg (1936, p. 164) the Tertiary channel can be traced from a point near Incline on Lake Tahoe to a point a short distance east of the south shore of Washoe Lake. The Tertiary gravels lie unconformably on granodiorite and are locally (outside of Little Valley) overlain by rocks of the Hartford Hill Rhyolite and by andesite flows of the Alta Formation. The gravel deposits are Oligocene or Eocene in age, since they are unconformably overlain by early Miocene rocks. The gravels are composed predominantly of Mesozoic metamorphic and granitic rocks (Bonham, 1969, p. 69).

LODI DISTRICT

Location

The Lodi district includes all mining properties in the Lodi Hills, northwestern Nye County. The Lodi Hills are a low, isolated group of hills lying between Gabbs Valley and Lodi Valley, about 8 miles north of the town of Gabbs. Three separate mining areas; the outlying camp of Quartz Mountain on the north, Marble Camp on the southeast, and Granite Camp on the southwest are included in the Lodi district. All of the mining areas within the Lodi Hills are easily accessible from several roads leading west from State Route 361 on the west or from the Lodi Valley road on the east.

History

Silver-lead ore was discovered at the site of the Illinois mine, on the southeastern flank of the Lodi Hills, in 1874 (Kral, 1951, p. 93). The Lodi district was organized in 1875, and a 10-ton smelter was erected by 1878. By 1880, when the first period of operation ended, about $400,000 in lead, silver, and gold had been produced (Paher, 1970, p. 377). Operations resumed in 1905 and the camp became known as Marble. A new 100-ton smelter was completed in 1909 and work continued on the property until 1914. The smelter apparently never produced metal, however, as no production is credited to the Illinois mine after 1890 (Couch and Carpenter, 1943, p. 118). Some underground development work was done at the mine around 1919 by Goldfield Consolidated Mines Co., but no production resulted from that activity (Kleinhampl and Ziony, 1984, p. 126). Paher (1970, p. 377) mentions that some ore was produced from the Illinois mine in 1940. In 1965, a 200-foot shaft was sunk on the Illinois mine property to test for extensions of the Illinois vein; minor veins were intersected but no production resulted (Kleinhampl and Ziony, 1984, p. 127).

Ore was discovered at Quartz Mountain, a low, isolated hill located about 1 mile separate from the north end of the Lodi Hills, in 1920. By the end of 1925 the discovery property, the Annette-Walker lease, had produced more than $90,000 worth of ore (Schrader, 1947, p. 118). A rich ore shoot was hit in one of the mines in 1925, causing a brief boom of activity in the district. Little apparently came of this, however, as the camp is reported to have folded in 1926 (Paher, 1970, p. 379). Schrader (1947, p. 118) presents a slightly different view of the camp by stating that; "... the San Rafael Co., which has since produced and shipped from the [San Rafael] mine about $250,000 worth of silver-lead ore running about $40 to the ton and has opened up sufficient ore to continue its present rate of output for a year." No date is given for Schrader's visit to the property, but it was probably about 1927. After 1936, small leasing operations continued for several years at Quartz Mountain. In 1967,

exploration on the San Rafael property is reported to have resulted in the discovery of new lead-zinc-silver sulfide ore; no mining, however, resulted from this work (Kleinhampl and Ziony, 1984, p. 127). Exploration for molybdenum-copper bodies began in the 1970's near the Calico shaft in the northwestern part of the Quartz Mountain area. Several companies, including Bear Creek Mining Co., Cyprus Mining Corp., and Amax Exploration, conducted geological, geophysical, and surface drilling programs (Kleinhampl and Ziony, 1984, p. 127-129). The results of these programs are not known.

Tungsten ore was discovered in the southern part of the Lodi Hills in about 1944 and, during the period from 1951 to 1963, the mines of the district have yielded more than $7 million in tungsten (Stager and Tingley, 1988, p. 141). The major producers have been the Victory, El Capitan, and Kay Cooper mines.

Many areas in the Lodi district show evidence of recent claim staking; scattered flagging indicates survey points and geochemical sampling points. When the district was visited in early 1989 there were, however, no signs of mining activity at any of the mining properties.

Geologic Setting

The Lodi Hills are primarily composed of Mesozoic metasedimentary and metavolcanic rocks which have been intruded by a large granitic mass. The oldest exposed rocks are Triassic greenstones, pelitic mudstone, and siltstone with minor quartzite, dolomitic sandstone, and sandy dolomite. These rocks occur mainly in the northern Lodi Hills.

Most of the sedimentary rocks in the southern Lodi Hills are carbonate strata, with some shale and siltstone, of the Late Triassic Luning Formation (Kleinhampl and Ziony, 1984, p. 129).

Plutonic rocks ranging in composition from granite to diorite crop out in the southern Lodi Hills. The largest pluton, the Illinois stock, is spatially and genetically related to the tungsten deposits of the district. On the west side of the district near the Victory tungsten mine, the contact of the Illinois stock with the sedimentary rocks is interpreted to be a low-angle fault. On the east side of the district, near the Illinois mine, the contact may be a normal intrusive relationship although it could be an extension of the low-angle thrust (Dougan thrust) that forms the western contact (Kleinhampl and Ziony, 1984, p. 130).

Encircling the northwest flank of the Lodi Hills, north and west of Quartz Mountain, is a series of nearly flat-lying Tertiary flows, tuff, and breccia. Just north of Quartz Mountain, carbonate rocks are down-faulted and are deeply buried

by the Tertiary volcanic rocks. In this area, the shaft of the Calico mine extends to 400 feet and bottoms in rhyolite and granodiorite porphyry. The volcanic rocks are hydrothermally altered and, in places, are cut by dikes probably related to younger volcanic rocks that crop out west of the district (Schrader, 1947, p. 119).

Ore Deposits

Metallic ore deposits in the Lodi district are concentrated in three areas; silver-lead-zinc occurrences on the southeast margin of the Lodi Hills in the area of the Illinois mine, silver-lead deposits at Quartz Mountain camp, on the northwest tip of the district, and tungsten deposits along the west and south side of the district in the area of the Victory and El Capitan mines. In addition, many other small mines and prospects occur around the northern edges of the main Lodi Hills. These smaller prospects are mainly silver-lead occurrences similar to those at Quartz Mountain, but some contain copper and barite. In addition, small amounts of talc have been shipped from one deposit (the Huntley mine) on the northeast side of the district.

At the Illinois mine property, three steep northwest-striking veins, the Illinois, Welch, and East veins, occur within a shear zone that cuts limestone and shaly limestone of the Triassic Luning Formation. The shear zone is up to 150 feet wide and is traceable for about 1 mile along strike. Most of the mine production was from the Illinois and Welch veins; they vary from 2 to 20 feet in width and are usually not over 20 feet apart. Mining has been done from surface to a depth of 700 feet (Kral, 1951, p. 96). The veins, at their outcrop, are expressed as lenses and fracture coatings of manganese and iron oxides which occur along the parallel fault zones. In some areas, the limestone wall rock is webbed with silica veinlets. The ore minerals were cerussite, anglesite, and hemimorphite in the near-surface material, and galena in the deeper ores.

At Quartz Mountain, Schrader (1947, p. 120-122) describes two varieties of ore deposits present. An older (Mesozoic) ore genetically associated with granodiorite porphyry consists of silver-lead replacement ores in limestone. The ore minerals are cerussite and argentiferous galena in a gangue of iron- and manganese-oxide stained quartz, jasperoid, calcite, dolomite, and jarosite. The Lease vein in the San Rafael mine is described as the largest of this type of deposit. Schrader's second variety of ore, Tertiary vein and fault breccia deposits, occupy parallel, northwest-trending, vertical fault fissures that extend through Quartz Mountain cutting limestone, granodiorite porphyry, and volcanic rocks. The ores in these fissures consist chiefly of cerussite, argentiferous galena, argentite, cerargyrite, and gold in a gangue of brecciated wall rock, quartz, and calcite. Most of the ore contains a little sphalerite, traces of antimony,

and is stained with iron and manganese oxides. These deposits at Quartz Mountain seem to be genetically related to the large andesite dike intruded along the contact of the Tertiary volcanics with the Mesozoic rocks (Schrader, 1947, p. 121). Kleinhampl and Ziony (1984, p. 133) question Schrader's age assignments for the two types of deposits; they feel the division into two groups may be valid but believe both types of ore are Tertiary in age.

The molybdenum occurrence at Quartz Mountain, explored in the late 1970's, is described in Kleinhampl and Ziony (1984, p. 137-138) as a molybdenum-bearing sulfide system spatially, if not genetically, related to a sequence of metasedimentary and meta-igneous rocks. Drilling northeast of the old Calico shaft encountered molybdenite disseminated in intensely silicified hornfels and coating fractures in the hornfels and in silicified and sericitized quartz latite porphyry; quartz-tourmaline veinlets were encountered at depth in one drill hole. Grades of 0.06% Mo in the bottom 78 feet on one hole, including a 4-foot interval of 0.34% Mo, were reported (Kleinhampl and Ziony, 1984, p. 138). The extent and economic significance of this sulfide system is unknown, and largely untested.

The tungsten deposits of the Lodi Hills, although not discovered until the early 1940's, have accounted for the bulk of the metal production of the district. Tungsten deposits occur mainly as disseminated scheelite in crushed and sheared granodiorite of the Illinois stock and in skarn along the contacts of the stock with limestone of the Luning Formation. The bulk of the tungsten production in the district came from the Victory mine. Scheelite at the Victory mine occurs as disseminations in the outer zone of the Illinois stock. The principal orebody was 2 to 4 feet wide and was enclosed in a feldspathized zone 10 to 40 feet thick that formed along a shear zone in the stock (Stager and Tingley, 1988, p. 144). Some scheelite occurs in small skarn deposits west of the Victory mine, along the contact of the stock with limestone, but the major production came from the granitic-hosted orebody. Tungsten occurrences at the nearby Kay Cooper and El Capitan mines are similar to the Victory occurrence but are much smaller.

Geochemistry

Ore samples collected from mines and prospects in this district generally contained anomalous gold and high silver associated with high arsenic, antimony, lead, zinc, and copper. Many samples were anomalous in molybdenum, cadmium, and bismuth.

LUCKY BOY DISTRICT

Location

The Lucky Boy district, Mineral County, is in the southern Wassuk Range southwest of the town of Hawthorne. The district is in the vicinity of Lucky Boy Pass and extends from Corey Peak on the north to Powell Mountain on the south. State Highway 359 forms the eastern boundary of the district and it extends to Mud Spring Canyon on the west. In reports by Hill (1915, p. 151) and Vanderburg (1937, p. 35), both the Lucky Boy area in the Wassuk Range and the Pamlico area, in the Garfield Hills to the east, are included in what they have named the Hawthorne mining district; in this report, both districts are discussed separately and the name Hawthorne is not used. The area of the Borealis mine, on the western side of Lucky Boy Pass, has been referred to as the Ramona mining district (Tenneco Minerals, 1987, p. 243); the origin of this name is not know, and it is not used in this report.

History

There may have been some activity in the area of the present Borealis mine around 1900-1906; in 1912, a shaft was sunk on what had been described as "Borealis Limonite" and a small amount of high-grade gold ore was produced from it (Tenneco Minerals, 1987, p. 243). The property was operated again between 1938 and 1939 when it is credited with producing around $28,600 in gold (Couch and Carpenter, 1943, p. 105).

Veins at the Lucky Boy deposit, on the east side of Lucky Boy Pass, were discovered in 1906 by a road crew working on the Hawthorne-Bodie stage road (Hill, 1915, p. 153). The mine was operated mainly between 1907 and 1911, and is credited with about $1 million production in gold, silver, and lead (Ross, 1961, table 6.3). Attempts have been made over the years to reopen the deposit, but the property is not active at the present time.

Mining was reactivated in the district beginning in 1978 when Houston Oil and Minerals acquired the old Borealis mine and was successful in developing a large tonnage of open-pit ore within the property. Mining began on the new ore body in 1981. Houston O&M, later acquired by Tenneco Minerals, in turn, acquired by Echo Bay Mining Co., have developed several other smaller orebodies in the Borealis area and are still mining in the district. Production from these deposits, through 1988, has been about 336,300 oz of gold (Bonham, 1989, p. 24)..

Geologic Setting

Most of the portion of the Wassuk Range within the Lucky Boy district is underlain by Cretaceous granite and granodorite which

have intruded Jurassic-Triassic metasedimentary and metavolcanic rocks. Only small masses of metamorphic rocks remain, mostly as isolated pendants within the granitic outcrops; the most extensive outcrops of the Jurassic-Triassic metamorphic rocks are found in the canyon east of Lucky Boy Pass where they serve as host rocks for the Lucky Boy deposit.

The west flanks of the Wassuk Range, at the western foot of Lucky Boy Pass, are covered by Tertiary andesite and related rocks of intermediate composition, including laharic breccias and minor lava flows (Stewart and others, 1982). These deposits, in turn, are overlain on the west by Quaternary basalt flows related to the volcanic dome field located in the Bodie Hills west of the district along the California state line.

Ore Deposits

At the Lucky Boy deposit, mineralization occurred along a narrow quartz-barite vein which followed an irregular, roughly east-west striking fracture in greenstone and marble near a granitic contact. Ore, consisting of concentrations of tetrahedrite, galena, sphalerite, argentite, pyrargyrite, and pyrite, occurred in small lenses and shoots throughout the vein. Secondary enrichment was apparently important in this deposit. Descriptions of the occurrence in Hill (1915, p. 153-155) mention that only pockets of ore remained in the upper, leached portions of the vein; from about 300 to 600 feet, high-grade, enriched ore was encountered; and below 900 feet, low-grade primary ore was encountered.

On the west side of the district, the Borealis disseminated gold deposit occurs in a sequence of Miocene volcanic rocks, mainly intermediate flows and pyroclastic deposits, that have been extensively silicified. The main Borealis deposit consists of micron-sized disseminated gold mineralization in a pyritic, silicified pyroclastic unit within the predominantly flow sequence. Peripheral to and below the deposit the flow units are successively argillized and propylitized. Two types of ore are interpreted to occur at Borealis: an early quartz-breccia ore, and a later, superimposed, spring-vent (hot spring) ore. The bulk of the ore mined at Borealis is of the quartz-breccia type, and highest gold grades in this are associated with open-space and barite mineralization. Spring vent ore, the small, high-grade deposits, prospected and partly exploited by the old-timers, occur associated with sponge-like silica marginal to the main deposit (Strachan, 1985, p. 92). Nearby gold deposits at Jaime's Ridge and Cerro Duro are similar to Borealis (Tenneco Minerals, 1987, p. 243).

Silica has been mined from a property south of and near Lucky Boy Pass. Milky quartz in granite crops out as a high, west-northwest-trending ridge south of the Lucky Boy road. The silicified mass is about 1,300 feet long and 350 feet wide; it have intruded Tertiary volcanic rocks and underlying Mesozoic rocks. Only small masses of intrusive rocks crop out, mostly as isolated pediments within the [illegible]. The most extensive outcrops of the Tertiary(?) small intrusive [illegible] are found in the [illegible] of Lucky Boy [illegible] the host rocks for the Lucky Boy (Pl. 3).

The west flanks of the Wassuk Range, [illegible] Lucky Boy Pass, are mantled by Tertiary andesite and dacite flows of intermediate composition [illegible] flows and [illegible] (Ross and others, 1962). These deposits, in turn, are overlain by the [illegible] to the [illegible] Walker Lake [illegible] alluvium along the Walker Lake shore line.

Ore Deposits

At the Lucky Boy deposit, mineralization is localized in narrow quartz-calcite veins along the [illegible] east-west striking fractures in [illegible] or contact, are, consisting of concentrations of argentiferous galena, sphalerite, [illegible] small [illegible] throughout the vein [illegible] was apparently important in [illegible] occurrence in Hill (1915, p. [illegible]) [illegible] ore remained in the upper [illegible] of the main vein [illegible] to 800 feet [illegible] below 400 feet [illegible] encountered.

On the west side of the district, [illegible] gold deposits occur in a sequence of [illegible] mainly intermediate tuffs and [illegible] have been extensively [illegible] silicified. [illegible] is [illegible] altered pyroclastic unit within the [illegible] sequence. [illegible] extensively [illegible] and propylitized. [illegible] interpreted to occur at [illegible] and a [illegible], superimposed, [illegible]. The [illegible] of the [illegible] gold grades in this [illegible] late [illegible] mineralization. [illegible] grade deposits, [illegible] (Ross [illegible], 1961, p. [illegible]) [illegible] p. [illegible]).

[illegible] Lucky Boy [illegible] north-northeast-trending [illegible] alteration zone [illegible].

has been prospected by adits and trenches and, in 1972, was being mined for silica (Archbold, 1966, p. 31; Kleinhampl and others, 1975, p. 25). The property was inactive in 1989, and appeared to have been inactive for many years.

MARIETTA DISTRICT

Location

The Marietta district, Mineral County, is located on the south flanks of the east-central Excelsior Mountains and includes the portion of the mountains lying generally north and west of Teels Marsh. Teels Marsh is also included in the Marietta district. Most of the historic mineral properties of the district are located in the canyon north of the Marietta townsite, but mines west of Marietta, on the ridge separating Teels Marsh from Huntoon Valley, and mines south of Moho Mountain, east of Marietta, are also included in the district.

Marietta was once known as the Black Mountain district (Vanderburg, 1937, p. 40), and Hill (1915, p. 171-181) and Ross (1961, p. 84-85) include Marietta in the Silver Star district.

History

The first mining activity in what is now considered to be the Marietta district occurred as early as 1867 when salt was mined from surface deposits at Teels Marsh. Salt was shipped to Aurora for use in the silver mills there (Lincoln, 1923, p. 156).

The earliest metallic mineral discovery in the district was made at the Endowment mine, high in the canyon north of Marietta camp, sometime before 1877 (Whitehill, 1879, p. 25). The mine produced rich silver-lead ore between 1877 and 1885, and is credited with production ranging from about $78,000 (Couch and Carpenter, 1943, p. 106) to "...in the neighborhood of $1.5 million, although no authentic figures of production can be obtained." (Hill, 1915, p. 176). Except for short periods of leasing activity, the property has been idle since that time. The Moho mine, east of Marietta camp, was located in 1903 and was the principal producer in the district into the 1930's (Vanderburg, 1937, p.40). It is credited with about $75,000 in gold, mainly produced in the first years following discovery; some production, however, was also made in the 1930's (Vanderburg, 1937, p. 40-42).

Tungsten deposits were found in the mountains west of Teels Marsh in September 1942 and about 445 units of WO_3 were produced from two small deposits between 1944 and 1954 (Stager and Tingley, 1988, p. 130). There has been no activity at these properties since the last production was made.

Borate discoveries at Teels Marsh may predate discovery of metals in the canyons north of the marsh. F. M. "Borax" Smith discovered deposits of borax at Teels Marsh in October 1872. Smith built a recovery plant, and Teels Marsh was soon the world's largest producer of borax (Papke, 1976, p. 18). Discovery and development of large colemanite deposits in the Death Valley region of California shifted interest from the limited deposits at Teels Marsh and other nearby playas and, by 1893, the playa borate deposits were nearly inactive; no activity is recorded after 1900 (Papke, 1976, p. 18).

Most recent activity in the Marietta district has been uranium prospecting along the western margins of Teels Marsh in the mid-1950's (Garside, 1973, p. 81) and drilling of an area around the Marietta mines for porphyry copper in the 1960's (Garside, 1982). Exploration trenching and drilling has been done recently (1989) in the vicinity of several of the old mines. Companies active in the district in the past several years include Phelps Dodge (1982), American Gold Resources and ASARCO (1988), and AU-Ag Inc., Madera Mining Co., and Western Gold and Uranium (1989).

Geologic Setting

The oldest rocks exposed in the Marietta district consist of Permian metavolcanic and metasedimentary rock of the Mina and Black Dike Formations. These rocks crop out in large areas on the south side of Moho Mountain and east and west of the Marietta mines where they are interpreted to be in thrust fault contact with metasedimentary rock of the Jurassic Dunlap Formation; the Permian rocks form the upper plate of the thrust sheet, the Jurassic rocks are in the lower plate (Garside, 1982). Both Permian and Jurassic rocks have been intruded by small to moderately large dikes and masses of granodiorite, quartz monzonite, and granite porphyry in several locations between Moho Mountain and the Marietta mines. West of Marietta, large parts of both the main Excelsior Mountains and the south-trending spur between Teels Marsh and Huntoon Valley are underlain by Cretaceous granitic rocks. Areas of skarn have formed where the granitic rocks have cut Jurassic metasedimentary rocks. Tertiary volcanic rocks, mainly andesite, cover a small part of the district west of Moho Mountain and extend to the crest of the Excelsior Mountains to the north.

Ore Deposits

Except where otherwise referenced, the following descriptions are taken mainly from Garside (1986, p. 5).

The mines and prospects of the Marietta district include lead-silver veins, gold-pyrite veins, copper veins, and iron and

tungsten skarn deposits. Lead- and silver-bearing barite veins occur on the west flank of Moho Mountain and deposits of borate minerals have been mined at Teels Marsh. Anomalous radioactivity occurs with some quartz and base metal veins in the district but no uranium deposits have been developed.

The lead-silver veins in the district, located in the northern canyon area around the Endowment, Silver Gulch, and Black Hawk mines, trend predominantly northwest to west and range in width from a few inches up to 7 feet in thickness. Oxidized outcrops of the veins contained sand carbonate (cerussite), smithsonite, and a little copper carbonate in limonitic gossan. The hypogene ore consists of galena, pyrite, tetrahedrite, sphalerite, chalcopyrite, and boulangerite in a gangue of milky quartz and white barite. Silver probably occurs as argentiferous tetrahedrite and galena; free gold is reportedly present at some properties. The veins do not cut overlying late Tertiary andesitic volcanic rocks and may be Mesozoic in age.

The Rutty group of mines (Marietta mines), located on the southern flank of the mountains north of the site of Marietta, consists of workings for gold from veins that contain free gold and pyrite in a gangue of quartz and siderite. Hypogene minerals (pyrite, chalcopyrite, bornite) occur sparsely on dumps; most minerals that can be seen are oxidized copper minerals and limonite.

Barite veins containing quartz, galena, and oxidized lead, zinc, and copper minerals occur in prospects west of the Moho mine. These veins cut Permian rocks and are similar to the occurrences at the Endowment and other mines in the northern part of the district.

The Moho mine, in the eastern part of the district, is located on a north- to northeast-trending set of quartz veins that cut silicified and sericitized clastic rocks of the Permian Mina Formation. The veins consist of procelaneous chalcedonic quartz with minor amounts of cerussite, jarosite, and sericite; galena is probably present in the hypogene ore.

Tungsten deposits in the district are located along an east-west-trending band of skarn outcrops associated with a large granitic intrusive in the south-trending part of the Excelsior Mountains, west of Teels Marsh. The largest deposit, the Defender mine, is at the east end of the skarn zone on a body of dense garnet skarn. Scheelite occurs irregularly distributed throughout the skarn associated with molybdenite and locally abundant fluorite. Scheelite-bearing skarn at the Pine Crow property, at the west end of the skarn zone, occurs interbedded with hornfels and contains considerable powellite. A quartz vein cutting the skarn at this occurrence is reported to contain wolframite, scheelite, and small crystals of light-blue beryl

Location where deposits [illegible] and [illegible] along the [illegible] on the west flank of [illegible] and [illegible]. [illegible] minerals have been [illegible] at [illegible] deposits [illegible] with some quartz and [illegible] metal [illegible] in the [illegible] deposits have been mentioned.

The lead-silver veins in the district, located in the northern canyon area around the mountains, [illegible] and Black Bear mines. [illegible] predominantly northwest [illegible] in width from a few inches up to 7 feet in thickness. [illegible] outcrops of the veins [illegible] with a little copper [illegible]. The [illegible] consists of galena, pyrite, [illegible] sphalerite, chalcopyrite, and tetrahedrite in a gangue of quartz and white barite. Silver [illegible] present [illegible] properties. The veins [illegible] volcanic rocks and may be [illegible] in age.

The [illegible] group of mines [illegible] the southern flank of the [illegible] north of the [illegible] consists of workings for metal from veins that contain [illegible] and pyrite in a gangue of quartz and siderite. Hypogene minerals [illegible] pyrite, chalcopyrite, bornite, [illegible] minerals that can be seen are malachite, [illegible] and limonite.

Barite veins containing [illegible] galena [illegible] and copper minerals occur in [illegible] of the [illegible] area. These veins cut [illegible] rocks and are similar to the [illegible] part of the district.

The [illegible] mine, in the western part of the district, is located on a [illegible] that cut [illegible] of the [illegible] formation. The veins consist of [illegible] quartz with minor amounts of [illegible] galena is generally present in the [illegible].

Tungsten [illegible] in the [illegible] occurs in quartz [illegible] pyritic [illegible] part of [illegible] in [illegible] district. [illegible]

(Stager and Tingley, 1988, p. 130). On the west slope of the hills, south of the Pine Crow property, considerable prospecting, including drilling, has been done in an area where magnetite-bearing skarn crops out. The magnetite occurs as lenses in siliceous hornfels along with lenses of massive epidote.

Uranium prospects in the Marietta district occur mainly in granitic rocks in the hills east and west of the old camp, and also around the mouth of the canyon near the Marietta mines. Two type of occurrences are described by Garside (1973, p. 81): radioactivity or uranium minerals associated with iron oxides along shear zones, and uranium mineralization associated with quartz veins containing base and precious metals. Uranium minerals reported to be present include torbernite, samarskite (?), autunite, kasolite(?), metatorbernite(?), zeunerite(?), cuprosklodowskite, gummite(?), and uranophane; most occurrences are as fracture coatings and stainings in shear zones with thin, iron-oxide stained quartz veins in granitic rocks (Garside, 1973, p. 81-82).

"Marsh" borate deposits at Teels Marsh, along with similar deposits at nearby Columbus and Rhodes marshes, provided most of the worlds' supply of borax prior to about 1883 (Papke, 1976, p. 18). At Teels Marsh, borax was the principal economic borate mineral and occurred as a borax-rich crust on the surface of the playa along with tincalconite, sodium chloride, and carbonate minerals. The borax minerals were recovered by raking the surface deposits into windrows, shoveling the material into wagons, and hauling to a nearby plant where it was refined by dissolving and crystallization in steam-heated vats. The refined product was then hauled by wagon to the railroad at Wadsworth, 130 miles to the north, for shipment (Papke, 1976, p. 18, 21-22).

Geochemistry

Ore samples collected from deposits generally contained high silver with high but spotty gold associated with high lead, copper, arsenic, and moderate antimony and zinc. Anomalous gold occurs in samples from two iron-rich skarns, indicating that there may be potential in the district for skarn gold deposits.

MASONIC DISTRICT

Location

The Masonic district is centered in the northern Bodie Hills, Mono County, California. Mineralization, however, crosses the state line and extends into the western border area of Mineral County, Nevada. The Nevada portion of the Masonic district is confined to the small portion of the Bodie Hills that

lies along the state line, south of the Walker River and generally northwest of the Bodie Creek drainage.

History

The historical accounts of this district describe the California portion of the district, and little is known of the Nevada side. The region was prospected in the 1860's, but valuable ore was not discovered until 1902; the chief period of production was 1907-1910, although some activity continued through the 1930's. Production of mines on the California side of the line was about $1.2 million in gold (Clark, 1970, p. 150). The entire district was being actively explored in 1988 and 1989; considerable drilling had been done west of the state line in California, but the area of the Gold Fund mine, in Nevada, was also being explored.

In the southeast part of the district, in Nevada, gold and copper was discovered at the Homestead (Hefler) mine about 1930. Tungsten was discovered on the property in the early 1950's and some tungsten ore was shipped in 1953. Intermittent activity on the property appears to have continued into the 1960's or 1970's, but the mine was abandoned when examined in 1988.

Geologic Setting

Most of the Masonic district in Nevada is underlain by a sequence of Oligocene and Miocene felsic volcanic rocks; Miocene rhyolitic ash-flow tuffs occur in local areas. The Tertiary rocks overlie Mesozoic metavolcanic and metasedimentary rocks and Cretaceous granitic rocks. Only small outcrops of the older rocks show through the Tertiary volcanic cover. In the south, the Homestead mine is located in a small window of pre-Tertiary rocks; in the north, northeast of the mines in California's part of the district, northeast-trending bodies of coarse-grained, porphyritic granite crop out (Kleinhampl and others, 1975).

Ore Deposits

Ore deposits in the Masonic district (California) are thick silicified zones or veins in the granite that strike north, northwest, or northeast. The ore consists of brecciated and recemented chert, quartz, and chalcedony that contains free gold and minor pyrite and chalcopyrite. The ore has an open, porous appearance and is often manganese-stained (Clark, 1970, p. 150). In the Nevada portion of the district, prospecting has been mainly in north-and northeast-trending breccia zones in silicified volcanic rock. The silicified breccias outcrop as wide, iron-stained, ribs cutting the volcanic section. Visually, the altered zone can be traced from prospects near the state line northeast to the vicinity of The Elbow on the East Walker river.

Much of the area of the Masonic district, especially along the state line, has recently been explored and new drill sites and trenches are in evidence. One small mining property appears to be active (in 1989) as new timbering was in evidence and equipment was on the property.

At the Homestead mine, in the southern part of the district, copper sulfides occur in a quartz lens in meta-andesite and hornfels near a granitic contact zone. Scheelite occurs in garnet skarn formed along this contact and a small amount of scheelite-bearing ore has been mined from the area (Stager and Tingley, 1988, p. 132).

MINERAL BASIN DISTRICT

Location

The Mineral Basin district is located in the Buena Vista Hills, a low range that extends north from the Stillwater Range near Copper Kettle. The hills form a low divide between the Carson Sink on the west and Buena Vista Valley on the east. Most of the Mineral Basin district is in the northern Buena Vista Hills in Pershing County, but the largest mine in the district, the Buena Vista mine, is about 4 miles south of the county line in Churchill County. The district is accessible via paved road from Colado, about 25 miles to the northwest on Interstate Highway 80.

History

The original claims in this district were located on the Buena Vista mine outcrops by John T. Reid of Lovelock in 1898 and 500 tons of iron ore from the property are reported to have been shipped to the Union Iron Works in San Francisco (Vanderburg, 1936, p. 22). No other activity is reported, however, until World War II when minor amounts of ore were shipped from several properties in the Pershing County portion of the district (Johnson, 1977, p. 69). Shipments of iron ore from the Buena Vista mine to markets in Japan commenced in 1951 and continued through 1953 when operations ceased. During this 15-month period, 283,000 tons of ore containing 57 percent iron was shipped from the Buena Vista mine. Various other mines in the district produced iron ore up until about 1970; total production of the district is about 4 million tons of ore of which about 625,000 tons is estimated to have originated in the Churchill County part of the district (Johnson, 1977, p. 69. Extensive exploration in this district has developed large reserves of low-grade iron ore; Johnson (1977, p. 70-72) shows estimated reserves of over 57 million tons of material averaging 20 to 35 percent iron. No reserve figures are available for deposits in the Churchill County portion of the district.

[illegible]

[illegible]

MINERAL BASIN DISTRICT

Location

[illegible]

History

[illegible]

Geologic Setting

The Buena Vista Hills are underlain by a lopolthic complex of gabbroic intrusive rocks and mafic extrusive rocks of Middle Jurassic age. The gabbro and cogenetic mafic volcanic rocks are overlain unconformably by Tertiary silicic and basaltic volcanic rocks and by extensive areas of Quaternary sediments. The gabbroic intrusive complex has been partially scapolitized (Wilden and Speed, 1974, p. 78).

Ore Deposits

The iron ore deposits in the Buena Vista Hills occur as vein and replacement deposits in scapolitized gabbro and mafic metavolcanic rocks. The iron ore mineralization is apparently related to a late stage, deuteric alteration of the mafic complex. The deposits were localized by major faults and fault intersections and minable ore bodies are frequently bounded by faults.

The main iron ore mineral is magnetite; associated with it are pyrite and very minor chalcopyrite. The gabbro and mafic volcanic rocks are highly scapolitized and are altered to chlorite, scapolite, and amphibole in and adjacent to iron mineralization. Apatite, sphene, and calcite occur in some of the ore. Much of the ore is oxidized to martite (hematite pseudomorphic after magnetite).

MOUND HOUSE DISTRICT

Location

The Mound House district is in extreme western Lyon County, in the low foothills of the Virginia Range adjacent to the border of Carson City.

History

Mining in the Mound House district is confined to recovery of gypsum from rock gypsum and gypsite deposits. The discovery of these occurrences is not recorded, but mining on the rock deposits was underway in 1914 and gypsite was being produced from the district in 1918. Couch and Carpenter (1943, p. 92) record production of $451,982 in gypsum from the district between 1914 and 1920. In 1965, small amounts of gypsum were being produced mainly for use as soil conditioner (Archbold, 1969, p. 34). The rock gypsum mine is currently (1989) in full production and output is shipped to two California cement plants and to the Nevada cement plant in Fernley (Papke, 1987, p. 19). The area of the gypsite deposits, close to U.S. Highway 50, is not presently

being mined; urbanization of the area may preclude any future mining (Papke, 1987, p. 20).

Geologic Setting

Rock units in the area ore of three main age groups. Metamorphosed Triassic and Jurassic igneous and sedimentary rocks are oldest; these are overlain by a complex group of Tertiary volcanic rocks. Both Mesozoic and Tertiary rocks are covered locally by Quaternary basalt and unconsolidated surficial deposits. The Triassic and Jurassic rocks consist of metamorphosed andesite and diorite with some limestone and gypsum units; the limestone and gypsum occur in a fault block within the metavolcanic rocks but, in one area, the metadiorite-limestone contact may by partly intrusive. Tertiary volcanic rocks in the district include the Hartford Hill, Alta, Kate Peak, and Lousetown formations (Archbold, 1969, p. 34).

Ore Deposits

The largest gypsum deposit mined in the Mound House area is the Adams property, located along the county line in the Virginia Range foothills. An irregular open pit exposes a bedded gypsum-anhydrite deposit that occurs within a section of Jurassic rocks. The deposit is overlain by limestone and, in one area, possibly by an igneous rock. The gypsum is very-thin to thin bedded and is commonly highly fractured; anhydrite is abundant in the deeper part of the mine pit (Papke, 1987, p. 19).

Gypsite deposits occur as units covering terraces in the alluvium southeast of the Adams open pit mine. Most of the terraces display a northeast-southwest orientation and slope gently southeastward. The gypsite occurs in the upper few feet of the terraces, generally immediately beneath a few inches of gypsiferous soil; the gypsite is commonly underlain by a few feet of silt or sand and then by gravel (Papke, 1987, p. 20). Most of the original outcrops in the area have been destroyed by trenching, mining, and extensive development; Papke (1987, p. 20) states that drilling in the area has revealed the remaining deposits are usually less than 6 feet thick and grade and thickness is often spotty.

MOUNT GRANT DISTRICT

Location

The Mount Grant district, Mineral County, is in the Wassuk Range, west of Walker Lake. The district includes the flanks of Mount Grant and extends from Corey Creek on the south to the Cottonwood Creek drainage on the northwest. Most all of the central part of the district is within the Hawthorne Army

Ammunition Depot withdrawn area, and has been closed to nonmetalliferous mineral entry since 1927.

History

Ross (1961, p. 83) states that the Mount Grant district was a minor producer of gold and silver as early as the 1870's; no records to substantiate this could be found, however. Hill (1915, p. 156) describes a deposit in Cat Canyon, on the south side of Mount Grant, that was discovered in the early 1880's, but noted that none of the deposits in the district were being worked in 1912 when he examined the area. Gold placer operations were begun in Laphan Meadows in 1906, and mining was done there intermittently for many years (Vanderburg, 1937, p. 44-45).

The main part of the Mount Grant district has been closed to mineral entry since 1927 when the area was withdrawn as part of the Naval ammunition depot. With the exception of sporadic placer operations on the west side of the district and minor activity at the Big Indian mine, south of the withdrawal border, no mining has occurred since the time of closure.

Geologic Setting

Most of Mount Grant, from upper Cat Creek on the south to Cottonwood Creek on the north and from just east of the its summit to the western foothills, is composed of dark gray to greenish gray metavolcanic rocks; the age of these rocks could be Permian, Jurassic, Triassic, or Cretaceous (Stewart and others, 1981). All of the remainder of the Mount Grant district, save small areas on the western flank of the mountain, is underlain by Jurassic/Cretaceous granitic rocks. These rocks, which range in composition from granodiorite to granite, intrude the older rocks. Tertiary andesite flows and breccias cover portions of the lower western flanks of Mount Grant.

Ore Deposits

All of the lode mines and prospects in the Mount Grant district are developed on narrow, brecciated quartz veins that follow shear zones in granodiorite and, rarely, in metavolcanic rocks. The veins carry small amounts of gold associated with pyrite and probably chalcopyrite; in outcrop the veins display limonite and occasional copper oxide staining. Vein thicknesses vary from less than an inch up to several feet; at the Big Indian mine, four distinct, nearly parallel, east-west striking veins follow a fault zone in granodiorite. Veins seen at the numerous prospects in the district trend east-west, northeast, northwest, and, rarely, north-south; dips also vary but are commonly steep. The characteristics common to many of the veins in district appear to be brecciation of the vein material and the scarcity of sulfide mineralization. Fine-grained pyrite is the most common

[illegible]

History

[illegible]

[illegible]

Geologic Setting

[illegible]

Ore Deposits

[illegible]

mineral seen, except for iron oxides; chalcopyrite is sometimes seen; and galena is reported to be present only in one vein at the Big Indian mine. Wall rocks adjacent to the veins display argillic alteration and vein outcrops are not prominent.

The most extensive mining operations in the district are related to gold placer deposits in Lapon (Laphan) Canyon which drains the southwest slope of Mount Grant. The deposits were apparently worked up into the mid-1930's and intermittently since then; at the time the area was examined in June 1989, there was no activity but considerable equipment was scattered the length of the canyon. Placer gold is reported to occur in a channel that averaged 40 feet in width and 9 feet in depth; gold is fairly coarse and was probably derived from the numerous small gold-bearing quartz veins in the granitic outcrops higher on the mountain (Vanderburg, 1937, p. 45). This area is just west of the boundary of the military withdrawal and is still open to mining development.

Vanderburg (1937, p. 46) mentions an occurrence of molybdenite occurring in granite in Corey Canyon; nothing more is known about this occurrence.

None of the mines within the Hawthorne Ammunition Depot withdrawn area have been active since the lands were closed to public entry in 1927 and, from the appearance of many of the workings, they were idle long before that time. The Big Indian mine, outside the withdrawal boundary to the south, was not active in 1936 (Vanderburg, 1937, p. 46) and it does not appear to have been worked since that time. No activity was in evidence anywhere in the district in June 1989, although Freeport McMoran was reported to be drilling in an area south of Mount Butler along the western border of the district.

Geochemistry

Samples of ores collected in this district reported low values in most elements. The base metal association, copper and lead with high bismuth, is present in some samples. Erratic, but high, values in arsenic and antimony occur, and a few samples were moderately high in silver. Zinc values are anomalously low throughout the district.

MOUNT MONTGOMERY DISTRICT

Location

The Mount Montgomery district is located in the southern tip of Mineral County, southwest of Montgomery Pass. The district includes the northern tip of the White Mountains, north of the Esmeralda County line, as well as the area of Truman Meadows,

north of Queen Valley and U.S. Highway 6. The Mineral-Esmeralda county line that forms the southern boundary of the district also divides the Mount Montgomery mining district, on the north, from the Buena Vista (Oneota) mining district in Esmeralda County, on the south. Prospects along the county/district line in upper Queen Canyon and around Sugarloaf Peak are included in the Buena Vista district and are not discussed in this report (see Smith and others, 1983).

<u>History</u>

The southern part of this area, in the vicinity of Queen Canyon, Esmeralda County, was prospected in 1862 but no valuable rock was found and the district was abandoned (Angel, 1881, p. 417). In 1864, discoveries were made in the Montgomery district, a few miles to the west in Mono County, California. This district is described (Stretch, 1867, p. 36-37) as extending into Nevada and some of the prospecting may have been done in Mineral County. In 1870, rich float was found in Queen Canyon, and led to the discovery of the Indian Queen mine. A 4-stamp mill was erected and the mine produced high-grade for a number of years (Lincoln, 1923, p. 140). All of this early mining activity was in the Buena Vista district of Esmeralda County; the stamp mill and surrounding facilities, however, were constructed at the mouth of Queen Canyon, in what is now Mineral County.

In 1914, fluorspar was discovered in deposits 3 miles south of Montgomery Summit; 5 carloads were shipped from the area in 1926 (Vanderburg, 1937, p. 49). The area has been explored over the intervening years but there has been no additional production (Papke, 1979, p. 32-34).

Tungsten mineralization was discovered north of Queen Valley, about 1 1/2 miles west of Montgomery Summit, around 1917 (Hess and Larsen, 1921, p. 277), but no production has been recorded from the property. A small amount of tungsten ore has been produced, however, from the Moonlight and Silver Moon property about 1 mile southeast of Montgomery Summit (Stager and Tingley, 1988, p. 115).

<u>Geologic Setting</u>

The oldest rocks in the Mount Montgomery district are Cambrian phyllite and marble and Ordovician siltstone, marble, and slate. Phyllite occurs in outcrops in Queen Canyon, along the county line northeast of Queen Canyon, and in an area north of U.S. Highway 6 west of Montgomery Summit. In the Queen Canyon area, the phyllite is thrust over siliceous siltstone and fine-grained marble of the Ordovician Palmetto Formation (Crowder and others, 1972). Cambrian marble crops out west of Montgomery Summit, west of the phyllite outcrops, and in a small area southeast of the summit, near the Moonlight and Silver Moon claims.

All of the metasedimentary rocks have been intruded by granitic rocks related to the Sierra Nevada batholithic complex. Within the Mount Montgomery district, granitic rocks crop out along the front of the White Mountains, west of Queen Creek Canyon, where they intrude Cambrian and Ordovician rocks; and west and southeast of Montgomery Summit where they intrude Cambrian marble. Skarn zones have formed locally along the contact of the granitic rocks with marble.

The remainder of the bedrock exposures in the district consist of Tertiary volcanic rocks that cover the older rocks. Rhyolite tuff cut by rhyolite plugs and dikes crops out in the area along the east side of Queen Valley, between Queen Canyon and Sugarloaf Peak. West of Montgomery Summit, andesite, andesite tuff, tuff breccia, and some tuffaceous sedimentary rocks are present along with extensive outcrops of rhyolite tuff and plugs (Crowder and others, 1972).

Ore Deposits

Garnet skarn containing small amounts of scheelite occurs north of U.S. Highway 6, on what is now known as the Panorama claim. This is probably the tungsten deposit described by Hess and Larsen (1921, p. 277). The skarn occurs along a granite-marble contact and is explored by a single adit. A quartz vein cutting andesite is also exposed in the mine workings; some vein material may also have been mined.

Several prospects both north and west of the tungsten area explore quartz veins, stringers, and breccias cutting silicified andesite and rhyolite; most of the quartz material contains fine-grained pyrite. Exploration work, consisting of road building, preparation of drill sites, and drilling, has been done in this area (on the Vol and Houndog claims) within the past two years.

In the southern part of the district, west of Queen Canyon, prospects explore narrow, iron-oxide-stained quartz veins that cut granite and metasedimentary rocks. These workings are old and may be related to 1860's activity in the Montgomery district of Mono County, across the state line to the southwest.

Fluorite at the Fluorspar King and Blue Bell prospects, about 2 miles south of Montgomery Summit, occurs as vuggy, crustified veins in shears in brecciated rhyolite. The veins are up to 4 feet wide and are exposed for a maximum length of 100 feet; some fluorite occurs distributed in the rhyolite as fracture coatings and small pods (Archbold, 1966, p. 11). About 3 miles to the south, in an area west of Mustang Point and north of Queen Canyon, fluorite occurs in a fault zone in Cambrian schist. The fluorspar occurs as pods, irregular masses, and in narrow, random veinlets in bleached, argillized schist along a

northwest-trending fault zone (Papke, 1979, p. 33-34). Both of these areas are presently inactive.

MOUNT SIEGEL

Location

The Mount Siegel district, Douglas County, lies on the north slope of Mount Siegel in the Pine Nut Range, about 20 miles east of the town of Minden. The district is a gold placer district, and the mines are located in the upper part of Pine Nut Valley, the drainage which separates Mount Siegel and Galena Peak on the west from Oreana Peak on the east.

History

The placer deposit originally known as the Buckeye Placer was discovered in 1891. The Ancient Gold Placer Mines Company, owned by George Slater, of Minden operated the placer deposits during most of the 1930's (Vanderburg, 1936, p. 68-69). The area has always been hampered by lack of a water supply and, in the 1890's, water was piped into the area from a small lake and stored in a reservoir above the placer ground for use in sluicing (Overton, 1947, p. 28-29). By the mid-1940's, only annual assessment was being done on the placer claims, and the district is now inactive. Total production from the district is listed at $3,510 (Couch and Carpenter, 1943, p. 37).

We did not visit this area during our reconnaissance work in Douglas County.

Geologic Setting, Ore Deposits

The placer deposits occur in a large depression in the granitic rock that comprises the Pine Nut Range in this area. Within this depression the surface has been crevassed by recent water courses making an undulating relief of hills and ravines. Gold is scattered over an considerable area, with some concentration in the ravines or on a false bedrock of pipe clay or hardpan. The gravels consist of loose, unassorted rock, gravel and sand, and soil, with some large boulders. Gold, both fine and coarse, as well as nuggets, is disseminated through the gravels. Some of the gold is believed to have been reconcentrated from gravels deposited in a Tertiary river system that flowed easterly from the Sierra Nevada Range, while some has been derived from the erosion of gold-bearing stringers and quartz veins in the Pine Nut Range (Vanderburg, 1936, p. 69).

MOUNTAIN HOUSE DISTRICT

Location

The Mountain House district, Douglas County, is situated in the southern portion of the Pine Nut Range southeast of Minden and adjacent to the California border. The district, also referred to as Holbrook or Pine Nut, is in the vicinity of Holbrook Junction on U.S. Highway 395; most of the mines are on Gold Hill, north of Holbrook Junction.

History

According to Overton (1947, p. 29) the Orpheus of Willard-Mcdonald mine was opened in 1879 and is reported to have produced $125,000. There is, however, no official record of this production. The mine was idle from 1896 to 1921 when it was reopened by the Carson Valley Mining Co. Couch and Carpenter (1947, p. 37) credits the district with production of $6,754 in gold and silver between 1922 and 1939. Tungsten was found on the south flank of Gold Hill, about 1/2 mile east of Holbrook Junction sometime in the early 1950's and 6 units of WO_3 were produced from the area in 1955 (Stager and Tingley, 1988, p. 48). No mining activity has been recorded in the district since that time.

Geologic Setting

Essentially all of the Mountain House district is underlain by Triassic and Jurassic metasedimentary and metavolcanic rocks. Metasedimentary rocks crop out on Gold Hill and along the California state line west of Topaz Lake; most of the remainder of the Pine Nut Range around Topaz Lake and north of Gold Hill is made up of metavolcanic rocks. A small body of Cretaceous granodiorite intrudes metasedimentary rocks east of Holbrook Junction and has formed areas of weak skarn within the intruded rocks. Tertiary andesitic rocks crop out in low hills in the basin area east of Gold Hill, and along the California state line northwest of Holbrook Junction.

Ore Deposits

Two types of mineral occurrences have been explored and mined within the Mountain House district. Quartz vein deposits in silicified metasedimentary and metavolcanic rocks have been mined for gold and silver and tungsten has been mined from small skarn deposits developed in metasedimentary rocks adjacent to contacts with granitic intrusive bodies.

The largest vein occurrence, the Willard McDonald mine, was developed on a N50°E-striking quartz vein system. Ore at the mine consisted of vuggy, iron-oxide-stained quartz and highly-

silicified breccia; the quartz contains pyrite and the breccia matrix is mostly pyrite. A vein exposed in a prospect on the south slope of Gold Hill was seen to contain arsenopyrite and galena as well as pyrite.

The Anderson and Cornell property, on the south slope of Gold Hill, was developed in weakly mineralized epidote skarn which is reported to contain scheelite (Stager and Tingley, 1988, p. 48). Other small skarn deposits occur in Minnehaha Canyon, in the northern part of the district. At one of these, the Last Dollar claim, gossanous outcrops mark small lenses of garnet skarn that have formed along bedding planes in metasedimentary rock. Strings of pale amber garnet occur with white quartz and limonite-hematite gossan probably formed from original magnetite.

This general area was prospected for iron in the early 1960's. Aeromagnetic survey work done by the U.S. Geological Survey revealed magnetic anomalies related to magnetite concentrations in skarn. Considerable geologic reconnaissance work and some trenching was done, but no deposits were defined in the area. The district has been inactive in recent years.

Geochemistry

Ore samples collected in this district displayed high silver values associated with high arsenic and lead; associated copper values were spotty, zinc only moderately high, antimony values were low. Molybdenum was moderately high in several samples, high gold was present in one location, and boron was very high in most samples. These associations are indicative of skarn mineralization associated with the Cretaceous intrusive rocks in the district.

MOUNTAIN VIEW DISTRICT

Location

The Mountain View district, Mineral County, is in the northern Wassuk Range west of the town of Schurz. The district extends from Reese River Canyon, on the south, to the north end of the range. Mines and prospects in this district are clustered in four general areas: near the mouth of Penrod Canyon in the south part of the district; around the Northern Lights mine, north of Hussman Spring on the west-central side of the district; in the canyon draining north from Black Mountain in the northeast part of the district; and on the northwest tip of Black Mountain, on the northwest edge of the district. Scattered mine workings south of U.S. Highway 95 Alt., along the northern tip of the Wassuk Range, are also included within the Mountain View district.

A large part of the district, including mines around the old camp of Granite north of Black Mountain, is within the Walker River Indian Reservation. Hill (1915, p. 129-133) referred to this area as the Granite district and, sometimes, it is called the reservation district (Ross, 1961, p. 83).

History

Gold was discovered at Mountain View, on the northwestern tip of the Wassuk Range in 1904; the area was included in the Walker Lake Indian Reservation and was not open to location. When the reservation was thrown open to prospectors in 1906, several claims were located at Mountain View by William Wilson who had made the 1904 discovery (Vanderburg, 1937, p. 44).

Two small mining settlements quickly sprang up in the district; Mountain View was located on the west side of the northwest tip of Black Mountain near the 1904 discovery site, and Granite was located near the head of an east-draining canyon at the north end of Black Mountain (Hill, 1915, p. 129). According to Lincoln (1923, p. 146-147), 55 lessees were active at Granite in 1908 and the first production from the district was made that year; $4,500 in gold and silver was produced the following year. In 1916-1917, a little over $29,000 was produced from the Yerington Mountain Copper Co. property (Beach mine) south of Granite (Couch and Carpenter, 1943, p. 102, 105). No production has been reported from the district since that time.

In the 1960's, attention focused on the Black Mountain area, including the mines near the old camp of Granite, as potentially interesting for porphyry copper exploration. Exploration work by several major mining companies was done in the district, both within and outside of the reservation. This work was largely discouraging, properties were dropped.

With the exception of some surface work on properties in the Penrod Canyon area, little appears to have been done in this district since the copper exploration of the late 1960's. Several small companies, however, were reported to be active in the district in 1989.

Geologic Setting

Rocks exposed in the Mountain View district range in age from Late Triassic through Tertiary and include metamorphosed volcanic and sedimentary rocks, a wide variety of intrusive rocks that range in composition from quartz diorite to quartz monzonite, and andesitic to rhyolitic flow rocks and ash-flow tuffs. The majority of the bedrock exposures are Jurassic or Cretaceous intrusive rocks typical of the Sierran Province (Bingler, 1978).

Mesozoic metasedimentary rocks are exposed on the west central part of the district in a roof pendant around the Northern Lights mine. Metavolcanic rocks of Triassic age are exposed in areas along the north side of Reese River Canyon and on the north end of the district. Plutonic and hypabyssal crystalline rocks ranging in age from Middle Jurassic(?) to Late Cretaceous form the core of the Wassuk Range within the Mountain View district. These rocks range in composition from quartz diorite to quartz monzonite; progressively younger intrusives are increasingly more granitic and are present in greater volume. Tertiary volcanic rocks exposed in the district consist of silicic ash-flow tuffs, latite flows, volcaniclastic rocks, andesite flows, and basaltic andesite flows. Basaltic andesite covers Black Mountain and the foothills to the west; rhyodacitic ash-flow tuff covers large areas in the northwest part of the district, around the old camp of Mountain View. Units of the Mickey Pass and Singatse tuff also crop out in areas along the west side of the district, west and south of the Northern Lights mine (Bingler, 1978).

Ore Deposits

In the Penrod Canyon area, on the south end of the Mountain View district, numerous small prospects expose weakly-mineralized quartz veins in shear structures. The shear zones strike northeast and northwest, display variable dips, and cut both Cretaceous granitic rocks and Triassic meta-andesite. The veins show coarse brecciation with silica cementation; minor iron- and copper-oxide minerals are present along with minor chalcopyrite, pyrite, and traces of galena. Skarn mineralization was noted at two prospects in this area.

At the Northern Lights mine (probably the Searchlight claim of Hill, 1915, p. 133), several shafts, adits, and stopes expose northwest-trending, steeply-dipping fissure veins in limy shale. The veins are up to 6 feet thick and follow breccia zones; vein outcrops are siliceous gossans that contain oxide copper and iron minerals. Oxidized ore present on dumps contains malachite, azurite, cuprite, and native copper along with iron-oxide minerals. Sulfide minerals seen include chalcopyrite, bornite, and pyrite.

The Beach Copper mine, near the camp of Granite north of Black Mountain, was developed on a series of copper-bearing quartz veins in granite. Siliceous vein croppings were 8 to 25 feet wide and contained copper carbonates. Underground, the vein split up and became a zone of narrow quartz stringers in crushed granite; minerals present in this zone consisted of pyrite, copper carbonates, and chalcocite. In some places the pyrite is coated or completely replaced by chalcocite. Hill (1915, p. 132) noted that the valuable content of the ore at this mine was entirely secondary and that the primary mineralization was

noncupriferous or only slightly cupriferous pyrite; Hill felt that the source of the copper was not thoroughly clear. In the vicinity of the Beach mine, large areas of metavolcanic and shallow intrusive rock display intense quartz-sericite-pyrite alteration. During the mid to late 1960's, this property and the surrounding altered area was explored for porphyry copper mineralization. Mapping and sampling, plus limited diamond drilling west of Black Mountain, however, led to the conclusion that the presence of a large, low-grade copper deposit in the area was unlikely (Satkosky and others, 1985, p. 113).

Northwest of Black Mountain, east of the camp of Mountain View, the Big Twenty and Mountain View veins follow shear zones in sericitized granodiorite. The vein at the Big Twenty mine strikes east-northeast and consists of iron-oxide-stained quartz stringers from a few inches to 4 feet in width (Hill, 1915, p. 132). Ore remaining on the mine dump consists mainly of massive pyrite in quartz; some native sulfur occurs in soft, porous vein material.

On the northern edge of the Mountain View district, just south of Highway 95A on the north flank of the Wassuk Range, several small workings expose weak skarn mineralization, and north-south to northwest-trending veins and breccias associated with aplite dikes. Minerals present include pyrite in en echelon quartz veins in east-west-trending, north-dipping shear zones, and pyrite, iron- and manganese-oxides in silicified , north-south to northwest-trending shear zones that have been brecciated and intruded by latite dikes. Weak alteration was noted by Satkosky and others (1985, p. 158) along a contact zone between Tertiary silicic ash-flow tuff and Triassic metavolcanic-metasedimentary rocks in one location in this area. They report no evidence of paleo-hot springs and attribute the alteration to geothermal cells associated with basin-range rifting(?).

OLINGHOUSE DISTRICT

Location

The Olinghouse district, Washoe County, is located in the eastern Pah Rah Range, about 7 miles northwest of the town of Wadsworth. The district extends from the Truckee River Canyon on the south to Big Mouth Canyon on the north. Most of the mines and prospects in the district are between Olinghouse and White Horse Canyons, along the eastern front of the Pah Rah Range.

History

The Olinghouse, or White Horse, district was first prospected in 1860, locations were made in Fort Defiance Canyon in 1864, and the Green Mountain mines at Olinghouse were located

in 1874 (Hill, 1911, p. 103). Prior to 1900, placer deposits situated in several ravines tributary to Olinghouse Canyon were extensively worked by Wadsworth residents (Overton, 1947, p. 71). The period between 1901 and 1903 witnessed the greatest activity in lode mining, with three mills running most of the time (Hill, 1911, p. 103). In 1906, a railroad was constructed between Olinghouse and Wadsworth, connecting the camp with a 50-stamp mill located on the Truckee River; the mill ran for only three months and the operation failed due to lack of ore. The railroad was dismantled in 1909 and the track was sold to the Nevada Copper Belt Railroad, then under construction near Yerington (Myrick, 1962, p. 56). After the failure of the railroad, company operations at Olinghouse ceased, the mines were turned over to lessees (Bonham, 1969, p. 73), and only intermittent mining activity has occurred at Olinghouse since that time.

In 1940, tungsten was found to be present in a small deposit in the Truckee River Canyon about 5 miles west of Wadsworth, and between 1940 and 1941, about 200 units of WO_3 were produced from the deposit (Stager and Tingley, 1988, p. 202).

Production is recorded from the Olinghouse district beginning in 1898 and, through 1966, about $1 million, mainly in gold and silver, has been reported to have been produced from the district (Bonham, 1969, p. 74).

Most recently, placer gold deposits in Olinghouse Canyon have been examined and some development has taken place. The Olinghouse open-pit placer mine was operated by various companies between 1985 and about 1988. These deposits, however, were not active in 1989. New Gold, Inc. is currently operating a placer gold mine on the alluvial fan east of Olinghouse.

Geologic Setting

The following descriptions of geologic setting and ore deposits have been abstracted largely from Bonham (1969, p. 73).

The oldest rocks exposed in the district are Mesozoic metasedimentary rocks intruded by granodiorite. These rocks crop out in a small area in the Truckee River Canyon west of Wadsworth.

The Mesozoic rocks are overlain unconformably by Tertiary volcanic and sedimentary rocks including ash-flow tuffs of the Hartford Hill Rhyolite, basaltic and andesitic rocks and associated sediments of the Chloropagus Formation, and andesitic to rhyodacitic flows, breccias, and shallow intrusives of the Kate Peak Formation. The Hartford Hill and Chloropagus formations are intruded by granodiorite porphyry dikes and masses in the central portion of the Olinghouse district. These intrusive rocks are probably related to Kate Peak vulcanism.

Precious metal deposits of the Olinghouse district occur in or adjacent to the granodiorite porphyry intrusive bodies. Rocks of both the Hartford Hill Rhyolite and Chloropagus Formation are also altered and mineralized, but the productive veins worked in the past are confined to the Chloropagus Formation and to the intrusive rocks.

Andesitic and basaltic rocks of the Chloropagus Formation have been propylitized within a rudely elliptical area of several square miles that encompasses the productive portion of the Olinghouse district. The altered area trends northeastward, essentially parallel to the trend of the Olinghouse fault and of the intrusive bodies.

Ore Deposits

The gold ore bodies in the Olinghouse district occur as small, "pockety", high-grade shoots emplaced along fault zones in or adjacent to granodiorite porphyry dikes and intrusive masses which cut rocks of the Chloropagus Formation. Most of the mineralized faults, dikes, and intrusive masses trend northeastward.

The main mines of the Olinghouse district are located on Green Hill, northeast of the town of Olinghouse. The workings of the Don Dero, Gold Center, Butte, and Renegade mines all explore the Olinghouse fault zone and subsidiary footwall branches. Brecciated vein material consisting of quartz and calcite with native gold, pyrite, and chalcocite occurs in fault breccia and gouge. Other mines in the district, such as the Keystone Nevada mine and the Tiger group and Buster mines, in the area of Tiger Canyon, are similar in setting and mineralization. To the north, in the Big Mouth Canyon area, prospecting explores northerly-trending fault zones in welded ash-flow tuff in the Hartford Hill Rhyolite. Some of these fault zones consist of a network of quartz veinlets in thoroughly propylitized, brecciated rhyolite welded tuff (Bonham, 1969, p. 75).

At the Derby tungsten deposit in the Truckee River Canyon, thin lenticular layers of scheelite-bearing skarn are found in two pendants of Mesozoic metamorphic rocks surrounded by granodiorite. Several faults cut the metamorphic rocks, and scheelite occurs in greater concentrations where the faults cut favorable beds. The skarn bodies that contain appreciable amounts of scheelite are exposed at the surface for widths of 3 feet and lengths of 30 to 50 feet. The WO_3 content of the ore mined was about 0.3 to 0.75 percent (Stager and Tingley, 1988, p. 202). The outcrop area of pre-Tertiary rocks is small and they are overlain unconformably by Tertiary and Quaternary rocks. The main adit of the Derby mine was obliterated during construction of Interstate 80, and it is now difficult to find traces of the old mine workings.

Eluvial and alluvial placer deposits have been worked intermittently in Olinghouse district from the 1860's to the present. The main placer workings occur in Olinghouse, Frank Free, and Tiger Canyons and in small side canyons tributary to these; eluvial placers also occur on the flanks of Green Hill. The most recent operations in the Olinghouse district have been at the Olinghouse mine on Green Hill. Extensive placer ground in the Olinghouse district is present in alluvial fans at the mouths of Frank Free and Olinghouse Canyons. These gravels have been tested by several major companies at various times beginning about 1939 and extending to the present. The limits of the placers have not been defined and, given proper economic conditions, they constitute a potentially important gold resource (Bonham, 1969, p. 76).

PAMLICO DISTRICT

Location

The Pamlico district, Mineral County, is in the western Garfield Hills, about 10 miles southeast of the town of Hawthorne. Most of the mines in the district are located along Pamlico and Never Sweat Canyons, but prospects in Bromide Canyon on the south, and the Ashby, Wamsley, and Rock Cabin mines to the east toward Garfield Flat are also included in this district. All of the western portion of the district, from the junction of Pamlico and Never Sweat canyons to the west and including all of Bromide Canyon, is within the Hawthorne Ammunition Depot and is closed to mineral entry.

Hill (1915, p. 151-157), Lincoln (1923, p. 144-146), Vanderburg (1937, p. 35-39), and Ross (1961, p. 82) group the mines at La Panta and Pamlico with mines in the Lucky Boy area and place them all into the Hawthorne mining district. In this report, both areas are treated as separate districts, and the name Hawthorne is not used.

History

Ross (1961, p. 82) and Vanderburg (1937, p. 38) both credit the Pamlico mines with production in the 1870's as well as the 1880's. Archbold and Paul (1970, p. 1) say that the date of discovery is unknown but that records of patent surveys indicate work was in progress in the district by 1885. Couch and Carpenter (1943, p. 105-106) list production between 1885 and 1889 of at least $426,900, mainly in gold, from mines in the district. The Ashby gold deposit, about 4 miles east of Pamlico, was discovered in 1933 and, between 1934 and 1937, produced $37,828 in gold. Total production of the district is estimated to be between $464,737 (Couch and Carpenter, 1943, p. 105-106)

and $1.1 million (Lincoln, 1923, p. 145). The production of the Ashby mine for 1934-1937 has been added into figures given in Lincoln to arrive at the higher total shown.

Many properties in this district have been intermittently active, but no production has been reported since the late 1930's from them. Evidence of exploration trenching, bulldozing, and drilling can be seen throughout the district. The remains of a large heap-leach operation were seen in the area of the Central mines, between Pamlico and La Panta, but it was not active at the time of our examination. A small screening plant at the Pamlico mine was active in May 1989, however. The Lazy Man (Ashby) mine was active and work was being done on the Big Deal claims, southeast of the Lazy Man mine. Companies recently active in the district include American Gold Resources, Westley Exploration, Inc., Appolo Explorations, Inc., and several individual operators.

Geologic Setting

Rocks exposed in the Pamlico district are dominated by a complex sequence of volcanic, clastic, and carbonate rocks that range from Jurassic to Cretaceous in age. These rocks are intruded on the north by quartz monzonite and related rocks, presumably of Cretaceous age. All of the older rocks are locally overlain by basaltic and rhyolitic flows of Tertiary to Quaternary age (Archbold and Paul, 1970, p. 4).

Ore Deposits

Most of the following section describing the mines of the district has been taken, with only slight modifications, from Archbold and Paul (1970, p. 8-11).

Four types of mineral deposits occur in the Pamlico district. Listed in order of decreasing value produced they are: gold in quartz veins in metavolcanic rocks of probable Jurassic age (Dunlap Formation?); gold in limonitic, vuggy quartz lodes in limestone; copper in skarn and contact zones between quartz monzonite and limestone; and gold and argentiferous galena in quartz veins in metavolcanic rocks of the Gold Range Formation (Cretaceous age according to Garside, 1979). Some gold in the district has also been mined from placer deposits below the main Pamlico mines.

Gold quartz veins in the Jurassic metavolcanic rocks, such as those at the Pamlico, Good Hope, and Gold Bar mines, usually occur along northwesterly-trending faults and shear zones. The veins are associated with gouge and breccia and range from scattered stringers of quartz to massive milky white quartz up to 4 feet thick. Most veins have dips of less than 45° to the northeast or the southwest and some veins have dips of 15° or

less. The main constituent of the veins is quartz along with substantial limonite, rare pyrite, occasional galena, copper sulfides, and copper carbonate minerals. Free gold is reported to have been present as wires and nuggets in parts of the veins. The Ashby (Lazy Man) mine, while not described by Archbold and Paul (1970), also appears to fall into this deposit category. At the Ashby mine, a series of northwest-striking quartz veins cut metavolcanic rocks. The veins contain quartz, barite, and some copper carbonate minerals (Archbold, 1966).

At the La Panta mine, ore forms irregular replacement bodies in limestone and consists of siliceous, ferruginous, locally jasperoidal, gossan material containing free gold. The gossan zone is up to 30 feet wide at surface and it crops out over a strike length of about 600 feet; the zone is partly controlled by faults and partly spreads out along bedding. Underground, ore is reported to have occurred in irregular, sporadic pods or lenses up to 100 feet across and 3 to 4 feet thick. The nearby Evening Star mine is similar in occurrence to the La Panta.

Copper occurs along the contact between quartz monzonite and limestone in the Gold Bug mine area, about 1 mile east of the La Panta mine. The copper occurs as secondary oxide and silicate minerals in quartz monzonite, skarn, and silicated limestone; mineralization is sporadically distributed along the contact. No tungsten mineralization is reported from the Gold Bug mine, but at the Silver Star prospect, north of the La Panta mine, scheelite occurs along with copper oxide minerals in small pods of skarn along a marble-quartz monzonite contact (Stager and Tingley, 1988, p. 116-117).

Quartz veins containing gold and argentiferous galena occupy northerly-trending shear zones in the Gold Range Formation in the area of the Central (New York Central) mines, about half way between Pamlico and La Panta. The veins are similar to those at Pamlico, except some galena is present. An attempt has been made recently to bulk-mine the surface here and operate a heap leach. The operation is not active at the present.

<u>Geochemistry</u>

Ore samples collected from this district show a base metals association; copper, lead, and zinc are associated with generally high arsenic and spotty, but anomalous antimony. Gold is present in anomalous to highly anomalous amounts in a large number of the samples collected in this district. Higher values in gold and silver generally are high in bismuth, and anomalous tungsten is present in many of the samples.

PEAVINE DISTRICT

Location

The Peavine district, Washoe County, is centered around Peavine Peak, northwest of Reno. The district lies north of the Truckee River and extends from the California state line on the west to the general area of U.S. Highway 395 on the east and north. Mines north and west of Highway 395 in the area of the Granite Hills, north of Reno, and in the area of Parr Boulevard in Reno, are also included in the Peavine district. Mines north of Sparks that have, in the past, been included in the Peavine district (Hill, 1915, p. 184-196) are considered to be in the Wedekind district and are described in that section of this report.

Most of the mines and prospects in the district are located northwest of Peavine Peak, in the area of the historic camp of Poeville west of the Reno neighborhoods of Black Springs and Raleigh Heights. Mines are also located on the southeast slope of Peavine Mountain, and there are old granite quarries located along the Truckee River between Verdi and Lawton.

History

The first report of mining activity in the Peavine area was in 1867 when Browne (1867, p. 327) reported the occurrence of gold and silver in quartz veins associated with carbonate copper ore. Hague (1870, p. 296-297) noted that the region had been "lying neglected" for several years but thought that the proximity to the recently completed railroad passing through Reno would encourage future development. The first production recorded from the district was in 1872 when $53,661 in gold, silver, copper, and lead was produced. Substantial production was recorded in 1873 and 1874, but only small amounts have been recorded at intermittent intervals since that time. Total production for the district, 1972 through 1966, is $242,389 (Bonham, 1969, p. 77).

Granite building stone was quarried from several sites north of the Truckee River west of Reno (Reid, 1904). The rock was apparently used in Reno buildings; the quarries are not large, however, and very little rock was mined. These quarries were idle in 1904, and apparently have not been worked since then.

There is no mining activity in the Peavine district at the present time and, due to advancement of the Reno urban area onto the flanks of Peavine Mountain, future mining development is unlikely.

PEAVINE DISTRICT

Location

The Peavine district, Washoe County, is centered around Peavine Peak, northwest of Reno. The district lies north of the Truckee River and extends from the California state line on the west to the general area of U.S. Highway 395 on the east and north. Mines north and west of Highway 395 in the area of the [illegible] Hills, north of Reno, and in the area [illegible] of Reno, are also included in the Peavine district. Mines north of Sparks that have, in the past, been included in the Peavine district (Hill, 1915, p. [illegible]) are considered as part of the Wedekind district and are described in that section of this report.

Most of the mines and prospects in the district are located northeast of Peavine Peak, in the area of the historic camp of Poeville west of the Reno subdivisions of [illegible] and [illegible] Heights. Mines are also located on the southwest slopes of Peavine Mountain, and there are [illegible] along the Truckee River between Verdi and [illegible].

History

The first report of mining activity in the Peavine area was in 1867 when Browne (1867, p. [illegible]) reported the occurrence of gold and silver in quartz veins [illegible]. Angel (1881, p. [illegible]) noted that the region had been "lying neglected" for several years but reported that new activity in the [illegible] would encourage future development. The first production [illegible] the district was in [illegible] when [illegible] of gold, silver, copper, and lead was produced. Substantial production was recorded in 1913 and 1914, and [illegible] has been recorded at intermittent intervals since that time. Total production for the district, [illegible] through [illegible], is [illegible] ([illegible], p. [illegible]).

Granite building stone was quarried [illegible] of the Truckee River [illegible] of Reno [illegible]. [illegible]

There is no mining activity [illegible]

Geologic Setting

The following sections on geologic setting and ore deposits are taken largely from Bonham (1969, p. 76-81) with some additional data from Hudson (1977).

The oldest rocks exposed in the Peavine district are metavolcanic and metasedimentary rocks of probable Jurassic age. These rocks have been intruded by granodiorite of Cretaceous age and by granodiorite and dacite porphyry of Tertiary age.

The Mesozoic rocks are unconformably overlain by a thick sequence of Tertiary volcanic rocks of the Hartford Hill Rhyolite, the Alta Formation, and the Kate Peak Formation. The Tertiary Coal Valley Formation, consisting of diatomite, shale, sandstone, and intercalated basalt flows, rests unconformably on all of the older rocks.

Ore Deposits

Two types of metallic mineralization are present in the Peavine district: older, mesothermal mineralization, presumably Mesozoic, occurring as quartz veins containing gold, silver, and copper and as lenses of copper in the metamorphic rocks; and a younger, base-metal epithermal mineralization of late Miocene or Mio-Pliocene age that occurs as replacement lodes and disseminations in both pre-Tertiary and Tertiary rocks (Bonham, 1969, p. 77).

Copper-gold deposits of the first type occur in the vicinity of Copperfield on the north side of the district. The Redelius copper prospect, in the Granite Hills west of Stead, and Red Metal copper properties on Peavine Peak, are the most significant deposits of this type. At the Redelius prospects, workings explore copper-sulfide-bearing quartz-tourmaline veins in Cretaceous granodiorite. The occurrence at the Red Metal mine is similar, but the quartz veins are hosted in skarn zones in Jurassic metavolcanic rocks. Other smaller occurrences of this type are found in the area of Peavine Peak.

All of the Tertiary base-metal epithermal deposits in the district occur within a belt of bleached rocks approximately 13 miles long and up to 4 miles wide that extends in an east-west direction along the south side of the Peavine district eastward to the Wedekind district. The surface bleaching delineates an area of pyritization and propylitization associated with the epithermal mineralization.

In the Poeville area on the western end of the alteration zone, economic metallic mineralization at the Golden Fleece and other nearby mines occurs in quartz-calcite stringers and veinlets which contain abundant pyrite and varying amounts of

enargite, galena, sphalerite, and argentite. These veinlets are concentrated in lodes or stockwork-like bodies which, in general, parallel the foliation of the altered metamorphic rocks.

Further east within the altered zone, numerous old workings explore areas of silicification and quartz veining in argillized andesite. Pyrite and enargite occur with quartz in these workings, and alunite and gypsum are commonly present. Most of the old workings in the central and eastern part of the district are caved, and it is difficult to establish geologic relationships; observations are usually limited to what can be surmised from material remaining on mine dumps.

In addition to the lode mines in the Peavine district, placer gold deposits are known to exist in one area south of Black Springs. Gold was mined from this area between 1876 and 1881 but the production is not known. Gold occurs in alluvial deposits derived from the weathering of auriferous pyrite from granitic rocks in the drainages to the south, toward Poeville.

Geochemistry

A number of the ore samples taken in this district showed anomalous base metals, including bismuth, associated with high gold-silver values. This could indicate potential for discovery of skarn gold occurrences.

PILOT MOUNTAINS DISTRICT

Location

The Pilot Mountains district includes all of the Pilot Mountains in southeastern Mineral County. The district lies east of Mina and U.S. Highway 95 and extends between the Bettles Well-Graham Spring road on the northwest to the Mineral-Esmeralda county line on the southeast. Monte Cristo Valley forms the eastern boundary of the district.

History

The first recorded discovery of mineral in the Pilot Mountains was in 1913 when cinnabar was found in a limestone ledge exposed in an old prospect pit (Knopf, 1916, p. 59). The date of the original work on the prospect is not known. Since the "rediscovery" of cinnabar in 1913, prospecting and mining of mercury have been carried on intermittently. Production through 1952 totaled about 5000 flasks of mercury (Phoenix and Cathcart, 1952, p. 145).

In 1916, tungsten deposits were discovered on the east slope of the Pilot Mountains, south of Graham Spring. Some mining was

done shortly following discovery and intermittently thereafter through about 1956. The district is credited with production of about 24,000 units of WO_3 during this time. In 1971, large deposits of scheelite-bearing skarn were defined in the area of the old Desert Scheelite and Gunmetal mines and plans were made to develop a large mine to exploit the deposits. The price of tungsten fell, however, and the deposits remain as an unmined resource; reserves in the district are estimated at about 8 million tons of ore containing around 0.3 percent WO_3 and significant amounts of copper and silver (Stager and Tingley, 1988, p. 117).

Gold discoveries were made about 2 miles northwest of Summit Springs, in the southern Pilot Mountains in May of 1932. A small "rush" occurred to the area and, by the fall of that year, Eddyville, a settlement of about 75 prospectors and miners, had grown up at the discovery site (Stoddard, 1932). Stoddard mentions that by September of 1932, 2-ton shipments, averaging about $1000 per ton in gold, were being made each week to the Selby smelter in California. No other records of activity at this camp exist, and its total production is not known. At the time of our examination of this area in May 1989, new mining claims were in evidence, but no work was in progress. FMC, however, was reported to be conducting drilling in the area of the Pine Tree mine in the northern part of the district.

Geologic Setting

The Pilot Mountains are composed largely of Permian, Triassic, and Lower Jurassic volcaniclastic, clastic, and carbonate rocks which have been locally intruded by stock-like bodies of Cretaceous granodiorite-quartz monzonite and, in one area, a Tertiary rhyodacite dome. Felsic to intermediate volcanic rocks of Middle to Upper Tertiary age crop out extensively over the area, the most extensive outcrops are on the north and south margins of the district (Grabher, 1984, p. 7).

The principal structural feature of the area is the Luning thrust, a regionally-extensive feature that has stacked coeval units of differing facies; in the Pilot Mountains, Triassic carbonate rocks of the Luning Formation have been thrust, as a complex, imbricately-stacked package, over post-Luning age clastic rocks as well as Permian volcaniclastic rocks. Faulting, in part related to the Walker Lane system, also is prominent in the area. Northwesterly faults of this system form portions of the western range front (Grabher, 1984, p. 7).

Ore Deposits

According to Phoenix and Cathcart (1952, p. 143), the cinnabar mines and prospects in the Pilot Mountains district, with one exception, are all below northward-dipping, low-angle thrust faults. These faults, the Cinnabar Canyon and Lost Steers [illegible] through about 1950. The district, as [illegible] about 14,000 [illegible] of alunite-bearing [illegible] were defined in the area of the [illegible] a large mine to exploit the [illegible] however, and the deposits [illegible] in the district are estimated at about 3 million tons of ore containing around 0.3 percent [illegible] and significant amounts of [illegible] and silver ([illegible] and Tingley, [illegible], p. [illegible]).

Gold discoveries were made about 2 [illegible] Springs in the southern Pilot Mountains in May of [illegible]. A "small boom" occurred [illegible] a settlement of about [illegible] grew up at the discovery site ([illegible]). [illegible] mentions that by September of [illegible] about $[illegible] per ton in gold, some [illegible] in California. [illegible] at the [illegible] evaluation of the area in May [illegible] [illegible] was reported to [illegible] the [illegible] mine in the northern part of the district.

Geologic Setting

The Pilot Mountains are composed largely of Mesozoic [illegible] and lower [illegible] sedimentary [illegible] and carbonate rocks which have been locally intruded by [illegible] bodies of Cretaceous granitic [illegible] rocks [illegible]. [illegible] major [illegible] north and south [illegible] ([illegible], p. [illegible]).

The principal structural feature of the [illegible] a [illegible] thrust [illegible] of the [illegible] in the Pilot Mountains [illegible] [illegible] rocks as well as [illegible] area. [illegible] range [illegible].

[illegible]

According to [illegible] and [illegible] mines and [illegible] in [illegible] [illegible] deposits. [illegible] thrusts, are related to the regional Luning thrust and probably constitute the major structural control for cinnabar mineralization in the district. Cinnabar, the only important mercury ore mineral, occurs as fracture fillings and is disseminated in the gouge of faults and through various country rocks. Most cinnabar has filled open spaces, but some has replaced limy sedimentary rock units. At the Mina mine, the largest mercury mine in the district, ore occurred as replacement bodies and fissure fillings localized by fault intersections in limestone. At the Drew mine, ore occurred as replacement bodies along shear zones and along thrust faults in limy shale. Some of the ore at this mine is highly silicified. Small retorts remain on several of the mercury properties and a large milling and processing facility still is in place at the Mina mine. There has been no mercury activity at any of the properties for a long time, however.

Skarn tungsten occurrences in the Pilot Mountains district are located on the east side of the district; the major properties, the Garnet, Gunmetal, and Desert Scheelite are all within an area about 1/2 mile wide by 1 1/2 miles long on the lower eastern flank of the range. The upper Luning limestone, composed of interbedded limestones (80%) and fine-grained clastic rocks (20%) hosts the tungsten mineralization at the Garnet and Gunmetal areas; ore at the Desert Scheelite is hosted by the lower Luning formation which is composed of 60% clastic rocks and 40% carbonate rocks (Grabher, 1984, p. 8). At the Garnet mine, scheelite-bearing garnet-epidote skarn occurs in two principal layers bordering a quartz monzonite sill. Skarn at the Gunmetal mine occurs in gently-dipping, bedded layers that extend as far as 100 feet from contacts of limestone with a quartz monzonite intrusive. Scheelite is disseminated through the skarn accompanied by quartz and very sparse sulfides (Stager and Tingley, 1988, p. 121). The Desert Scheelite deposit is a base metal-enriched skarn deposit. Skarn at this occurrence extends for about 2000 feet along the contact of lower Luning carbonate rocks with the Desert Scheelite stock. The skarn has concentrations of pyrite and base metal sulfides (principally chalcopyrite and sphalerite) reaching 20 percent in unoxidized samples. Scheelite content of this deposit is reported to be more uniform than at the other two deposits (Grabher, 1984, p. 13).

Gold ore at the Eddyville mine occurs in bodies of irregular shape and size, sporadically distributed throughout a narrow quartz vein occupying fractures within Triassic metasedimentary and metavolcanic rocks. The ore zones within the narrow vein are composed principally of soft, earthy manganese and iron oxide in a frail, sponge-like structure of silica; gold occurs as very fine threads ant thin plates in interlacing masses, often in sufficient quantity to bind together pieces of broken ore (Stoddard, 1932, p. 1). The vein occupies a fault plane, strikes

east-west, and dips steeply north; at the Eddyville mine, the vein ranges from two inches to three feet in thickness. Stoddard (1932, p. 2) described the discovery vein at Eddyville (the Stormcloud) as occurring within meta-andesite which has been intruded by later andesite dikes, probably of Tertiary age; he related the ores of the district to the later andesite. Stoddard also described the occurrence of other, similar, veins in the area surrounding the original discovery. None of these, however, must have developed ore, as workings in the district are mainly confined to one mine.

Geochemistry

Ore samples collected at mines in this district displayed interesting geochemical associations. The mercury ores were strangely high in base metals, especially zinc. Many mercury ores were anomalous in lead, copper, silver, and zinc, with spotty, high arsenic. The gold ores from Eddyville contained moderately high, but spotty lead, moderately anomalous arsenic, and high manganese. The tungsten skarns were very high in copper and moderately anomalous in tin and molybdenum.

PYRAMID DISTRICT

Location

The Pyramid district, Washoe County, is in the vicinity of Mullen Pass in the northern Pah Rah Range, about 30 miles north of Reno. Most of the mines and prospects in the district are southeast of the Pyramid Highway, in Perry Canyon and other north-draining canyons, on the northwest slope of the Pah Rah Range.

History

Claims were located in the Pyramid district as early as 1863, and the district was officially organized in April 1866. By 1878, two of the important mines in the district, the Jones and Kincaid, and the Monarch were active (Overton, 1947, p. 81). Apparently nothing was produced from the district until 1881 when production is recorded from the Franco-American property; between 1881 and 1889, this mine is credited with about $87,000 in gold, silver, copper, and lead (Couch and Carpenter, 1943, p. 142). This was the main period of production from the district and, since that time, only small-scale mining activity has taken place in the district. Total recorded production from 1881 to 1966 is $95,478, mainly in gold and silver (Bonham, 1969, p. 81).

Uranium mineralization was discovered in the Pyramid district in 1954, large numbers of claims were staked, and small-scale production of uranium ore began in 1956 and continued on an

intermittent basis up to about 1969; total uranium production, however, has not been large (Bonham, 1969, p. 81).

Geologic Setting

Bonham (1969, p. 82-87) has described the geology and mineral deposits of the Pyramid district in great detail; most of the following information on geologic setting and ore deposits has been taken from Bonham's work.

Although pre-Tertiary plutonic and metamorphic rocks crop out a few miles outside the boundaries of the Pyramid district, the oldest rocks exposed in the district are ash-flow tuffs of the Tertiary Hartford Hill Rhyolite. The Hartford Hill Rhyolite is unconformably overlain by intermediate to mafic volcanic rocks and intercalated sedimentary rocks of middle to late Miocene age; both of these units are intruded by dacite plugs of the Kate Peak Formation.

Ore Deposits

Two basic types of mineralization have been prospected and mined within the Pyramid district: vein deposits of copper-lead-zinc-silver in the area of Perry Canyon, in the Pah Rah Range southeast of the Pyramid Highway; and uranium deposits in the area extending from the Pyramid Highway northwest to the vicinity of the Painted Hills and Tule Peak in the Virginia Mountains.

The copper-lead-zinc-silver ore deposits in the district occur in west- to northwest-trending veins cutting ash-flow tuffs of the Hartford Hill Rhyolite. Three zones of hypogene mineralization have been recognized in the district: pyrite, silver-bearing enargite, and barite occurring in a central mineral zone; galena, sphalerite, tetrahedrite, chalcopyrite, and bornite in an outer zone; and a fringe zone of least importance containing mainly galena and pyrite (Wallace, 1975, p. 85-87). These types of ore occur in the same vein system and are intergradational. Both of the main types of ore contain appreciable amounts of silver but gold is present in only minor amounts (Bonham, 1969, p. 82). The tuffs have been subjected to pervasive propylitic alteration throughout the district. Sericitic alteration envelopes 10-15 feet wide border the veins, and in the central enargite-pyrite zone, an advanced argillic assemblage, 4-8 feet wide, of quartz, kaolinite, diaspore, and topaz occurs between the veins and the sericitic envelopes (Wallace, 1975, p. 104-109). Outcropping portions of the veins are relatively thoroughly oxidized to depths of up to 100 feet below the present surface; the oxidized outcrops contain quartz, iron oxides, clay, minor amounts of barite, and oxide copper minerals.

Uranium mineralization in the Pyramid district occurs in high-angle, generally northeast-trending fault zones which are

commonly localized along diabase dikes intrusive into the Hartford Hill Rhyolite. Uranium minerals include autunite, sabugalite, uranospinite, phosphuranylite, and uraniferous opal, chalcedony, and hematite. Mineralization occurs principally in the ash-flow tuffs, but some also occurs in the diabase dikes (Bonham, 1969, p. 83).

RAMSEY DISTRICT

Location

The Ramsey district covers an area in the eastern Flowery Range along the Storey-Lyon County line. The central part of the district, including the site of the camp of Ramsey, is east of the county line in Lyon County. The district extends west of the line about 4 miles into Storey County to include the Gooseberry mine. The central Ramsey area is accessible from the south via roads leading northerly from U.S. Highway 50 near the small community of Stagecoach. The Gooseberry area is reached via a road leading south from the Truckee River canyon at Clark Station on Interstate Highway 80.

History

Gold was discovered in the hills near the present Ramsey mine early in 1906, starting a mining rush that promised to equal those at Fairview, Buckskin, and other contemporary camps (Mining and Scientific Press, 1906, p. 227). The town of Ramsey was founded, a 30-ton amalgamation mill was constructed, and, until operations ceased in 1910, about $80,000 in gold and silver was produced (Lincoln, 1923, p. 130). Operations at Ramsey by various companies between 1915 and 1940 are credited with a total production of $373,325 (Couch and Carpenter, 1943, p. 93); no production has been recorded from the Ramsey mines since that time.

Asamera Inc. currently controls most of the Ramsey district and has explored the area for deposits of bulk-minable gold-silver. Considerable drilling has been completed, and it is reported that they have defined reserves in the southern part of the district totaling about 500,000 tons averaging 0.04 ounces gold per ton.

The Gooseberry deposit, in the northern part of the district, was also discovered in 1906. The deposit was developed to some extent by various individuals until 1928 when it was acquired by J. D. Martin, of Fresno, California. The Martin family retained ownership of the mine until 1974. During this time, a 1000-foot shaft was sunk, thousands of feet of underground workings were driven, but no ore was mined from the deposit. Apco Minerals, Inc. purchased the Gooseberry Mine in

1974 and, following sampling and testing, constructed a 350 ton per day mill on the property and began production. In 1976, Westcoast Oil and Gas Corporation took over the mine and operated it until 1981 when they suspended mining operations. Asamera Inc. purchased the mine and surrounding properties in late 1982. In 1983, ore reserves at the property, in both proven and probable categories, totaled 607,000 tons at an average grade of 0.23 ounces of gold and 9.71 ounces of silver per ton (Asmera Inc., 1983).

Asamera Inc. is currently (1988) operating the Gooseberry mine and mill (Fleming and Jones, 1989).

Geologic Setting

With the exception of a small area of pre-Tertiary rocks southeast of the old camp of Ramsey, most of the Ramsey district is underlain by Tertiary andesitic and dacitic rocks of the Alta and Kate Peak formations along with minor rhyolite tuff of the Hartford Hill Rhyolite.

The pre-Tertiary rocks consist of Jurassic metasandstone and dolomitic limestone which have been intruded and altered by a body of Cretaceous granodiorite. These rocks crop out in a somewhat circular area southeast of Ramsey, at the edge of a basin on the range front. Jurassic metavolcanic rocks, shown by Rose (1969, plate 1) to occur in this same area, are now interpreted by Garside and Bonham (personal communication) to be altered parts of the Tertiary Kate Peak Formation.

The central portion of the Ramsey district, including the area between Ramsey site and the Ramsey Comstock mine, consists of altered Tertiary andesitic rocks which have been locally intruded by porphyritic rhyodacitic dikes. The altered rocks are surrounded by dacitic to rhyodacitic rocks which are, except for small localized areas, largely unaltered. To the northwest, outcrops surrounding the Gooseberry mine show similar relationships; rocks in an irregular pattern surrounding the mine are altered and are surrounded by unaltered rocks of similar composition. Rose (1969, p. 25 and plate 1) has mapped all of these rocks as Kate Peak Formation and described the altered outcrops as an altered variety of the Kate Peak. Recent work in the district, however, indicates that the altered rock at Ramsey is Alta Formation andesite which is overlain by largely unaltered Kate Peak Formation (Garside and Bonham, personal communication). To the northwest, at the Gooseberry mine, the altered rock is altered Kate Peak, however, and similar altered rocks to the southeast at Talapoosa are also altered Kate Peak Formation.

Alteration in the volcanic rocks appears to be related to faults of regional extent which pass through the district. A system of west-northwest-trending faults passes through the

center of the Ramsey district and can be projected to Gooseberry to the northwest and to Talapoosa to the southeast; all three mapped alteration patches are strung out along this structural trend, and the outcrop pattern of the alteration is elongate along the same trend. North-south-trending faults have been mapped in the canyon south of Gooseberry and the altered rock outcrops extend south along the north-south structures. In the Ramsey mine area, silicified, porphyritic intrusives of the Kate Peak Formation follow a northeast trend that is also marked by several fault structures. Again, the alteration outcrop pattern is elongated to the northeast and southwest following the structural grain.

Alteration in rocks of both the Alta and Kate Peak formations consists of propylitization, argillization, and local silicification and quartz veining. Tabular masses of alunitized rock occur near the Ramsey Comstock mine (Rose, 1969, p. 25).

Ore Deposits

Ore at the Ramsey-Comstock mine occurred in a wide fracture zone in silicified andesite. The zone trends east-west and dips to the north; some gold was present in a body of quartz along the main zone, but the main production was from zones of cross-fracturing within the vein. Near surface, gold was free and associated with small quantities of silver chloride; below the surface oxidation, gold was associated with pyrite. Other occurrences in the nearby area are reported to be similar; gold occurs associated with pyrite in fractures in silicified andesite. The contact zones of Kate Peak dikes and small intrusive masses into the Alta Formation are locally silicified, fractured, and mineralized with gold. In some areas, the silicified, mineralized zones are quite extensive; these areas are the focus of the current exploration activity in the district.

At the Gooseberry mine, ore occurs in a quartz-calcite vein that ranges from a few inches up to 10 or more feet in width; in underground workings, however, it averages about 7 feet in width. The vein strikes about N70°W, dips about 80° to the south, and has been traced by drilling and underground workings for a lateral distance of 3,000 feet and to a depth of 1,450 feet (Asmera Inc., 1983). The ore minerals are disseminated or form thin bands in the quartz-carbonate mass and consist of electrum, argentite, pyrite, stephanite, polybasite, and fine native gold and silver. Minor chalcopyite, sphalerite, and galena are also reported to be present. Open space filling and cockade textures are present in the vein in places (Oliveira, 1984. p. FT12-1). The wall rock at the Gooseberry mine is a pyritic propylitized dacite that is argillized at the surface. Secondary gypsum and jarosite are fairly common in the argillized areas as are minor quartz veins (Rose, 1969, p. 25).

RAWHIDE DISTRICT

Location

The Rawhide district, Mineral County, is restricted to the areas of the old camps of Regent and Rawhide on the west side of the southern Sand Springs. The district is about 3 miles west of the Nevada Scheelite mine camp and 3 miles south of the Churchill County line.

History

Mineral discoveries were made in the spring of 1906 at a site about 2 miles northwest of the later camp of Rawhide. The earlier discovery site was named Regent; an attempt was made to start a "boom" at Regent, but failed as no "jewelry" rock was found in the area (Shamberger, 1970, p.2). On Christmas Day, 1906, the first location was made in what is now the Rawhide district and by the early spring of 1907 major discoveries had been made at Rawhide. Between 1908 and the early 1920's, Rawhide produced about $1.5 million in gold and silver (Ross, 1961, p. 84). Mining continued at Rawhide on a small scale up to 1943, but the years of highest production were the first ten, 1908 through 1918. Small amounts of placer gold were recovered from the pediment slopes in the district; this activity was never large scale, but placer exploration in the district continued up into the 1960's. Several large dredging companies, including the Yuba Dredging Co., evaluated the placer potential of the district but deposits extensive enough to support a dredging operation were not found.

Interest in the Rawhide district was revived in the early 1970's when government restrictions on the gold price were lifted and the price rose. Homestake Mining Co. and Getty Mines, Ltd. entered the district and, between 1972 and 1975, conducted extensive surface exploration and drilling in the area of the old high-grade mines. In 1982, a subsidiary of the Kennecott Corp. acquired interest in the district and began a detailed exploration and development program. This work resulted in the definition of ore reserves totaling about 24 million tons grading 0.045 oz gold per ton and 0.47 oz silver per ton; an additional 15 million tons of leach ore have also been defined, and areas of the district remain to be evaluated. Production at the Rawhide Gold mine was scheduled to begin in 1989. In addition to Kennecott, other companies, including Newmont Exploration, have been active in the Rawhide district.

Geologic Setting

Triassic metasedimentary rocks crop out beyond on the margins of the Rawhide district where they are cut by masses of

Cretaceous granitic rock. The metasedimentary rocks are mainly medium to thick-bedded limestone and marble that exhibit various deformational structures (Schrader, 1947, p. 148). None of these rocks are seen at surface in the Rawhide district, but Schrader reported that limestone has been intersected in the deep workings of the Black Eagle mine, 2 miles west of Rawhide.

Tertiary volcanic rocks underlie nearly all of the Rawhide district and are host to gold-silver mineralization in the district. These rocks are rhyolitic pyroclastic rocks; pumice-rich tuff, and volcaniclastic rocks that have been cut by a series of rhyodacite porphyry plugs adjacent to a northwest-trending zone of rhyolite vents. The volcanic rocks have been interpreted as a rhyolitic flow-dome complex aligned along a northwest trend.

Ore Deposits

The silver-gold lode deposits mined during the early period of activity at Rawhide consisted of quartz veins up to 5 feet in width that occurred within much wider "lodes" of kaolinized wall rock; they occur largely as replacement veins and irregular bodies along zones of sheeting, fracturing, and faulting. Metallic mineralization within the veins consisted of cerargyrite, pyrite, native silver, native gold, and electrum in the oxidized zone; and argentite, proustite, pyargyrite, pyrite, gold, and electrum in the sulfide zone. Ore deposition was accompanied by silicification, kaolinization, and alunitization of the adjacent wall rock. The chief gangue minerals in the veins were adularia, alunite, jarosite, quartz, and calcite. The early day ore, which was largely mined from the oxidized zone, was mostly friable and free-milling; much of the gold was fine and light-weight. In areas within the district, fractures in the rhyolite are cemented by veinlets of alunite (Schrader, 1947, p. 161-164). There is ample evidence of subaqueous hot-spring deposition and hydrothermal brecciation and stockwork mineralization is present at many locations in the heart of the district.

The open-pit gold mining operation now in progress at Rawhide is exploiting large areas of mineralized vent breccia associated with a northwest-trending group of quartz latite porphyry intrusives (Plexus Resources Corp., 1986). The historic mines were developed on high-grade lenses within the larger areas of low-grade mineralization.

RED CANYON DISTRICT

Location

The Red Canyon district, Douglas County, is in the southeastern part of the Pine Nut Mountains in the vicinity of

Red Canyon. The district extends along the crest of the mountains between Bald Mountain on the south and Oreana Peak on the north, and from the mountain crest to the Lyon County line on the east. Access to most of this district is difficult and depends on very poor roads up steep canyons from the west. The Red Canyon road is presently (1989) passable and provides access to the Lucky Bill mine area.

History

The first ore mined in the Red Canyon district, then known as the Silver Lake district, was taken from the Longfellow mine and hauled to Virginia City for treatment in 1862; early production from the mine was about $50,000 from near-surface ores. The ore body at the Winters mine was discovered in 1872; a 5-stamp mill was built on the property and the mine produced about $8,000 up to 1881 (Hill, 1915, p. 52; Lincoln, 1923, p. 36). A custom mill was built in Mill Canyon to treat ores from the district and, in 1905, a small cyanide mill was erected at the Winters mine (Lincoln, 1923, p. 36).

The Longfellow, Winters, and other smaller properties in Mill and Red Canyons operated until about 1936; recorded production for the period 1881 through 1936 is $102,818 in gold, silver, and lead (Couch and Carpenter, 1943, p. 37). Small shipments of ore were made from the Red Canyon claims up until 1940, but the amount recovered is not known.

Exploration work has been conducted in the Red Canyon area intermittently since the period of last production in the 1940's. Some underground work was done on the Red Canyon claims, and considerable surface trenching and bulldozer work is in evidence at the Gold Bug and Lucky Bill mine areas. Most of this work was probably done in the 1960's and 1970's, although roads in the Red Canyon area have received some maintenance work in the past 10 years.

Geologic Setting

Rocks exposed in Red Canyon, and extending west across the crest of the mountains into the Mill Canyon area, consist of a section of metasedimentary and metavolcanic rocks of Triassic and Jurassic age. These rocks include Upper Triassic limestone and volcanic rocks of the Oreana Peak Formation; siltstone, sandstone, and volcanic conglomerate of the Jurassic-Triassic Gardnerville Formation; and volcanic and sedimentary rocks of Jurassic age that include the Veta Grande, Gold Bug, and Double Springs formations (Stewart and others, 1982).

The section of Mesozoic sedimentary and volcanic rocks has been intruded by dioritic and granitic rocks ranging from Jurassic to Cretaceous in age; the intrusive rocks form extensive

outcrops in the northern and southern parts of the district and underlie most of the area north of Oreana Peak and most of Bald Mountain and Eagle Mountain, south of Red Canyon. Skarn zones have formed in places along the contacts of the intrusive rocks and the older metasedimentary rocks.

Tertiary andesitic rocks, consisting of volcanic breccia and minor lava flows, cap Bald Mountain and cover a large area on the southern flanks of Bald Mountain and parts of Eagle Mountain to the east (Stewart and others, 1982).

Ore Deposits

Three general types of ore deposits have been prospected and mined within the Red Canyon district: quartz veins in granitic rocks, skarn deposits formed in metasedimentary rocks, and replacement deposits in calcareous metasedimentary rocks (Hill, 1915, p. 59; Lincoln, 1923, p. 36).

At the Longfellow mine, a west-northwest-trending, vertical quartz vein cutting quartz monzonite was the source of ore. The vein is stained with iron- and copper oxide minerals on outcrop, and contains pyrite and specular hematite along with minor galena and chalcopyrite. Most of the ore is reported to have been mined from the oxidized, near-surface portions of the vein (Overton, 1947, p. 30).

Skarn deposits were mined on the Red Canyon claims, located near the mouth of Red Canyon. Lenses of sulfide ore, containing pyrite, chalcopyrite, and pyrrhotite in a gangue of epidote, quartz and calcite, were mined from a northwest-striking contact zone between Triassic limestone and a dike of quartz monzonite porphyry (Hill, 1915, p. 61).

Replacement deposits were mined at the Winters mine, north of Oreana Peak, and at the Lucky Bill mine in the north fork of Red Canyon.

The Winters deposit is described by Hill (1915, p. 62) as a replacement of slightly calcareous argillites. The deposit has the form of a north-northeast-striking, steeply-dipping vein, or fairly continuous quartz stringer, 6 inches to 4 feet in width; it has been developed over a vertical distance of about 250 and along strike for about 1,000 feet. The vein-replacement zone contains galena, some stibnite, and occasional pyrite and chalcopyrite. Valuable metals recovered were gold and silver.

At the Lucky Bill mine, pockety deposits of argentiferous galena, quartz, and stibnite along with minor pyrite and chalcopyrite are reported to occur as replacement mineralization in quartzite (Hill, 1915, p. 62). During field examination of the property, ore containing sphalerite, galena, and pyrite was

found to occur, probably as a bedding replacement, in siltstone and carbonate rocks of the Triassic Gardnerville Formation.

Mineralization at other occurrences in the district, such as the Premier mine and the Gold Bug mine, are similar to those described. Quartz veins at the Premier cut granitic rocks and contain chalcopyrite and pyrite; exposures at the Gold Bug mine indicate that the deposit was a chalcopyrite-pyrite-bearing quartz vein hosted in metavolcanic rocks. The sulfide content of these veins appears to have been spotty, and the valuable metals present were only gold and silver.

RED MOUNTAIN DISTRICT

Location

The Red Mountain district is in Lyon County and overlaps into Storey County along the southeast flank of the Flowery Range about 12 miles east of Dayton. Mines and prospects in the district are located in the foothill and pediment area along the county line about 1 to 2 miles north of U.S. Highway 50.

History

Claims covering what is known as the Dayton iron deposit were staked in 1903 and 1905, and several prospect shafts and a long adit were driven in 1909-1910. There is no record of other activity in the Red Mountain district until the early 1940's when the U.S. Bureau of Mines examined and drilled the Dayton deposit as part of the War Minerals program. In 1951, the Dayton property was leased to Utah Construction Co., and the company proceeded to explore the property by trenching and diamond drilling (Moore, 1969, p. 24). Utah made plans to place the property into production, but market conditions for iron ore declined and the plans were abandoned before they could be placed into motion. Utah International maintained control of the property into the early 1980's, but its current status is not known.

Tungsten was discovered in the district in 1942 and, in 1943 and between 1954 and 1956, 337 units of WO_3 were produced from the Pearl Harbor mine (Stager and Tingley, 1988, p. 112-113).

There is no activity in the district at the present time, and land developments along Highway 50 are spreading from the valley north into the area of the iron deposit.

Geologic Setting

The oldest rocks in the region are Triassic to Jurassic metasedimentary and metavolcanic rocks which are cut by Mesozoic

diorite to quartz monzonite intrusives. Tertiary volcanic and sedimentary rocks cover a large area north and south of the Mesozoic outcrops and, together with Quaternary alluvium, make up about 95 percent of the formations cropping out in the district (Roylance, 1966, p. 129).

Ore Deposits

The major mineral occurrence in this district, the Dayton iron deposit, is a hematite-magnetite skarn deposit developed in a series of metamorphosed and folded sedimentary rocks near contacts with granitic rocks. Magnetite and pyrite selectively replaced limestone beds in the sedimentary sequence. Subsequent surface oxidation of the deposit reaches to a depth of more than 100 feet and has converted much of the magnetite to hematite and has leached pyrite from the surface zone (Moore, 1969, p. 24). The largest exposure of iron oxide, in the central part of the district, and a smaller iron oxide occurrence, 1,000 feet northwest, are connected at depth and together form the main Dayton iron deposit (Roylance, 1966, p. 130).

The Pearl Harbor tungsten is in the same general area and geologic setting as the Dayton iron deposit; a small pendant of hornfels occurs in a largely granitic outcrop and contains a thin layer of scheelite-bearing skarn. The skarn is about 3 feet wide, is exposed for about 100 feet along strike, and is cut off by granite at depth in shallow mine workings (Stager and Tingley, 1988, p. 112-113).

RISUE CANYON DISTRICT

Location

The Risue Canyon district is in the southern Wellington Hills, Douglas County, about 8 miles east of Topaz, California. The mines in the district are located in Risue Canyon and in tributary canyons to the southwest, between Risue Canyon and the California state line. Moore (1969, p. 30) includes Risue Canyon in the Wellington district.

History

Nothing is recorded regarding the history of this area. According to Stager and Tingley (1988, p. 49), the major property in the district, the Arrowhead mine, was first explored for gold in 1939; tungsten was discovered on the property in 1942, and 40 units of WO_3 were produced between 1951-1954. Two cars of lead-zinc ore are reported to have been shipped from the Lindsey and Barry prospect, located in the area of the Arrowhead mine, sometime prior to 1943 (U.S. Bureau of Mines, 1943).

There was no activity at the time the district was examined in July 1989.

Geologic Setting

The area southwest of Risue Canyon is underlain by Triassic and Jurassic metasedimentary rocks that have been intruded on the south by Cretaceous granodiorite. The metasedimentary rocks are exposed near the Arrowhead mine; the metavolcanic rock crop out lower in the canyon to the west. Risue Canyon follows the trace of a fault that separates Triassic and Jurassic rocks, on the southwest, from Tertiary sedimentary rocks, on the northeast (Moore, 1969).

Ore Deposits

From the descriptions of the properties in this district found in older reports and from field observations, it is not clear which of the several adjacent mines produced copper, gold, lead, and zinc from replacement deposits as described in Moore (1969, p. 30) and the U.S. Bureau of Mines field report (1943), and which produced tungsten as described in Stager and Tingley (1988, p. 49). It seem logical that all of the production has come from different sections of the same mineralized, sheared skarn. Succeeding operations have reported production under the name of the Arrowhead mine even though separate workings have been the source of the ore.

The principal rock exposed in the Arrowhead mine area is a meta-andesite. Limestone, generally highly metamorphosed, crops out to the south and east of the mine area. Zones in which the limestone has been almost completely epidotized occur south and east of the Arrowhead shaft. Light-colored dikes of quartz-monzonite, aplite, and pegmatite cut the meta-andesite and locally occur in it as sill-like intrusions. Both meta-andesite and the limestone generally dip steeply to the north (Stager and Tingley, 1988, p. 49).

Base metal sulfide replacement deposits at the Arrowhead mine are reported to have occurred in shear zones and fault breccia in limy metasedimentary rocks. Minerals present in this type of deposit consisted of oxidized lead and zinc minerals in a gangue of limonite, quartz, and calcite. Galena, chalcopyrite, and pyrite are also present, and scheelite was found to be present in trace amounts associated with the sulfide ore.

Tungsten mineralization at the Arrowhead mine occurs in meta-andesite along north-trending faults. Scheelite occurs with azurite, malachite, chalcopyrite, and pyrite, and molybdenite occurs in small quantities in garnetized limestones in the mine area (Stager and Tingley, 1988, p. 49).

Geochemistry

Samples collected in this district contained high silver associated with high lead and moderately high arsenic and antimony; copper and zinc values were low.

SAND PASS AREA

Location

The Sand Pass area, Washoe County, includes the north end of the Virginia Mountains and the Terraced Hills. Sand Pass, the division point between Smoke Creek Desert and Honey Lake Valley, is on the north end of the area; Zenobia, a point on the old Western Pacific line south of Astor Pass, is on the south end.

History

Bog lime deposits (calcium carbonate) were discovered in the Sand Pass area in 1919 (Overton, 1947, p. 63), and the first shipment was made in 1922 (Lincoln, 1923, p. 234). Large shipments were made from these deposits and from deposits south of Astor Pass in 1945 and 1946. Production was again recorded for the period 1952 through 1966 (Papke, 1969, p. 110).

Geologic Setting

The north end of the Virginia Mountains are underlain by intermediate to mafic volcanic rocks of the Miocene Pyramid Sequence. The Terraced Hills, to the north of Astor Pass, are composed of andesitic, basaltic, and pyroclastic flows of Upper Miocene and Pliocene age (Bonham, 1969, p. 28).

Ore Deposits

Only one metallic occurrence, the Adobe Springs prospect east of Zenobia in the Virginia Mountains, has been reported from this area; prospecting, probably for gold, was confined to a fault zone in silicified volcanic rocks.

Deposits of calcium carbonate (marl) occur near Zenobia and a number of halloysite clay deposits are present in the Terraced Hills north of Astor Pass (Papke, 1969, p. 108-112).

The calcium carbonate deposits are remnants of a single, flat-lying bed within a sequence of impure diatomite that was deposited in shallow waters of Pleistocene Lake Lahontan. The halloysite deposits occur in hydrothermally altered pyroclastic rocks which separate a series of andesitic and basaltic flows (Papke, 1969, p. 110).

SAND SPRINGS DISTRICT

Location

The Sand Springs mining district, Churchill County, is located in the Sand Springs Range about 30 miles east of Fallon. The major gold-silver mines in the district are located within a 1 mile-square area just south of U.S. Highway 50 at Summit Pass. The district includes several small tungsten mines on the both the northern and southern ends of the Sand Springs Range and small precious metals prospects on the west side of the range both north and south of Highway 50. Evaporite deposits of salt and borax covering about 1,600 acres of Fourmile and Eightmile Flats in the Salt Wells basin, west of the Sand Springs Range, are historically included within the Sand Springs district.

History

Mining in the district began in 1863 with the discovery of salt deposits on Fourmile Flat and salt production has been almost continuous to the present. According to Vanderburg (1940), considerable quantities of salt from these deposits were used in mills at Virginia City prior to 1870 for the reduction of silver ores from the Comstock mines. Later production has gone to dairies and ranching as well as highway use.

Borate minerals were discovered on Fourmile Flat in 1869 and two plants were put into operation to produce borax from the deposits. According to Paher (1970, p. 95) one plant produced 1/2 ton of borax per day while the second, smaller plant produced 5 tons per month. In 1872, the demand for borax fell and borax mining was halted permanently at this site.

Gold-silver veins of the Dan Tucker-Summit King mines at Summit Pass were first prospected in 1905 by C. W. Kinney, but very little work was done until 1912 when a 100 foot shaft was sunk. The first production came in 1919 when lessors shipped three car-loads of ore to the Selby smelter. A small amalgamation mill was built in 1927 and approximately 1,000 tons of gold-silver ore were treated. Work and minor production continued until 1939 when the Bralorne Mining Company acquired a lease on the best properties and organized the Summit King Mines, Ltd. Major development followed and a 50 ton per day cyanide plant was constructed at the site of the Dan Tucker mine and placed into operation early in 1940 (Dobson, 1939). Thereafter, the annual production steadily increased before operations were shut down during the war years (1942-1946). Operations resumed in 1948 and continued until 1951 when mining ceased because of a lack of ore. Total production of the Dan Tucker mine amounted to 20,895 ounces of gold and 1,262,655 ounces of silver with the major production occurring between 1940-1941 and 1948-1951

(Willden and Speed, 1974, p. 80-81). There has been no reported production since 1951 but the area continues to be actively prospected by small and large operators.

Several small tungsten deposits occur in the Sand Springs Range just south of Summit Pass. The most notable of these properties is the Red Top mine located near the crest of the range about 3 miles south of the highway. Between 1951 and 1956, the Red Top mine produced 691 units of WO3 from ore with an average grade of 0.05 to 1.0 % WO3. During this same period, tungsten operations on the nearby Stardust claims and Garnet and Sunflower properties are reported to have produced 291 units of WO3 (Stager and Tingley, 1988, p. 35). The largest tungsten mine in the Sand Springs district, the Red Ant, is located in the southwestern part or the Sand Springs Range, east of Fourmile Canyon. This property is credited with a production of 2,650 units of WO3 between 1941-47, 1954-56, 1961, and 1971-80 (Stager and Tingley, 1988, p. 35).

<u>Geologic Setting</u>

The Sand Springs district includes all of the Sand Springs Range north and south of U.S. Highway 50 at Summit Pass and extending south in the range to the Mineral County line. Most of the area is underlain by a granitic pluton that is bounded on the north and south by metamorphic rocks of Mesozoic age. Locally both the granite and metamorphic rocks are covered by rhyolites and andesites of Tertiary age. Numerous aplite and pegmatite dikes cut the granite, and andesite and rhyolite dikes cut the entire complex. In the area of the Summit King mines, metamorphic and intrusive rocks are locally overlain by Tertiary rhyolite and andesite which host the precious-metal vein systems. A wide west-northwest fault and braided-vein system cuts the central part of the range just south of Summit Pass. The south-dipping veins have a known strike length of five to six thousand feet that is traceable on the surface (Dobson, 1939).

<u>Ore Deposits</u>

The ore deposits of the Summit King mines were reported by Dobson (1939) to be associated with a complex fracture system striking west-northwest and dipping 35o to 55o to the south. The host rock is andesite with local inclusions of thin-bedded limestone, schist and basalt. In the upper levels, the ore was highly oxidized, soft, crumbly quartz in veins 2 to 8 feet wide. At depth, the veins were fine-grained to vuggy quartz and breccia with locally abundant pyrite and calcite. Gold occurred in a free state; silver occurred as chloride and argentite (acanthite?). The initial work by Bralorne Mining Co., Ltd. in 1939 led to development of substantial ore reserves from several new veins in the fracture system that were below the original workings. Below the 400-foot level, the veins were reported to

be barren of precious metals. The eastern and western ends of the vein system were reported to be faulted off and no attempts to find extensions to the veins are known to have been made. An eastern extension of the vein system into the alluvial-covered area of Frenchman Flat seems probable.

Contact metasomatic tungsten deposits occur in the metamorphic sequence, usually in limestone, at the north and south ends of the range along the contact with the granitic body. At these deposits, scheelite and minor amounts of powellite occur with garnet, calcite, quartz, cordierite, diopside, and other skarn minerals in small, irregular replacement bodies. Small, irregular quartz veins containing scheelite locally cut the replacement bodies and the surrounding rocks (Stager and Tingley, 1988, p. 35). Extensive prospecting and some mining has been done at these deposits, but their small size and low grade makes them difficult to mine profitably.

Some prospecting has occurred in the central part of the Sand Springs Range near the old Shoal Project site. Here, prospecting in the Chukar Canyon area and in roadless canyons to the north is directed at rhyolite and andesite dikes and at least one quartz vein system with in the central portion of the pluton. Some projects in this area have been staked and a little development work has been done. This activity appears to date from the mid-1970's. Further south, east of the Red Ant tungsten mine and south of Arterial Canyon, the Laxon Mining Co. has done limited development work on a small, copper-stained quartz vein in granite. A small leaching plant has been constructed at the mine site, but it was not in operation when the property was visited in July 1989.

Two areas on the west side of the Sand Spring range have recently been prospected for gold; prospecting on the T.M.R. claims just southwest of Summit Pass explored silicified breccia zones associated with a small rhyolite plug cutting ash-flow tuff. Further south, on the west side of the range near the Mineral County line, exploration work for gold has been done at the Apache prospect. At this property, small amounts of gold occur associated with jasperoid, quartz, and cinnabar in a shear zone in Triassic-Jurassic carbonate rocks. In 1989, Corona Gold, Inc. was reported to be drilling in the Apache prospect area.

Geochemistry

Geochemical associations in ore samples from the district show low base metals, as would be expected, from the skarn tungsten occurrences. Samples from the mercury occurrence on the west side of the range show anomalous antimony, arsenic and gold as well as high cobalt and nickel; these samples are also low in base metals.

SANTA FE DISTRICT

Location

The Santa Fe district, Mineral County, covers the southern Gabbs Valley Range, east of Luning, and the eastern Garfield Hills, west of Luning. East of Luning, the portion of the Gabbs Valley Range included in the Santa Fe district extends from Stewart Valley on the east to Soda Spring Valley on the West; the northern boundary of the district is formed by State Highway 361 at Calavada Summit (Santa Fe Pass), the southern boundary is the Mina-Bettles Well road which separates Santa Fe from the Pilot Mountains district to the south. West of Luning, the Santa Fe district includes properties around Black Dyke Mountain in the eastern Garfield Hills.

History

The Santa Fe property, immediately west of the present Santa Fe open pit mine, is said to have been discovered in 1879 and was in operation in 1883 (Hill, 1915, p. 163). Up to 1894, mining in the district was confined mainly to silver deposits but little was done on these occurrences after that time. From 1900 to 1929, intermittent work was done on copper-lead deposits which carried some silver; the period of greatest activity was during World War I when high copper prices enabled lessees to work the deposits at a profit; about $2 million in copper was produced during this time (Vanderburg, 1937, p. 69). Also, between 1912 and 1928, the copper smelter was in operation at Wabuska, Nevada and ores could be shipped to that location for treatment (Vanderburg, 1937, p. 66).

Tungsten was discovered in vein and skarn deposits in the southern part of the district in 1943 and the district produced a small quantity of tungsten ore during and after World War II (Stager and Tingley, 1988, p. 126-127). Additional production was made during the 1950's and the district is credited with a total of 5104 units of WO_3, through 1975 (Stager and Tingley, 1988, p. 126-129).

In the 1960's and early 1970's, many properties in this district were examined for their porphyry copper/molybdenum potential and drilling projects were conducted in several areas. Considerable work was done on the New Boston-Blue Ribbon area, west of Luning in the eastern Garfield Hills, but no large deposits were found.

The most recent mining activity in the district has been the development of a large, open-pit gold mine near the site of the old Santa Fe mine. Exploration for disseminated gold began in the district sometime in the late 1960's-early 1970's and, in

1974, a substantial tonnage of low-grade gold ore had been indicated by drilling. Continued exploration was successful in adding to the property reserves and, in 1984, reserves of 8 million tons of ore averaging 0.032 oz gold per ton and 0.26 oz silver per ton were announced. In 1989, this property was in production as a open-pit, heap-leach operation. Companies active in the Santa Fe district include Westley Exploration, Inc., Coca Mines, Inc., Wombat Mining Co., Corona Gold, Inc., and Phelps Dodge Corp.

Geologic Setting

Rocks in the southern Gabbs Valley Range consist of Jurassic and Triassic metasedimentary and metavolcanic rocks that have been intruded by large masses of Cretaceous granitic rocks. In the southern part of the district and along the northern margin of Sunrise Flat, intermediate volcanic rocks of Tertiary age overlie the older rocks (Ross, 1961). The oldest rocks present, limestone and clastic rocks of the Jurassic Dunlap Formation, crop out near the south end of Volcano Canyon and southwest of Volcano Peak, in New York Canyon. Triassic limestones, dolomites, and clastic rocks of the Luning Formation crop out in large areas along the western crest of the range west of Sunrise Flat and also along the east side of Sunrise Flat. The Jurassic and Triassic rock have been intruded by Cretaceous-Jurassic granitic rocks, mainly quartz monzonite with some granodiorite. Tertiary volcanic rocks, mainly andesite, quartz latite, and some rhyolite tuff cover areas north of Sunrise Flat as well as small areas in the main range. Several thrust faults are mapped within the Jurassic-Triassic rocks and, in places, these rocks show evidence of multiple thrusting and overturning (Ferguson and others, 1954). The Tertiary volcanic rocks are also complexly faulted and many contacts of these rocks with the older rocks are mapped as detachment faults by Ekren and Byers (1985).

The geologic setting in the eastern Garfield Hills is similar to that in the Gabbs Valley Range; Jurassic and Triassic rocks of the Luning Formation are cut by granitic rocks and overlain by Tertiary volcanic rocks. The granitic masses are much smaller in outcrop, however.

Throughout the Santa Fe district, large areas of skarn have formed in response to the Cretaceous granitic intrusions. The skarns and silicated zones in the carbonate rock are hosts for most of the mineralization in the district.

Ore Deposits

All of the historic mines in this district were typical contact-metamorphic (skarn) deposits carrying ores of copper and lead. At some distance from any known intrusives there are a few bodies of replacement ores which are usually copper bearing.

Veins are rather uncommon in the district although a few lead-silver-bearing veins are found in quartz monzonite in a least two areas (Hill, 1915, p. 164). The contact metamorphic deposits formed principally in rocks of the Luning Formation at the quartz monzonite contact, and the replacement ores principally followed thin-bedded limestones of the Gabbs Formation in the upper plate of the New York Canyon thrust. The ores mined consisted largely of copper carbonates, cerussite, copper pitch, and chalcocite; the primary ores, containing chalcopyrite, galena, and pyrite were apparently only mined at periods of high prices during World War I (Ferguson and others, 1954).

At the New Boston-Blue Ribbon prospect in the eastern Garfield Hills, a polymetallic skarn system with significant tungsten and molybdenum and lessor copper values has been extensively explored by drilling. Tungsten occurs as scheelite and molybdo-scheelite in quartz-garnet-idocrase veins. Molybdenum occurs as molybdenite without quartz in stockwork veinlets in limestone. Tungsten is found near the surface while molybdenum is found deeper in the system; a supergene chalcocite blanket is present in one area of the property (Frost, 1984, p. 25).

The low-grade gold-silver deposit at the new Santa Fe mine, in the northeastern part of the district, occurs as sheeted and pipe-like bodies found principally within a 50- to 1000-foot wide breccia zone in carbonate rocks of the Luning Formation. The breccia consists of finely to coarsely crystalline gray and brown limestone and marble that have been variably argillized, sericitized, dolomitized, and silicified. Primary mineralization at this property consisted of native gold, electrum, and probably argentum associated with marcasite, stibnite, cinnabar, and quartz; a later stage of mineralization introduced jasperoid, quartz, and pyrite along with additional precious metals; and a third stage of mineralization introduced late-stage quartz-pyrite, quartz-calcite, and quartz-barite veins. Trace amounts of pyrrhotite, chalcopyrite, and stibiconite are occasionally associated with the precious metals. Anomalous gold-silver values are continuously present at the surface along 4000 feet of strike of the main breccia zone, but economic, oxide, mineralization is confined to areas of highest fracture-fault strand density within the breccia zone (Fiannaca, 1987, p. 233).. Sulfide ore is known to exist in areas beneath oxidized outcrops; this material, due to considerations of grade and metallurgical characteristics, is not economic at the present time.

Geochemistry

Samples of ores collected in this district were almost uniformly very high in copper associated with high silver, arsenic, lead, antimony, and zinc. Bismuth values were very high in some samples, molybdenum and tungsten were anomalous in many samples, and boron and tin showed spotty, high values. These

associations are indicative of base-metal skarn and polymetallic replacement deposits, gold skarn deposits, as well as porphyry copper-molybdenum mineralization. Since these types of deposits can be spatially and genetically related, all types could be present in the district. Anomalous gold was present in the replacement ore.

SHADY RUN DISTRICT

Location

The Shady Run district, Churchill County, includes the area on the west side of the Stillwater Range from Mill Canyon on the south to Fondaway Canyon on the north.

History

Lincoln (1923, p. 9) mentions that the Shady Run district was "an early discovery that never got beyond the prospecting stage". A custom mill was built at the mouth of Shanghai Canyon in the 1880's, but it is reported to have operated for only a brief period. Vanderburg (1940, p. 43) says the last work in the district, up to the time of his report, was done at a gold prospect in Fondaway Canyon about 1916. Mercury and tungsten were subsequently found in the area of the gold deposit in Fondaway Canyon. Only small amounts of mercury were produced, but the property has produced 10,000 units of WO_3 between 1956 and 1978 (Stager and Tingley, 1988, p. 36). In the early 1980's, Fondaway Canyon attracted attention as a disseminated, or bulk-minable, gold prospect, and a succession of companies have been working in the district since that time. In 1986, a "geologic resource" of 4.4 million tons averaging 0.134 ounces gold per ton was reported to be present in the Fondaway Canyon deposit. In 1988, ore reserves of 400,000 tons of ore averaging 0.06 ounces gold per ton were announced (Bonham, 1989, p. 19). At the time this district was visited in July 1989, a heap-leach operation was active on the property. Companies reported to be active in the district in the past few years include Billiton Minerals USA, Inc., and Tenneco Minerals Company.

Geologic Setting

Rocks in the Shady Run district are largely of Triassic age and consist of slate and phyllite with some interbedded quartzite and limestone. Two Jurassic units, a quartzite, and a shale and limestone formation, crop out at the mouth of Fondaway Canyon; these units are intruded on the ridge north of Fondaway Canyon by a Cretaceous granitic pluton. Felsite dikes are common in some areas of Triassic rocks and dacite porphyry dikes that are usually deeply weathered or altered occur in some areas. The rocks are intricately folded and displaced by faults, with both

thrust and high-angle faults mapped in places (Willden and Speed, 1974, p. 82).

Ore Deposits

Quartz veins are common in the Triassic rocks and have been prospected for gold in several areas in the district. The veins are composed mostly of iron-oxide-stained quartz with some calcite. Limonitic boxworks, after pyrite and possibly arsenopyrite, can be seen in veins at the mouth of Shady Run Canyon.

In Fondaway Canyon, gold mineralization occurs in N71°E-striking, near-vertical faults which cut pyllite and quartzite. The fault zones are brecciated, silicified and range up to 10 feet wide. The sulfide ore contains pyrite, stibnite, arsenopyrite, and is typically carbonaceous.

Tungsten occurs in Fondaway Canyon as scheelite pods and single crystals in a coarsely crystalline marble. At one location, the scheelite-bearing marble is cut by quartz veins containing stibnite and valentitite, at another location close by, quartz veins containing cinnabar cut marble containing disseminated scheelite (Willden and Speed, 1974, p. 82). The grade of the ore mined from these deposits ranged from about .4 percent to over 6 percent WO_3, and has averaged about 1 percent WO_3 (Stager and Tingley, 1988, p. 37).

Iron ore (magnetite-hematite) occurs in Jurassic quartzite near its contact with a granitic pluton in a deposit at the range front north of Fondaway Canyon. A few truckloads of ore are reported to have been mined from this deposit and sold to operators in the Buena Vista Hills (Willden and Speed, 1974, p. 82).

SILVER STAR DISTRICT

Location

The Silver Star district is located in the eastern Excelsior Mountains of Mineral County, about 4 miles west of the old mill town of Sodaville on U.S. Highway 95. The district lies between Garfield Flat on the northwest and Soda Springs Valley (and Rhodes Salt Marsh) on the east and southeast. The mines of the district lie in the vicinity of Camp Douglas on the north slopes of Thunder Mountain, and north of Silver Dyke Canyon, on the south slopes of the mountain.

Hill (1915, p. 171-181), Lincoln (1923, p. 154-155), and Ross (1961, p. 84-85) included mines in the vicinity of the camp of Marietta in the Silver Star district. In this report, Marietta is considered to be a separate district and only mines

and prospects around Camp Douglas and Silver Dyke Canyon are included in the Silver Star district.

History

Gold-silver veins in the Camp Douglas area were discovered in 1893; other discoveries were made in 1894 and, in that year, a 5-stamp mill was built in the district to treat ores from these properties (Hill, 1915, p. 176). Precious metals production from the district between 1893 and 1901 is estimated at $300,000 (Lincoln, 1923, p. 154); district production of silver, gold, copper, and lead, through 1935, is recorded at $779,000 (Vanderburg, 1937, p. 72-73).

In 1915, tungsten was discovered to be present in veins at the old camp of Silver Dyke, south of Camp Douglas (Kerr, 1936, p.12). During World War I, ore from Silver Dyke was milled at a plant erected at Sodaville and, in 1926, milling facilities were constructed on the mine property. The property produced tungsten between 1916-1945, 1951-1958, and in 1972; total production is estimated to be between 50,000 and 65,000 units of WO_3 (Stager and Tingley, 1988, p. 130).

The most recent work in the Silver Star district has been exploration for precious metals. Although no activity was noted when the district was visited in May 1989, several major companies, including ASARCO, Noranda, and U.S. Borax, are reported to be active in various parts of the district.

Geologic Setting

The oldest rocks exposed in the Silver Star district are metasedimentary rocks of the Permian Mina Formation and metavolcanic and metasedimentary rocks of the Cretaceous Gold Range Formation. These rocks are in normal stratigraphic contact in one small area south of Silver Dyke Canyon; northeast of that area, the Permian rocks form the upper plate of a thrust sheet that overlies the Cretaceous formation (Garside, 1979). The Gold Range Formation is intruded by Cretaceous diorite and granite porphyry in an area along the southwest side of Thunder Mountain in upper Silver Dyke Canyon.

Large areas along the lower flanks of the district are covered by Tertiary volcanic rocks. These rocks are mainly hornblende andesites but some olivine basalt occurs in Douglas Canyon, north of Camp Douglas (Garside, 1979).

Ore Deposits

The following discussion of the mineral occurrences in the district has been taken largely from Garside (1979 and 1986) with only slight modification.

The gold-silver mineralization in the Camp Douglas area is associated with massive quartz veins in Mesozoic volcaniclastic and volcanic rocks. The main mineralized area, on the north flank of Thunder Mountain, is associated with a nearly 2-mile long, N85°W striking, 40°-70° southwest-dipping, branching quartz vein and numerous, steeply inclined, subparallel veins. Northerly trending, silicified and sericitized faults with free gold and spotty vein quartz cut Tertiary andesite in the northern part of the district. In the central part of the district, well-defined veins, 7 to 16 feet wide, consist of sugary white quartz with some comb structures and finely crystalline adularia. Free gold and pyrite are the main metallic minerals present in veins in the central part of the district, but some veins at the west end of the district contain minor amounts of pyrite, chalcopyrite, galena, and tetrahedrite.

At the eastern end of the Camp Douglas mining area, stibnite is present in a gold-bearing quartz vein in Tertiary volcanic rocks at the Kernick mine, and spotty anomalous gold values have been reported from a 2-3 mile square area of silicified, argillized, and alunitized volcanic rocks to the east of the Kernick mine. Pyrite-bearing hydrothermal breccias occur locally in this area.

The Silver Dyke tungsten mine is located near the center of the Silver Dyke vein, a 4-mile long quartz vein located near the head of Silver Dyke Canyon, south of Camp Douglas. The vein trends N60°W and dips 70°-90°, is up to 200 feet wide, and cuts Mesozoic metavolcanic and plutonic rocks and Tertiary volcanic rocks. The quartz vein material contains finely divided adularia, and some platy quartz pseudomorphic after calcite is present. The quartz adularia veins contain scheelite, albite, pyrite, chalcopyrite, and the gold-silver tellurides hessite and petzite.

The following comments concerning the relative ages of mineralization in the Camp Douglas-Silver Dyke area have been summarized from Garside (1986, p. 4-5).

Age determinations on adularia from quartz vein matter collected in the central part of the Camp Douglas district showed a K-Ar age of 15.4 m.y. Adularia in quartz vein material from the Silver Dyke mine gave a K-Ar age of 17.3 m.y., 2 m.y. older than the age of the Camp Douglas veins.

Separate from the main Silver Dyke veins, several narrow veins that contain quartz, pink potassium feldspar, pyrite, chalcopyrite, bornite, molybdenite, bismuthinite, and scheelite cut Mesozoic diorite both west of the Silver Dyke mine and in the lower levels of the mine. Potassium feldspar from vein material collected from the lower adit of the Silver Dyke mine gave a K-

Ar date of 75.9 m.y. Garside considers this age to be a minimum, and relates the veins to 90 m.y. granite porphyry in the area; Garside (1986, p. 5) states that tungsten and molybdenum in the Silver Dyke vein system may have been remobilized from concealed Mesozoic mineral deposits related to the pink potassium feldspar veins.

Geochemistry

Samples collected of ores from the Silver Star district displayed an epithermal association of silver and gold with only moderately, and spotty, anomalous arsenic, low base metals and antimony, traces of molybdenum, and slightly anomalous beryllium.

STATE LINE AREA

Location

The State Line area, Washoe County, covers the eastern flanks of State Line Peak in the Fort Sage Mountains. The area is south of Honey Lake Valley in the southwestern corner of the Kumiva Peak 30' by 60' quadrangle. The Stateline Peak district, as defined by Bonham (1969, p. 88) is located about 20 miles further to the south and is not included in this area.

History

The only prospecting in this area has been for iron and possibly uranium but there has been no recorded mineral production. Nothing is recorded of the mining history of this area.

Geologic Setting

State Line Peak is composed of Cretaceus granodiorite which has intruded Triassic and Jurassic metavolcanic rocks; the older rocks are present only as small pendants and lenses. Tertiary volcanic rocks skirt the lower flanks of the peak.

Ore Deposits

Small deposits of magnetite have been prospected at three localities along the east side of State Line Peak. The magnetite occurs in veins associated with faults which cut both granodiorite and metavolcanic rocks. Uranium minerals are reported from a location near the Black Hawk prospect, the northern-most of the iron localities (Garside, 1973, p. 106).

STATELINE PEAK AREA

Location

The Stateline Peak district, Washoe County, is located along the California state line north of the community of Border Town. The district includes Peterson Mountain and the surrounding low hills between Cold Spring Valley on the south and Red Rock Valley on the north.

History

According to Bonham (1969, p. 88), the oldest property in the district is the Antelope mine. Two claims at the mine were patented in 1887, and shipments of oxide copper ore were made from the property prior to 1900. A small production was made in the period 1939-1941 and the mine is reported to have been reopened in 1945 (Overton, 1947, p. 81), but no activity has been reported since that time.

In 1954, uranium mineralization was discovered on the west flank of Peterson Mountain, in California, and the district was extensively prospected for uranium. Shipments of uranium ore, in excess of 400 tons of material with a grade exceeding 0.2 percent U_3O_8, were made in 1955 and 1956, mainly from the Buckhorn claims in the California portion of the district (Bonham, 1969, p. 88). Mining activity in the district since about 1957 has been limited to assessment work and minor exploration.

Geologic Setting

The oldest rocks exposed in the district are Mesozoic metavolcanic units consisting of flows, tuffs, and tuffaceous sedimentary rocks. These rocks have been metamorphosed to hornfels and locally converted to schist along contacts with granitic intrusive rocks (Bonham, 1969, p. 89). Metavolcanic rocks crop out at the southern end of Peterson Mountain, but the bulk of the mountain consists of Cretaceous granodiorite which intrudes the metavolcanic rocks.

Tertiary volcanic rocks, consisting of rhyolitic ash-flow tuffs of the Hartford Hill Rhyolite and andesite flows and breccias of the Kate Peak Formation overlie the Mesozoic rocks along the west and southwest flanks of Peterson Mountain. Pliocene fluviatile and lacustrine deposits unconformably overlie all of the older units; these units crop out mainly to the west in California but outcrop areas are also found along the northern end of Peterson Mountain in Nevada (Bonham, 1969, p. 89 and plate 1).

Ore Deposits

Within the Stateline Peak district, copper mineralization occurs in veins in Mesozoic metavolcanic rocks and uranium mineralization occurs in ash-flow tuffs of the Hartford Hill Rhyolite and in the Pliocene sedimentary rocks.

At the major copper occurrence, the Antelope mine, oxide copper minerals, mainly chrysocolla and copper pitch, occur with quartz, black tourmaline, and epidote in a northwest-trending vein. Tourmaline is the most common gangue mineral and tourmaline veins and veinlets are cut in places by veinlets of epidote. Bonham (1969, p. 89) reports that the vein has an average width of 5 feet, and extends for about 4,000 feet along strike.

At the Buckhorn uranium mine, uranium mineralization occurs in two principal zones within rhyolite tuffs of the Tertiary Hartford Hill Rhyolite. Uranium minerals present are gummite, autunite, and uranophane which occur in small veinlets in a northwest-trending zone in the tuff (Bonham, 1969, p. 89). The California-Nevada state line extends through this property; most nearby uranium prospects, however, are in California. Secondary uranium minerals also are reported to occur within Pliocene lacustrine deposits that overlie the Hartford Hill Rhyolite; there has apparently been no production from any of these deposits (Bonham, 1969, p. 91).

STEAMBOAT SPRINGS DISTRICT

Location

The Steamboat Springs district, Washoe County, includes the northern tip of the Steamboat Hills in the immediate vicinity of Steamboat hot springs. Small prospects and altered areas along the eastern flank of the Carson Range, north of Steamboat Springs, do not fall within any recognized districts and are included in the Steamboat district for descriptive purposes.

History

Steamboat Hot Springs have a long history as a resort and health spa; they were first located in 1860 and were well developed by the time the Virginia and Truckee Railroad was constructed through the area in 1871. The Steamboat Hot Springs area is the best known and most extensively studied geothermal area in Nevada, and is one of the better known thermal areas of the world (Garside and Schilling, 1979, p. 66). The area has been extensively explored for its geothermal energy potential, and, in 1985, a geothermal electric generating facility was completed and placed into operation on the site (Garside, 1986, p. 27).

In 1875, deposits of sulfur and quicksilver were discovered about 3000 feet west of the active hot springs; a roasting furnace was erected on the property, and for several years, both sulfur and mercury were produced (Bailey and Phoenix, 1944, p. 191). Following this first activity, many other attempts to recover mercury have been made. The only one of these know to have been successful, however, was the Old Enterprise Mining Co. who, between 1968 and 1969, produced about 100 flasks of mercury. No mining activity has taken place in the district since that time.

Geologic Setting

The geology of the Steamboat Springs area is described in detail in publications by White and others (1964), and Bonham (1969, p. 87-88). The following material is taken mainly from Bonham's description.

The oldest rocks in the Steamboat Springs area are Triassic metasedimentary rocks which have been intruded by Cretaceous granodiorite. The granodiorite has been hydrothermally altered over most of the area, and near-surface bleaching is prevalent in and adjacent to the thermal areas.

To the north, andesite flows of the Kate Peak formation crop out along the east slopes of the Carson Range in the vicinity of the Wheeler prospect. The volcanic rocks display local alteration and bleaching, probably related to older hot spring activity along north-trending faults that generally parallel the range front.

Ore Deposits

The main area of economic interest in the Steamboat Springs district is centered around what is known as the "silica pit", the area where cinnabar and sulfur were first discovered in the district and where all subsequent mining operations have taken place. In this area, granodiorite, overlying Tertiary basalt, and alluvium have been moderately to strongly altered and bleached and now consist, within 100 feet of the surface, largely of quartz and cristobalite. Cinnabar and sulfur occur in these altered rocks as fracture fillings, disseminated in veinlets of opal and chalcedony, and as films and encrustations on joint and fracture surfaces. The mine area is within the active thermal area of the Steamboat Springs, and some steam and hydrogen sulfide rise through fractures and drill holes in the area. Other chalcedonic sinter deposits in the area have been found to contain cinnabar, stibnite, and trace amounts of gold and silver. The Steamboat area could contain significant deposits of mercury, but hot water and sulfurous gasses hamper deep prospecting in the district (Bonham, 1969, p. 88).

At the Wheeler Ranch prospect, cinnabar occurs as veinlets along north-trending faults in altered and bleached Kate Peak andesite. Discontinuous quartz veins also occur along the faults. Disseminated crystals of cinnabar occur in fractures in the quartz and in the argillically altered andesite wall rock along with pyrite, jarosite, gypsum, chalcedony, and possibly native mercury (Bonham, 1969, p. 94).

TABLE MOUNTAIN DISTRICT

Location

The Table Mountain district is located in the vicinity of Cottonwood Canyon in the Stillwater Range along the northern boundary of Churchill County. Table Mountain, for which the district is named, is located in Pershing County and many of the important mining areas are located north of the county line in Pershing County. Only the Churchill County portion of the district is discussed in this report.

History

Several large wagon-trains of rich copper sulfides and oxides are reported to have been hand-cobbed from the Boyer (Treasure Box) copper property in 1861 and shipped to Sacramento (Carpenter, 1911, p. 804). This is the earliest mining activity reported from the district. The Boyer property was still being explored and promoted in 1911, but no additional production has been reported from it.

Nickel and cobalt deposits were discovered in Cottonwood Canyon about 1882. The Nickel mine was worked from the time of its discovery until 1890 and from 1904 to 1907 when it closed permanently. The nearby Lovelock mine shipped some 500 tons of high-grade nickel-cobalt ore to Swansea, Wales, for treatment during the early period of mining, but it too has been idle for many years (Lincoln, 1923, p. 11).

The area around Table Mountain was been explored for porphyry type copper deposits in the 1960's and 1970's. Most of that work, however, is thought to have been mainly in the northern part of the district, in Pershing County. Little work, save annual assessment work by various claimholders, has been done in the Cottonwood Canyon portion of the district in recent years. The district was not active when examined in 1984, but ASARCO and Cordex Exploration Co. are reported to have drilled in the district in 1984 and 1985, and Santa Fe Pacific Mining Co. is reported to have drilled in the district in 1989.

Geologic Setting

The Table Mountain district is underlain principally by facies of the Jurassic Humboldt gabbroic complex (Humboldt lopolith) and by Tertiary volcanic rocks. Extrusive facies of the complex consist of interbedded basaltic lapilli tuffs, tuffaceous sandstones, and flows of basalt. The mafic volcanic rocks lie above and are invaded by intrusive facies of the lopolithic complex. In the northern part of the district, near the Pershing County line, Jurassic quartz arenite occurs between the extrusive and intrusive rocks of the gabbroic complex. The Jurassic arenite also underlies portions of the lopolith. The sequence of Jurassic rocks is thrust over Upper Triassic siltstone; the thrust is exposed on the southeastern portion of the district, along the south side of Cottonwood Canyon near its mouth. Tertiary units, including rhyolite tuff, rhyolitic welded tuffs, tuffaceous lacustrine sediments, and basalt, unconformably overlie the older rocks (Willden and Speed, 1974, p.82-82).

Ore Deposits

The Boyer copper deposit is reported to include several copper properties located at the head of a canyon to the south of Cottonwood Canyon. This group of properties includes the Treasure Box mine. The copper occurs as concentrations of copper sulfides in fine fractures and as amygdule fillings in Jurassic mafic metavolcanic rocks. The mineralization, consisting of chalcopyrite, chalcocite, bornite, tenorite, cuprite, malachite, and azurite, occurs in a bed of andesite about 100 feet thick which dips about 20° to the northwest (Vanderburg, 1940, p. 47; Willden and Speed, 1974, p. 83).

Deposits at the Nickel and Lovelock mines, near the old camp of Bolivia lower in Cottonwood Canyon, occur in and along a sheared contact between fine-grained gabbro and albitized Jurassic quartz arenite. Ore minerals are reported to be a mixture of arsenides and sulfarsenides of nickel with their alteration products of chloanthite and annabergite as well as tetrahedrite, erythrite (cobalt bloom), and azurite (Willden and Speed, 1974, p. 84).

TALAPOOSA DISTRICT

Location

The Talapoosa district covers a small area of the eastern Virginia Range in northern Lyon County. The district lies about 3 miles northwest of Silver Springs and is about 3 miles west of the Ramsey district.

History

According to Hill (1911, p. 103), ore deposits at Talapoosa were worked by prospectors from Virginia City as early as 1864. There is, however, no production recorded from that early period.

Couch and Carpenter (1943, p. 94) record production of gold, silver, and copper from the district in 1914 and 1940 totaling $12,401, and Moore (1969, p. 24) shows production of $304,151 from the district for the period 1939-1942. There is one major property in the district, and most of the recorded production has apparently resulted from operations on this property.

Recently, the Talapoosa has been the object of exploration focused on developing bulk-minable gold-silver deposits. Several major companies, including Superior Oil Company, Duval Corp., and Kennecott, have been active in the district. Kennecott, in 1981, outlined possible sulfide ore reserves in the area of the old mines totaling 9 million tons averaging 0.04 ounces per ton gold and 0.67 ounces per ton silver (Athena Gold Corp., 1986). The properties in the district are presently controlled by Athena Gold Corp. Announced pre-production reserves now stand at 2.5 million tons of 0.041 ounce per ton gold and 0.53 ounce per ton silver oxide ore, and 14.9 million tons 0.03 ounce per ton gold and 0.49 ounce per ton silver sulfide ore (Bonham, 1989, p. 24). Production was planned to commence in 1988 on these reserves, but the property remained idle in the summer of 1989.

Geologic Setting

Most of the rocks exposed in the central part of the Talapoosa district are dacitic and rhyodacitic flows and breccias of the Tertiary Kate Peak Formation. These rocks have been argillized, silicified, and propylitized over a large area and, on the geologic map of the quadrangle that includes Talapoosa, are shown as a separate map unit of "altered variety" of Kate Peak Formation (Rose, 1969, plate 1).

Small masses of intrusive dacite porphyry, also part of the Kate Peak Formation, crop out in the central district and to the north. Several ridges and high points surrounding the Talapoosa site are capped by Quaternary basalt of the Lousetown Formation.

Ore Deposits

Ore mined at Talapoosa consisted of gold-bearing, silicified dacite associated with quartz veins filling both east-west-trending faults and north-south cross fractures. The quartz is fine-grained, commonly drusy, and is locally accompanied by adularia. Much of the richest ore was found along low-dipping cross fractures. Silver was a minor constituent of most of the ore, but high-grade ore consisting of ruby silver in silicified

breccia was encountered in parts of the mine (Rose, 1969, p.25). Alteration and quartz veining seen in exploration cuts in the center of the district appear to generally parallel an east-west-striking dacitic dike that forms a prominent outcrop to the west of the mine workings.

Rose (1969, p. 25) mentions that although the known high-grade ore has been mined, apparently there is considerable low-grade material remaining in the mine. This low-grade material has apparently been better defined by drilling and is now classified as a large, low-grade ore reserve.

TUNGSTEN MOUNTAIN

Location

The Tungsten Mountain district, Churchill County, is located on the east slope of the northern Clan Alpine Mountains. The district extends from Rocky Canyon on the south to Stone Canyon on the north and is centered around Tungsten Mountain, a steep peak along the eastern mountain front. Vanderburg (1940, p. 15-16), and Willden and Speed (1974, p. 56-59) include mines around Tungsten Mountain in the Alpine district, which is centered around Cherry Creek about 10 miles to the south. Based on considerations including periods of activity and types of mineralization as well as spacial separation, these two areas are treated separately in this report. Alpine district is restricted to precious metals mines to the southwest and mines and prospects surrounding Tungsten Mountain are placed in the Tungsten Mountain district.

History

Apparently mining in this section of the Clan Alpine Mountains did not commence as early as in the nearby camps of Alpine or Bernice. The first record of mineral in the district was made in 1916 when the presence of molybdenum at Scott's Camp was mentioned by Horton (1916, p. 87). The Nevada Gold group, in Stone Canyon, was probably prospected in the early days, but the first mention of it was by Vanderburg in 1940 (p. 15) when he noted that it was in production. This property is credited with production of $3,498 in gold, silver, and lead between 1934 and 1965 (Willden and Speed, 1974, p. 58).

Tungsten was discovered 1951 at the Hilltop (Tungsten Mountain) mine. The mine operated in the early to mid-1950's and intermittently after that until 1978; recorded production between 1954 and 1978 is 3,981 units WO_3 (Stager and Tingley, 1988, p. 41).

The most recent activity in the district has been at the Scott prospect where underground exploration has been done within

the past 10 or so years, and at the Nevada Gold group where some small-scale work has been done within the past 1 or 2 years. Dome Exploration, Ltd. is reported to have drilled in this district in 1985.

Geologic Setting

The oldest rocks exposed in the Tungsten Mountain mining district are Upper Triassic metasedimentary rocks, mainly shale, sand, and siltstone with 30 to 50 percent intercalated limestone and dolomite. The Triassic rocks are intruded by a roughly circular mass of Cretaceous granodiorite; the granodiorite intrusion is centered at Tungsten Mountain and has caused skarn lenses to form in carbonate rocks in the intruded section. From the northeast side of Stone Canyon north, and in the higher parts of the range above upper Augusta Canyon, Tertiary andesite and basalt flows and rhyolitic ash-flow tuff units cover the older rocks.

Ore Deposits

At the Nevada Gold group, in Stone Canyon, workings follow a N-S to N10°E-striking, west-dipping quartz-calcite vein that generally follows the footwall of an aplitic dike. The dike cuts Triassic phyllite; the vein follows a gossany shear zone along the footwall of the dike. Minerals present include tetrahedrite, pyrite, stibnite, and possibly jamesonite in a gangue of quartz and calcite; some quartz displays the lamellar texture of quartz that has replaced calcite.

Tungsten mineralization at the Hilltop (Tungsten Mountain) mine consists of scheelite occurring in skarn lenses developed along a granodiorite-limestone contact. The orebodies are in skarn lenses a few inches to about 15 feet wide along bedding planes in a limestone stratum. The most abundant gangue mineral in the skarn is quartz, but garnet and epidote are also locally abundant. Pyrite is present and molybdenite occurs in small amounts, commonly in tiny fractures associated with pyrite and arsenoypyrite. Ore produced from the mine averaged about 1 percent WO_3, but in places contains as much as 4 percent WO_3 (Stager and Tingley, 1988, p. 41).

At the Scott prospect, on the south face of Tungsten Mountain, south of the Hilltop mine, several flat-lying, lenticular quartz veins follow joint surfaces in the Tungsten Mountain granodiorite mass. The veins, exposed in cuts along the face of the mountain and in declines driven into the mountain face, strike about N70°E and dip about 10° NW, are 1 to 2 feet thick, and are composed of banded milky-white quartz. Dark bands following the footwall of the veins are composed of tetrahedrite, pyrite, and molybdenite along with some chalcopyrite and sphalerite. Quartz along the footwall of the vein is vuggy and clusters of clear quartz crystals and some calcite crystals line the vugs.

VOLTAIRE DISTRICT

Location

The Voltaire district is situated on the east slope of the Carson Range west and southwest of Carson City. Most of the mines and prospects in the district lie in the drainage basins of Kings Canyon and Voltaire canyon immediately west of the advancing suburbs of Carson City.

History

Veins of quartz were discovered in the foothills of the Carson Range west of Carson City in 1859. By the fall of that year, two districts, Clear Creek and Eagle, were organized in this area Angel, 1881, p. 537). The exact location of these districts is not clear, but they appear to have overlapped in the vicinity of C Hill; Clear Creek was generally south of present-day U.S. Highway 50 an Eagle must have been in the Kings Canyon area, directly west of Carson City. In 1866, the Athens mine (possibly now known as the Premier) was being actively prospected (Angel, 1881, p.537). In 1880, the Voltaire mine was reported to be active, but no metal production has been recorded from it or any property in the district, (Couch and Carpenter, 1943). At least three of the old mine sites in the district, including the Premier mine, however, have small piles of what appear to be mill tailings. This indicates that some small production has come from the district. Graphite was produced from from the Carson Black Lead mine, near the old Voltaire mine, from about 1903 at least until 1947 (Overton, 1947, p. 43-44).

Geologic Setting

The district is entirely underlain by Triassic felsic schist and metavolcanic rocks that have been intruded by Cretaceous granodiorite related to the Sierra Nevada batholith complex. The Triassic rocks are generally northwest of C Hill, in the Kings Canyon basin, while outcrops from Voltaire Canyon south are mostly granodiorite.

Ore Deposits

The several small mines in the district worked narrow quartz veins in granodiorite or in metasedimentary rocks. At the Premier mine, copper-bearing sulfide minerals occur in massive quartz bodies and in replacement bodies in schist adjacent to the quartz bodies. Copper oxide minerals are present in the vein outcrops along with trace amounts of galena. Graphite at the Carson Black Lead mine was mined from a graphite lense or bed enclosed in metasedimentary schist and gneiss. The dumps from this mine also contain base-metal sulfide-bearing vein quartz.

Geochemistry

Ore samples taken in the district were high in gold and display a gold-base metals association. Copper, lead, zinc, and silver were generally high, some samples were very high in boron, antimony, and arsenic.

WASHINGTON DISTRICT

Location

The Washington district is located along the canyon of the East Walker River in the southeastern corner of Lyon County. The district extends from the vicinity of Wichman Canyon on the north to the Mineral County line on the east and the south.

Many roads along the East Walker River in this district are closed due to locked gates. Ranchers in the area have apparently leased fishing access rights to various sports clubs who have closed the roads to all but their members. This has made many of the mines and prospects inaccessible.

History

According to White (1869, p. 91), the Washington district, then within Esmeralda County, was organized in 1861. Little was done in the district, however, until February 1867 when the Eclipse and Warsaw mines were located; the Silver King mine was located in May of the same year. Two and a half tons of ore is reported to have been shipped from the Eclipse mine to a mill in Washoe County later in 1867. No other production is recorded until 1915 when a few tons of copper ore were shipped from an unidentified property in the district (Lincoln, 1923, p. 157). In the intervening years, however, county lines had been adjusted, and the district was in Mineral County.

In 1919, coal deposits were being prospected southeast of the East Walker River and, in 1920, drilling for oil was reported to have taken place in the same area. The coal deposits were determined to be of little value, and no work has been done on them since (Lincoln, 1923, p. 157).

In 1950, uranium minerals were found in several locations in the district, mainly on the west side of the river in the area of some of the historic silver-gold prospects (Moore, 1969, p. 29). No commercial deposits were found, however, and no development or mining was done.

Several companies, including Echo Bay Exploration, Hycroft Resources and Development, Inc., and Newmont Exploration filed work

plans for this district in 1988 and 1989, but, in the early summer of 1989 when this district was visited, no work was being done.

Geologic Setting

The canyon of the East Walker River is cut mostly in Cretaceous granitic rock. In the upper parts of the canyon, in the southwestern part of the district, the granitic rocks are covered by Tertiary andesitic volcanic rocks. Tertiary volcanic rocks also outcrop along the river in the northern part of the district. Rocks in the eastern part of the district, generally between the mouth of the narrow canyon of the East Walker and the Mineral County line to the east, consist mainly of Tertiary sedimentary rocks. These rocks are composed of lacustrine and fluvial sediments and include sandstone, mudstone, shale, marl, diatomite, limestone, and calcareous tufa (Moore, 1969). Most of the mines and prospects in the district are located in the outcrops of Cretaceous granitic rocks; the coal prospects, however, are located within the area of Tertiary sedimentary rocks.

Ore Deposits

Most of the metallic ore deposits in the district occur in quartz veins in porphyritic quartz monzonite which crops out in the river canyon and in the bluffs to the west. The exact location of the Eclipse and Warsaw mines is lost, but they may have been in the area northwest of the river described by Garside (1973, p. 74) as the West Willys group uranium prospect. Pods of pyrite, chalcopyrite, and galena along with limonite and secondary copper minerals occur in northeast-trending, steeply-dipping quartz veins in granite at this prospect.

At the Silver King mine, southeast of the river and about 2 miles southeast of the West Willys area, a stockwork system of quartz veins cutting granite has been exposed in an area honeycombed with old workings. The veins are iron-oxide-stained and contain fine grained pyrite, galena, and possibly silver sulfides.

The uranium occurrences in this area consist mainly of uraninite and various secondary uranium minerals that occur along with the silver-bearing sulfide minerals in quartz veins in granitic rocks. Some secondary uranium minerals occur in gouge zones along faults, and, at the Grant View Hot Spring, radon is suspected to occur in the water (Garside, 1973, p. 73-75). With the exception of the hot spring occurrence, all of the reported occurrences of uranium occur in veins and faults cutting the granitic rocks.

Coal at the Lewis coal mine, located in the basin east of the Silver King mine, occurs within the Miocene-Pliocene Coal Valley Formation. The main outcrop of coaly material can be traced for about 4000 feet along strike and is up to 6 feet thick; the seam

dips about 20° to 40° northwest. In outcrop, the seam has the appearance of lignitic shale with thin coaly layers and thin seams of gypsum; where encountered in deeper exploration workings, the quality is said to improve and the material consists of shale and lignitic coal layers up to 1 foot thick (Archbold, 1969, p. 41). The remote location and low quality of this coal have discouraged its development.

Geochemistry

Ore samples collected from one prospect in this area showed high gold and silver associated with moderately anomalous arsenic, high antimony, lead, and molybdenum.

WEDEKIND DISTRICT

Location

The Wedekind district, Washoe County, is located in the low hills immediately north of Sparks. The district, sometimes included in the Peavine district centered on Peavine Mountain north of Reno, includes the area lying between Wedekind Road-Pyramid Highway and the community of Sun Valley. The Wild Creek Golf Course now covers the western part of this district, and housing developments of the city of Sparks cover the southern part of the old district.

History

The first mining location in the Wedekind district was made in 1896 upon the Reno Star claim by George H. Wedekind (Morris, 1903, p. 275). The major production from the district was made between 1901-1903. Records, however, disagree on how much production was made. Official production of $107,000 in gold and silver is recorded by the U.S. Bureau of Mines (Bonham, 1969, p. 91); records supplied by local residents show about $230,000 in gold and silver between 1901-1903 (Overton, 1947, p. 84).

The original mill constructed at the Wedekind mine was designed to treat oxide ores found at and near surface. Sulfide ore, however, was encountered at shallow depths in the deposit and the mill was not successful in treating this ore. Hot water was encountered by the mining operations at the Wedekind mine in 1903, and the large flow of hot water, together with milling problems in treating the sulfide ores brought operations to a close. Attempts were made to operate the Wedekind mine in the 1920's and 1930's, but none were successful and the district has not been in production since that time.

Geologic Setting

The following descriptions of geologic setting and ore deposits are taken, with modifications, from Bonham (1969, p. 91-92).

The oldest rock exposed in the Wedekind district is granodiorite of probably Mesozoic age which crops out on the northeast part of the low ridge separating Sun Valley from Spanish Springs Valley. The granodiorite is overlain by andesite flows of the Alta Formation. Alta andesite is the principal rock unit exposed in the district and is the host rock for the silver, gold, lead, and zinc ore bodies that have been mined in the district. The andesite flows are generally highly altered and have undergone extensive near-surface leaching. Andesites below the zone of near-surface acid leaching are propylitized and speckled with abundant fine-grained pyrite.

The strongly propylitized andesites are within an east-west-trending band of altered rocks that extend westward into the Peavine district; the zone is over 1 mile wide in the Wedekind district. Dikes of granodiorite porphyry intrude the andesitic flow rocks; these rocks can be recognized in propylitized rocks beneath the zone of surface leaching but, at surface, are virtually undetectable.

Ore Deposits

The Wedekind ores consisted of silver haloids, free gold, cerussite, and anglesite in the oxide zone. Primary sulfides were reached at depths of 50 feet and consisted of galena, sphalerite, pyrite, and probably argentite and silver sulfosalts. The mineralization did not occur in well-defined veins, but rather in stockworks in northwest- and north-trending fracture zones. In the oxide zone, lenses of cerussite and anglesite "sand" rich in silver occurred. In the sulfide zone, lenses and stringers of sulfides occurred in fracture zones; andesite breccias in the fractures were reported to have been cemented by chalcedonic quartz and sulfides (Bonham, 1969, p. 92).

Hydrothermal breccias can be seen in silicified outcrops in the district as well as in rocks from underground workings found on various mine dumps. Alunite and selenite commonly occur in soft altered wall rock near the mine workings.

Although the deposits in the Wedekind district display may characteristics common to volcanic-hosted precious metals deposits found elsewhere in Nevada and the Great Basin, Hudson (1977, p. 87-92), feels that the hydrothermal system at Wedekind resembles the upper part of the major porphyry copper system explored at El Salvador, Chile. If this is the case, the Wedekind district has

potential for development of important copper mineralization at depth beneath the surface precious- metals-rich zone.

WELLINGTON DISTRICT

Location

The Wellington district, Douglas and Lyon Counties, includes the southern tip of the Pine Nut Mountains, north of the town of Wellington, and the northern portion of the Wellington Hills, south of Wellington. In the Pine Nut Mountains portion of the district, most of the mines and prospects are found on Taylor Hill and about 3 miles to the west, along the southern extension of South Camp Canyon. The mines in the Wellington Hills part of the district are spaced along about 2 miles of the eastern range front near Boulder Hill, about 4 miles southeast of Wellington.

All of this district was formerly in Douglas County, but adjustments to the county line left only the mines in the Pine Nut Range in Douglas County. The county line passes along the east flanks of Taylor Hill and some of the prospects on the lower parts of the hill, east of the line, are in Lyon County. To the south, the county line passes west of the Boulder Hill mine area and those mines too are in Lyon County.

History

The Yankee Girl mine on Taylor Hill is reported to have been worked in the 1880's and the ore was treated in arrastres in the West Walker River just west of Wellington (Hill, 1915, p. 52). Lincoln (1923, p. 37), who used the name Silver Glance for this district, mentions that a 2-stamp mill had formerly been on the South Camp property, high in South Camp Canyon and, in 1908 a 5-stamp mill was operating on the Poco Tiempo property (location now unknown). A 5-stamp mill was in operation on the Yankee Girl property in 1915. Total production from the Wellington (Silver Glance) district, 1884-1940, is recorded at $6,099 (Couch and Carpenter, 1943, p. 37). The only production recorded after 1940 has been 2 units of WO_3 from the High Jacks tungsten prospect in 1954 (Stager and Tingley, 1988, p. 48). The High Jacks prospect is in the area of the Imperial claims, at the mouth of South Camp Canyon.

In the southern part of the district, the Boulder Hill mine is reported to have produced some silver ore but the date of the production is not known (Moore, 1969, p. 30). Fluorite was found on this property in 1949; considerable exploration has been done but no fluorite has been produced (Papke, 1979, p. 28).

The latest exploration work in this district appears to have been on tungsten prospects in the area north of Wellington, and on

the Boulder Hill mine, south of Wellington; this work is several years old and no activity was noted in the district at the time it was visited in July 1989.

Geologic Setting

The oldest rocks exposed in the Wellington district are Triassic and Jurassic metasedimentary rocks which crop out as a narrow, fault-bounded sliver along the east side of the Wellington Hills. The crest of the Wellington Hills, northwest of the metasedimentary outcrops, consist of Tertiary andesitic rocks which are overlain on the northwest, in the vicinity of the canyon of the West Walker River, by Tertiary sedimentary rocks. All of the Wellington district within the southern Pine Nut Range is underlain by Cretaceous granitic rocks.

The mines and prospects in the district are confined to the Triassic and Jurassic rocks in the Wellington Hills and to the granitic rocks in the southern Pine Nut Range.

Ore Deposits

Ore zones at the Yankee Girl, Imperial claims, and South Camp mines in the southern Pine Nut Range consist of narrow quartz veins that follow shear zones in quartz monzonite. The veins strike north-south to northeast and are generally steeply-dipping; they contain quartz with minor pyrite and some galena. Outcrops are brecciated and stained with limonite and minor copper carbonate minerals; specular hematite is present locally (Hill, 1915, p, 60-61). Most of the veins range from 4 inches to 2 feet in width and the workings on them appear to be very shallow. Although the veins cut mainly granitic rocks, small areas of Triassic and Jurassic metasedimentary rocks occur near some of the workings. These older rocks, probably preserved as roof pendants in the granitic rocks, have been altered to skarn along their contacts. In an area on the old Imperial claims of Hill (1915, p. 60-61), scheelite has been mined from one of the small skarn occurrences.

At the Boulder Hill precious metal/fluorite occurrence on the east side of the Wellington Hills, fluorspar is present principally in two large siliceous masses that replaced dolomite adjacent to a northwest-trending, high-angle fault. The siliceous masses form bold, iron-oxide-stained outcrops that have been explored by numerous workings. The northernmost body is richer in fluorspar and has had the most exploration; the southernmost body is largely jasperoid with sections richer in fluorite near its boundary fault. Iron oxides and gossan, after sulfides, and a few small barite crystals occur in the jasperoid (Papke, 1979, p. 28-29). Mine dumps on this property contain brecciated vein quartz with fine-grained pyrite; this material may represent ore mined for precious metals during the period of work pre-dating fluorspar exploration.

Geochemistry

Ore samples collected in the area of the fluorite/jasperiod occurrence south of Wellington displayed spotty high silver values associated with anomalous arsenic, antimony, lead, zinc, and copper. Some bismuth is present. Samples collected in the northwestern part of the district, west of Wellington, were generally low in all metallic elements. Some samples contained moderate values in bismuth and contained trace tin, but did not display any precious or base metal values.

WESTGATE DISTRICT

Location

The Westgate district, Churchill County, is at the south end of the Clan Alpine Mountains in the hills on either side of U.S. Highway 50. Most of the workings in the district are located on the southwest end of the Clan Alpine Mountains and are accessible via unmaintained desert roads that lead into the canyons from Stingaree Valley.

History

Nothing is known of the mining history of this area. Lincoln (1923, p. 13) states that silver-lead-gold ore was produced in the district in 1915 but does not elaborate on the source or amount. A custom mill was erected on the point of the range north of the highway in 1939 and operated for a time on ores obtained from the nearby Wonder and Fairview districts (Vanderburg, 1940, p. 29). This milling operation left tailings and building foundations that give the false impression that Westgate was an important source of ore.

Road building and drilling has been done in the area north of the highway, east of the old custom mill area sometime within the last 10-15 years. The object of this work is not clear, however, and the district is inactive at the present time.

Geologic Setting

Rocks present in the district are limestone and limy shale of Late Triassic and Early Jurassic age, quartz arenite, volcanic sediments and basalt flows of probable Triassic or Jurassic age, Middle Jurassic limestone, aplitic rocks that intrude the Jurassic and Triassic rocks, and rhyolitic welded tuffs of Tertiary age (Willden and Speed,1974, p. 86). The metasedimentary rocks crop out along the western and in the northern parts of the district where they form the lower plate of a thrust sheet; Triassic and Jurassic metavolcanic rocks form the upper plate of the thrust. Large masses of aplite crop out mainly in the upper plate of the

thrust sheet, although in some areas, the aplite may have intruded along the thrust plane (Willden and Speed, 1974, p. 87). Large areas of marble have formed in the metasedimentary rock outcrops, probably in response to intrusion of the aplite.

Ore Deposits

Mineral deposits in the Westgate district are restricted to the Mesozoic rocks. Quartz veins occur in slates south of U.S. Highway 50 and in carbonate rocks in the north part of the district. Workings in the central part of the district, just north of the highway, explore shear zones in marble (Willden and Speed, 1974, p. 86)..

The workings immediately north of the highway are in intricately folded marble and consist of several adits and shafts. No metallic mineralization is visible in most of the workings. This area has been drilled in the past few years, but it is not clear why.

To the north, in the first major canyon on the west side of the range, irregular workings generally follow a thrust contact which has masses of aplitic intrusive along and cutting the thrust plane. The aplite is silicified and veined with quartz, and gossan zones occur in phyllitic limestone in the lower plate of the thrust zone. Traces of copper stain and some lead carbonate minerals occur locally in the gossan. It appears that no mining has taken place in this area since the 1930's.

WHISKY FLAT DISTRICT

Location

The Whisky Flat district, Mineral County, historically includes only a small part of the northern Excelsior Mountains along the southeast side of Whisky Flat. Mines in the district are concentrated on the northwest slope of a north-trending spur of the Excelsior Mountains that separates Whisky Flat on the west from Rattlesnake Flat on the east. In this report, one prospect near Anchorite Pass, about 10 miles to the southwest, is also included, as there are no other nearby districts in which to place it.

History

According to Hill (1915, p. 157), a group of claims was worked in this area by the Excelsior Mountain Copper Co. in 1882. The claims were first worked for copper, but they were rich in silver and carried a little gold. For a time, the ores were smelted on the property in a 400-pound mexican furnace. The Excelsior Mountain Copper Co. was active in 1907 and 1914 (Lincoln, 1923, p. 157), but no activity is reported after that time. In 1914,

tungsten was found to be present in a test lot of ore from the Qualey mine that was treated at the Pamlico mill, but there has been no production of tungsten ore reported from the district (Stager and Tingley, 1988, p. 132). Considerable exploration work has been done at the Qualey mine in the past 10-15 years, but the mine was idle at the time it was examined in September 1988 and May 1989. Combined Metals Reduction Co. was reported to have conducted drilling on a property a few miles northeast of the Qualey mine in 1989.

Geologic Setting

The area is underlain by Triassic metasedimentary rocks that are intruded and metamorphosed by Cretaceous granodiorite. The intruded rocks are metamorphosed to hornfels and skarn; dikes and apophyses of coarse-grained granodiorite cut both skarn and hornfels.

Ore Deposits

Copper ores in the district are described to occur in narrow zones parallel to and within a limestone-granodiorite contact zone. A narrow zone of rich silver ore associated with chalcocite occurred on the contact, a 140-foot-wide barren zone then occurred, then an 11-foot-wide zone of copper carbonate ore with chalcocite and pyrite, then 80 feet of sulfide ore, pyrite, and chalcopyrite said to run between 3.5 and 5.5 percent copper; this zone was followed by a 200-foot-wide belt within the contact zone said to average 1.5 percent copper throughout, together with a little silver (Hill, 1915, p. 157).

Scheelite in this deposit occurs in the same contact zone as the earlier-discovered copper ores, but is in a much more restricted area. The scheelite occurs along a fault zone that also contains chalcopyrite, pyrite, quartz, and altered hornfels. The zone is from 1 to 3 feet wide and the scheelite occurs in narrow seams localized mainly along the footwall of the zone (Stager and Tingley, 1988, p. 133).

Exploration at the Qualey property in the past 10-15 years consisted of trenching, bulldozing, and diamond drilling. Diamond drilling was probably done underground from the main haulage tunnel; considerable AX-size drill core is scattered around the mine dump and is piled in the ruined office trailer on the site.

WHITE CLOUD DISTRICT

Location

The White Cloud district, Churchill County, is in White Cloud Canyon on the western side of the Stillwater Range, about

45 miles northeast of Fallon. The district is centered around the Coppereid mine, located about a mile east of the narrow canyon mouth.

History

The district was discovered in 1868, but because of difficulties with the Indians, it was not organized until 1869. The first work in the district was done in 1871-1873 and, in 1893-1896, a small copper smelter was in operation at Coppereid. Considerable prospecting was done in the district between 1906-1912 (Vanderburg, 1940, p. 53) but no production resulted. Mining was quiet in the district until 1948 when small-scale production of copper resumed for a few years. Between 1948 and 1952, small yearly production was reported with a total value of $9,936 (Willden and Speed, 1974, p. 88). No work has been done in the district since the mid-1950's, and the area is currently (1989) inaccessible due to destruction of roads and trails by flash flooding. The mine area was not visited during our examination of the Stillwater area in the fall of 1989.

Geologic Setting

A granitic pluton of Cretaceous age, intruded by many dikes of granite porphyry and some dikes of diorite porphyry is exposed at the west front of the Stillwater Range on both sides of White Cloud Canyon. The pluton intrudes a series of Triassic limestone and calcareous shales which contain some thin gypsum beds. The limestones have been mapped as klippen of a thrust sheet. A large contact metamorphic aureole in the older rocks extends into the range at least locally for more than a thousand feet (Willden and Speed, 1974, p. 88). East of the mine area, in the upper parts of White Cloud Canyon and extending to the summit of the Stillwater Range, the older rocks are covered by a series of Tertiary rhyolite flows, tuffs, and ash-flow tuffs.

Ore Deposits

The ore deposits in White Cloud Canyon were found for the most part in contact-metamorphosed limestone and consisted of bodies of secondary copper minerals, in some areas, associated with large masses of specular hematite (Willden and Speed, 1974, p. 88). Along the contact zone, the minerals present are garnet, epidote, fluorite, quartz, pyrrhotite, pyrite, sphalerite, chalcopyrite, and hematite. Near the surface the primary mineral, chalcopyrite, has been altered to malachite and chrysocolla (Vanderburg, 1940, p. 53).

The main workings of the principal mine consisted of a long adit driven south from the south canyon wall at a location about 1 1/2 miles east of the canyon mouth. In 1930, this adit had been driven south for 3,050 feet and was 1,400 feet below outcrop

at its south end. The workings encountered considerable water with maximum flow said to be in excess of 1 million gallons per day. Sulfide ore containing values in lead, zinc, and silver were apparently encountered in the deep workings, but not in sufficient amounts of sufficient grade to allow profitable mining (Vanderburg, 1940, p. 53).

Most of this area was prospected for porphyry copper deposits in the 1950's and 1960's and exploration for bulk-minable gold deposits is now underway in the nearby canyons. New claim posts were in evidence in the White Cloud Canyon area, but no work was in progress in the fall of 1989.

WILD HORSE DISTRICT

Location

The Wild Horse mining district, Churchill County, is located in the low, rolling hills of the Augusta Mountains approximately 30 miles northwest of Austin. The district historically was located in Lander County but, following realignment of the Churchill County-Lander County line, the new county line passes through the east side of the district and most of the older workings now fall into Churchill County. For this report, the boundaries of the district have been expanded somewhat to include all the mining properties between the Churchill-Lander county line on the east and the Shoshone Creek drainage on the west. The district is accessible along good, but occasionally washed out, dirt roads that lead north from U.S. Highway 50 west of New Pass into the south end of the district.

All of the Churchill County portion of the Wild Horse district is within the Carson City BLM district. The small part of the district that remained in Lander County following realignment of the county line is within the Shoshone-Eureka BLM district and is not discussed in this report.

History

Originally, the Wild Horse district was formed when cinnabar was discovered by Bert McCoy and associates at the site of the McCoy mine (Dane and Ross, 1942, p. 263). This mine produced mercury in 1919 and intermittently thereafter until the early 1970's. The nearby Wild Horse deposit was discovered in 1939 and began mercury production in 1940; the Wild Horse deposit also was active into the early 1970's. Total production of mercury for the district is about 1,200 flasks, 1919 through 1970 (Stewart, McKee, and Stager, 1977, p. 97). The Black Devil manganese deposit, the only deposit in the district that remained in Lander County after the border realignment, was discovered in 1954 and shipped one carload of 47.6% manganese ore in 1958 (Stewart, McKee, and Stager, 1977, p. 98).

The Red Bird mercury property and the Mack gold property, both located northeast of Shoshone Creek canyon, are included in our expanded Wild Horse district. Little is known of the history of the Red Bird property although Willden and Speed (1974, p. 63) credit it with production of 49 flasks of mercury. The area surrounding the Red Bird mine has been staked within the past 2 to 3 years and some trenching has been done. This new work is probably for precious metals. Old mine workings in the area of the Mack claims appear to date from the 1920's but there are no records of any production. Recent exploration for gold in the area began in with the staking of the Mack claims in 1974 and road building and drilling appears to date from 1983.

In the spring of 1989, there was no activity on any of the properties in the district that were visited, although Rio Algom Exploration, Inc. was reported to be active on a property a few miles to the north of the Mack claim area.

Geologic Setting

Rocks cropping out in the northern Wild Horse district consist mainly of the Lower and Middle Triassic Augusta Sequence. The lower part of the sequence is chiefly sandstone, shale, and conglomerate, with the upper sequence being limestone, shale, and sandstone. The beds dip gently to steeply west except in the southern part of the district where they dip steeply south and southwest (Dane and Ross, 1942, p. 264). The beds appear to be an northward continuation of the west dipping homocline structure found in the New Pass Range (Stewart, McKee, and Stager, 1977, p. 57). Locally, the sedimentary rocks are unconformably overlain by Tertiary volcanics consisting of andesite, dacite, ash-flow tuffs, and tuffaceous lake sediments. The pre-Tertiary rocks of the northern part of the district are cut by high-angle faults with an average northward trend (Dana and Ross, 1942, p. 270).

Most of the southwestern part of the district, that area lying between the old Churchill County line on the northeast and Shoshone Creek canyon on the southwest, is covered by a sequence of rhyolite and rhyodacite flows and ash-flow tuffs. A small, fault-bounded window of Triassic rocks shows through volcanic cover in the area of the Mack claims in the central part of this volcanic terrain and the volcanic rocks overlap Triassic rocks to the southwest in the vicinity of the Red Bird mine. The contact between volcanic rocks and the Triassic sequence at the Red Bird mine is described by Willden and Speed (1974, p. 61) to be a steep fault. There is, however, what appears to be a basal vitrophyre exposed at this contact and, although faulted, the contact may not have much offset on it.

Ore Deposits

Deposits of mercury at the McCoy and Wild Horse mines occurred in fractures and indefinitely bounded bodies in silicified limestone and sandstone of Middle Triassic age. The deposits contain cinnabar, together with small amounts of mercuric chloride minerals, pyrite, and stibnite,in a quartz gangue with some calcite, barite, kaolin, and collophane (Dane and Ross, 1942, p. 272). Mining was done along gossany replacement zones in carbonate rocks associated with large lenses and pods of grey, black, and reddish-brown jasperoid.

At the Red Bird mine in the southern part of the district, cinnabar deposits occur in Upper Triassic rocks beneath a thrust sheet of slightly younger Triassic rocks; the cinnabar deposits are thought to be localized by fractures associated with the thrust fault (Willden and Speed, 1974, p. 61). Mercury mineralization also occurs in altered volcanic ash at the base of a thick rhyolitic tuff unit that lies east of the Triassic rock outcrops. The ash contains blocks and nodules of vitrophyre and rhyolite "bombs" up to 8-inches is diameter. These nodules and bombs have been opalized and have specks and coatings of cinnabar within them.

Old mine workings in the area of the present Mack claim block expose pyrite- and stibnite-bearing, milky-white quartz veins which occur along iron-oxide-stained shear zones in Triassic argillite. In the northern part of this area, a quartz-latite dike or plug cuts the argillite. At the contact, the latite is altered and laced with quartz stockwork veins and is flooded with hematite. Recent exploration work on this property appears to have been concentrated along this contact.

Geochemistry

Ore samples collected in this district generally reflect the types of mineralization in the two areas. Samples from the mercury mines in the north contained anomalous antimony and tungsten, but low base metals, low arsenic, and no detectable silver or gold. Samples from prospects in the southern part of the district showed very high arsenic associated with high antimony, slightly anomalous silver, and moderately high lead. Copper and zinc values were low, and tungsten values were erratic, but generally low.

WILSON DISTRICT

Location

The Wilson district includes all of the Pine Grove Hills and the Cambridge Hills in southern Lyon County. The district is

separated from the Yerington district to the north by Wilson Canyon on the West Walker River. The East Walker River, east of the Cambridge Hills, forms the east boundary of the district. Most of the mines of the district are located in Pine Grove and Rockland canyons on the east side of the Pine Grove Hills, and in the southern Cambridge Hills. There are, however, isolated mines on the west side and northern tip of the Pine Grove Hills which are included within the district.

The district is sometimes referred to as the Pine Grove district and the Cambridge and Rockland areas are also sometimes described as separate mining districts.

History

The first discoveries of gold in the district were made on the north side of Pine Grove Canyon in 1866; the first mine, and the district, were named Wilson after the discoverer. The Wheeler mine was found shortly afterward and, by 1869, there were several arastres and a 10-stamp mill in operation in the canyon (Hill, 1915, p. 135). Deposits in Rockland Canyon were also discovered in the early 1860's, and a 20-stamp mill was constructed at that location. Mines at Pine Grove are credited with production of $386,279 between 1870 and 1899; the Rockland mines are credited with $74,503 between 1870 and 1879, $263,071 between 1915 and 1917, and $43,037 between 1933 and 1934 (Moore, 1969, p. 28). The total recorded production of the district, through 1943, is listed at $778,734 (Couch and Carpenter, 1943, p. 92-93). The total includes production from Pine Grove, Rockland, and the Cambridge Hills. In addition to this amount, the Cowboy tungsten mine, on the west side of the district, produced about 600 units of WO_3 between 1941-1943 and 1952-1955 (Stager and Tingley, 1988, p. 113).

The Pine Grove area has been explored intermittently over the years since its last production period. Most interest has been for precious metals, but the area was examined for its molybdenum potential in the late 1960's and early 1970's. Parts of lower Pine Grove Canyon were explored for placer gold during this same general time. At the time this area was examined in June 1989, a small gold leaching facility was in operation at the Wilson mine. Materials to feed the operation were mainly old dumps from the Pine Grove mines, but some sulfide ores from underground were also being treated.

Geologic Setting

Both the Pine Grove Hills and the Cambridge Hills to the east are underlain by large masses of Cretaceous granodiorite which have been intruded locally by dikes and larger masses of granitic porphyry. Small outcrops of Triassic and Jurassic metasedimentary and metavolcanic rocks occur along the western

slope of the Pine Grove Hills and in one area in the southern Cambridge Hills. These rocks have been intruded by the Cretaceous granitic rocks and, in some areas, remain only as metamorphosed roof pendants in the intrusive rocks.

On the crest and the west slope of the Pine Grove Hills, Tertiary rhyolitic rocks lie directly on the granitic basement of the range. Much of this rock is rhyolitic lava flows, but tuffs are also abundant and much of the rhyolite is underlain by a layer of pumice tuff. On the northeastern edge of the Pine Grove Hills, south of Wilson Canyon, a thick succession of andesitic flows and breccias overlie the granitic rocks (Moore, 1969, p. 11, 13). Predominantly west-dipping Tertiary sedimentary strata overlie all of the older rocks on the northwestern and eastern flanks of the Pine Grove Hills. South of Wilson Canyon, these sedimentary rocks are probably more than 3,000 feet thick and are composed mainly of channeled stream deposits with some interbedded lacustrine material (Moore, 1969, p. 13).

Structurally, the Pine Grove Hills area form a west-tilted fault block; the northern and southern ends of the hills best show the west-tilted nature of the block, toward the center, the structure is more horst-like with a central granitic plateau flanked on the east and west by Tertiary sedimentary and volcanic rocks (Moore, 1969, p. 21). The contact of Tertiary volcanic rocks and granodiorite exposed along the east flank of the Pine Grove Hills is highly sheared, brecciated, and altered. The structures exposed there suggest that this contact may represent the margin of a large volcanic center, or caldera, located to the west.

<u>Ore Deposits</u>

Mineralization within the Wilson district occurs in two general settings: skarn, replacement, and vein mineralization in Triassic and Jurassic metasedimentary and metavolcanic rocks; and vein mineralization following shear zones in granitic rocks.

Tungsten occurs in skarn formed in Triassic and Jurassic metasedimentary rocks at the Cowboy mine and Beita claims on the west side of the Pine Grove Hills. At the Cowboy tungsten mine, scheelite occurs in skarn with garnet, quartz, epidote, pyroxene, and calcite. Sulfides are rare, but some molybdenite is present. The skarn occurs in a thin septum of metasedimentary rocks completely surrounded by granitic rocks; the skarn is cut by dikes of pegmatite and granitic rocks related to the main intrusive mass. Ore shoots at the mine were small, but averaged about 0.4 to 0.6 percent WO_3 in the bodies mined (Stager and Tingley, 1988, p. 113).

Replacement lead-zinc-silver ore occurs in Triassic and Jurassic metasedimentary rocks southeast of Smith, on the

northwest flank of the Pine Grove Hills. At the largest property in this area, the Jack Rabbit (Jack Pot) mine, vein and replacement ore occur along a northeast-striking, steeply-dipping shear zone cutting metavolcanic rocks. The ore consists of brecciated quartz containing galena, sphalerite, pyrite, and possible silver sulfides. At nearby properties, similar ore occurs in veins and shear zones cutting metasedimentary rock (limestone).

Vein occurrences of magnetite iron ore are reported to occur in Triassic and Jurassic metavolcanic rocks in the southern Cambridge Hills. According to Reeves and others (1958, p. 76) the veins range between 2 and 4 feet in width and can be traced in outcrop for more than 300 feet. In places, the veins are nearly pure magnetite, and in other places they contain abundant white quartz and red, jaspery hematite.

The largest an most important ore deposits in the Wilson district are precious-metals-bearing veins in granitic rocks that were exploited at the camps of Pine Grove, Rockland, and to a lesser extent, in the Cambridge Hills.

At Pine Grove, the ore bodies in the Wilson and Wheeler mines occurred in a zone of intense crushing and alteration immediately south of a northwest-striking fault cutting granodiorite. The crushed, altered zone is 150 to 160 feet wide and contained within it a considerable quantity of disseminated pyrite and a large number of interlacing quartz stringers carrying pyrite; lenses of quartz and pyrite 2- to 3-feet thick and extending along strike for 10 to 150 feet also occurred along the zone of shearing and alteration. Alteration in the shear zone and in the adjacent granodiorite consists of alteration of hornblende to biotite, some addition of epidote, and sericitization. The small streaks and lenses of quartz and sulfides constituted the ore in these mines. The sulfide is 95 percent pyrite with minor amounts of chalcopyrite, and contains gold and silver within it. The ores were somewhat oxidized to about 170 feet; gold in the oxidized ores was free and some very rich bodies were found at the surface (Hill, 1915, p. 137-138).

The occurrence at the Rockland, in the canyon to the south of Pine Grove is similar to those at Pine Grove. Gold-silver-bearing veins occur in northwest-striking shear zones in granodiorite. At Rockland, however, a granite porphyry dike forms the hanging wall of the mineralized structure (Hill, 1915, p. 140).

Small mines in the Cambridge Hills expose narrow, gold-bearing quartz veins in shear zones in granodiorite. At one of these properties, however, the veining extends into overlying Tertiary volcanic rocks.

Brecciated quartz veins outcropping on the northeast edge of the Pine Grove hills follow northeast- and east-west-striking shear zones in granodiorite. The veins contain galena, chalcopyrite, pyrite, and crystalline calcite. Workings in this area are not extensive, but a fairly large area in the granodiorite is sheeted and altered. The fracture surfaces are coated with carbonate and the carbonate surfaces are fluted with striations resembling the effects of gas-streaming.

WONDER DISTRICT

Location

The Wonder district, Churchill County, is located about 15 miles north of U. S. Highway 50 in the Louderback Mountains, a spur range that runs south from the southwestern part of the Clan Alpine Mountains. The best access to the district is by the road that leads east from the Dixie Valley road at a point a little over one mile north of Highway 50 and skirts the north end of Chalk Mountain. This road leads directly to the old townsite of Wonder. A second access is possible, from the north, by traveling east from Dixie Valley through Victor, over Geiger Gap and up Hercules Canyon to Wonder townsite. Routes into the district from the north and west via Red Top Gulch are no longer passable.

History

Vanderburg (1940, p. 54) summarized the early history of the camp as follows: "The first location in the Wonder district was made in April 1906 by T. J. Stroud on the Jackpot group of claims, and the Nevada Wonder mine was located shortly afterward by Murray Scott, William May, and others. The discovery of rich silver-gold ore started quite a stampede from Fairview that began in May of that same year, and, in a few weeks over 1,000 locations were made". According to Schrader (1947, p. 25), "Many of the more promising properties were soon taken over by mining companies or mining men of experience and means, with the result that, by 1908, the Nevada Wonder, Jack Pot, Spider and Wasp, Vulture, June Wonder, and Capitol Wonder companies were working in good ore. Of these, the Nevada Wonder had 5,000 sacks of ore ready for shipment, the Jack Pot 1,000, the Spider and Wasp 1,600, and the Vulture had shipped 16 tons. Fully 30 other properties were working on ore bodies or prospects assaying from $2 to $50 to the ton". Although the district was only 4 miles by 6 miles, it is in very mountainous terrain which led to the development of townsites adjacent to favorable workings. As a result, the townsites of Hercules, 2 miles north, Victor, 4 miles northwest, and Red Top, 3 miles west, were developed around the main camp of Wonder (Shamberger, 1973, p. 13). The life of such townsites depended on the mines and when it was found that the orebodies did not extend much below a hundred feet, mining operations were halted and the camps quickly died. The

financial panic of 1907, resulting from the San Francisco earthquake and fire of 1906, also had a serious impact on the district by drying up venture capital and slowing or halting the development of many properties.

With the construction of a 200-ton/day cyanide mill at the Nevada Wonder mine in 1911, the camp began a new era of mining. Thereafter, until the mine closed for the want of ore in December 1919, the history and the deep production of the camp was essentially that of the Nevada Wonder mine (Schrader, 1947, p.25).

Production from Wonder during the period 1911 to 1919 was over 69,000 ounces of gold and over 6,400,000 ounces of silver, most of which was credited to the Nevada Wonder mine. Over the life of the district, the average value of ore mined was $15 per ton. Small scale mining and heap-leaching has occurred intermittently at Wonder beginning in the early 1980's. Operators included F. W. Lewis, Belmont Resources, and International Recovery Services, Ltd.

Geologic Setting

According to Willden and Speed (1974, p. 88) the oldest rocks in the district are andesites and basalt flows of Oligocene age, that crop out along its western boundary, north and south of Red Top Gulch. Lying unconformably on the older volcanics is a 2,000 foot section of quartz-latite to rhyolite flows of probable late Oligocene to Miocene age that extends over most of the area. These rocks--known collectively as the Wonder rhyolite--are cut by dacite plugs and stocks, by rhyolite and andesite plugs and dikes, and by basalt dikes (Schrader, 1947, p. 36-39).

Schrader (1947, p. 28-30) described the volcanic section as being intensely fractured and highly altered. Of the several different fault systems, the most important, with exceptions, trends in a northwesterly direction; its fissures contain nearly all of the veins in the district and show slickensides, brecciation, and gouge associated with fault movement. The northwest-striking, northeast-dipping Nevada Wonder vein system is the main gold-silver producer in the district. The Gold King fault just west of Geiger Gap can be traced for several miles on the surface and contains the veins of the Gold King Group.

North-striking faults intermittently active to the present are credited with forming earthquake scarps within the district in 1906, 1911 and 1954. The same fault system helped form fault-controlled valleys, such as north-running Hercules Canyon.

Ore Deposits

Most of the following information on the ore deposits of the Wonder district was taken from Schrader (1947, pp. 40-42). Schrader reported the presence of over 50 veins in the district,

mostly in Wonder rhyolite, all highly siliceous, with quartz-adularia gangue common, and all with values in gold and silver. Almost all of the gold-silver production from the district came from Wonder rhyolite, principally from the Nevada Wonder vein system. According to the early investigations of the district, the Wonder vein system--or branches from it--continues northward for several miles and is present in the Jack Pot and Hercules Mines. These vein systems form prominent ledges due to their erosion resistant siliceous gangue, and are largely replacement deposits. Some of them are 2 to 3 miles in length and range in thickness from 1- to- 40 feet. The vein filling is generally soft and crushed by faulting and pressure, and therefore is easily mined and milled. Some of the veins are thought to extend to considerable depth but only the Nevada Wonder vein system was opened to 2,000 feet while the Jack Pot vein was examined to 1,000 feet.

The main gangue is quartz and adularia with iron- and manganese- oxides and occasional fluorite, calcite, or barite. The quartz-adularia is partly pseudomorphic after calcite and often is banded, sheared, brecciated, or crushed. Locally, the gouge is well mineralized and constituted good ore in some mines. Recoverable values were nearly all in gold and silver with minor copper and lead. The principal ore minerals are argentite, ceragyrite, and silver halogen salts. Gold occurs both free and native, in combination with the argentite. Schrader (1947, p. 43) considered the age of the mineralization to be late Miocene or Pliocene since all of the volcanics to that date were mineralized.

Adularia collected from the Gold King mine on the north end of the district in 1986, however, was dated at 23.0 +/- .7 ma, indicating that mineralization in that area is at least early Miocene (E. H. McKee, personal comm., 1987)

<u>Geochemistry</u>

Ore samples collected in the district display a geochemical association seen in many other epithermal districts; high silver and gold values occur associated with anomalous molybdenum and beryllium but with very low base metals. Some samples were anomalous in tin, but most were very low in both antimony and arsenic.

YERINGTON DISTRICT

<u>Location</u>

The Yerington district, Lyon County, includes all of the Singatse Range, Mason Valley to the east, and a small portion of the Wassuk Range lying east of Mason Valley. The district

extends from Wilson Canyon on the south end of the Singatse Range to the vicinity of Gallagher Pass on the north end of the range. To the east of Mason Valley, the district includes Pumpkin Hollow, parts of the Gray Hills, and the low foothills of the Wassuk Range that lie along both sides of the Lyon-Mineral County line; a small portion of Mineral County east of the county line is also included in the Yerington district. On the north end of Smith Valley, the western border of the district is the Lyon-Douglas County line; farther south, the district generally ends along the western margin of the Singatse Range.

History

Mining in the Yerington district dates back at least as far as 1865 when "bluestone" (copper sulfate) was mined from oxidized outcrops of the Ludwig copper deposit, on the west side of the Singatse Range, for use in reduction works on the Comstock lode (Knopf, 1918, p. 58). Between 1870 and 1875, considerable amounts of bluestone were also mined on the east side of the range from deposits at the Bluestone and Mason Valley mines.

It was not until sometime later that deposits in the Singatse Range began to be mined for copper metal; the first recorded production was between 1883 and 1891 when about $272,000 in copper was produced from the Douglas mine (Stoddard and Carpenter, 1950, p. 88). A smelter was built at Ludwig sometime during this early period, in 1900 a blast furnace was erected below the Bluestone mine, and a smelter was also built at Yerington Station; none of these operated for long periods nor made any notable output of copper (Knopf, 1918, p. 11).

In 1907, interest in the copper mines entered a revival period and several companies consolidated properties in the district and began exploration and development. A smelter was built at Thompson, north of Wabuska, and the Nevada Copper Belt Railroad was constructed from the smelter, around the eastern Singatse Range, through Wilson Canyon, and up the western side of the Range to Ludwig to service the copper mines. Although the smelter was not a financially successful venture for its backer, it did provide stimulation for the copper mines in the Yerington district. The smelter operated between 1912-1914, in 1917, 1919, and, finally, between 1926 and 1928; during this time over $15 million in copper was produced. Total district production of copper recorded between 1884 and 1940 is $17 million (Couch and Carpenter, 1943, p. 94).

Most of the early work in the Yerington district was concentrated on high-grade replacement lodes of copper ore formed in skarns. About 1917, interest was generated in outcrops of what appeared to be low-grade disseminated copper ore on the old Empire Nevada property at the edge of Mason Valley; deposits similar in appearance to this in Arizona and Utah were being

successfully developed as open-pit, "steam-shovel" mines. It was not until 1941, however, that The Anaconda Company acquired the property and began exploration. By 1950, after an extensive diamond drilling program, Anaconda had proven that reserves of 60 million tons of ore averaging between 0.9 and 0.95 percent copper were present within what was now known as the Yerington deposit. More than half of this tonnage was oxide ore. In 1953, production from oxide ore began and, in 1961, Anaconda began processing sulfide ore. The Yerington mine produced copper continuously until depressed world copper prices brought mining to a close in 1978. Production from this deposit totaled about 89 million tons of copper in 25 years of operation (Einaudi, 1982, p. 146).

In the 1960's and early 1970's, at the height of a world-wide boom in the copper industry, the Yerington district was the object of intense exploration activity by Anaconda and other major mining companies. At least 6 additional large copper deposits were discovered and remain in various stages of exploration and development, awaiting improvements in copper markets. Deposits explored by Anaconda: Ann Mason, MacArthur, Lyon, and Bear contain partially defined mineral resources totaling some 1.04 billion tons containing in the range of 0.4 percent copper per ton (The Anaconda Co., 1976, p. 66-68). Phelps Dodge Corporation defined a deposit, the Lagomarsino, under deep valley fill and the Walker River in the general vicinity of the Yerington airport. Work by U.S. Steel, Anaconda, Conoco, and others, in Pumpkin Hollow, east of Yerington, has defined a large area of copper-iron skarn mineralization which may contain several deposits of copper along with undefined amounts of iron. No information is available on grade or tonnage of the Lagomarsino or Pumpkin Hollow deposits.

At the present time, there are indications that the copper industry may be reappearing at Yerington; Anaconda is gone from the district but the Yerington mine has been acquired by an Arizona group, Arimetco, and a small-scale leach operation is planned. Higher-grade oxide dumps will be leached, and mining on a limited scale may resume in areas of the old open-pit (Paydirt, 1989. p. 17B). Activity is also reported at the MacArthur property where Timberline Resources is planning to begin leaching oxide reserves developed at that property. Other companies reported to be active in the Yerington district in 1989-90 include Coeur Explorations, Inc., Cyprus Metals Co., Western Gold and Uranium, Inc., and Kennecott.

Placer gold was discovered in deposits on the west side of the Singatse Range, northwest of Yerington, in 1931 (Vanderburg, 1936, p. 115). A short time later, placer deposits were discovered in the area of Lincoln Flat, on the west side of the Singatse Range; some of these deposits extend into the Buckskin district of Douglas County. Considerable effort, including

sinking of prospect shafts and construction of costly water systems, was expended on these properties in the 1930's but no production is recorded from them. The placer properties have been idle for many years but sand and gravel operations in northern Smith Valley, near the old Guild-Bovard placers, are reported to have recovered some placer gold as a by-product.

Gypsum has been mined from two localities within the Yerington district. Combined production from the two deposits is estimated at $1 million and both still retain some reserves of gypsum (Archbold, 1969, p. 32). The Ludwig property, at the site of the Ludwig copper mine, is the larger of the two deposits. Gypsum was mined from this deposit between 1911 and 1930. Initially, gypsum was shipped by rail, on the Nevada Copper Belt Railroad, to a plaster plant in Reno; later, plaster was produced at the property (Papke, 1987, p. 22). The second gypsum property, the Regan quarry, is located in Mineral County, on the west side of the Wassuk range along the eastern border of the Yerington district. Work on this deposit began about 1922 and gypsum was produced in the 1930's, 1940's, and briefly in 1983; tonnage produced is unknown, but Stoddard and Carpenter (1950, p. 94) estimate production of $193,000 through 1943. Neither property has been active for many years.

Geologic Setting

The summary of the geology of the Yerington district given herein has been abstracted from Proffett and Dilles (1984). Their excellent geologic map of the district should be consulted for details on specific areas of interest.

The Yerington district is underlain by early Mesozoic volcanic and sedimentary rocks intruded by two Middle Jurassic batholiths and an early Mesozoic pluton. Mesozoic rocks are unconformably overlain by Oligocene ignimbrites and Miocene andesites, sediments, and basalts. Major east-west-striking steep faults developed in Middle Jurassic time, and east-dipping normal faults and related westward tilting developed in late Cenozoic time. All pre-late Miocene rocks have been tilted steeply west; thus, the surface map of the district reveals what would have been nearly a cross-sectional view before tilting.

Mesozoic plutonic rocks compose 80 percent of the pre-Tertiary rocks exposed in the Yerington district. The plutons were emplaced to relatively shallow levels and shouldered aside the early Mesozoic volcanic and sedimentary rocks, which are now exposed as folded pendants within the batholiths. Three major plutons were intruded within the district; the Middle Jurassic Yerington batholith, the younger Middle Jurassic Shamrock batholith to the south, and the Strosnider Ranch pluton of probable Middle Jurassic age or older. Late Jurassic or Early Cretaceous rhyolite and andesite dikes which cut the older

batholiths are the final pre-Tertiary rocks to be emplaced in the district.

Following a long period of hiatus in the stratigraphic record, conglomerates and basalts were deposited in an early Tertiary river channel cut into the Mesozoic rocks and trending west and northwest through the district. These deposits were overlain by a thick sequence of Oligiocene quartz latite, dacite, and rhyolite ash-flow tuff sheets which are locally overlain by early Miocene basalt flows. Miocene andesite flows overlie the basalt and, in areas, the basalt is intruded by dikes and plugs of andesite and dacite.

Basin and Range faulting in the district, beginning about 19 m.y. ago, is expressed by tilting and east-west extension of the section by more than 100 percent along east-dipping, curved, concave-upward normal faults.

Granodiorite of the earliest intrusive phase of the Yerington batholith is commonly converted to garnet endoskarn at its contacts with Mesozoic carbonate rocks and the carbonates are converted to a garnet hornfels or skarnoid. Porphyry copper mineralization is thought to have formed contemporaneously with swarms of quartz monzonite porphyry dikes which cut a later, quartz monzonite phase of the batholith. Copper and magnetite skarns formed in adjacent early Mesozoic carbonate rocks are also thought to be related to these late porphyry dikes.

Ore Deposits

The major ore bodies of the Yerington district are contact-metamorphic replacement (skarn) copper and iron deposits formed in early Mesozoic carbonate rocks and porphyry copper deposits formed in the Jurassic plutonic rocks. Placer gold deposits found in the district are in the Tertiary river channel which traverses the district and in alluvium which overlies the channel gravels. Gypsum at the Ludwig and Regan deposits has been mined from a relatively thin gypsum-anhydrite sequence found within the Jurassic sedimentary section.

The following section on the skarn copper occurrences is abstracted from Knopf (1918, p. 31-66).

Copper skarn deposits were mined at the Ludwig, Mason Valley, Bluestone, Douglas Hill, Casting Copper, Western Nevada, McConnell, and other smaller mines on both the eastern and western sides of the Singatse Range. Most of these deposits are similar; the gangue is commonly skarn composed of variable amounts of pyroxene, garnet, and epidote with quartz and calcite. The primary ore mineral is chalcopyrite associated with pyrite; no other primary sulfides occur in the district. Secondary copper minerals, common in the original outcrops of many of the

mines, consisted of chalcanthite (the "bluestone" mined in Comstock days), brochantite, azurite, chrysocolla, chalcocite, copper pitch (melaconite), and sparse native copper. Covelite and cuprite also occur locally, and gypsum was common in the oxidized ores; selenite crystals up to 8 inches long were reported from the 600 level of the Ludwig mine. At many of the mines, the ore consists of clots and small lenses of chalcopyrite and pyrite occurring in brecciated masses of garnet rock which is in fault contact with adjacent unmineralized sedimentary or intrusive rocks; the faulting has been interpreted to pre-date formation of the ore bodies. In some deposits, two periods of garnet formation are noted; an early fine-grained garnet which has been brecciated and healed with later coarse-grained garnet associated with copper mineralization. At the Ludwig mine, the main deposit is a narrow lode which formed along a steep fault zone between limestone and skarn. Quartz and pyrite with associated copper minerals replaced limestone breccia along the fault. Intense supergene leaching of this deposit resulted in a quartzose gossan at the surface and rich tenorite ores up to 800 feet thick below the surface. The Ludwig is the only known major sulfide deposit in carbonate rocks in the Yerington district not directly associated with skarn minerals (Einaudi, 1982, p. 147-148).

Skarn iron occurrences in the Yerington occur in the Pumpkin Hollow area, east of Mason Valley. Small copper properties have been prospected in the hills in this part of the district, but the large skarn deposits do not outcrop. Found during airborne magnetic surveys of the area by U.S. Steel Corporation, these occurrences lie under about 1000 feet of Quaternary alluvium and Tertiary volcanic rocks. Both copper-rich and iron rich skarns occur in this area; they are related but occur in somewhat discrete bodies. Up to 8 separate skarn bodies have been outlined by drilling; some are very high-grade magnetite bodies, some are largely copper mineralization, and some of the copper deposits contain fairly high precious metals in areas within them. The deposits occur as lenses within magnesian skarns formed in Triassic-Jurassic carbonate rocks; endoskarns are present within adjacent intrusive rocks. The mineralizing plutonic rocks are part of the Jurassic-age Yerington batholith. Minerals present in the skarns range from massive sulfide skarns where the rock is 90 percent pyrrhotite-chalcopyrite-pyrite to massive magnetite skarn. The form of the occurrences appears to be lenses of massive magnetite skarn which are bordered by copper-rich sulfide masses that occur between the magnetite skarns and bleached marble (Smith, 1984).

At the Yerington porphyry copper deposit, primary sulfide minerals, consisting of pyrite and chalcopyrite, occur as minute grains in the groundmass of a quartz monzonite porphyry, in feldspar and quartz phenocrysts, and as narrow seams. Generally chalcopyrite is slightly more abundant than pyrite, small amounts

of bornite and covelite are present, and primary chalcocite has been detected present. Molybdenite is rare, and no appreciable gold or silver is present (Wilson, 1963, p. 33). In the zone of high-grade mineralization, the porphyry is intensely silicified, but elsewhere it is only moderately altered; wall rocks show albitic alteration (Wilson, 1963, p. 34). The ore body has been oxidized but most of the oxidized products were redeposited, for the most part, in-situ and significant secondary enrichment did not occur in the ore body. Oxide minerals consist mainly of chrysocolla with some cuprite, tenorite, and melaconite; malachite and azurite are present but not abundant. Between the oxide ore and the primary sulfide zone, a thin zone of chalcocite, cuprite, melaconite, native copper and chrysocolla occur superimposed on primary mineralization. The ore body has been tilted westward on the order of 50 to 60 degrees by post-mineral faulting and the "bottom" of the ore body would have represented the western end of a tabular body of porphyry (Wilson, 1963, p. 34).

Geochemistry

Samples of ores collected in this district restate the fact that Yerington is mainly a copper-rich district. High copper values were present in almost all samples. Most samples contained no zinc, and, with few exceptions, silver, arsenic, lead, and antimony values were low. Two samples from the Ludwig mine displayed anomalously high cobalt and nickel.

KNOWN MINERAL DEPOSITS

Known mineral deposits within the BLM Carson City district are shown in Table 1. This information has been collected from a variety of sources, including The Nevada Mineral Industry, 1989, Lowe and others, 1985, USBM MILS records, and USGS MRDS records. In many cases, more complete information on occurrences is given in other locations within this report (Appendix A and mining district folios); those sections, under the appropriate mining district headings, should be referred to for additional data.

KNOWN PROSPECTS, MINERAL OCCURRENCES, AND MINERALIZED AREAS

Known prospects, mineral occurrences, and mineralized areas are organized into three separate files to accompany this report. Due to the large number of listings, it is not practical to include any of these data within the body of the report; all of this type of information is found either in Appendix A of this report, or within the mining district folios which accompany the report as backup documentation.

TABLE 1. KNOWN MINERAL DEPOSITS

BLM Carson City District

Geothermal Resources (Power Plants)

Commodity	Mining district	Deposit	County	Size
geothermal resources	Soda Lake	Soda Lake power plant	Churchill	3.6 MW[6]
	Steamboat Springs	Steamboat power plant	Washoe	9.8 MW[6]
		Yankee/Caithness power plant	Washoe	13.2 MW[6]
	Stillwater	Stillwater power plant	Churchill	13.0 MW[6]
	Wabuska	Wabuska power plant	Lyon	1.8 MW[6]
	Dixie Valley	Oxbow power plant	Churchill	60 MW

Saline and Brine Resources

Commodity	Mining district	Deposit	County	Published reserves	Grade
salt	Sand Springs	Huck Salt mine	Churchill	--	[5]

Metallic Mineral Resources

Commodity	Mining district	Deposit	County	Published reserves	Grade
antimony	Bernice	Drumm mine	Churchill	--	[5]
		Hoyt mine	Churchill	--	[5]
		I.H.X. mine	Churchill	--	[5]
copper	Yerington	Ann Mason deposit	Lyon	449,056,000 tons	0.4%[1]
		Bear deposit	Lyon	453,592,000 tons	0.4%[1]
		MacArthur deposit	Lyon	44,000,000 tons	0.3%[4]
		Yerington mine (Copper Tek)	Lyon	115,122,000 tons	0.34%[1]
gold	Aurora	Aurora mine (Mineral Resources, Ltd.)	Mineral	1,200,000 tons	0.101 oz Au/ton[4]
		Aurora mine (Nevada Goldfields)	Mineral	347,000 tons	0.253 oz Au/ton[2]
	Buckskin	Bouvie Lou placer mine	Douglas	--	[5]
		Buckskin mine	Douglas	360,000 tons	0.24 oz Au/ton; 0.9% Cu/ton[1]
	Comstock	Flowery mine	Storey	500,000 tons	0.07 oz Au/ton; 0.86 oz Ag/ton[2]
		Gold Hill mine	Storey	--	[5]
	Dixie Valley	Dixie-Comstock mine	Churchill	4,037,000 tons	0.047 oz Au/ton[4]
	Garfield	Mindora deposit	Mineral	1,780,000 tons	0.036 oz Au/ton; 1.78 oz Ag/ton
	Lucky Boy	Borealis mine	Mineral	1,792,000 tons	0.046 oz Au/ton[2]
		East Ridge mine	Mineral	--	[5]
	Olinghouse	Green Hill mine	Washoe	--	[5]
	Rawhide	Denton-Rawhide mine	Mineral	59,300,000 tons	0.0274 oz Au/ton; 0.298 oz Ag/ton[4]
	Santa Fe	Santa Fe mine	Mineral	8,500,000 tons	0.037 oz Au/ton; 0.316 oz Ag/ton[2]
		Spot deposit	Mineral	--	[5]
	Shady Run	Fondaway Canyon mine	Churchill	400,000 tons	0.06 oz Au/ton[2]
	Talapoosa	Talapoosa deposit	Lyon	17,900 tons	0.054 oz Au/ton; 0.654 oz Ag/ton[4]
gold, silver	Como	Fire Angel deposit	Lyon	4,500,000 tons	0.033 oz Au equiv/ton[4]
iron ore	Calico Hills area	Calico Hills deposit	Mineral	--	[5]
	Red Mountain	Dayton deposit	Lyon	46,000,000 tons	42% Fe[1]
	Yerington	Pumpkin Hollow deposit	Lyon	250,000,000 tons	40% Fe[1]
molybdenum	Gardnerville	Pine Nut deposit	Douglas	82,000,000 tons	0.06% MoS_2[1]
silver	Bell Mountain	Bell Mountain deposit	Churchill	2,050,000 tons	1.27 oz Ag/ton; 0.04 oz Au/ton[2]
	Candelaria	Candelaria mine	Mineral	24,000,000 tons	1.27 oz Ag/ton[2]
	Ramsey	Gooseberry mine	Storey	6,270,000 tons	0.228 oz Au/ton[4]
	Wonder	Wonder mine	Churchill	11,000,000 tons	0.015 oz Au/ton; 1.75 oz Ag/ton
tungsten	Leonard	Nevada Scheelite mine	Mineral	--	[5]
	Pilot Mountains	Gunmetal-Desert Scheelite deposit	Mineral	8,000,000 tons	0.32% WO_3[3]

TABLE 1. KNOWN MINERAL DEPOSITS (continued)
BLM Carson City District

Commodity	Mining district	Deposit	County	Published reserves	Grade
Industrial Mineral Resources					
clay (montmorillonite)	unknown	Tuttle mine	Lyon	--	[5]
diatomite	Clark-Derby area	Clark mine	Storey	--	[5]
	unknown	Hazen pit	Lyon	--	[5]
		Section 8 mine	Churchill	--	[5]
gypsum	Mound House	Moundhouse Adams mine	Lyon	--	[5]
kyanite group aluminous minerals	Fitting	Dover and Green Talc mines	Mineral	14,000-27,000 tons	27% Al_2O_3 [1]
limestone	unknown	Limestone mine	Lyon	--	[5]

Sources of Information:
[1]Lowe and others, 1985
[2]Bonham, 1989
[3]Stager and Tingley, 1988
[4]Nevada Bureau of Mines and Geology NVMINRES database, 3/21/90
[5]Fleming and Jones, 1989
[6]Hess and Garside, 1989

Descriptions of mines, prospects, mineral occurrences, and mineralized areas which were examined in the field during the course of this project are compiled by mining district and are included in this report as Appendix A.

Information obtained from the USGS MRDS records, mostly collected early in the stages of the project as background data, has been given to the Carson City BLM office as part of the backup documentation. Records obtained from computer search of USGS master files are organized by: 1) 2^0 sheet, 2) county, 3) mining district, 4) property name. These data mainly describe metallic mineral properties.

Information on industrial rock and mineral localities, obtained from the USBM MILS records and collected at the request of the BLM Carson City office to supplement metallic occurrence information, is also supplied in the form of a computer printout. These records are sorted by Latitude and Longitude, and list property name, location, and commodity.

MINING CLAIMS, LEASES, AND MATERIAL SITES

A listing of mining claims, leases, and material sites within the BLM Carson City district has been supplied by the BLM Nevada State Office. This material has been examined and considered in the preparation of this report. The data supplied is too extensive to summarize within this report, but it is supplied as part of the general background information on mineral activity within the BLM Carson City district.

TABLE 2. EXPLORATION AND MINING ACTIVITY, 1981-1990
BLM Carson City District

Mining district	Year	Operator	Commodity	Activity
Alpine	1985	ASARCO, Inc.	gold, silver	drilling
	1985	Lovestedt, C.	gold, silver	mining
	1988	Molitor, F.	gold, silver	mining
	1988	Prouchnau Co.	gold, silver	drilling
Aurora	1985	Black Rock Exploration Co.	gold	drilling
	1988	Nevada Goldfields	gold	milling
	1988	Teck Resources	gold, silver	drilling
	1988	Von Haften, A.	gold	excavation
Bell	1984	Utah International Inc.	gold	drilling
	1985	Fury Exploration Ltd.	gold, silver	road building
	1987	Canyon Resources Corp.	gold	road building
	1987	Newmont Exploration Limited	gold, silver	drilling
	1988	Black Beauty Gold	gold	road building
	1988	Palosky Exploration Co.	gold, silver	drilling
	1988	Westley Exploration, Inc.	gold	road building
	1989	American Gold Resources	gold	excavation
	1989	Battle Mountain Exploration Co.	gold	drilling
	1989	Bond Gold Corp.	gold	drilling
	1989	Cominco American Resources, Inc.	gold	drilling
	1989	FMC	gold	drilling
	1989	Intermountain Resources Inc.	gold	drilling
	1989	Lewis, F. W.	gold	drilling
	1989	Lewis, F. W.	gold	road building
	1989	Steen, M.	gold	drilling
Bell Mountain	1981	Bell Mountain Mining Co.	gold, silver	road building
	1984	Dome Exploration Ltd.	gold, silver	drilling
	1984	Kennecott	gold, silver	road building
	1985	Degerstrom, N.	gold, silver	drilling
	1987	Pegasus Gold Corp.	gold, silver	drilling
	1988	Alhambra Mines, Inc.	gold, silver	drilling
	1988	Calloway, V.	gold, silver	road building
	1989	The Standard Magnesia Company	gold, silver	drilling
	1989	Wigley, J.	gold, silver	milling
Bernice	1985	Minerals Exploration and Development, Inc.	antimony	mining
Bovard	1982	Powder River Mining Co.	gold, silver	mining
	1985	Fischer Watt Mining Co. Inc.	gold	drilling
	1985	Placid Oil Co.	--	road building
	1986	Carrol Min. Exploration	--	drilling
	1986	Dome Exploration Ltd.	gold	drilling
	1987	PRC Inc.	gold, silver	milling
	1988	Etruscan Enterprises Ltd.	gold	drilling
	1988	FMC	gold	road building
	1988	Palosky Exploration Co.	gold, silver	drilling
	1989	Birch and Minchey	gold	drilling
	1989	Combined Metals Reduction Co.	--	excavation
Bruner	1985	Kennecott	gold, silver	drilling
	1986	Corn and Ahern	gold, silver	drilling
	1989	Marshall Earth Resources	gold, silver	drilling
Buckley	1982	Mako Mining Corp.	--	milling
	1989	Atlas Precious Metals, Inc.	gold	road building
	1989	Strato Geological Engineering Ltd.	gold	drilling
Buckskin	1987	Christenson, L.	gold, silver	excavation
	1989	Alta Gold Company	gold	drilling
Bunejug Mountains area	1986	Leising, J.	gold, silver	drilling
	1988	Alhambra Mines, Inc.	gold, silver	drilling
	1989	Miramar Energy Corp.	gold, silver	excavation
Candelaria	1982	Locke, G.	gold	road building
	1989	Miramar Energy Corp.	gold	excavation
	1989	Nerco Metals	silver	mining
	1990	Nevada Minerals Venture	gold, silver	mining
Carson City	1987	Gray, D.	gold, silver	excavation
Castle Peak	1984	Norwest Exploration Co.	pumice	mining
Chalk Mountain	1989	Hayden, R.	gold, silver	drilling
Churchill	1983	Economic Development Corp.	gold, silver	drilling
Clark-Derby area	1986	Eagle-Pitcher Industries	diatomite	mining

TABLE 2. EXPLORATION AND MINING ACTIVITY, 1981-1990 (continued)
BLM Carson City District

Mining district	Year	Operator	Commodity	Activity
Como	1981	Humphrey, L.	gold, silver	excavation
	1983	Jolcover, S.	gold, silver	mining
	1983	Wise Corp.	gold, silver	drilling
	1984	Knox, W.	gold, silver	excavation
	1987	Horizon Gold Shares	gold, silver	drilling
	1987	N-P K Nevada Mining Co.	gold, silver	drilling
	1988	Bowman, I.	gold, silver	excavation
	1988	Torexx Nevada Resources, Inc.	gold	road building
	1989	Amax Mineral Resources Co.	gold	drilling
	1989	U.S. Borax	gold	drilling
Comstock	1984	Carrington, R.	gold, silver	excavation
	1987	Alhambra Mines, Inc.	gold	mining
	1988	Curran and Antunovich	gold	excavation
	1988	Touchstone Resources Co.	gold	drilling
	1989	Gold Hill 88 Company	gold	mining
	1990	Raddco Industries	gold	mining
Dead Camel Mountains area	1983	Noranda Exploration	gold, silver	road building
	1987	Wood, J.	gold, silver	road building
	1988	Bristlecone Mining Co.	gold, silver	excavation
Delaware	1983	Bowers, J.	gold, silver	excavation
	1983	Forbusch, L	gold, silver	excavation
	1983	Parkhurst, D.	gold	excavation
	1984	Forbusch, L	gold, silver	excavation
	1985	La Teko Resources Ltd.	gold, silver	drilling
	1986	Bedrosian, C.	gold, silver	excavation
	1987	Gold Bond Mines Inc.	gold, silver	drilling
	1988	Robinson, R.	gold	excavation
	1989	Berryman, R.	gold	excavation
	1989	Billiton Minerals USA, Inc.	gold	drilling
	1989	Gold Hill 88 Company	gold	mining
	1989	Walker, D.	gold	excavation
Dixie Valley	1985	ASARCO, Inc.	gold, silver	drilling
	1988	Spencer, B.	gold, silver	drilling
Eagleville	1986	Donovan, H.	gold, silver	excavation
Eastgate	1984	Cordex Exploration Co.	gold, silver	excavation
	1985	JK Associates	gold, silver	drilling
	1986	Dome Exploration Ltd.	gold	drilling
	1986	East West Minerals, Inc.	zeolite	mining
	1987	Cipar, M.	gold	mining
	1987	Freeport McMoran Gold Co.	gold, silver	drilling
	1987	Lowell, D.	gold, silver	excavation
	1988	Hopkins, D.	gold, silver	drilling
	1988	Miller, D.	diatomite	mining
	1988	U.S. Borax	gold, silver	drilling
	1989	Cache Creek Exploration Co.	gold, silver	drilling
	1989	Miramar Energy Corp.	gold, silver	excavation
Eastside	1982	Rhames, D.	--	excavation
Eldorado	1989	Bedrosian, C	gold	mining
	1989	New Aurora Mining Inc.	gold	drilling
Fairview	1985	Friberg, R.	silver, gold	excavation
	1989	Johnson, D.	gold, silver	mining
Fernley	1988	Nevada Cement Co.	limestone	mining
Fitting	1982	Western Gold and Uranium, Inc.	gold	drilling
	1983	Norsemont Mining Co.	gold	drilling
	1986	Dome Exploration Ltd.	gold	drilling
	1987	Homestake Mining Co.	gold, silver	drilling
	1987	Kennecott	gold, silver	drilling
	1988	American Gold Resources	gold, silver	drilling
	1988	Coca Mines Inc.	gold	drilling
	1988	Combined Metals Reduction Co.	gold	road building
	1988	Palosky Exploration Co.	gold, silver	drilling
	1988	Placid Oil Co.	--	road building
	1988	Sierra Contact Minerals, Inc.	gold	excavation
	1988	Westley Exploration, Inc.	gold	road building
	1989	Allen and Archer	gold	excavation

TABLE 2. EXPLORATION AND MINING ACTIVITY, 1981-1990 (continued)
BLM Carson City District

Mining district	Year	Operator	Commodity	Activity
Fitting	1989	Bond Gold Corp.	gold	drilling
	1989	Corona Gold Inc.	gold	drilling
Gabbs Valley area	1982	Rhyne, S.	--	mining
	1984	Combined Metals Reduction Co.	gold	road building
	1984	Sunatco Development, Inc.	--	drilling
	1986	Gabbs Resources Ltd.	gold, silver	drilling
	1987	Rawhide Mines Inc.	gold, silver	mining
	1989	Adwest Gold, Inc.	gold	drilling
	1989	Ekren, E.	gold, silver	drilling
	1989	FMC	gold	drilling
	1989	Glamis Gold Inc.	gold	drilling
	1989	Hecla Mining Co.	gold, silver	drilling
	1989	Merlin Mining Co.	gold, silver	drilling
	1989	Texas Minerals and Metala, Inc.	gold, silver	drilling
Galena	1984	Chariton, N.	gold, silver	drilling
	1987	C.E.C. Engineering Ltd.	gold, silver	--
Gardnerville	1981	Veta Grande Companies, Inc.	silver	mining
	1985	Humboldt Mining Service	silver	excavation
	1989	Hurst, E.	gold	excavation
	1989	Jones, C.	gold	excavation
	1989	Shipley, B.	gold	mining
	1989	Treloar, R.	gold	excavation
Garfield	1981	Santos, J.	gold	drilling
	1988	Perkins, A.	gold	excavation
	1990	Eureka Resources, Inc.	gold, silver	drilling
	1990	Ingle, H.	gold	excavation
Gold Basin	1989	Kennecott	gold, silver	drilling
	1989	Pegasus Gold Corp.	gold, silver	drilling
Highway 95 area	1989	Manville Sales Corp.	diatomite	drilling
Hungry Valley area	1985	Mountain Gate Mining Co.	gold, silver	mining
I.X.L.	1981	Carrington, R.	--	road building
	1983	Texaco, Inc.	--	drilling
	1984	Pegasus Gold Corp.	gold, silver	drilling
	1984	Williams, J.	--	excavation
	1985	Rhames, D.	--	excavation
	1986	Amos, V.		road building
	1987	Fisk, R.	gold, silver	excavation
	1987	Mitts, C.	gold, silver	mining
	1989	ASARCO, Inc.	gold, silver	drilling
Jumbo	1985	Vorel, F.	gold, silver	excavation
	1988	Biaggini, H.	gold	excavation
	1989	McCewen, J.	gold, silver	excavation
	1989	Orequest	gold, silver	drilling
King	1984	Amselco Exploration, Inc.	silver	excavation
La Plata	1982	Crabtree, R.	--	mining
	1987	Jacobs, C.	gold	--
	1987	Renolds, J.	gold, silver	drilling
Lahontan Mountains area	1988	Western Clay Co.	clay	excavation
	1987	Freeport McMoran Gold Co.	gold, silver	drilling
Leonard	1981	Empire Minerals	gold, silver	milling
Lodi	1988	McKinny, L.	gold, silver	milling
Lucky Boy	1983	Cucura, V.	gold	drilling
	1984	Clavell, R.	gold	road building
	1988	Can Am Gold Corp.	gold	mining
	1989	Palosky Exploration Co.	gold	drilling
Marietta	1982	Phelps Dodge Corp.	gold	drilling
	1984	Hendrix, W.	gold	mining
	1984	Nassau Ltd.	gold	road building
	1987	Gibson Coal Co., Inc.	gold	road building
	1988	American Gold Resources	gold, silver	road building
	1988	ASARCO, Inc.	gold	road building
	1989	Au-Ag Inc.	gold	excavation, milling
	1989	Madera Mining Co.	gold	mining
	1989	Western Gold and Uranium, Inc.	--	drilling
Mound House	1990	Oliver Hills Mining Co., Inc.	gold	mining

TABLE 2. EXPLORATION AND MINING ACTIVITY, 1981-1990 (continued)
BLM Carson City District

Mining district	Year	Operator	Commodity	Activity
Mount Grant	1984	Williams, R.	--	road building
	1985	Williams, A.	gold	mining
	1987	Crook, K.	gold	excavation
	1989	Breckenridge, F.	gold	excavation
	1989	Freeport McMoran Gold Co.	gold	drilling
	1989	Millar Mining Co.	gold	excavation
	1989	Nylene, H.	gold	mining
Mount Moungomery	1988	Palosky Exploration Co.	gold, silver	drilling
Mountain House	1988	Dunbar, T.	gold	excavation
Mountain House	1989	Miller, D.	gold, silver	excavation
Mountain View	1987	Aurum Geological Consultants Inc.	gold, silver	excavation
	1987	Hardrock Mining Co. Inc.	gold	road building
	1988	Palosky Exploration Co.	gold, silver	drilling
	1989	Kunde, R.	gold	road building
	1989	Smith Consulting Inc.	gold	excavation
	1989	Zane and Kunde	gold	road building
Olinghouse	1981	Pearl, M.	gold	mining
	1984	Canaustra Resources, Inc.	gold	mining
	1985	Cipponeri, V.	gold	mining
	1986	Norris, T.	gold, silver	excavation
	1987	Billiton Minerals USA, Inc.	gold, silver	drilling
	1987	Keane, P.	gold	mining
	1989	Bristlecone Mining Co.	gold, silver	drilling
	1989	New Gold Inc.	gold	mining
Pamlico	1982	Hilberg, S.	gold	mining
	1984	Howe and Brannon	gold	excavation
	1988	American Gold Resources	gold	drilling
	1988	American Gold Resources	gold	road building
	1988	Apollo Explorations, Inc.	gold	drilling
	1988	Westley Exploration, Inc.	gold, silver	drilling
	1989	Ben Hardy	gold	excavation
	1989	Carlstrom, D.	gold	milling
	1990	Ingle, H	gold	mining
	1990	Schultz, D.	copper	mining
Peavine	1986	Forrester, R.	gold, silver	excavation
	1986	Jackson, B.	gold, silver	drilling
Pilot Mountains	1981	Umetco Minerals Corp.	tungsten	drilling
	1983	Hunt Energy Corp.	gold	road building
	1984	Rawhide Mines Inc.	gold	mining
	1988	Loving, E.	gold	excavation
	1989	FMC	gold	drilling
Pyramid	1982	U.S. Mining and Exploration Co. Inc.	uranium	road builing
	1988	Taylor, J.	gold, silver	excavation
Quartz Mountain	1989	Aintree Resources, Ltd.	gold, silver	drilling
	1989	Merlin Mining Co.	gold, silver	drilling
Ragtown Pass area	1989	Santa Fe Mining Co.	--	drilling
Rainbow Mountain	1982	Link, J.	barite	mining
Ramsey	1989	Asamera Minerals, Inc.	gold, silver	mining
Rawhide	1986	Kennecott	gold, silver	drilling
	1986	Kiewit Mining Group, Inc.	gold, silver	mining
	1988	Coca Mines Inc.	gold	drilling
	1989	Newmont Exploration Limited	gold, silver	drilling
	1990	Denton-Rawhide mine	gold, silver	mining
Red Canyon	1984	Morgan, K.	gold, silver	excavation
	1987	Landsat Minerals Exploration Co.	gold, silver	excavation
	1990	Four Clover mine	gem stone	excavation
Red Mountain	1987	Miller and Associates	gold, silver	road building
Russell Pass area	1989	Manville Sales Corp.	diatomite	drilling
Sand Pass area	1984	Joshi, V.	limestone	mining
Sand Springs	1983	Wacker, W.	gold	mining
	1984	Duval Corp.	gold, silver	drilling
	1988	Laxon, G.	gold, silver	excavation
	1989	Corona Gold Inc.	gold, silver	drilling
	1990	Marshall, H.	gold, silver	drilling
Santa Fe	1984	Lebret, J.	gold	road building

TABLE 2. EXPLORATION AND MINING ACTIVITY, 1981-1990 (continued)
BLM Carson City District

Mining district	Year	Operator	Commodity	Activity
Santa Fe	1987	Degerstrom, N.	gold	milling
	1987	Richard, M.	gold, silver	milling
	1988	Swanson, M.	limstone	excavation
	1988	Westley Exploration, Inc.	gold	road building
	1989	Birch and Minchey	gold	drilling
	1989	Camenzind, L.	gold	drilling
	1989	Coca Mines Inc.	gold	drilling
	1989	Loving, E.	gold	excavation
	1989	Wombat Mining Inc.	gold	drilling
	1990	Corona Gold Inc.	gold	mining
	1990	Phelps Dodge Corp.	gold	drilling
Shady Run	1982	Occidental Petroleum Co.	gold	Road building
Shady Run	1983	Tundra Gold Mines Ltd.	gold	drilling
	1984	Jones Mining Co.	gold, silver	mining
	1986	Janess, W.	gold, silver	mining
	1988	Billiton Minerals USA, Inc.	gold, silver	drilling
	1990	Tenneco Minerals Company	gold, silver	drilling
Silver City	1983	Gold Bug Joint Venture	gold	mining
	1983	Manny Consultants, Ltd.	gold, silver	drilling
	1985	McCuneo, B.	gold, silver	mining
	1986	McFarland, J.	gold	mining
	1986	Norex Corp.	gold, silver	excavation
	1986	Reamsbottom, S.	gold, silver	drilling
	1987	Gray, D.	gem stone	milling
	1988	Art Wilson Co.	gold	excavation
	1988	Maxwell and Lewis	gold	drilling
	1989	Eglinton Mining (Nevada) PLC.	gold	drilling
	1989	Grizley Hill JV	gold	drilling
	1990	Derossier, C.	gold	road building
Silver Star	1981	Martin, J.	gold	road building
	1985	Hoyer and and Walton	gold	milling
	1985	Williams, R.	gold	excavation
	1986	Cameron, E.	gold	excavation
	1988	Driscoll, R.	gold	excavation
	1988	Eureka Consolidated	gold	milling
	1989	ASARCO, Inc.	gold	drilling
	1989	Marshall Earth Resources	gold	road building
	1989	Noranda Exploration	gold	drilling
	1989	U.S. Borax	gold	drilling
Stateline Peak	1987	Fong, R.	gold, silver	mining
	1987	Hallman, F.	gold, silver	mining
	1988	Weiss, D.	clay	mining
Steamboat Springs	1988	Travers, D.	gold, silver	sampling
Table Mountain	1984	ASARCO, Inc.	gold, silver	drilling
	1985	Cordex Exploration Co.	gold	drilling
	1989	Santa Fe Pacific Mining Co.	gold, silver	drilling
Talapoosa	1985	Pancana Minerals, Inc.	gold, silver	drilling
	1988	Combined Metals Reduction Co.	gold, silver	drilling
	1988	Von Haften, A.	gold, silver	excavation
	1989	Athena Gold Corp.	gold, silver	drilling
	1989	Axagon Resources Ltd.	gold, silver	drilling
Tungsten Mountain	1982	Lloyd, H.	gold, silver	excavation
	1983	Farr, D.	gold, silver	mining
	1985	Dome Exploration Ltd.	gold, silver	drilling
Washington	1984	Can Am Gold Corp.	gold	road building
	1987	Donovan, H.	gold	--
	1988	Echo Bay Exploration	gold	road building
	1989	Hycroft Resources and Development Inc.	gold	drilling
	1989	Newmont Exploration Limited	gold	drilling
Wellington	1989	Federal Resources Reserve Partnership	gold	drilling
Westgate	1988	Landsat Minerals Exploration Co.	gold, silver	drilling
Whisky Flat	1989	Combined Metals Reduction Co.	gold	drilling
Wild Horse	1987	Dome Exploration Ltd.	gold	drilling
	1987	Maestretti, S.	gold, silver	excavation
	1989	Rio Algom Exploration Inc.	--	drilling

TABLE 2. EXPLORATION AND MINING ACTIVITY, 1981-1990 (continued)
BLM Carson City District

Mining district	Year	Operator	Commodity	Activity
Wilson	1987	Crown Development and Mining Co.	gold, silver	milling
Wonder	1982	Belmont Reources	gold, silver	drilling
	1989	Merlin Mining Co.	gold, silver	drilling
Yerington	1985	Sermines Inc.	gold, silver	drilling
	1987	PAC Industries, Inc.	gold	mining
	1988	Cassidy, T.	gem stone	excavation
	1988	Landsat Minerals Exploration Co.	gold	drilling
	1988	Miles and Ballman	gold	excavation
	1989	Arimetco, Inc.	copper	drilling
	1989	Coeur Explorations, Inc.	gold	drilling
	1989	Cyprus Metals Company	gold	drilling
	1989	Hunewill, H.	gypsum	mining
	1989	Keane, P.	gold	drilling
	1989	Macarthur Mining and Processing Co.	copper	mining
	1989	Seubert, D.	gold, silver	excavation
Yerington	1989	Timberline Minerals, Inc.	gold	drilling
	1989	Western Gold and Uranium, Inc.	gold	drilling
	1990	Kennecott	gold, silver	drilling

Table 2, showing exploration and mining activity within the Carson City district, 1981-1990, was constructed from the Mineplan Notices Data Base, supplied by the BLM Carson City office. This information is a good measure of activity levels in the various mining districts and areas within the BLM Carson City district; it is much more specific than information from the mining claims listing.

TYPES OF MINERAL DEPOSITS

The classification of mineral deposits used in this report generally follows the system outlined in Cox and Singer (1986). Models of mineral deposits described, however, are descriptive and field-oriented and may not conform rigidly to the genetic models defined by Cox and Singer.

Metallic mineral deposit types represented in the portion of western Nevada included within the BLM Carson City district are dominated by deposits associated with acidic to intermediate igneous rocks. These deposits include iron and copper skarns and copper porphyry deposits associated with Jurassic granitic rocks; tungsten skarns, copper skarns (some gold-bearing), and copper and molybdenum porphyry deposits associated with Cretaceous and Tertiary granitic rocks; polymetallic replacement deposits, polymetallic vein deposits, and sediment-hosted stockwork and disseminated deposits, all probably related to Cretaceous and Tertiary intrusive rocks. Precious metal-bearing vein deposits are widespread throughout the district; most of these are hosted in and are genetically related to andesitic to rhyolitic volcanic rocks of Tertiary age. Hot-spring deposits of precious metals, mercury, and sulfur also occur in the area and are related to the latest stages of volcanic activity.

Nonmetallic mineral deposits, with the exception of fluorspar and vein barite, are described only by the present form of the deposit and, for descriptive purposes only, are divided into three groups: bedded, evaporite, and alluvial.

The types of mineral deposits represented within the BLM Carson City district are listed in Table 3.

ALBITITE DIKE GOLD-TITANIUM DEPOSITS

This deposit category includes a single deposit, in the Corral Canyon district of Churchill County, which is associated with the Humboldt gabbroic complex. In this district, albite-calcite dikes and veins contain small amounts of gold and various titanium minerals. Gabbro near some of the albitite bodies is serpentinized, and gold-bearing quartz-calcite bodies occur within and along the contacts of the albite-calcite bodies and the country rock. Titanium minerals are locally abundant. Minerals present include free gold, quartz, anatase, ilmenite, leucoxene, and rutile.

ALLUVIAL DEPOSITS

In this report, this category of deposit is used to include the extensive sand and gravel deposits occurring as pediment, river, and lake deposits throughout western Nevada. These deposits were formed by weathering of rock outcrops and physical transport of the weathered material, by a combination of the actions of water, wind, and gravity, to locations along the flanks of the mountain ranges and along river channels. Some grading of the deposits has occurred during transport and deposits vary from well-sorted to poorly-sorted. Variations of gravel type depend on source rock type, and commercial utilization of various deposits depends on rock type as well as degree of sorting and angularity of the gravel.

One type of metallic occurrence, placer deposits, are included in this deposit type. In the BLM Carson District, the only metallic placers known are of gold and titanium. Both are stream channel deposits which have concentrated heavy minerals weathering from outcrops into sand deposits in favorable locations along small stream channels.

BEDDED DEPOSITS

As used in this report, this model is descriptive and does not imply any genetic model or common rock or mineral associations. It is used mainly for nonmetallic deposits and describes only the form of the deposit. These deposits are strataform and stratabound and

TABLE 3. MINERAL DEPOSIT TYPES
BLM Carson City District

Deposit type	Commodity	Mining district/area
albitite dike gold-titanium	gold	Corral Canyon
	titanium	Corral Canyon
bedded	barite	Candelaria
		Pamlico
	clay	Desert Mountains area
		Fitting
		Virginia Range, Carson Range, southern Pah Rah Range
	clay (halloysite)	Sand Pass area
	clay (montmorillonite)	Hawthorne area
		Rhodes Marsh
		Soda Spring Valley
	coal	Eldorado
		Peavine
		Washington
	diatomite	Basalt
		Bell
		Clark Station
		Comstock
		Dead Camel Mountains area
		Desert Mountains
		Desert Mountains area
		Dicalite Summit area
		Hazen
		Russell Pass area
		southern Pah Rah Range
		Washington
		Wilson
	dimension stone	Carson
	flagstone	Aurora
	gem stone (wonderstone)	Dead Camel Mountains area
	gypsum	Mound House
		Yerington
	marble	Garfield
	marble (terrazo)	Santa fe
	marl	Sand Pass area
	perlite	Aurora
		Sand Pass area
		Truckee Canyon
		Wellington
		White Throne Mountain
		Wilson
	pumice	Pilot Mountains
		Rainbow Mountain
	silica	Gabbs Valley area
	volcanic cinder	Flowery Range
		Jumbo
		Steamboat Springs
	zeolite	Eastgate
		Smoke Creek Desert area
epithermal manganese	manganese	Delaware
evaporite	borate	Salt Wells
	borate, sodium chloride (halite)	Teels Marsh
	borate, sodium sulfate, sodium chloride (halite)	Rhodes Marsh
	salines and brines	Alkali Valley
		Artesia Lake
		Carson Lake
		Churchill Valley
		Cold Spring Valley
		Edwards Creek Valley
		Gabbs Valley
		Garfield Flat
		Huntoon Valley
		Labou Flat
		Misfits Flat

TABLE 3. MINERAL DEPOSIT TYPES (continued)
BLM Carson City District

Deposit type	Commodity	Mining district/area
evaporite	salines and brines	Rawhide Flats
		Smith Creek Valley
		Soda Spring Valley
	sodium carbonate	Double Spring Marsh
	sodium carbonate, borate	Soda Lakes
	sodium chloride (halite)	Carson Sink
		Sand Springs Marsh
	sodium chloride (halite), sodium sulfate, sodium carbonate, borate	Dixie Marsh
	sodium sulfate	Wabuska Marsh
geothermal	geothermal rescurces	Dixie Hot Spring KGRA
		Dixie Valley
		Dixie Valley (KGRA's)
		Eagle Valley, Carson Valley
		Eightmile Flat
		Fallon
		Gabbs Valley
		Hawthorne
		Hazen
		Lahontan Basin
		Lee Hot Springs
		McCoy
		Moana Springs
		Smith Creek Valley
		southern Dixie Valley
		southern Walker Lake Basin
		Steamboat Springs
		Stillwater-Soda Lake
		Truckee Meadows
		Wabuska Hot Spring
		Wabuska Marsh
		Warm Springs Valley
		west Smith Valley
		Wilson Hot Springs
hot-spring	clay	Castle Peak
		Steamboat Springs
	gold	Allen Hot Springs area
		Dead Camel Mountains area
		Gabbs Valley area
		Steamboat Springs
	mercury	Castle Peak
		Clark-Derby area
		Gabbs Valley area
		Steamboat Springs
	silica	Steamboat Springs
	sulfur	Steamboat Springs
intrusive	feldspar	Stateline Peak
	lightweight aggregates	Castle Peak
		Flowery Range
		Virginia Range, Carson Range, southern Pah Rah Range
metamorphic, disseminated	graphite	Voltaire
	kyanite group aluminous minerals	Buckskin
		Fitting
oil and gas	oil and gas	Carson Sink, Dixie Valley
placer	gold	Mount Grant
	titanium	Freds Mountain area
polymetallic replacement	copper, lead, zinc, gold	Risue Canyon
	gold, lead, copper	Red Canyon
	lead, silver, zinc	Chalk Mountain
	silver, copper, lead, zinc	Pilot Mountains
	silver, gold, lead, copper, antimony, zinc	Candelaria
	silver, lead, zinc	Bell
		Lodi
		Wilson

TABLE 3. MINERAL DEPOSIT TYPES (continued)
BLM Carson City District

Deposit type	Commodity	Mining district/area
polymetallic replacement	silver, lead, zinc, copper	Gabbs (Downeyville)
polymetallic vein	copper	Benway
		Eastside area
		Gardnerville
	copper, gold	Freds Mountain area
	gold, copper	Buckskin
	gold, copper	Eagleville
	gold, silver	Pamlico
		Tungsten Mountain
		Washington
	gold, silver, copper	Delaware
		Desert Mountains area
		Voltaire
		Yerington
	gold, silver, lead	Mountain House
	gold, silver, lead, copper	King
		Mount Grant
		Red Mountain
	lead, zinc, silver	Galena
	silver, copper, lead	Garfield
		La Plata
	silver, gold	Huntoon Valley area
		I.X.L.
	silver, gold, lead	Lucky Boy
	silver, gold, lead, copper	Red Canyon
	silver, gold, lead, zinc	Holy Cross
	silver, lead, gold	Marietta
porphyry	copper	Benway
		Buckskin
		Desert Mountains area
		Eastside area
		Gabbs Valley area
		Mountain View
		Peavine
		Wedekind
		Yerington
		Yerington
	copper, molybdenum	Chalk Mountain
		Fairview
		Santa Fe
	copper, silver, gold	Pyramid
	molybdenum	Gardnerville
		La Plata
		Lodi
quartz adularia vein	clay (illite)	Wonder
quartz segregation	silica	Lucky Boy
		Pine Grove Hills
quartz-adularia vein	gold	Mountain View
		Silver Star
		Yerington
	gold, silver	Aurora
		Bruner
		Dixie Valley
		Eagleville
		Eastgate
		Gold Basin
		Jumoo
		La Plata
		Lucky Boy
		Masonic
quartz-adularia vein		Mount Montgomery
		Olinghouse
		Ramsey
		Rawhide
		Talapoosa

TABLE 3. MINERAL DEPOSIT TYPES (continued)
BLM Carson City District

Deposit type	Commodity	Mining district/area
quartz-adularia vein	gold, silver	Wilson
	gold, silver, copper	Como
	silica, silver, gold	Gardnerville
	silver	Bell Mountain
	silver, gold	Alpine
		Clark-Derby area
		Comstock
		Fairview
		Fitting
	silver, gold	Sand Springs
		Wonder
quartz-alunite vein	alunite	Bovard
		Rawhide
	gold	Silver Star
	gold, silver	Bell
		Bovard
		Castle Peak
		Holy Cross
		Lucky Boy
		Olinghouse
		Ramsey
		Talapoosa
		Wedekind
	gold, silver, copper	Peavine
	mercury	Holy Cross
	silver, gold	Broken Hills
		Clark-Derby area
replacement fluorspar	fluorspar	I.X.L.
	fluorspar	La Plata
	fluorspar	Wellington
replacement. disseminated	mercury	Eastside area
		Pilot Mountains
		Sand Springs
		Wild Horse
sediment-hosted gold-silver	gold	Bernice
		Pamlico
		Pilot Mountains
		Sand Springs
		Santa Fe
		Shady Run
		Wild Horse
	gold, silver	Wellington
skarn	copper	Bell
		Bovard
		Buckley
		Garfield
		Peavine
		Red Canyon
		Silver Star
		Stateline Peak
		Wedekind
		Yerington
	copper, gold	Fitting
		Freds Mountain area
	copper, tungsten, gold	Whisky Flat
	gold	Bovard
		Buckley
		Chalk Mountain
		Delaware
		Gardnerville
		Garfield
		Lodi
		Marietta
		Pamlico
		Peavine

TABLE 3. MINERAL DEPOSIT TYPES (continued)
BLM Carson City District

Deposit type	Commodity	Mining district/area
skarn	gold	Red Canyon
		Red Mountain
		Santa Fe
		Wedekind
	gold, copper	Gabbs Valley area
	gold, silver, copper	Mountain House
	iron	Buckley
		Buckskin
		Chalk Mountain
		Copper Kettle
		Delaware
		Marietta
	iron	Red Mountain
		Santa Fe
	mica	Fitting
	quartz crystal	Eagleville
		Eagleville
		Pamlico
	silver, gold	I.X.L.
	talc	Lodi
	tungsten	Bell
		Buckley
		Churchill
		Delaware
		Fairview
		Fitting
		Galena
		Gardnerville
		La Plata
		Leonard
		Lodi
		Lucky Boy
		Marietta
		Masonic
		Mount Montgomery
		Mountain House
		Olinghouse
		Pilot Mountains
		Red Mountain
		Risue Canyon
		Sand Springs
		Santa Fe
		Tungsten Mountain
		Wellington
		Wilson
stratabound uranium	uranium	Olinghouse
		Stateline Peak
synorogenic-synvolcanic nickel-copper	nickel, cobalt, copper	Table Mountain
vein	graphite	Fitting
vein and nodule turquoise	gem stone (turquoise)	Bovard
		Eastside area
		Pilot Mountains
		Silver Star
		Yerington
vein antimony	antimony	Bernice
		Pamlico
		Silver Star
		Wild Horse
vein barite	barite	Buckley
		Eagleville
vein barite	barite	Fitting
vein fluorspar	fluorspar	Broken Hills
		Mount Montgomery
vein tungsten	tungsten	Silver Star
vein uranium	uranium	Marietta
		Washington
volcanogenic uranium	uranium	Pyramid

include sedimentary deposits such as coal, gypsum, sand, limestone, marl, clay, and some barite as well as deposits of diatomite, perlite, and zeolite.

EPITHERMAL MANGANESE DEPOSITS

In these deposits, manganese mineralization occurs in epithermal veins filling faults and fractures in subaerial volcanic rocks. Rock types present include flows, tuffs, breccias, and agglomerates of rhyolitic, dacitic, andesitic, or basaltic composition. The deposits are localized along through-going faults and fractures and in brecciated zones in the host rock. Wall rocks can be kaolinized and minerals present include rhodochrosite, manganocalcite, calcite, quartz, chalcedony, barite, and zeolites; tungsten is rarely present, probably as fine-grained scheelite. The oxidized portions of these deposits contain abundant manganese oxides, psilomelane, pyrolusite, braunite, wad, manganite, cryptomelane, hollandite, coronadite, and iron oxides.

EVAPORITE DEPOSITS

In this report, this type of deposit includes only salines and brines formed in playas and desert lake basins. Saline minerals (evaporites) were chemically precipitated in these desert lake basins whenever evaporation caused the water to become saturated with a particular compound; this can happen many times in the evolution of a playa. The saline minerals occur in surface crusts, in crystals and small masses enclosed in sediments, in buried beds. or in soluble form as brines. Many deposits that occur as porous surface crusts or near-surface crystals and masses were deposited during evaporation of water brought near the surface by capillary action. Playa lakes become more saline and alkaline toward their centers and some zoning of salt deposits may occur. Minerals known to occur in Nevada playa deposits include: halite, sylvite, gypsum, bassanite, anhydrite, thenardite, mirabilite, glauberite, epsomite, calcite, aragonite, dolomite, gaylussite, magnesite, trona, natron, thermonatrite, borax, tincalconite, ulexite, colemanite, searlesite, fluorite, zeolites, and potassium feldspar. In addition to mineral deposits, strong to weak brines are present in many playas and may occur within a few feet of the surface. Brines may contain up to 30 percent or more dissolved solids; sodium and chlorine commonly make up more than half of this, and magnesium, sulfate, and carbonate generally are abundant but vary in amount from basin to basin (Papke, 1976, p. 9).

HOT-SPRING DEPOSITS

Hot-Spring Gold-Silver Deposits

These are deposits of fine-grained silica and quartz in silicified breccia with gold, pyrite, and antimony and arsenic sulfides. The deposits occur in subaerial rhyolitic volcanic centers, rhyolite domes, and shallow parts of related geothermal systems. Ore is controlled by through-going fracture systems, brecciated cores of intrusive domes; cemented breccias are important carriers of ore. Deposits are commonly crustified, banded veins, stockworks, breccias (cemented with silica or uncemented). Sulfides may be very fine grained and disseminated in silicified rock. Alteration, from top to bottom of system consists of: chalcedonic sinter, massive silicification, stockworks and veins of quartz, adularia and breccia cemented with quartz, quartz and chlorite. Veins are generally chalcedonic, although some are opal. Some deposits have alunite and pyrophyllite. Ammonium feldspar (buddingtonite) may be present. Minerals present include native gold, pyrite, stibnite, realgar; or arsenopyrite with or without sphalerite, chalcopyrite, fluorite; or native gold, silver selenide or tellurides, pyrite. On weathered outcrop, these deposits display bleached country rock, yellow limonites with jarosite and fine-grained alunite, hematite, goethite.

Hot-Spring Mercury Deposits

These are deposits of cinnabar and pyrite disseminated in siliceous sinter. Rock types present include siliceous sinter, andesite-basalt flows, diabase dikes, andesitic tuffs, and tuff breccia. The deposits form as disseminations and coatings on fracture surfaces in hot-spring sinter. Alteration consists of kaolinite, alunite, iron oxides, and native sulfur formed above the paleo ground-water table; and pyrite, zeolites, K-feldspar, chlorite, and quartz formed below the paleo ground-water table. Opal is deposited at the paleo water table. Minerals present consist of cinnabar, native sulfur, and minor marcasite.

INTRUSIVE DEPOSITS

This category is used in this report to cover those few deposits where the mined material is the intrusive rock itself. The only deposits in the BLM Carson City district that fall into this class are rhyolitic intrusive rocks mined for lightweight aggregate and quartz segregations within granitic rocks which have been mined for silica. Granitic rocks mined for feldspar would also fall into this category. The shape and size of these deposits is usually defined by some physical or compositional characteristic of the intrusive body with the mass of the intrusive itself providing only a maximum constraint on deposit shape and size.

METAMORPHIC-DISSEMINATED DEPOSITS

This deposit class includes deposits in only two restricted areas within the BLM Carson City District: deposits of kyanite group aluminous minerals in the Fitting district, Mineral County, and in the Buckskin district, Douglas County. In these deposits, kyanite, andalusite, and corundum occur in sericitized shear zones in metamorphosed volcanic rocks. Other minerals present include sericite, quartz, rutile, diaspore, and pyrophyllite.

POLYMETALLIC REPLACEMENT DEPOSITS

These are hydrothermal, epigenitic deposits of silver, lead, zinc, and copper minerals in massive lenses, pipes, and veins in limestone, dolomite, or other soluble rock near igneous intrusions. Rock types are sedimentary, chiefly limestone, dolomite, and shale, commonly overlain by volcanic rocks and intruded by porphyritic, calc-alkaline plutons. Tabular, podlike and pipelike ore bodies are localized by faults or vertical beds; ribbonlike or blanketlike ore bodies are localized by bedding-plane faults, by susceptible beds, or by preexisting solution channels, caverns, or cave rubble. Limestone wallrocks are dolomitized and silicified (to form jasperoid); shale and igneous rocks are chloritized and commonly argillized; where syngenetic iron oxide minerals are present, rocks are pyritized. Jasperoid near ore is coarser grained and contains traces of barite and pyrite. Minerals in these deposits commonly display a zonal sequence outward: 1) copper-rich central area of enargite, sphalerite, argentite, tetrahedrite, digenite, with or without chalcopyrite, and rare bismuthinite; 2) lead-silver zone of galena, sphalerite, argentite, with or without tetrahedrite, proustite, pyrargyrite, rare jamesonite, jordanite, bournonite, stephanite, and polybasite; and 3) a zinc- and manganese-rich fringe of sphalerite and rhodochrosite. Quartz, pyrite, marcasite, and barite are widespread; locally rare gold, sylvanite, and calaverite occur. Jasperoid related to ore can often be recognized by high barite and trace silver content. Upon weathering, these deposits commonly oxidize to ochreous masses containing cerussite, anglesite, hemimorphite, and cerargyrite.

POLYMETALLIC VEIN DEPOSITS

These deposits are quartz-carbonate veins with gold and silver associated with base metal sulfides related to hypabyssal intrusions in sedimentary and metamorphic terranes. Rock types include calc-alkaline to alkaline, diorite to granodiorite, monzonite to monzogranite in small intrusions and dike swarms in sedimentary and metamorphic rocks and subvolcanic intrusions, necks, dikes, and plugs of andesite to rhyolite composition. The deposits occur in near-surface fractures and breccias within thermal aureols of clusters of small intrusions. In some cases,

these deposits form peripheral to porphyry systems. The deposits form in areas of high permeability: intrusive contacts, fault intersections, and breccia veins and pipes. Replacement ore bodies may form where structures intersect carbonate beds. Deposits are generally associated with wide zones of propylitic alteration and narrow sericitic and argillic alteration zones. Associated carbonate rocks are silicified to form jasperoid. Minor gossans and zones of manganese-oxide staining commonly form on the weathered outcrops of these deposits. Minerals present include native gold and electrum with pyrite and sphalerite, with ore without chalcopyrite, galena, arsenopyrite, tetrahedrite-tennantite, silver sulfosalts, argentite, and hematite in veins of quartz with chlorite, calcite, with or without dolomite, ankerite, siderite, rhodochrosite, barite, fluorite, chalcedony, adularia.

PORPHYRY DEPOSITS

Porphyry Copper Deposits

This generalized deposit model includes various subtypes which contain chalcopyrite in stockwork veinlets in hydrothermally altered porphyry and adjacent country rock. Rock types include tonalite to monzogranite or syenitic porphyry intruding granitic, volcanic, calcareous sedimentary, and other rocks. Deposits form associated with high-level intrusive rocks contemporaneous with abundant dikes, breccia pipes, and faults. Deposits form in stockwork veins in porphyry, along porphyry contacts, and in favorable country rocks such as carbonate rocks, mafic igneous rocks, and older granitic plutons. Alteration commonly associated with these deposits is, from bottom, innermost zones outward: sodic-calcic, potassic, phyllic, and argillic to propylitic. Propylitic or phyllic alteration may overprint the early potassic assemblage. Minerals present include chalcopyrite and pyrite with or without molybdenite; chalcopyrite and magnetite with or without bornite and gold. Late veins of enargite, tetrahedrite, galena sphalerite, and barite occur in some deposits. Green and blue copper carbonates and silicates occur in weathered outcrops of these deposits, or, where leaching is intense, barren outcrops remain after copper is leached, transported downward, and deposited as secondary sulfides. Fractures in leached outcrops are coated with hematitic limonite. Deposits of secondary sulfides contain chalcocite and other copper sulfide minerals replacing pyrite and chalcopyrite.

Porphyry Copper-Molybdenum Deposits

In deposits of this type, stockwork veinlets of quartz, chalcopyrite, and molybdenite occur in or near a porphyritic intrusion. Rock types include tonalite to monzogranite stocks and breccia pipes intrusive into batholithic, volcanic, or sedimentary

rocks. Deposits occur in high-level intrusive porphyries contemporaneous with abundant dikes, faults, and breccia pipes. Ore grade is, in general, positively correlated with spacing of veinlets and mineralized fractures. Country rocks favorable for mineralization are calcareous sediments, diabase, tonalite, or diorite. Alteration sequences include quartz plus K-feldspar plus biotite (chlorite) with or without anhydrite (potassic alteration) grading outward to propylitic. Late phyllic alteration may form a capping or outer zone or may affect the entire deposit. Minerals include chalcopyrite, pyrite, and molybdenite. Peripheral vein or replacement deposits may contain chalcopyrite, sphalerite, and galena with or without gold. Outermost zone may have veins of copper-silver-antimony sulfides, barite, and gold. Weathered deposits may display intense leaching and wide areas of iron-oxide stain at surface. Supergene copper, as chalcocite, may form a blanket deposit below the leached zone.

Porphyry Molybdenum Deposits, Low-Fluorine

These are stockwork deposits of quartz-molybdenite veinlets formed in felsic porphyry and in nearby country rock. Rock types include tonalite, granodiorite, and monzogranite. Alteration associated with this deposit type is potassic grading outward to propylitic. Phyllic and argillic alteration often occur as overprints. Minerals present include molybdenite and pyrite with or without scheelite, chalcopyrite, and argentian tetrahedrite along with quartz, K-feldspar, biotite, calcite, white mica, and clays. Ore minerals are disseminated in fractures and veinlets. Weathered outcrops commonly display yellow ferrimolybdite after molybdenite; secondary copper enrichment may form copper ores in some deposits.

QUARTZ-ADULARIA VEINS

Deposits of this type are also generally known as Comstock epithermal veins or epithermal gold veins. The deposit type includes deposits of gold, electrum, silver sulfosalts, and argentite in vuggy quartz-adularia veins hosted by felsic to intermediate volcanic rocks. Host rocks include andesite, dacite, quartz latite, rhyodacite, rhyolite; and associated sedimentary rocks. Mineralization is related to calc-alkaline or bimodal volcanism. The deposits are related to through-going, anastomosing fracture systems, centers of intrusive activity; vein textures include banding, open-space filling, lamellar quartz, and stockwork. Alteration, from top to bottom of the system is: quartz, kaolinite, montmorillonite, with or without zeolite, barite, calcite; quartz, illite; quartz, adularia, with or without illite; quartz, chlorite. The presence of adularia in these deposits is variable. Minerals present include argentite, gold, electrum, with or without silver sulfosalts and naumannite.

Galena, sphalerite, chalcopyrite, tellurides, hematite, and arsenopyrite occur in moderate to sparse amounts. Gangue minerals are quartz, pyrite, with or without adularia, calcite, chlorite, and sericite. Barite, fluorite, rhodochrosite, kaolinite, and montmorillonite are moderate to sparse. Ore minerals constitute only a few percent of the veins.

QUARTZ-ALUNITE VEINS

These are deposits of gold, pyrite, and enargite in vuggy veins and breccias in zones of high-alumina alteration related to felsic vulcanism. The deposits are also known as acid-sulfate or enargite-gold deposits. Rock types are volcanic: dacite, quartz latite, rhyodacite, and rhyolite associated with hypabyssal intrusions or domes. Deposits form within volcanic edifices and in ring fracture zones of calderas. Ore controls include through-going fractures and centers of intrusive activity. Deposits form as veins, breccia pipes, pods, and dikes; replacement veins are often porous and vuggy, with comb structure and crustified banding. Alteration associated with these deposits is: inner zone of pervasive host rock alteration and veining by early-stage quartz, alunite, pyrophyllite with or without corundum, diaspore, andalusite, or zunyite; middle zone of quartz, alunite, kaolinite, and montmorillonite; outer zone of pervasive propylitic alteration (chlorite, calcite). Ammonium-bearing clays may be present. Minerals present include native gold, enargite, pyrite, silver-bearing sulfosalts, with or without chalcopyrite, bornite, precious metal tellurides, galena, sphalerite, huebnerite. A hypogene oxidation phase containing chalcocite, covellite, with or without luzonite and late-stage native sulfur and cinnabar may by present. Base metal content of these deposits normally increases with depth. Weathered outcrops commonly display abundant yellow limonite, jarosite, goethite, white argillization with kaolinite, fine-grained white alunite veins, and hematite.

REPLACEMENT, DISSEMINATED MERCURY DEPOSITS

Many mercury deposits within the BLM Carson City District do not lend themselves to inclusion within the mercury deposit categories listed in Cox and Singer (1986). The category of "replacement, disseminated" has been fabricated to describe these occurrences. The deposits can generally be described as replacement lenses and disseminations of cinnabar which form mainly in sedimentary and metamorphic rocks in areas of structural preparation. Host rocks include limestone, shale, calcareous sandstone, chert, phyllite, and quartzite. The ore bodies lie along normal and bedding faults, and their localization is in many places affected by the intersection of these faults with favorable beds. The lack of wall rock alteration, the association of small quantities of stibnite, and the common presence of quartz, calcite,

and barite as gangue minerals are characteristics of these deposits. The ore mineral is cinnabar. It generally only fills openings forming networks of irregular veinlets, high-grade lenses along faults, and distinct veins along fractures. Replacement of rock by cinnabar, although uncommon, locally assumes importance in the more limy rocks. The ore bodies vary both in size and grade, depending upon the kind of sediment in which they formed.

REPLACEMENT FLUORSPAR DEPOSITS

Replacement deposits of fluorspar commonly occur in faults, fault zones, or along intrusive contacts. Most of these bodies have a tabular or lenticular shape, and they can occur in all rock types. Silicification is present in host rocks surrounding most replacement deposits, and masses of jasperiod occur adjacent to some deposits. Other than fluorite, quartz is the most common introduced mineral but calcite, and barite also can occur in variable amounts. Most fluorite is white, very light gray, or some hue of green or purple. Depositional banding is common in these deposits; the bands are either fluorite with different colors or crystal sizes or, more rarely, alternating fluorite and quartz.

SEDIMENT-HOSTED GOLD-SILVER DEPOSITS

This class of deposit includes carbonate-hosted gold-silver deposits (Carlin-type) as well as fracture-controlled, stockwork, and disseminated deposits. Host rocks can be thin-bedded silty or argillaceous carbonate rocks or limy shales and siltstones. Felsic dike rocks are commonly present in the area of these deposits. Most of these deposits are selective replacement deposits formed adjacent to and along high-angle faults, regional thrust faults, bedding, or bedding-plane faults. The addition of large amounts of silica is a common alteration effect associated with these deposits. Alteration minerals common in unoxidized parts of the ore bodies are jasperoid, quartz, illite, kaolinite, calcite, and, in some, abundant amounts of introduced, amorphous carbon. Minerals present in hypogene oxidized ore include kaolinite, montmorillonite, illite, jarosite, and alunite. Minerals present include native gold (commonly very fine grained), pyrite, realgar, orpiment, with or without arsenopyrite, cinnabar, fluorite, barite, and stibnite.

SKARN DEPOSITS

Skarn Tungsten Deposits

In these deposits, scheelite occurs in calc-silicate contact metasomatic rocks. Rock types include tonalite, granodiorite, quartz monzonite intrusive rocks and carbonate or carbonate-rich

wall rock. Deposits form at contacts of batholiths and stocks with intruded rocks generally within the thermal aureoles of the intrusions. Alteration is mainly silication; alteration minerals include diopside-hedenbergite plus grossular and andradite, late stage spessartine plus almandine and an outer, barren wollastonite zone. An inner zone of massive quartz may be present. Minerals present include scheelite with or without molybdenite, pyrrhotite, sphalerite, chalcopyrite, bornite, arsenopyrite, magnetite, and sometimes traces of wolframite, fluorite, cassiterite, and native bismuth.

Skarn Copper Deposits

In these deposits, chalcopyrite occurs in calc-silicate contact metasomatic rocks. Rock types include tonolite to monzogranite intrusive rocks and carbonate or calcareous clastic wall rocks. Deposits form as irregular or tabular bodies in carbonate rocks or calcareous rocks near igneous contacts or in xenoliths in igneous stocks. Mineralized breccia pipes can be present. Associated igneous rocks are commonly barren. Alteration is mainly silication; alteration minerals include diopside and andradite in a central zone, wollastonite with or without tremolite in an outer zone, and a peripheral marble zone. Igneous rocks may be altered to epidote-pyroxene-garnet endoskarn. Retrograde alteration to actinolite, chlorite, and clays may be present. Minerals present include chalcopyrite and pyrite with or without hematite, magnetite, bornite, and pyrrhotite. Molybdenite, bismuthinite, sphalerite, galena, cosalite, arsenopyrite, enargite, tennantite, and tetrahedrite may be present; gold and silver may be present in significant amounts.

Skarn Iron Deposits

In these deposits, magnetite occurs in calc-silicate metasomatic rocks. Rock types include gabbro, diorite, diabase, syenite, tonalite, granodiorite, and granite intrusive rocks and limestone and calcareous sedimentary wall rocks. Deposits form in carbonate rocks, calcareous rocks, igneous contacts and in fracture zones near contacts. Iron skarns can also form in gabbroic host rocks near felsic intrusives. Alteration is mainly silication; alteration minerals include diopside and hedenbergite with grossular, andradite, and epidote. Late stage amphibole with or without chlorite can be present. Minerals present include magnetite with or without chalcopyrite, pyrite, and pyrrhotite.

STRATABOUND URANIUM DEPOSITS

In western Nevada, these deposits include mainly occurrences of carnotite, autunite, uranophane, and other oxide minerals which

occur in Tertiary sedimentary rocks. Uranium minerals occur as encrustations or disseminated flakes along bedding planes or iron-stained fractures in water-laid tuffs, tuffaceous shales, or, less commonly, sandstones and conglomerates. Hydrothermal alteration and typical hydrothermal minerals are almost universally absent.

SYNOROGENIC-SYNVOLCANIC NICKEL-COPPER DEPOSITS

These deposits are lenses and disseminated sulfides in small to medium sized gabbroic intrusions in greenstone belts. Associated rock types include norite, gabbro-norite, pyroxenite, peridotite, troctolite, and anorthosite forming layered or composite igneous complexes. The deposits formed synvolcanically or during orogenic development of a metamorphic terrain containing volcanic and sedimentary rocks. Sulfides commonly are in the more ultramafic parts of the complex and near the basal contacts of the intrusion. Minerals present can include pyrrhotite, pentlandite, chalcopyrite, pyrite, Ti-magnetite, Cr-magnetite, graphite, nickel minerals, and platinum-group-elements.

VOLCANOGENIC URANIUM DEPOSITS

In these deposits, uranium mineralization occurs in epithermal veins composed of quartz, fluorite, and iron, arsenic, and molybdenum sulfides. Rock types consist of high-silica alkali rhyolite and potash trachytes; peralkaline and peraluminous rhyolite host ore. Ore forms in through-going fractures and breccias formed along the margins of shallow intrusives; vugs in surface flows are of minor importance. Kaolinite, montmorillonite, and alunite are common alteration minerals; silicification, accompanied by adularia, affects wallrocks spatially associated with ore. Most common uranium minerals present are coffinite, uraninite, and brannerite. Other minerals include pyrite, realgar/orpiment, leucoxene, molybdenite, fluorite, quartz, adularia, and barite. Gold is present in some deposits; deposits associated with alkaline complexes may contain bastnaesite.

VEIN ANTIMONY DEPOSITS

The deposits are stibnite veins, pods, and disseminations in or adjacent to brecciated or sheared fault zones. Deposits are found associated with a wide variety of lithologies including limestone, calcareous shale, sandstone, quartzite, slate, rhyolitic flows and tuffs, argillite, granitic rocks, schists, and gneiss. Alteration associated with these deposits include silicification, sericitization, and argillization along with minor chloritization. Minerals present are stibnite, quartz, with or without pyrite, calcite, and minor other sulfides including arsenopyrite, sphalerite, tetrahedrite, chalcopyrite, galena, and jamesonite.

Gold and scheelite can be present. Upon weathering, these deposits display yellow to reddish antimony oxides on outcrop.

VEIN BARITE DEPOSITS

This class of deposits includes epigenetic deposits formed by filling of open spaces, replacement of the host rock, or a combination of both processes. These deposits have great variation in size, form, and character. Some are long, relatively narrow tabular bodies whose location and deposition were controlled by preexisting structures. At the other extreme, some are zones in which barite-rich bodies occur as irregular stringers, veinlets, masses, and veins and where the barite bodies generally make up only a relatively small part of the volume. Barite veins can occur in all types of host rocks but, in western Nevada, igneous rocks--metavolcanic, volcanic, and intrusive are the most common host rocks. Controlling structures for the veins include faults, joints, and breccia zones. Generally the contacts between tabular veins and wallrock are sharp, and the wallrock is unaltered or only slightly altered. Barite is the most common mineral in these veins. Unreplaced wall rock fragments are rather common but other impurities are present in only sparse amounts; many of the thicker barite veins are capable of producing high-quality, direct-shipping ore. Quartz, usually in small amounts, is the principal associated mineral, mica or calcite can be present, and iron oxides are often present. Secondary copper minerals can be present along with minor amounts of galena, pyrite, chalcopyrite, or sphalerite. Other minerals sometimes present include manganese oxides, fluorite, gypsum, stibnite, and stibiconite.

VEIN FLUORSPAR DEPOSITS

Vein fluorspar deposits are relatively simple, tabular bodies, generally with moderate to steep dip. Pinching and swelling of the veins are common and both open-space filling and replacement of host rocks were probably important in the formation of most vein deposits. Vein deposits show a decided preference for certain rock types and about three-fourths of them occur in acid to intermediate volcanic rocks or intrusive rocks. In a large portion of vein deposits in Nevada, the adjacent country rock is essentially unaltered and, in the remainder, the alteration generally extends for only a foot or two from the vein. Alteration of wall rock to montmorillonite is most common. Other than fluorite, quartz is the most common introduced mineral, but calcite and barite also can occur in variable amounts. Most fluorite is white, very light gray, or some hue of green or purple. Depositional banding is common in these deposits; the bands are either fluorite with different colors or crystal sizes or, more rarely, alternating fluorite and quartz.

VEIN TUNGSTEN DEPOSITS

In this report, this deposit class is restricted to scheelite-bearing quartz veins. In this area, these veins cut metavolcanic, metasedimentary, granitic, and volcanic rocks. The veins occupy through-going faults and fracture systems and can be extensive. Minerals present include scheelite and quartz with minor amounts of gold, silver-bearing galena, tetrahedrite, sphalerite, and pryite.

VEIN AND NODULE TURQUOISE DEPOSITS

Turquoise normally forms narrow veinlets and nodules in the weathered outcrop portions of altered zones associated with copper deposits. Host rocks for the deposits can be limestone, shale, chert, intrusive bodies, or metamorphosed volcanic and sedimentary rocks; no deposits seem to occur, however, in Tertiary volcanic rocks. Turquoise is generally believed to be a product of supergene processes and is found in the leached cappings of many porphyry copper and molybdenum deposits. Variscite commonly occurs with turquoise. Turquoise is usually not found in large masses, most of the ore occurs in pieces a few inches to less than an inch across.

VEIN URANIUM DEPOSITS

This category includes a number of deposit types whose similarity is basically form and structural setting. Occurrences of uranium minerals in shear zones, fracture zones, and veins in various rock types are grouped together in this category. Many of the occurrences consist of anomalous radioactivity associated with sulfide-bearing quartz veins; in others, secondary uranium minerals such as autunite have been identified as flakes along gouge zones, quartz veins, and joints.

MINERAL ECONOMICS

Information included in this section has been compiled entirely from a variety of standard references on mineral commodities. Only brief summaries of commodity occurrences, uses, and markets are given here, and the various references should be consulted for more detailed information on specific commodities. Recommended general references include: Mineral Facts and Problems, 1980, U.S. Bureau of Mines; Mineral Commodity Summaries, 1988, U.S. Bureau of Mines; The Mineral Industry of Nevada, in the Minerals Yearbook, 1988, U.S. Bureau of Mines; The Nevada Mineral Industry, 1988, Nevada Bureau of Mines and Geology Special Publication MI-1988; Commodity Review Section, Engineering and Mining Journal, March, 1989; Principal Deposits of Strategic and Critical Mineral

in Nevada, 1985, U.S. Bureau of Mines Information Circular 9035; and Mineral and Water Resources of Nevada, 1964, Nevada Bureau of Mines and Geology Bulletin 65.

References on specific commodities include: Garside, 1973; Garside and Schilling, 1979; Garside and others, 1988; and Papke, 1970, 1972, 1976, 1979, 1984, and 1987. Since all of the following text has been abstracted from one or more of the listed references, no internal referencing is done.

Commodities included in this section are confined to those which are reported to occur within the BLM Carson City district and which are discussed in the section of this report that covers mineral potential. Strategic and critical minerals are noted by a comment in the introductory paragraph in each commodity description. Strategic and critical minerals are those that fall under the definition stated in Section 12 of the Strategic and Critical Materials Stockpiling Act (P.L. 96-41, 50 U.S.C. 98 et seq.) and are listed in the National Defense Stockpiling Goals for Strategic and Critical Materials as of July 8, 1985.

ALUMINUM (ALUNITE)

Aluminum is the most abundant metal element in the Earth's crust. It is important in virtually all segments of the world's economy, but principal uses have been developed in six major industries: transportation, construction, electrical, containers and packaging, consumer durables, and mechanical equipment. The aluminum ore, bauxite, is classified as a strategic and critical mineral.

Bauxite, the main ore of aluminum is plentiful, with principal deposits located in less developed countries far from the main aluminum producing centers in North America, Europe, and Japan. The world reserve base for bauxite is sufficient to meet world demand for metal for at least the next decade.

Domestic aluminum requirements, however, cannot be met by domestic bauxite resources. One potential domestic, non-bauxitic, aluminum resource, alunite, is relatively abundant in parts of the U.S. and may become an important future source of aluminum and other products such as potassium and sulfur. Its development, along with dawsonite which occurs in the large oil shale deposits of the western United States, may reduce the volume of aluminum imported into the United States. The largest known resources of alunite are in Utah. Alunite is also present in many of the metal mining districts in Nevada where it occurs as an alteration product. Profitable exploitation of the large alunite reserves is yet to be demonstrated. Recent developments in its economic extraction, however, have been encouraging and near-term exploitation is anticipated.

ANTIMONY

Antimony has many industrial applications; the most important is the use of the metal as a hardener in lead storage batteries and its use in fire-retardant formulations. Virtually all domestic production of primary antimony metal is a byproduct of the refining of base metal and silver ores and custom treatment of imported antimony ores and concentrates. United States antimony resources are mainly in Idaho, Nevada, Alaska, and Montana. Principal world resources are in China, Bolivia, the U.S.S.R., South Africa, and Mexico. Antimony is classified as a strategic and critical mineral.

The most significant factors in domestic antimony production have been the occurrence of antimony in small, discontinuous ore bodies not amenable to large-scale mining operations; and the availability of foreign ores at prices below those required for domestic primary production.

BARITE

Barite is one of the more important industrial minerals produced in Nevada and the state contains the largest known barite deposits in the United States. In the high-production year of 1981, Nevada accounted for 82 percent of the total U.S. production and nearly one-quarter of the estimated world production. Unfavorable market conditions, however, are reflected in continuing declines in Nevada barite production and, in 1988, Nevada produced only about 8 percent of the amount produced in the peak production year. In specific reference to Nevada, barite can be classified as a critical mineral.

About 65 percent of the barite produced in the United States is used as a weighting agent in oil- and gas-well-drilling fluids, mostly in the Gulf and Pacific Coast areas. Barite is also used in paints, rubber, and for producing barium chemicals and glass. The low cost and technical advantages of barite preclude substitutes in the drilling mud market. Transportation costs, the availability of lower cost imports, and the growth rate of barite demand affect the development of domestic barite resources. Imports of ground drilling-mud-grade barite, largely from China and in smaller amounts from Morocco and India, continue to compete with domestically ground barite in the already depressed coast area markets.

CLAY

Clays are classified as bentonite, fuller's earth, kaolin, ball clay, and common clay. There are complications in usage of the

terms bentonite, fullers's earth, and montmorillonite. Montmorillonite is a more all-inclusive term and probably should be used instead of bentonite or bentonitic; fuller's earth is composed of kaolinite as well as of minerals of the montmorillonite group. Each class of clay has specific physical and chemical properties which determine its specific use and market value. Large quantities of clay minerals of the montmorillonite group are consumed in foundries, rotary drilling, pelletizing iron-ore concentrates, and oil refining.

Most clays are mined from open pits using modern surface mining equipment. Some kaolin is mined by hydraulic mining and dredging. A few clay mines are underground operations.

The United States is a major supplier of high-quality clays; this position is assured by the possession of more than adequate resources of all major types of clay. Georgia contains large quantities of high-quality kaolin and the largest reserves of "bentonite" are located in Wyoming.

Nevada has produced in excess of a third of a million tons of montmorillonite clays and slightly less than that amount of fuller's earth. A large percentage of both types of clay has originated in the Ash Meadows area of Clark County, but substantial amounts of montmorillonite have been mined from deposits in Mineral and Nye counties.

COAL

Coal is formed by burial and consolidation of decaying plant material. Various ranks, or types, of coal are formed depending upon the geological processes involved. In order of increasing rank, coals are classified as lignitic, subbituminous, bituminous, and anthracitic. The higher rank coals contain more carbon and less volatile elements than do the lower rank coals.

Coal may be burned for heat in homes or to generate electrical power, gasified for industrial or residential use, or coked for metallurgical purposes. The byproducts of coking; gas, tar, and light oils, can be used as such or processed to serve as raw materials for the chemical industry.

The United States has about one-third of the earth's coal reserves. Nearly 80 percent of these reserves, on the basis of heating value per pound, is bituminous or subbituminous. The coal reserves are distributed throughout the United States, about one-third east of the Mississippi River, one-third in the interior, and one-third in the northern Great Plains, Rocky Mountains, and Gulf and Pacific Coast areas; there are no commercial deposits of coal in Nevada.

COBALT

Cobalt, a little-known but strategic metal, is an essential element in many alloys and an important ingredient in chemical compounds. Cobalt is one of several vital alloying elements in the aerospace and electrical product industries. In most of its alloying applications, cobalt imparts essential qualities such as heat resistance, high strength, wear resistance, and superior magnetic properties. Major uses include cutting tools, jet engine parts, electrical devices, permanent magnets, catalysts, and pigments and dryers for paints and allied products. Cobalt is classified as a strategic and critical mineral.

Cobalt is usually mined as a byproduct of either nickel or copper. Because of this relationship, cobalt supply is relatively inelastic with respect to price; the amount of copper and nickel produced ultimately places an upper limit on the amount of cobalt that can be produced.

The United States has not produced cobalt since 1971. Most of the U.S. cobalt resources are in Minnesota, but other important occurrences are in Alaska, Idaho, California, Missouri, Montana, and Oregon. Although large, most domestic resources are in subeconomic concentrations that will not be economically usable in the foreseeable future. The last U.S. production was from the Blackbird mine in Idaho and the deposit has potential for additional production; however, considerable environmental opposition to mining in the area has been encountered. Cobalt is classified as a strategic metal, and the United States is said to be about 16,000 metric tons below the stockpile goal.

COPPER

Copper has been one of the more important metals in the advance of modern industry and technology and is considered vital in electrical applications. Used primarily by ancient civilizations for jewelry, coinage, and weaponry, copper is used by modern society in thousands of applications because it possesses a versatility surpassed by few metals. More than 50 percent of the copper produced domestically is used in the electrical and communications industries, while another 40 percent is used in brass mills. Other materials may substitute for copper in some applications, such as aluminum in electrical equipment, automobile radiators, and refrigerator tubing; titanium and steel in heat exchangers; steel in artillery shell casings; optical fiber in telecommunications cable; and plastics in water pipe and plumbing fixtures. Copper is classified as a strategic and critical mineral.

The United States was the leading copper producing country between 1883 and 1981. Chile became the premier copper-mining

country in 1982, but the United States recaptured, at least temporarily, the top place again in 1988. Principal copper producing states are: Arizona, Utah, New Mexico, Montana, Nevada, and Michigan. About 25 percent of the total copper used in the United States is imported, mainly from Chile, Canada, and Peru.

Copper production, both worldwide and domestic, is expected to continue to increase slightly in the next few years. Demand for copper will continue to be unfavorably affected by the decision of telephone companies to switch to fiber optics. Offsetting the loss in this application, however, there has been a steady growth in the quantities of copper required for building wire, automotive wiring systems, motor windings, and other major applications for power distribution.

CRUSHED STONE AND DIMENSION STONE

Stone is an inclusive term that relates to products and materials ranging from highly finished exotic marble shapes to crushed and broken stone, and the quantity of stone produced is greater than that of any other mineral mined in the United States. Approximately two-thirds of U.S. crushed stone is used in road, railroad, and bridge construction. Other uses are concrete aggregate, cement production, chemical lime production, agriculture, and metallurgical flux. A minor but growing use for limestone is in the removal of sulfur oxides from stack gases, mainly from coal-burning plants. Limestone is the major type of domestic crushed stone, normally accounting for over 75 percent of production tonnage. Limestone is followed by granite, traprock, sandstone, and shell; approximately 80 percent of the crushed limestone is produced east of the Mississippi River. Numerous sources of limestone and dolomite are present throughout eastern and southern Nevada and small quantities of crushed stone for use in the cement and agricultural industries are produced from deposits in Clark and Elko counties. The largest limestone mining operation in the state at this time is near Fernley, Lyon County, where a deposit of fresh-water limestone is being mined as cement plant feed.

DIATOMITE

Diatomite is a silicious sedimentary rock that consists mainly of the fossilized remains of diatoms, forms of microscopic unicellular organisms. Many sedimentary rocks contain diatom remains, but the term "diatomite" is restricted to material of a quality and purity suitable for commercial uses. Pure diatomite is composed of opaline or hydrous silica and in addition most deposits contain unusually high amounts of free water. Diatomite is characterized by its generally light colors and extreme lightness of weight. Diatomite is particularly susceptible to diagenetic

changes caused by leaching and redeposition as opal, chert, or porcelaneous silica. After such changes have occurred, the deposits can rarely be considered commercial.

Almost all of the uses for diatomite are based upon its unique natural microscopic cellular structure, but because of wide variations in origin, geologic history, and content of impurities, any single deposit may have only a limited or nonexistent value and not necessarily be competitive with nearby deposits. Testing and evaluating of diatomite samples is a highly developed and complicated process which is usually only practiced by diatomite producers; such services are not generally available through commercial assaying firms. There are literally hundreds of uses for diatomite and product specifications for these uses are extremely complicated and exacting. The industrial uses for diatomite include filtration, mineral filler or extender, insulation, absorbent, mild abrasive, and process applications such as brick, admixture or pozzolan for cementitious mixtures, and conditioning agent to prevent caking.

The United States is the world's largest producer and consumer of diatomite and, in 1987, exported diatomite to 50 other countries. Major U.S. producers are located in California, Nevada, Oregon, and Washington. California, in 1987, accounted for over 50 percent of the U.S. production. In terms of dollar value, diatomite was the second most important industrial mineral produced in Nevada in 1988. Four companies ship diatomite from Nevada; three are located in a relatively small area in the northern part of the state. One of these plants, at Colado in Pershing County, exports filter-grade diatomite worldwide.

World resources of diatomite are large and deposits are known on six continents. Current world requirements for diatomite are met primarily by supplies from the United States, France, Denmark, and possibly the U.S.S.R. U.S. diatomite reserves can easily meet cumulative domestic demands in the foreseeable future and World demands are also estimated to be adequate. The need for diatomite near markets, however, encourages development of new sources for the material.

FELDSPAR

Feldspar is the general name given to members of a group of closely related potassium-, sodium-, and calcium-aluminum-silicate minerals (potash, soda, and lime feldspars). Feldspar is one of the most abundant materials in the world, and a virtually inexhaustible supply is available.

Feldspar, usually of the potash or soda type or in mixtures of the two, is used in the manufacture of glass and ceramics where it acts as a flux. In glassmaking, feldspar also provides a source of

alumina which enhances the workability of the product, inhibits any tendency toward devitrification, and increases its chemical stability. Other uses for feldspar include abrasives and scouring soaps.

The United States is a net exporter of feldspar; major production comes from North Carolina (70 percent) with five other states providing smaller quantities.

Identified and hypothetical resources of feldspar are more than adequate to meet anticipated world demands. There is ample geologic evidence that resources are immense although not always conveniently accessible from the principal centers of consumption.

FLUORSPAR

Fluorine is a pale-yellow, corrosive gas; fluorine resources are widely distributed around the world in various combined forms, the most important of which is the mineral fluorite (CaF_2), or fluorspar. Fluorspar has been known since Greek and Roman times, when it was used in drinking cups and ornamental vases and slabs. Its usefulness as a metallurgical flux was recognized and described by Agricola in 1556; this use today represents nearly 60 percent of total fluorine demand. Other major consumers of fluorine are the world's aluminum smelters and chemical industries which together account for about one-third of total demand. Minor amounts of fluorine are also consumed in many diverse end-products that range from portland cement and fiberglass to synthetic blood and water fluoridation. Fluorspar is classified as a strategic and critical mineral.

U.S. fluorine production has fallen short of domestic demand since the early 1950's, resulting in a high reliance on foreign sources. Two producers in southern Illinois account for over 90 percent of domestic output. Small shipments from Nevada and Texas account for the remainder. The domestic supplies are supplemented by mainly by imports from Mexico and South Africa.

There is no substitute for fluorspar in many of its varied industrial applications and fluorspar will remain in great demand for the foreseeable future. Projected rates of consumption indicate all currently known fluorite deposits will be depleted by the year 2000 unless new resources of fluorite or alternative sources of fluorine are found.

GEM STONES

Commercial gem stone mining in the United States has never been extensive. While more than 60 gem minerals and materials have been produced commercially from domestic sources, most of the

deposits are relatively small and contain semiprecious stones. For the most part, production lies in the hands of numerous hobbyists, small lapidary shops, and members of mineralogical and lapidary clubs.

Rocks, mineral specimens, and materials derived from organic action, such as pearl, amber, jet, and coral, are included in the category of gem stones. No sharp distinction exists between precious and semiprecious gems. Customarily, diamond, ruby, sapphire, and emerald are considered precious stones and all other gems, semiprecious. The term "gem stone" refers to a material suitable for personal adornment, and the most important qualities of gem stones are beauty, durability, and rarity. Of all the mineral species, only about 100 possess all of the attributes required in gems. Silicate minerals, such as beryl, topaz, tourmaline, and feldspar, furnish the greatest number. Oxide minerals such as corundum (ruby and sapphire) and quartz (amethyst, agate, opal, etc.) make up the second largest group. Phosphate minerals yield only turquoise and variscite. Pearl is ranked high as a gem and, from the point of view of value, diamond (a form of the element carbon) has the highest rank of all gems.

The United States has no known reserves of precious gem stones, although occasional finds of diamonds have been made. Numerous domestic deposits of semiprecious gem stones are known and have been mined for many years. In 1987, U.S. output of natural gems was primarily fresh-water pearls from Tennessee, turquoise from Arizona and Nevada, tourmaline from Maine, and tourmaline, kunzite, and garnet from California. Other domestic production includes jade and opal from several western states, star garnet from Idaho, and jade from Alaska.

GEOTHERMAL RESOURCES

The potential market demands of geothermal resources are heavily dependent upon the cost of competitive energy systems. Inasmuch as the value of competitive energy is based upon economics, the inherent uncertainty of the future economics greatly impacts attempts to evaluate geothermal resources and the market demand.

Geothermal resources can be divided into three categories based on the cost of recovery: submarginal geothermal resources; paramarginal geothermal resources; and geothermal reserves.

The submarginal geothermal resources are recoverable only at a cost that is more than two times the current price of competitive energy. Paramarginal geothermal resources are recoverable at a cost between one and two times the current price of competitive energy. Geothermal reserves are competitive now with other commercial energy resources.

The cost of geothermal power can be broken down into seven component costs: exploration, land acquisition, production wells, fluid transportation facilities, plants, fluid disposal, and money. The range and uncertainty of these costs are critical in determining whether development of a given field is feasible. Its value is primarily controlled by the market demand. At today's costs, only high-temperature geothermal reserves are considered feasible to develop. With advanced technology, many areas of intermediate temperature resources may also become feasible to develop in the future.

It is important to note that thermal water can only be transmitted a few kilometers economically in considering potential uses of low- to intermediate-temperature resources. This makes many geothermal resources submarginal to paramarginal for commercial use by local power companies. A use must be available at the site, and in many cases, the only market for relatively low temperature geothermal resources are private individuals who live near thermal sites. For the low-temperature geothermal energy that can be recovered from these resources, only a limited demand exists at present time. Typical uses for this resource, at present, include space heating, greenhouses, recreation, and agriculture. As the cost of competitive energy increases and as recovery systems become more technologically efficient, the market demand for all geothermal resources is expected to increase. As costs become more competitive with conventional energy systems, the local power companies may find it profitable to develop the geothermal resources for use within nearby small communities.

GOLD

Treasured since ancient times for its beauty and permanence, gold has emerged in the late 20th century as an essential industrial metal. The oldest use of gold, and still the most important in terms of quantity used, is its use in jewelry. Chemically inert toward most substances, gold does not tarnish or corrode in use. It is the most malleable of metals, is very ductile, has a bright, pleasing color, is highly reflective to infrared radiation and to most of the visible spectrum, alloys readily with common metals, and has a high electrical and thermal conductivity. Thus, in jewelry, gold is nonallergenic, remains tarnish-free indefinitely, and is relatively easy to fashion. For many of the same reasons, it has long been used in dentistry. Of the industrial uses of gold, the most important is its use in electronic devices, especially in printed circuit boards, connectors, keyboard contacts, and miniaturized circuitry. Gold brazing alloys are used in the aerospace industry and gold is used as a reflector of infrared radiation in radiant heating and drying devices and heat-insulating windows for large buildings. In specific reference to Nevada, gold is classified as a critical mineral.

The five major world gold producers are South Africa, the United States, Canada, Australia, and Brazil; these producers in 1988 produced a total of about 1,200 tonnes of gold, about 80 percent of total newly mined gold supplied to western markets. Nevada ranked first among the States of the United States, and accounted for 67 percent of total 1988 U.S. production. In 1989, Nevada production again showed substantial increases with preliminary figures showing over 5 million ounces of gold produced.

Gold production from all types of ore should increase in the next few years, but at a slower rate that has recently been experienced. Factors working against expansion of production within the U.S. include cost of meeting environmental standards, possible unfavorable changes in mining laws, withdrawal of public lands from prospecting, and new taxation and leasing measures. Also, many of the near surface deposits will approach depletion and it will become increasingly difficult to find entirely new deposits.

The dominant factor in world gold production is South Africa. It appears likely that gold production in that country will trend downward in the future, as the presently known ore bodies are depleted. Political instability will play a very important role in the future of South Africa's gold industry, along with higher costs of deep mining and depletion of reserves. The U.S.S.R. currently contributes about 20 percent of world gold output, and may also play an increasing role in future world gold production.

GRAPHITE

Graphite, also called plumbago and black lead, is a mineral form of crystallized, elemental carbon. Natural graphite is marketed in the form of crystalline graphite as flake, lump, chip, and dust, and in the form amorphous graphite in sizes from fine powder to lumps the size of walnuts. The largest uses for graphite are for carbon raising in the steel industry, for refractories, and for foundry casings. Graphite is also important as a lubricant and as an ingredient in special packings; the best known use of graphite, in pencils, accounts for only about 3 percent of the total demand. Other uses for graphite include dry batteries, brake and clutch linings, electric and generator motor brushes, paints, polish, rubber, and explosives. Graphite is classified as a strategic and critical mineral.

Graphite mining in the United States has always been a small-scale industry and, in 1987, there was no domestic production. Graphite deposits have been reported in 25 states and commercial quantities have been produced in 17. Flake graphite has been mined in Alabama, California, Massachusetts, New Jersey, New York, Pennsylvania, and Texas. Amorphous graphite has been mined in

Colorado, Georgia, Michigan, Nevada, New Mexico, North Carolina, Rhode Island, Utah, and Wisconsin. The most recent U.S production has been from Texas.

All domestic needs for natural graphite are now met through imports, mainly from Mexico, China, Brazil, and Madagascar. Because of the limited domestic resource outlook for most grades of graphite, especially coarse, crystalline flake, it appears that reliance on foreign sources for most U.S. requirements will continue. Rest-of world reserves of graphite are considered to be large and certainly capable of supplying the forecast needs of the world in the foreseeable future.

GYPSUM

Gypsum is the most common of the naturally occurring sulfate minerals. It is found in very extensive, bedded sedimentary deposits all over the world and is associated with limestones, shales, and sandstones, marls, and clays. Crude commercial gypsum is generally high-grade material, the major portion of which can be utilized with no beneficiation.

The mineral term "gypsum" is used as a commercial and generic term for all calcium sulfate materials, including anhydrite, gypsum, and selenite. All of these minerals, calcined gypsum (plaster), the product manufactured from them, as well as articles molded from the plaster, are called gypsum.

Gypsum, one of the most common building materials in use all over the world, is used for interior walls, partitions, and ceilings, either as plaster ore in prefabricated products such as wallboard. Crude gypsum is marketed for use in cement, agriculture, or fillers.

The United States is the leading gypsum-producing country, producing about 20 percent of the world total. U.S. consumption, however, is about 30 percent of the world total, and a considerable amount must be imported; imports come mainly from Canada, Mexico, and Spain. Leading gypsum-producing States in the U.S. are Texas, Michigan, Iowa, Oklahoma, California, and Nevada.

Domestic and foreign resources and reserves of gypsum are adequate for any foreseeable period of time. These reserves are not evenly distributed, however. There are no gypsum deposits on the eastern seaboard of the U.S., for example, and large imports form Canada must augment the domestic supply of crude ore in this industrial area.

IRON ORE

Iron ore is one of the more important mineral commodities in the world. The United States is one of the world's largest producers of iron ore, yet it imports nearly one-third of the primary iron required by the steel industry.

The Lake Superior district produces about 96 percent of the total United States output, with the remainder derived from six other states. Most of the ore is produced by large-scale, mechanized, open-pit operations in order to maintain competitive costs.

The world supply of iron ore continues to exceed demand, although world production and consumption have both increased slightly since 1986. The United States has a 47-year supply at average demand rates in the reserve category, with an additional supply in the resources category. In spite of this apparent self-sufficiency, a considerable amount of iron will continue to be imported for two major reasons: (I) most imports (66 percent) come from mines owned or controlled by American companies; and (2) the investment required to attain true self-sufficiency on lower-grade domestic ores would probably strain the capabilities of the steel industry, at least in the near future.

KYANITE GROUP ALUMINOUS MINERALS

The high-alumina, nonclay minerals of the kyanite, or sillimanite group provide a basic raw material for use in the production of mullite, a high-alumina refractory material that is exceptionally resistant to thermal shock and maintains its strength at high temperatures. The kyanite group consists of andalusite, kyanite, and sillimanite. Commonly included with the kyanite group are dumortierite and topaz along with pyrophyllite, pinite, and corundum. Pyrophyllite, owing to its soft, flaky nature, is most commonly used as a filler for paints, asphalt, rubber, and insecticides; pinite, a mixture of white mica and pyrophyllite, might well be used for the same purposes. Corundum, because of its hardness, is used as an abrasive. All three of these mineral, however, are of use in the production of mullite and other high-temperature refractories.

Immense resources of kyanite and related minerals are known to exist in the United States, chiefly in deposits of micaceous schist and gneiss in the Appalachian area and in Idaho. Most of these resources are not economical at present, but one mine, in Virginia, supplied all of the U.S. kyanite production in 1987. The U.S. is a net exporter of kyanite.

LEAD

Lead is the fifth major metal used in the world following iron, aluminum, copper, and zinc. The United States has been the leading lead producing country for several years, accounting for about 16 percent of the total mine production; however, the country is also the largest consumer of lead (about 25 percent of world demand), and thus is a net importer. Lead is classified as a strategic and critical mineral.

Lead is one of the oldest metals used by man; lead pipe was used in ancient Egypt, and the hanging gardens of Babylon were floored with sheets of lead. Many medieval buildings in Europe still stand under their original lead roofs. At present, the largest use for lead is in storage batteries. The second largest use is as the active component of gasoline antiknock additives; this usage is declining. Lead is also used in the construction, communications, ammunition, and electrical industries; and in paint, TV glass, ceramics, and as ballast.

The domestic mining industry is composed of about 30 major mines in 15 states with Missouri contributing 82 percent of the national output. Idaho, Colorado, and Utah add another 16 percent to lead production.

Lead is considered to be a strategic and critical material, and, as such, is one of the metals stockpiled by the General Services Administration. Although the domestic resource base is probably adequate to supply all domestic primary lead requirements through the year 2000, it is likely that dependence on imports will continue.

LIGHTWEIGHT AGGREGATES

This commodity, a specialty item mined in western Nevada, includes mainly pumiceous rhyolite. Other products used as lightweight aggregate, such as pumice and perlite, are described under those specific headings. Rhyolite used to produce lightweight aggregate is mined from several deposits in the Dayton and Reno areas. Nevada lightweight aggregate is mainly used in concrete and concrete blocks, but also finds use in base aggregate. Minor specialty uses for this product include the "stone" used to produce stone-washed denim.

Rhyolite lightweight aggregate could develop into an important local industry as the market for this product increases. Depletion of traditional sources of base gravel for highway and bridge gravel in urban areas will require sources to be developed at greater distances from the use area; in these cases, light-weight aggregate, with lower haulage costs per unit volume, will demand premium prices. The material will, however, need to pass stringent

strength and durability tests to allow it to substitute for standard-weight products.

MANGANESE

Manganese, an extremely critical material in an industrial economy, is essential in the production of virtually all steels and pig iron. The demand for manganese, therefore, varies in direct proportion with steel production in both the United States and the rest of the world. As presently defined, deposits must grade 35 percent manganese to be classified as ore reserves. The United States does not have significant domestic reserves of this grade, but there are an estimated 74 million tons in low-grade resource materials in Arizona, Arkansas, Colorado, Maine, and Minnesota. In 1976, the National Research Council concluded that the domestic land-based resources would not be developed except in times of emergency. The United States is virtually dependent upon foreign supplies except that portion which is obtained from government and industry stocks. Manganese is classified by the U.S. Bureau of Mines as a strategic and critical mineral.

MERCURY

Mercury, also known as quicksilver, was used by the Greeks as early as the fourth century B.C. Until the 16th century, however, consumption was small and chiefly for medicinal and cosmetic purposes. For several centuries following the discovery of rich silver and gold deposits in the Americas, large quantities of mercury were used in the amalgamation process to recover those metals from their ores. The history of mercury usage in the United States is also closely associated with gold and silver mining and usage rose in response to the development of California's early gold industry. Since about the time of World War I, however, significant quantities of mercury have been used in explosives, drugs, electrical apparatus, and instruments. The mercury cell process to produce caustic soda and chlorine became widespread following World War II and continues to be a major factor in mercury usage. Mercury is classified as a strategic and critical mineral.

Since the mid-1970's, Nevada has been a major source of U.S. mercury production and, in 1988, Nevada was the principal source of primary mercury production in the United States. Primary production was from one mine in Humboldt County and byproduct production came from six gold mines in Eureka, Humboldt, Mineral, Nye, Washoe, and White Pine Counties.

MICA

Sheet mica is used extensively in the electrical and electronic industries. Scrap, flake, and ground micas are used primarily in the construction industry, but uses also include well-drilling muds and high-quality paints. Principal commercial varieties of mica are muscovite and, to a lessor extent, phlogopite. Sheet mica is classified as a strategic and critical mineral.

Muscovite, the principal form of sheet mica is mined primarily in India and Brazil by hand labor from pegmatite deposits. Sheet mica production in the United States has declined to almost zero and most of the material from India and Brazil is exported to the U.S. for fabrication and use. The United States, however, is the major producer of scrap (flake) mica in the world and production continues to grow, owing to utilization of low-cost, mass-mining techniques. North Carolina produces about 60 percent of the U.S. output of scrap mica with the remainder being mined in Connecticut, Georgia, New Mexico, Pennsylvania, South Carolina, and South Dakota.

The United States has no economically recoverable reserves of sheet mica. Resources of scrap and flake mica are available in granite, pegmatite, schist, and clay deposits and are considered more than adequate to meet anticipated demand in the foreseeable future.

MOLYBDENUM

Molybdenum is a strategic element used principally as an alloying agent in steels, cast irons, and superalloys for hardening, strength, toughness, and resistance to wear and corrosion. Molybdenum finds significant usage as a refractory metal and in numerous chemical applications, including catalysts, lubricants, and pigments. Molybdenum is classified as a strategic and critical mineral.

Almost all molybdenum is recovered from low-grade deposits of the mineral molybdenite. Deposits mined primarily for molybdenum provide 65 to 70 percent of U.S. output and about 55 percent of world output. The remainder is obtained mainly as a byproduct from mining large, low-grade porphyry copper deposits. Molybdenum reserves and production capacity is concentrated in a few countries of the world. The U.S. is historically the world's leading producer, supplying about 63 percent of the total; the U.S., Canada, and Chile together supply about 87 percent of the world supply and the U.S.S.R. provides about an additional 10 percent. In 1987, identified resources amounted to about 19 billion pounds of molybdenum in the U.S. and about 46 billion pounds in the world. Resources of molybdenum are adequate to supply the world needs for the foreseeable future.

NICKEL

Nickel is vital to the iron and steel industry and plays a key role in the aerospace industry. Nickel's greatest value is in alloys with other elements where it adds strength and corrosion resistance over a wide range of temperatures. In addition to its use in alloys, nickel is used in chemicals and allied products, in petroleum refining, in batteries and fuel cells, in carbides and hard-facing materials, and in ceramics.
Nickel is classified as a strategic and critical mineral.

U.S. reserves of nickel are small, however the country possesses large resources that could be used if technological and environmental problems were resolved. The Hanna Mining Co, which operates an open pit mine and ferronickel smelter at Riddle, Oregon, is the only significant U.S. producer. Nickel is also produced in the U.S. as a byproduct of copper refining. The Sudbury area of Canada has remained the principal source of nickel in the world. World resources of lower-grade nickel deposits are very large and, in addition, there are extensive deepsea resources of nickel in manganese crusts and nodules covering large areas of ocean floor, particularly in the Pacific ocean.

OIL AND GAS

The majority of the world's known oil and gas resources occur outside the United States. The United States is no longer energy self-sufficient and about 40 to 50 percent of its oil supplies are imported.

Large reserves of oil and gas may exist in Nevada. In eastern Nevada, the known reserves of oil and gas occur at relatively shallow depths. Deep potential exists, however, within what is known as the Overthrust Belt. In this area, which includes a large part of eastern and southern Nevada, rocks favorable as sources and traps for oil are thought to be present at depth beneath thick sheets of usually barren rock.

PERLITE

Perlite, a glassy volcanic rock, has the unusual characteristic of expanding to about 20 times its original volume upon heating within its softening-temperature range. The resulting expanded product has a low density with attendant properties of low thermal conductivity and high sound absorption and is used in a variety of industrial and construction applications. The more important applications include abrasives, acoustical plaster and tile, charcoal barbecue base, concrete construction aggregates,

fertilizer extender, filter aid, insulation board filler, loose-fill insulation, and lightweight insulating concrete.

The United States is the world's principal producer and consumer of perlite, and the commodity has enjoyed continued growth in its brief history since initial commercial production in 1946.

Perlite occurs throughout much of the United States in Tertiary and Quaternary volcanic rocks. New Mexico supplies 88 percent of the domestic crude processed perlite to expanding plants throughout the United States. Most deposits are extensive enough to permit using low-cost, open-pit mining methods. Deposits of perlite in the United States occur in the western states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, and Utah.

Although imports of perlite from Greece have increased, the supply of perlite from domestic reserves is expected to adequately meet requirements for the foreseeable future.

PUMICE AND VOLCANIC CINDER

Pumice is a classic lightweight building material that has been extensively used since the time of the Roman Empire. The variety of applications of pumice and related volcanic materials (pumicite, scoria, and cinder) utilize the material's characteristic abrasiveness, inertness, and light weight.

Pumice is essentially an aluminum silicate of igneous origin with a cellular structure formed by a process of explosive volcanism. Pumicite, also called volcanic ash or dust, is a pumice subjected to additional volcanism whereby the cellular structure is broken down to form a very finely divided, unconsolidated material. Volcanic scoria and cinder are uncemented volcanic fragments formed from basic igneous magma (basalt). Compared with pumice, scoria and cinder are higher in density and darker in color.

Pumice and related volcanic materials are used both as crude ore and as carefully processed material. The principal end uses are abrasives for cleaning and scouring compounds, concrete aggregate, railroad ballast, road construction, and landscaping. Miscellaneous uses include absorbents, carriers for insecticides, herbicides, fungicides, soil conditioners, roofing granules, and lightweight refractory bricks.

Domestic supplies of pumice and related volcanic materials are available to meet overall requirements in most U.S. markets for the foreseeable future, especially in the western states. Market areas on the east coast are primarily supplied by imports from Greece and Italy.

QUARTZ CRYSTAL

Electronic-grade quartz crystal is a single-crystal silica that is free of all macroscopic defects and has piezoelectric properties that permit it to be used in electronic circuits for accurate frequency control, timing, and filtration. These uses generate practically all of the demand for electronic-grade quartz crystal. Natural electronic-grade quartz crystal, historically supplied by Brazil, was the leading form of quartz used by the electronics industry until 1971 when cultured quartz took the lead. Natural quartz feedstock, termed "lasca", is needed, however, to produce cultured quartz. Lasca, a Brazilian term, is composed of pure quartz chips and small crystals that do not meet specifications for electronic-grade crystal. Natural quartz crystal is classified as a strategic and critical mineral.

The United States has never produced enough natural electronic-grade quartz crystal to be self-sufficient, and production in recent years has been nonexistent. Only limited resources of quartz crystal suitable for electronic use are available throughout the world. Dependence on these resources will continue to decline due to increasing acceptance of cultured quartz crystal as an alternate material. This will, however, mean in increased dependence on lasca for growing cultured quartz. Lasca has been produced from mines in Arkansas, but these deposits were idle in 1987. Japan is the present world leader in the production of cultured quartz crystal but the U.S. cultured quartz industry has been expanding since 1987; at present, the U.S. depends on Brazilian lasca as feedstock for this quartz production.

SALINES AND BRINES

This category includes mineral products that, in Nevada and other western states located in the Basin and Range province, are commonly found in and recovered from playas and playa lakes. In this large inland area, playa sediments and brines have been the source of sodium compounds (sodium chloride, sodium carbonate, and sodium sulfate) and borax, and the brine from one is the world's largest supplier of lithium. In addition, playa sediments and brines are potential sources of potash, magnesium, calcium chloride, fluorine, tungsten, uranium, zeolites, and clays.

Sodium Compounds

Sodium compounds are of vital importance, both as an essential element of diet and as the source of chemicals required in many industrial products and processes. The natural sodium compounds of major importance are sodium chloride, sodium carbonate, and sodium sulfate. These sodium compounds are found in brines, in underground deposits, and as efflorescent deposits on dry lakes.

Common salt, or sodium chloride, is a plentiful mineral commodity. Besides the oceans, which contain inexhaustible quantities of dissolved salt, large amounts are found in underground deposits throughout the world. The United States has virtually unlimited resources of salt. Major domestic resources of rock salt and salt from brine are located in the northeast, central western, and southern Gulf Coast states. Saline lakes and solar evaporated salt facilities are close to populated regions in the western United States. About half of the salt produced in the United States is consumed by the chemical industry, and about 96 percent (in 1987) of the chemical use is for the manufacture of chlorine and caustic soda. Salt for highway deicing accounts for slightly over one-quarter of the domestic salt demand and the remainder is used for varied purposes including agricultural, food processing, and water treatment.

Common salt was one of the earliest mined materials in Nevada and large amounts were produced between 1860 and 1900 for use in processing silver ores from Virginia City and other bonanza camps. The salt was obtained by solar evaporation of natural or artificial brines, from surface crusts, and from older rock salt beds. Eagle and Sand Springs Marshes in Churchill County had the largest production but nearly 20 other localities were sources. In recent years, production has come from Sand Springs Marsh and is used mainly for road salt along with minor agricultural uses.

Sodium Carbonate (Soda Ash)

Sodium carbonate, known commercially as soda ash, is an important industrial mineral which is used principally in the glass and chemical industries. Natural soda ash produced in the United States comes from deposits of the mineral trona or from brines, but a number of other minerals are potential sources. The world's largest deposit of trona is in the Green River basin of Wyoming where it is mined underground by room-and-pillar methods from thick beds that are intermixed with halite. The United States is the largest producer and consumer of sodium carbonate and is a net exporter to the world market.

Over half of the sodium carbonate produced in the United States is used in the glass industry, chemicals account for about 20 percent of its use, and the remainder is used in soap and detergents, water treatment, flue gas desulfurization, and in the pulp and paper industry.

Sodium carbonate has been produced from brines at Soda Lakes in Churchill County and, to a lessor extent, from a surface crust at Double Spring Marsh in Mineral County. A large tonnage of gaylussite, a sodium-calcium carbonate mineral, is present in evaporite beds in Railroad Valley in Nye County. Gaylussite is not now a commercial source of sodium carbonate, but probably will become one in the future.

Sodium Sulfate

Sodium sulfate, known commercially as salt cake, is produced mainly from brines in California, Utah, and Texas. About half of the U.S. annual production is used in the manufacture of soap and detergents, about 40 percent is used in the pulp and paper industry, and the rest is used in glass manufacturing and other miscellaneous uses.

World sodium sulfate resources are sufficient to last hundreds of years at the present rate of consumption. In addition to the United States, major producing countries are Canada, Spain, Turkey, the U.S.S.R, and Argentina.

Nevada's sodium sulfate production came from Rhodes Marsh in Mineral County and Wabuska Marsh in Lyon County. Only minor production is recorded from these deposits, and they have been inactive since the 1930's.

Borates

The commercially important borate minerals are borax (tincal), kernite, ulexite, probertite, and colemanite. The most important commodities produced from borate minerals are borax, anhydrous borax, and boric acid, but the borate industry also produces many other boron compounds, and it ships quantities of crushed or partly processed borate minerals. About half of the borate consumed in the U.S. market is used in the manufacture of various kinds of glass. Other uses include insulating glass fibers, textile glass fibers, enamels, and glazes. A well-known and historic use, in soaps and detergents, accounts for only about 7 percent of the annual consumption.

Boron minerals occur in the few locations in the world where ideal combinations of a boron source (generally related to volcanic activity) and special topographic and climatic conditions have interacted to allow accumulation and preservation of deposits. All of the known U.S. deposits of boron minerals are concentrated in the Mojave Desert region of California and in western Nevada. The California deposits are mainly in two deposits, Kramer and Searles Lake, but deposits have also been mined in Death Valley. Deposits in Nevada, although inactive for many years, supplied most of the borate mineral raw material consumed in the United States between about 1873 and 1892. Borax minerals were recovered from marsh or playa lake deposits in Churchill, Mineral, and Esmeralda counties.

At the present time, the United States is the leading world producer and consumer of boron-containing minerals and chemicals. For many years, U.S. output has satisfied domestic requirements as well as a large share of foreign markets. Turkey, however, has

reserves which may be greater than those of the U.S., and in the future, may rival the U.S. as a world supplier.

SAND AND GRAVEL AND CRUSHED ROCK AGGREGATES

Aggregate is among the most important of the industrial materials in the United States. Annual consumption in the United States exceeds one billion tons and correlates closely with the health of the economy. In 1988, Nevada produced approximately 15.7 million tons of sand and gravel for use in the construction industry. Aggregate demand is expected to expand at the rate of 1.6 percent over the next few years nationwide and at a higher rate in some of the faster growing western states such as Nevada.

Aggregate resources (both basin-fill and rock sources) occur in abundance throughout Nevada. Within the sparsely populated areas outside of the Reno-Las Vegas urban zones, the majority of sand and gravel usage is for highway construction and maintenance and amounts to a little over one million tons per year. Projected usage is expected to rise due to increasing population, continued road construction, increasing mining activity, and possible future energy-related projects.

SILICA

Silica (SiO_2), as a naturally occurring commodity, is differentiated from sand and gravel. Sand and gravel are used mostly for construction purposes of relatively low value per unit volume, while silica has a wide variety of higher-value industrial applications. Silica is used in abrasives, glass manufacturing, chemicals, silicon alloys, foundry sand, furnace lining, and as a filter media. The most important source of silica is the mineral quartz, and those quartz deposits which have been cleaned and sorted by natural processes into nearly monomineralic deposits are economically the most desirable.

Silica sand is the most commonly mined variety of silica. Silica may also be produced as a byproduct of clay treatment or be mined from quartzite, sandstone, or igneous deposits such as pegmatites and quartz segregations. The volume of silica derived from such deposits is small, however, when compared to that obtained from the various types of silica sand and pebble deposits. The main types of silica sand deposits are stream, marine and lake, glacial, and residual. Windblown deposits, although common and widespread throughout the world, are of relatively minor importance.

Silica deposits in the United States are sufficient to sustain industry needs indefinitely, based on present requirements.

SILVER

Silver has a profile quite similar to gold. Silver is also relatively scarce and, though not as scarce as gold, its durability and desirability have allowed it to retain a comparable position as a medium of exchange or monetary base. In addition, major uses for silver are in photography, sterlingware, and electrical contacts and conductors. Jewelry, arts, and crafts also account for a substantial use of silver, especially in the western U.S. where large amounts are used as sterling silver jewelry, commonly handcrafted with turquoise by American Indians.
Silver is classified as a strategic and critical mineral.

Projections for silver production are relatively uncertain. The reason for such uncertainty is related to price. During many sustained periods production generally parallels that of gold; however, at other times, silver's photographic and industrial uses cause wide variances from the trends of other so-called precious metals. In 1987, the United States imported 57 percent of its silver needs, mainly from Canada, Mexico, the United Kingdom, and Peru.

Nevada is the nation's leading silver-producing State and, in 1989, reported production of 19.9 million ounces. Nevada silver production is likely to increase over the next several years, especially if precious metal prices remain attractive. A large share of the increase will be from byproduct silver produced from Nevada's expanding gold mining industry.

SULFUR

Sulfur is one of the most important of the industrial raw materials. In one way or another, it is of prime importance to every sector of the fertilizer and industrial complexes of the world. Sulfur in its various forms is produced worldwide, with no one country being a predominant producer or supplier to the world markets. The United States, however, is the largest producer and consumer of sulfur in the world. The major problem facing the domestic sulfur industry, and perhaps the world industry as well, is a very probable change in the major sources of sulfur supply. The necessity of removing sulfur from solid, liquid, and gaseous industrial wastes for environmental reasons will create a large volume of "coproduct" sulfur that could replace traditional mined sources. At the present time, most of the U.S. sulfur production comes from sulfur deposits associated with salt domes in the Gulf coast region, and from the processing of sour natural gas and oil.

TALC

The mineral talc, a hydrous magnesium silicata, can be distinguished from most other minerals because it is both exceedingly soft and chemically inert. In a commercial sense, the term "talc" also refers to a mixture of minerals, predominantly magnesium silicates, in which the mineral talc may or may not be a prominent constituent. Soapstone is a term used for a massive form of rock containing the mineral talc in quantities ranging from nearly pure to as little as 50 percent. Ordinary usage, however, usually restricts the term "soapstone" to impure, massive talcose rock, while the high-purity massive talc is called steatite. Much of the talc of commerce consists largely of the hard mineral tremolite. Both the mineral and the commercial material range widely in color and the ease with which they can be broken and ground.

Commercial talc is used mostly as an extender in paints, and as an ingredient in the manufacture of paper and various ceramic products including tile, whiteware, and electrical insulators. An increasing use for talc is in light weight plastics which can replace certain steel parts in the automobile industry. Talc is used as a filler that enhances certain desirable properties of the plastic matrix and also acts as a reinforcing agent that by strengthening the plastic matrix, allowing smaller amounts to be used.

The United States is self-sufficient in most grades of talc and related minerals, and is a net exporter of these products. In 1987, 27 talc mines in 9 states accounted for the U.S. domestic production; production from Montana, New York, Texas, and Vermont provided 95 percent of the total production.

TITANIUM

Titanium is used in the United States in both its oxide and metallic form. Two titanium bearing minerals are of interest. Ilmenite is rather common and is used to produce most titania pigment. Rutile is more scarce, but it is more versatile, and is the necessary raw material for producing titanium sponge metal. These two major uses account for over 96 percent of domestic consumption of titanium. Other uses of titanium-bearing raw materials are for manufacturing welding-rod coatings, titanium carbides, ceramics, and chemicals. The titanium-bearing minerals are found as detrital minerals in sand deposits or as primary minerals in rock deposits. The sand deposits are placer concentrations, almost always at or near the coast, in which rutile and ilmenite commonly, but not always, occur together. In rock deposits, ilmenite is the mineral of consequence and rutile is rarely found in economic concentrations. All the ilmenite produced in the United States comes from Florida, New Jersey, and New York;

rutile localities are in Arizona, Arkansas, California, North Carolina, South Carolina, Tennessee, and Virginia.

Titanium is classified as a strategic and critical mineral. Rutile, however, is the only titanium mineral included in the list of strategic and critical minerals, and no other minerals have been purchased by the government for stockpiling.

The United States is a major importer of titanium ore. About 39 percent of imported titanium ore is ilmenite and the rest is rutile. Most of the United States' mined titanium is from the eastern states; most imports come from Australia.

TUNGSTEN

Tungsten is unique for having the highest melting point of any metal and tungsten retains its hardness in alloy form at elevated temperatures. Until about 1900, the main use the main use for tungsten was as a hardening agent in tungsten-manganese steel. The demand for tungsten steel for use in armaments during World War I caused the first important increase in world-wide tungsten exploration and mining. Sintered tungsten carbide was developed for use in cutting tool and drilling bits in the 1920's, and tungsten carbide is now the largest industrial use for tungsten. Many of the uses of tungsten are basic to a modern, diversifying technology and consequently the metal should continue to be a critical commodity of worldwide importance. Molybdenum can be substituted for tungsten in tool steels; titanium carbide, combined with molybdenum, nickel, or cobalt can be used in cutting tools; and industrial diamonds can be substituted for certain applications. For some uses, such as filaments for electric lamps, however, no adequate substitutes are now available. Tungsten is classified as a strategic and critical mineral.

More than 90 percent of the world's estimated tungsten resources are located outside the United States, with about 50 percent located in China. In times of favorable market conditions, domestic tungsten production generally ranges from one-third to two-thirds of U.S. demand and needs are augmented by imports mainly from China, Canada, Bolivia, Portugal, Australia, Austria, Brazil, and Korea with smaller amounts from many other countries.

Ninety percent of the tungsten produced in the United States has historically been obtained from California and Colorado with Nevada ranking third in production. Most of the tungsten produced was recovered with molybdenum as a by-product (California) or with tungsten as a by-product of molybdenum (Colorado). United States reserves are relatively small and their production, in part, is dependent on the demand for molybdenum as a coproduct. No major primary tungsten mines have operated within the United States since late 1982.

Tungsten is an important strategic material necessary for defense purposes. The General Services Administration (GSA) remains a major factor in the supply/demand equation. The strategic stockpile goal is now about 25,000 metric tons and, in late 1987, there were about 464 metric tons in excess of this which are available for future disposal. With no new mine production, concentrate for domestic consumption has been supplied from stockpile sales; when stockpile excesses are depleted, market conditions could favor mine reopenings. Should additional stockpile material be released for sale, however, tungsten prices could remain too low to support domestic mining.

URANIUM

Uranium is available for use in two forms; enriched uranium and depleted uranium. Depleted uranium is a byproduct of the uranium enrichment process and, in the United States, uranium enrichment is performed only at Government-owned facilities. Simply stated, during the enrichment process, some of the naturally-fissionable uranium isotope (U_{235}) is removed from part of the uranium and added to another part. The resulting products are enriched uranium and depleted uranium. The depleted uranium is only mildly radioactive and it can be used as metallic uranium. As metallic uranium, its uses depend on its high density (almost as dense as gold), and its high chemical reactivity (it is pyophoric; it oxidizes rapidly-ignites in air-at room temperature). Under current DOE rules, customers with enrichment work done by DOE have the option of getting the depleted uranium back along with their enriched uranium; few customers take the depleted uranium, however, and ownership of most of it has reverted to DOE.

The major use of enriched uranium is as reactor fuel in electrical generating plants. Thus, as total energy demand compounds during future years, the requirements for uranium as a utility fuel should increase at a significant rate. Presently, nuclear energy in the United States is subject to severe political pressure for abandonment. However, such a concept may lose some of its appeal as hydrocarbon energy becomes increasingly scarce and costly in the 1990s. As the nation reappraises its energy options and recognizes the need for a revitalized nuclear energy program, demand may increase for new uranium deposits and reserves. There are, however, large deposits of uranium in Canada, Australia, and Africa which offer serious competition to the generally low-grade domestic deposits.

Historically, the use of depleted uranium has been minor compared with the use of uranium for energy applications. In recent years, however, the demand for uranium used in non-energy applications has approached that of enriched uranium. Depleted uranium is used primarily in the manufacture of armor-piercing

projectiles. Other uses include counterweights, radiation shielding, and catalysts in the aircraft, medical, and chemical industries. Although demand has increased rapidly in the past few years, available supply is far in excess of demand.

ZEOLITE

Although minerals of the zeolite group have been known for many years, the commercial utilization of natural zeolite became a possibility only in the late 1950's, when it was recognized that extensive deposits of zeolite are present in altered tuffaceous rocks in Nevada and adjoining states. Zeolite minerals are crystalline, hydrated aluminum silicates that contain exchangeable alkali or alkaline-earth cations. The framework of the mineral is honeycombed with large cavities that are accessible through smaller apertures and contain the exchangeable cations and the water molecules. Zeolite minerals include erionite, chabazite, mordenite, ferrierite, clinoptilolite, and phillipsite. Interest in natural zeolite for industrial applications is mainly centered on erionite, chabazite, mordenite, and ferrierite.

The physical properties that make zeolite useful include: the ability to lose and regain water of hydration with little change in structural state; the open structure with connecting apertures of definite size, which permit the mineral to pass or adsorb some molecules and exclude others; the ability to act as catalysts for some reactions; and the high ion exchange capacity. Industrial uses that take advantage of these properties include: as catalysts in the petroleum cracking industry; as molecular sieves for removal of water and other impurities from natural gas, jet fuel, and other petroleum and chemical products; and as an ion exchange agent for such uses as water purification. Other uses include soil conditioner, kitty litter, pesticide carrier, and lightweight aggregate and tile. One historic use was as a building material and many historic buildings in Nevada (the Nye County courthouse, for example) were constructed of zeolite rock.

Of the approximately 40 zeolite minerals, six of them, clinoptilolite, chabazite, erionite, analcime, mordenite, and phillipsite, occur in deposits in Nevada and either are being used in, or are known to have, potential industrial applications.

The U.S. Bureau of Mines does not compile statistics on either the production or consumption of zeolite minerals; however, as uses for this material increase, zeolite could become one of the major industrial minerals produced in Nevada.

ZINC

Zinc stands fourth among metals of the world in annual consumption, being surpassed only by steel, aluminum, and copper. It is exceedingly versatile and essential to modern living. About 75 percent of domestic demand used in protective coatings for steels and as die cast articles largely for the automobile industry. Other uses are as a chemical compound in rubber and paints. In the United States, zinc ores are widely distributed from Maine to the Rocky Mountains. Eighteen states have had some production and, in 1987, three states, Tennessee, New York, and Missouri, contributed 85 percent of the total domestic output. A new domestic zinc mine (the largest zinc mine in the world), the Red Dog mine in Alaska, is scheduled to began production in late 1989-early 1990 and will provide an addition to U.S. zinc supplies. Zinc is classified as a strategic and critical mineral.

Zinc is on the list of strategic and critical materials for emergency stockpiling. Reserves at the operating mines are sufficient to permit increased production on a short-term basis, but the limiting factor in metal production is inadequate smelter capacity. This has resulted in recent years in increasing imports of the metal. The chief suppliers of zinc to the United States are Canada, Peru, Mexico, and Honduras.

POTENTIAL FOR THE OCCURRENCE OF MINERAL RESOURCES, DISCUSSION BY COMMODITY

The following comments regarding mineral resources potential are organized by commodity. Each area discussed is shown on a map included within the mineral assessment map set. The general assessment category that each area is assigned applies only to the area outlined; no assessment is implied for lands outside the specific marked areas or, for the more general categories, outside of the district/area outlines. The definition of levels of mineral resource potential and levels of certainty of assessments generally followed in this section is patterned after that used by the U.S. Geological Survey in their wilderness study program. A chart showing the levels of potential and certainty and defining these terms is shown in Table 4.

COAL

There are no commercial deposits of coal in the BLM Carson City district. Attempts have been made, however, to mine low-grade deposits associated with lake deposits of Tertiary age near Washington, Lyon County; in Eldorado Canyon, Carson City; and near Verdi, Washoe County.

The inferred potential for the occurrence of coal resources at these sites is shown in Table 5.

OIL AND GAS

Nevada's petroleum potential can be predicted in a very general fashion on the basis of known production, shows of oil and gas, and proximity to areas of potential source and reservoir rocks. Areas of medium to high potential are located in the eastern part of the state, where most source rocks are found, and where these rocks have not been heated beyond the petroleum generation "window" to temperatures at which hydrocarbons have been destroyed. Western Nevada consists predominantly of fewer good source rocks which are mostly overmature or undermature (in the case of Tertiary sedimentary rocks not buried deep enough to generate petroleum). Small amounts of methane gas have been produced from some of the valley sediments in western Nevada, notably in the Fallon area, Churchill County. It is generally believed that this gas is generated by decomposing vegetation buried in recent lake deposits and that commercial quantities of gas are not likely to be present.

TABLE 4. DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

Definitions of Mineral Resource Potential

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

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

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

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

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

Levels of Certainty

LEVEL OF RESOURCE POTENTIAL →

<table>
<tr><td rowspan="4">U/A
UNKNOWN POTENTIAL</td><td>H/B
HIGH POTENTIAL</td><td>H/C
HIGH POTENTIAL</td><td>H/D
HIGH POTENTIAL</td></tr>
<tr><td>M/B
MODERATE POTENTIAL</td><td>M/C
MODERATE POTENTIAL</td><td>M/D
MODERATE POTENTIAL</td></tr>
<tr><td rowspan="2">L/B
LOW POTENTIAL</td><td rowspan="2">L/C
LOW POTENTIAL</td><td>L/D
LOW POTENTIAL</td></tr>
<tr><td>N/D
NO POTENTIAL</td></tr>
<tr><td>A</td><td>B</td><td>C</td><td>D</td></tr>
</table>

LEVEL OF CERTAINTY →

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

Abstracted with minor modifications from:

Taylor, R.B., and Steven, T. A., 1983, Definition of mineral resource potential: Economic Geology, v. 78, no. 6, p. 1268-1270.

Taylor, R. B., Stoneman, R. J., and Marsh, S. P., 1984, An assessment of the mineral resource potential of the San Isabel National Forest, south-central Colorado: U.S. Geological Survey Bulletin 1638, p. 40-42.

Goudarzi, G. H., compiler, 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report 84-0787, p. 7, 8.

TABLE 5. POTENTIAL FOR THE OCCURRENCE OF COAL RESOURCES
BLM Carson City District

Commodity	Mining district/area	Deposit type	Level of potential	L/C	30' by 60' quadrangle
coal	Eldorado	bedded	low	B	Carson City
coal	Peavine	bedded	low	B	Reno
coal	Washington	bedded	low	C	Walker Lake; Excelsior Mountains

TABLE 6. POTENTIAL FOR THE OCCURRENCE OF OIL AND GAS RESOURCES
BLM Carson City District

Commodity	Mining district/area	Deposit type	Level of potential	L/C	30' by 60' quadrangle
oil and gas	Carson Sink, Dixie Valley	oil and gas	low	C	Carson Sink, Fallon, Edwards Cr. Valley

The BLM Carson City district is considered to have very low to low oil and gas potential (Garside, 1987; Garside and others, 1988). The inferred potential for the occurrence of oil and gas within the BLM Carson City district is shown in Table 6.

GEOTHERMAL

Geothermal resources in Nevada are widespread and varied: the state has about 900 reported thermal springs and wells (Garside and Schilling, 1979). The higher-temperature resources are concentrated in northern Nevada, but many areas of the state have potential for low-to moderate-temperature resources. Data from thermal springs, water wells, and geothermal exploration wells listed in Garside and Schilling (1979) and Trexler and others (1983) have been used to estimate potential for geothermal resources within the BLM Carson City district. Geothermal resources within the NAS Fallon and associated Naval Bombing Ranges are reported in studies conducted by the Naval Weapons Center, China Lake, California; the results of these studies have been incorporated into resource estimates presented in this report. The inferred potential for the occurrence of geothermal resources within the BLM Carson City district is shown in Table 7.

TABLE 7. POTENTIAL FOR THE OCCURRENCE OF GEOTHERMAL RESOURCES
BLM Carson City District

Commodity	Mining district/area	Deposit type	Level of potential	L/C	30' by 60' quadrangle
geothermal resources	Dixie Hot Spring KGRA	geothermal	high	C	Edwards Cr. Valley
	Dixie Valley	geothermal	high	B	Edwards Cr. Valley
	Dixie Valley (KGRA's)	geothermal	high	D	Edwards Cr. Valley,
	Eagle Valley, Carson Valley	geothermal	moderate	B	Carson City, Smith Valley
	Eightmile Flat	geothermal	moderate	C	Fallon
	Fallon	geothermal	high	C	Fallon
	Gabbs Valley	geothermal	moderate	B	Walker Lake
	Hawthorne	geothermal	high	C	Walker Lake
	Hazen	geothermal	high	C	Reno
	Lahontan Basin	geothermal	moderate	B	Fallon, Carson Sink, Reno, Carson City
	Lee Hot Springs	geothermal	moderate	C	Fallon
	McCoy	geothermal	high	C	Edwards Cr. Valley
	Moana Springs	geothermal	high	D	Carson City, Reno
	Smith Creek Valley	geothermal	moderate	B	Smith Cr. Valley
	southern Dixie Valley	geothermal	moderate	B	Carson Sink, Fallon
	southern Walker Lake Basin	geothermal	moderate	B	Walker Lake, Excelsior Mountains
	Steamboat Springs	geothermal	high	D	Carson City
	Stillwater-Soda Lake	geothermal	high	C	Fallon, Carson Sink
	Truckee Meadows	geothermal	high	B	Carson City, Reno
	Wabuska Hot Spring	geothermal	high	D	Carson City
	Wabuska Marsh	geothermal	high	C	Carson City
	Warm Springs Valley	geothermal	moderate	B	Reno
	west Smith Valley	geothermal	moderate	B	Smith Valley
	Wilson Hot Springs	geothermal	high	C	Smith Valley

SALINES AND BRINES

Playas and playa deposits are common in western Nevada and they have been and are important sources of industrial minerals in the form of salines and brines (including sodium and potassiumminerals). Detailed exploration of Nevada playas has been rather limited and, with few exceptions, very little is known about their subsurface features. Information in Table 8, summarizing the inferred potential for the occurrence of salines and brines within the BLM Carson City district, has been obtained mainly from Papke (1976).

TABLE 8. POTENTIAL FOR THE OCCURRENCE OF SALINES AND BRINES
BLM Carson City District

Commodity	Mining district/area	Deposit type	Level of potential	L/C	30' by 60' quadrangle
borate	Salt Wells	evaporite	low	B	Fallon
borate, sodium chloride (halite)	Teels Marsh	evaporite	low	B	Excelsior Mountains
borate, sodium sulfate, sodium chloride (halite)	Rhodes Marsh	evaporite	moderate	B	Excelsior Mountains
salines and brines	Alkali Valley	evaporite	unknown	A	Excelsior Mountains
	Artesia Lake	evaporite	unknown	A	Smith Valley
	Carson Lake	evaporite	unknown	A	Fallon
	Churchill Valley	evaporite	unknown	A	Carson City

TABLE 8. POTENTIAL FOR THE OCCURRENCE OF SALINES AND BRINES (continued)
BLM Carson City District

Commodity	Mining district/area	Deposit type	Level of potential	L/C	30' by 60' quadrangle
salines and brines	Cold Spring Valley	evaporite	unknown	A	Reno
	Edwards Creek Valley	evaporite	unknown	A	Edwards Cr. Valley
	Gabbs Valley	evaporite	unknown	A	Walker Lake
	Garfield Flat	evaporite	unknown	A	Excelsior Mountains
	Huntoon Valley	evaporite	unknown	A	Excelsior Mountains
	Labou Flat	evaporite	unknown	A	Fallon
	Misfits Flat	evaporite	unknown	A	Carson City
	Rawhide Flats	evaporite	unknown	A	Fallon
	Smith Creek Valley	evaporite	unknown	A	Smith Cr. Valley
	Soda Spring Valley	evaporite	unknown	A	Excelsior Mountains
sodium carbonate	Double Spring Marsh	evaporite	low	B	Walker Lake
sodium carbonate, borate	Soda Lakes	evaporite	low	C	Carson Sink
sodium chloride (halite)	Carson Sink	evaporite	low	C	Carson Sink
	Sand Springs Marsh	evaporite	high	C	Fallon
sodium chloride (halite), sodium sulfate, sodium carbonate, borate	Dixie Marsh	evaporite	moderate	C	Edwards Cr. Valley
sodium sulfate	Wabuska Marsh	evaporite	moderate	B	Carson City

METALLIC MINERALS

Based on past production, information in the literature, and known mineral occurrences, there is potential for the discovery and/or future exploitation of deposits of at least fifteen metallic mineral commodities within the BLM Carson City district. Table 9 lists the inferred potential for the occurrence of these metallic mineral resources within the BLM Carson City district.

ALUNITE

Aluminum, in the form of the mineral alunite, occurs in many precious metals districts as an alteration mineral. It is considered to be low-grade aluminum resource, however, and is therefore included in this section. Two districts that may have, at best, low potential for development of alunite resources are Bovard and Rawhide.

ANTIMONY

The Bernice antimony district, in Churchill County, has been one of the largest and most consistent producers of antimony in Nevada. It contains unknown amounts of reserves and is inferred to have high potential for the discovery of additional antimony deposits. Three other districts within the BLM Carson City district have low to moderate potential for discovery and development of antimony resources.

TABLE 9. POTENTIAL FOR THE OCCURRENCE OF METALLIC MINERAL RESOURCES
BLM Carson City District

Commodity	Mining district/area	Deposit type	Level of potential	L/C	30' by 60' quadrangle
alunite	Bovard	quartz-alunite vein	low	B	Walker Lake
	Rawhide	quartz-alunite vein	low	B	Fallon
antimony	Bernice	vein antimony	high	C	Edwards Cr. Valley
	Pamlico	vein antimony	low	B	Excelsior Mountains
	Silver Star	vein antimony	low	B	Excelsior Mountains
	Wild Horse	vein antimony	moderate	B	Edwards Cr. Valley
copper	Bell	skarn	moderate	B	Ione Valley
	Benway	polymetallic vein	low to moderate	B	Fallon
		porphyry	low	B	Fallon
	Bovard	skarn	moderate	B	Walker Lake
	Buckley	skarn	moderate to high	C	Walker Lake
	Buckskin	porphyry	moderate to high	C	Carson City; Smith Valley
	Desert Mountains area	porphyry	low to moderate	B	Carson City
	Eastside area	polymetallic vein	low	B	Excelsior Mountains
		porphyry	low	C	Excelsior Mountains
	Gabbs Valley area	porphyry	moderate	B	Walker Lake
	Gardnerville	polymetallic vein	low to moderate	B	Smith Valley
	Garfield	skarn	low	B	Excelsior Mountains
	Mountain View	porphyry	low	C	Fallon; Walker Lake
	Peavine	porphyry	moderate to high	B	Reno
		skarn	low	B	Reno
	Red Canyon	skarn	low	B	Smith Valley
	Silver Star	skarn	low	B	Excelsior Mountains
	Stateline Peak	skarn	low	B	Reno
	Wedekind	porphyry	moderate to high	B	Reno
		skarn	low	B	Reno
	Yerington	porphyry	low to moderate	B	Carson City; Fallon; Smith Valley; Walker Lake
		porphyry	moderate to high	C	Carson City; Fallon; Smith Valley; Walker Lake
		skarn	low to moderate	B	Carson City; Fallon; Smith Valley; Walker Lake
copper, gold	Fitting	skarn	moderate	B	Walker Lake
	Freds Mountain area	polymetallic vein	low	B	Reno
		skarn	low	B	Reno
copper, lead, zinc, gold	Risue Canyon	polymetallic replacement	moderate	B	Smith Valley
copper, molybdenum	Chalk Mountain	porphyry	moderate	B	Fallon
	Fairview	porphyry	moderate	B	Fallon
	Santa Fe	porphyry	moderate	B	Excelsior Mountains; Tonopah; Walker Lake
copper, silver, gold	Pyramid	porphyry	low to moderate	B	Reno
copper, tungsten, gold	Whisky Flat	skarn	moderate	B	Excelsior Mountains
gold	Allen Hot Springs area	hot-spring	low to moderate	B	Fallon
	Bernice	sediment-hosted gold-silver	moderate	B	Edwards Cr. Valley
	Bovard	skarn	moderate	B	Walker Lake
	Buckley	skarn	moderate	B	Walker Lake
	Chalk Mountain	skarn	low to moderate	B	Fallon
	Corral Canyon	albitite dike gold-titanium	moderate	B	Edwards Cr. Valley
	Dead Camel Mountains area	hot-spring	low to moderate	C	Fallon
	Delaware	skarn	low to moderate	B	Carson City
	Gabbs Valley area	hot-spring	low to moderate	B	Ione Valley; Walker Lake
	Gardnerville	skarn	low to moderate	B	Smith Valley
	Garfield	skarn	moderate	B	Excelsior Mountains
	Lodi	skarn	moderate	B	Smith Cr. Valley
	Marietta	skarn	moderate	B	Excelsior Mountains
	Mount Grant	placer	low to moderate	C	Excelsior Mountains
	Mountain View	quartz-adularia vein	low to moderate	B	Fallon; Walker Lake
	Pamlico	sediment-hosted gold-silver	moderate	B	Excelsior Mountains; Walker Lake
		skarn	moderate to high	B	Excelsior Mountains; Walker Lake
	Peavine	skarn	low to moderate	B	Reno
	Pilot Mountains	sediment-hosted gold-silver	moderate	B	Tonopah
	Red Canyon	skarn	moderate	B	Smith Valley
	Red Mountain	skarn	low	B	Carson City
	Sand Springs	sediment-hosted gold-silver	low to moderate	B	Fallon
	Santa Fe	sediment-hosted gold-silver	high	C	Excelsior Mountains; Tonopah; Walker Lake
		skarn	moderate to high	B	Excelsior Mountains; Tonopah; Walker Lake
	Shady Run	sediment-hosted gold-silver	moderate to high	C	Carson Sink
	Silver Star	quartz-adularia vein	moderate to high	B	Excelsior Mountains
		quartz-alunite vein	moderate to high	B	Excelsior Mountains
	Steamboat Springs	hot-spring	low	B	Carson City
	Wedekind	skarn	low to moderate	B	Reno

TABLE 9. POTENTIAL FOR THE OCCURRENCE OF METALLIC MINERAL RESOURCES (continued)
BLM Carson City District

Commodity	Mining district/area	Deposit type	Level of potential	L/C	30' by 60' quadrangle
gold	Wild Horse	sediment-hosted gold-silver	moderate to high	B	Edwards Cr. Valley
	Yerington	quartz-adularia vein	low to moderate	B	Carson City; Fallon; Smith Valley; Walker Lake
gold, copper	Buckskin	polymetallic vein	low to moderate	B	Carson City; Smith Valley
	Eagleville	polymetallic vein	low to moderate	B	Fallon
	Gabbs Valley area	skarn	moderate	B	Ione Valley; Walker Lake
gold, lead, copper	Red Canyon	polymetallic replacement	moderate	B	Smith Valley
gold, silver	Aurora	quartz-adularia vein	high	C	Excelsior Mountains
	Bell	quartz-alunite vein	moderate	B	Ione Valley; Tonopah
	Bovard	quartz-alunite vein	moderate to high	B	Walker Lake
	Bruner	quartz-adularia vein	moderate to high	C	Smith Cr. Valley
	Castle Peak	quartz-alunite vein	low to moderate	B	Carson City
	Dixie Valley	quartz-adularia vein	high	C	Carson Sink
	Eagleville	quartz-adularia vein	moderate to high	B	Fallon
	Eastgate	quartz-adularia vein	moderate to high	B	Smith Cr. Valley
	Gold Basin	quartz-adularia vein	moderate to high	B	Fallon
	Holy Cross	quartz-alunite vein	moderate to high	B	Fallon
	Jumbo	quartz-adularia vein	moderate to high	B	Carson City
	La Plata	quartz-adularia vein	low to moderate	B	Fallon
	Lucky Boy	quartz-adularia vein	high	C	Excelsior Mountains
		quartz-alunite vein	high	C	Excelsior Mountains
	Masonic	quartz-adularia vein	moderate to high	B	Bridgeport
	Mount Montgomery	quartz-adularia vein	moderate	B	Benton Range
	Olinghouse	quartz-adularia vein	moderate	B	Reno
		quartz-alunite vein	moderate	B	Reno
	Pamlico	polymetallic vein	moderate	B	Excelsior Mountains; Walker Lake
	Ramsey	quartz-adularia vein	moderate to high	C	Carson City
		quartz-alunite vein	medium to high	C	Carson City
	Rawhide	quartz-adularia vein	high	C	Fallon
	Talapoosa	quartz-adularia vein	moderate to high	C	Carson City; Reno
		quartz-alunite vein	moderate to high	C	Carson City; Reno
	Tungsten Mountain	polymetallic vein	moderate	B	Edwards Cr. Valley
	Washington	polymetallic vein	low	B	Bridgeport; Excelsior Mountains; Walker Lake
	Wedekind	quartz-alunite vein	low to moderate	B	Reno
	Wellington	sediment-hosted gold-silver	moderate to high	B	Smith Valley
	Wilson	quartz-adularia vein	moderate to high	B	Smith Valley; Walker Lake
gold, silver, copper	Como	quartz-adularia vein	moderate to high	B	Carson City
	Delaware	polymetallic vein	low	B	Carson City
	Desert Mountains area	polymetallic vein	low to moderate	B	Carson City
	Mountain House	skarn	moderate	B	Smith Valley
	Peavine	quartz-alunite vein	low to moderate	B	Reno
	Voltaire	polymetallic vein	low to moderate	B	Carson City
	Yerington	polymetallic vein	low to moderate	B	Carson City; Fallon; Smith Valley; Walker Lake
gold, silver, lead	Mountain House	polymetallic vein	low to moderate	B	Smith Valley
gold, silver, lead, copper	King	polymetallic vein	moderate to high	B	Fallon
	Mount Grant	polymetallic vein	low to moderate	B	Walker Lake; Excelsior Mountains
	Red Mountain	polymetallic vein	low	B	Carson City
iron	Buckley	skarn	high	C	Walker Lake
	Buckskin	skarn	moderate to high	B	Carson City; Smith Valley
	Chalk Mountain	skarn	low	B	Fallon
	Copper Kettle	skarn	moderate to high	B	Carson Sink
	Delaware	skarn	moderate	C	Carson City
	Marietta	skarn	low	B	Excelsior Mountains
	Red Mountain	skarn	high	D	Carson City
	Santa Fe	skarn	low	B	Excelsior Mountains
lead, silver, zinc	Chalk Mountain	polymetallic replacement	moderate to high	B	Fallon
lead, zinc, silver	Galena	polymetallic vein	moderate to high	B	Carson City
manganese	Delaware	epithermal manganese	low	B	Carson City
mercury	Castle Peak	hot-spring	moderate	B	Carson City
	Clark-Derby area	hot-spring	low	A	Reno
	Eastside area	replacement, disseminated	low to medium	B	Excelsior Mountains
	Gabbs Valley area	hot-spring	low to moderate	B	Ione Valley; Walker Lake
	Holy Cross	quartz-alunite vein	moderate	B	Fallon
	Pilot Mountains	replacement, disseminated	moderate to high	C	Tonopah
	Sand Springs	replacement, disseminated	moderate	B	Fallon
	Steamboat Springs	hot-spring	low to moderate	C	Carson City
	Wild Horse	replacement, disseminated	moderate	C	Edwards Cr. Valley
molybdenum	Gardnerville	porphyry	high	C	Smith Valley
	La Plata	porphyry	low to moderate	B	Fallon
	Lodi	porphyry	moderate	B	Smith Cr. Valley
nickel, cobalt, copper	Table Mountain	synorogenic-synvolcanic nickel-copper	low	B	Edwards Cr. Valley
silver	Bell Mountain	quartz-adularia vein	moderate to high	C	Fallon

TABLE 9. POTENTIAL FOR THE OCCURRENCE OF METALLIC MINERAL RESOURCES (continued)
BLM Carson City District

Commodity	Mining district/area	Deposit type	Level of potential	L/C	30' by 60' quadrangle
silver, copper, lead	Garfield	polymetallic vein	moderate	B	Excelsior Mountains
	La Plata	polymetallic vein	low	B	Fallon
silver, copper, lead, zinc	Pilot Mountains	polymetallic replacement	low to moderate	B	Tonopah
silver, gold	Alpine	quartz-adularia vein	moderate to high	B	Edwards Cr. Valley; Smith Cr. Valley
	Broken Hills	quartz-alunite vein	moderate to high	B	Fallon
	Clark-Derby area	quartz-adularia vein	moderate	A	Reno
		quartz-alunite vein	moderate	A	Reno
	Comstock	quartz-adularia vein	moderate to high	C	Carson City
	Fairview	quartz-adularia vein	moderate to high	B	Fallon
	Fitting	quartz-adularia vein	moderate	B	Walker Lake
	Huntoon Valley area	polymetallic vein	moderate	B	Excelsior Mountains
	I.X.L.	polymetallic vein	moderate	B	Carson Sink
		skarn	moderate	B	Carson Sink
	Sand Springs	quartz-adularia vein	moderate	B	Fallon
	Wonder	quartz-adularia vein	moderate to high	B	Fallon
silver, gold, lead	Lucky Boy	polymetallic vein	moderate	B	Excelsior Mountains
silver, gold, lead, copper	Red Canyon	polymetallic vein	moderate	B	Smith Valley
silver, gold, lead, copper, antimony, zinc	Candelaria	polymetallic replacement	high	C	Excelsior Mountains
silver, gold, lead, zinc	Holy Cross	polymetallic vein	moderate to high	B	Fallon
silver, lead, gold	Marietta	polymetallic vein	moderate	B	Excelsior Mountains
silver, lead, zinc	Bell	polymetallic replacement	moderate	B	Ione Valley; Tonopah
	Lodi	polymetallic replacement	moderate to high	B	Ione Valley; Smith Cr. Valley
	Wilson	polymetallic replacement	moderate	B	Smith Valley
silver, lead, zinc, copper	Gabbs (Downeyville)	polymetallic replacement	moderate to high	B	Ione Valley
titanium	Corral Canyon	albitite dike gold-titanium	low	B	Edwards Cr. Valley
	Freds Mountain area	placer	low	B	Reno
tungsten	Bell	skarn	moderate to high	B	Ione Valley; Tonopah
	Buckley	skarn	high	B	Walker Lake
	Churchill	skarn	low to moderate	B	Carson City
	Delaware	skarn	moderate	C	Carson City
	Fairview	skarn	low to moderate	B	Fallon
	Fitting	skarn	low	B	Walker Lake
	Galena	skarn	low	B	Carson City
	Gardnerville	skarn	high	C	Smith Valley
	La Plata	skarn	low	B	Fallon
	Leonard	skarn	moderate to high	C	Fallon
	Lodi	skarn	high	C	Smith Cr. Valley
	Lucky Boy	skarn	low	B	Excelsior Mountains
	Marietta	skarn	moderate	B	Excelsior Mountains
	Masonic	skarn	low to moderate	B	Bridgeport
	Mount Montgomery	skarn	low	B	Benton Range
	Mountain House	skarn	low	B	Smith Valley
	Olinghouse	skarn	low	B	Reno
	Pilot Mountains	skarn	high	D	Tonopah
	Red Mountain	skarn	low to moderate	B	Carson City
	Risue Canyon	skarn	low	B	Smith Valley
	Sand Springs	skarn	moderate	B	Fallon
	Santa Fe	skarn	moderate	B	Excelsior Mountains; Tonopah; Walker Lake
	Silver Star	vein tungsten	low to moderate	B	Excelsior Mountains
	Tungsten Mountain	skarn	high	C	Edwards Cr. Valley
	Wellington	skarn	low	B	Smith Valley
	Wilson	skarn	low	B	Smith Valley

COPPER

The Yerington district, historically the second-largest copper-producing district in Nevada, contains known copper resources as well as moderate to high potential for the discovery of additional copper resources. Sixteen other districts within the BLM Carson City district have potential, ranging from low to high, for the discovery of polymetallic vein, skarn, and porphyry deposits of copper. In many of these districts, gold and silver are potential coproducts; in at least two, either copper or iron could be the major product depending on market conditions. Many of the copper skarn occurrences within the BML Carson City district contain trace element associations that, in other areas, are indicative of the presence of skarn gold deposits.

GOLD

Sixty six mining districts within the BLM Carson City district have potential, ranging from low to high, for the discovery and development of gold resources. Much of this resource is inferred to be in quartz-adularia and quartz-alunite vein occurrences, but there is potential for the discovery and development of hot-spring, sediment-hosted, skarn, and polymetallic vein occurrences in many locations within the Carson City district. In many cases, areas with favorable potential for gold deposits occur far beyond the defined limits of known mining districts. Insufficient information is available on these areas, however, to assign potential classifications to them.

IRON

Iron resources are known to exist in three mining districts within the BLM Carson City; low to high potential for the discovery of additional iron resources may be present in these three and seven other mining districts within the BLM Carson City district. Several of these areas have potential for coproduct resources of copper and gold.

LEAD

Lead, as a primary resource, has been assigned moderate to high potential for discovery and production in only two districts. Lead, however, commonly occurs as a major coproduct in many silver-lead-zinc polymetallic vein and replacement deposits and potential exists in numerous districts for the discovery and exploitation of occurrences of these types.

MANGANESE

Manganese occurs in association with many metallic mineral deposits within the BML Carson City district. In most of these, however, it is a weathering product of primary gangue minerals and does not constitute a potential metallic resource. One primary manganese deposit has low potential for development of small quantities of manganese.

MERCURY

There is low to high potential for the discovery and development of mercury resources in at least eight separate mining districts and areas within the BLM Carson City district. Many of these districts have potential for the discovery of hot-spring type mercury deposits, but replacement, disseminated deposits may also

be present. Bulk-minable precious metals deposits could also be present in some of these districts and, in these deposits, mercury could be potentially valuable as a coproduct.

MOLYBDENUM

There is low to moderate potential for the discovery and development of porphyry molybdenum deposits in at least three districts and molybdenum could occur as an important coproduct in at least three additional districts.

NICKEL, COBALT

Occurrences of these two metals, associated with copper, are reported only in the Table Mountain district of Churchill County. While ore has been produced from the district, the deposits are very small and the potential for discovery and development of new resources of cobalt and/or nickel is assessed at very low.

SILVER

There is inferred potential, from low to high, for the discovery and development of silver resources in at least eighteen separate districts within the BML Carson City district. In addition to these districts, where silver would be the primary commodity with potential gold and sometimes lead and zinc coproducts, silver also is a potential coproduct in most, if not all, of the primary gold districts. Much of the silver potential is inferred to be in quartz-adularia, quartz-alunite, polymetallic vein, and polymetallic replacement deposits. Moderate potential exists, however, for silver in skarn deposits in at least one district.

TITANIUM

Although titanium is reported to occur in two districts within the BLM Carson City district, these deposits are small and the areas are inferred to have only low potential for the development of significant titanium resources.

TUNGSTEN

Important resources of tungsten are known to be present in at least one district within the BLM Carson City district and low to moderate potential is inferred to exist for the discovery and development of tungsten resources in at least twenty five additional districts. With only one exception, all of these areas

are inferred to have potential for development of resources in skarn deposits.

ZINC

Zinc is not given a potential rating as a primary product in any area within the BLM Carson City district. Zinc is a potentially valuable coproduct in polymetallic vein, polymetallic replacement, and skarn deposits in many occurrences but, in most of these, silver, lead, copper, or sometimes tungsten would be the potential primary metal.

URANIUM

Low to moderate potential for the discovery and development of small-sized, low-grade uranium resources may exist in at least five mining districts within the BLM Carson City district. Table 10 lists these areas.

TABLE 10. POTENTIAL FOR THE OCCURRENCE OF URANIUM RESOURCES
BLM Carson City District

Commodity	Mining district/area	Deposit type	Level of potential	L/C	30' by 60' quadrangle
uranium	Marietta	vein uranium	low	B	Excelsior Mountains
uranium	Olinghouse	stratabound uranium	low	B	Reno
uranium	Pyramid	volcanogenic uranium	moderate	B	Reno
uranium	Stateline Peak	stratabound uranium	low to moderate	B	Reno
uranium	Washington	vein uranium	low	B	Excelsior Mountains; Walker Lake; Bridgeport

NONMETALLIC MINERALS/INDUSTRIAL MINERAL RESOURCES

Occurrences of about nineteen nonmetallic/industrial mineral commodities have been documented within the BLM Carson City district. Information on a few of these commodities is so sparse that their resource potential is unknown. For most, however, low to high potential may exist for the discovery and development of additional resources. Table 11 lists inferred resource potential for the known types of nonmetallic/industrial mineral resources within the BLM Carson City district.

BARITE

Moderate to high potential is inferred for the discovery and development of additional resources of bedded barite in one district within the BLM Carson City district and low to high

TABLE 11. POTENTIAL FOR THE OCCURRENCE OF INDUSTRIAL MINERAL RESOURCES

BLM Carson City District

Commodity	Mining district/area	Deposit type	Level of potential	L/C	30' by 60' quadrangle
barite	Buckley	vein barite	moderate	B	Walker Lake
	Candelaria	bedded	moderate to high	B	Excelsior Mountains
	Eagleville	vein barite	moderate to high	C	Fallon
	Fitting	vein barite	low to moderate	B	Walker Lake
	Pamlico	bedded	low to moderate	B	Walker Lake
clay	Castle Peak	hot-spring	low	B	Carson City
	Desert Mountains area	bedded	unknown	A	Carson City
	Fitting	bedded	low to moderate	B	Walker Lake
	Steamboat Springs	hot-spring	low	B	Carson City
	Virginia Range, Carson Range, southern Pah Rah Range	bedded	unknown	A	Carson City, Reno
clay (halloysite)	Sand Pass area	bedded	high	C	Kumiva Peak
clay (illite)	Wonder	quartz adularia vein	unknown	A	Fallon
clay (montmorillonite)	Hawthorne area	bedded	moderate	B	Walker Lake
	Rhodes Marsh	bedded	moderate	B	Excelsior Mountains
	Soda Spring Valley	bedded	moderate	B	Excelsior Mountains
diatomite	Basalt	bedded	high	C	Benton Range
	Bell	bedded	moderate	C	Ione Valley
	Clark Station	bedded	high	C	Reno
	Comstock	bedded	moderate	C	Carson City
	Dead Camel Mountains area	bedded	moderate to high	B	Fallon
	Desert Mountains	bedded	unknown	A	Carson City
	Desert Mountains area	bedded	unknown	A	Carson City
	Dicalite Summit area	bedded	moderate to high	C	Tonopah
	Hazen	bedded	high	C	Reno
	Russell Pass area	bedded	moderate to high	B	Fallon
	southern Pah Rah Range	bedded	moderate to high	B	Reno
	Washington	bedded	low	B	Walker Lake, Excelsior Mountains
	Wilson	bedded	unknown	A	Smith Valley
dimension stone	Carson	bedded	high	C	Carson City
feldspar	Stateline Peak	intrusive	low	B	Reno
flagstone	Aurora	bedded	moderate	B	Excelsior Mountains
fluorspar	Broken Hills	vein fluorspar	moderate to high	C	Fallon
	I.X.L.	replacement fluorspar	moderate	C	Carson Sink
	Mount Montgomery	vein fluorspar	moderate	B	Benton Range
	Wellington	replacement fluorspar	low	B	Smith Valley
gem stone (turquoise)	Bovard	vein and nodule turquoise	unknown	A	Walker Lake
	Eastside area	vein and nodule turquoise	low	B	Excelsior Mountains
	Pilot Mountains	vein and nodule turquoise	moderate to high	B	Tonopah
	Silver Star	vein and nodule turquoise	unknown	A	Excelsior Mountains
	Yerington	vein and nodule turquoise	moderate	B	Carson City
gem stone (wonderstone)	Dead Camel Mountains area	bedded	moderate	B	Fallon
graphite	Fitting	vein	low	B	Walker Lake
	Voltaire	metamorphic, disseminated	low	B	Carson City
gypsum	Mound House	bedded	high	D	Carson City
	Yerington	bedded	moderate	C	Smith Valley
kyanite group aluminous minerals	Buckskin	metamorphic, disseminated	low	C	Smith Valley
	Fitting	metamorphic, disseminated	moderate to high	C	Walker Lake
lightweight aggregates	Castle Peak	intrusive	high	C	Carson City
	Flowery Range	intrusive	high	C	Carson City
	Virginia Range, Carson Range, southern Pah Rah Range	intrusive	unknown	A	Carson City, Reno
marble	Garfield	bedded	low	B	Excelsior Mountains
marble (terrazo)	Santa fe	bedded	moderate	B	Walker Lake
marl	Sand Pass area	bedded	high	C	Kumiva Peak
mica	Fitting	skarn	low	B	Walker Lake
perlite	Aurora	bedded	moderate	B	Excelsior Mountains
	Sand Pass area	bedded	unknown	A	Kumiva Peak
	Truckee Canyon	bedded	unknown	A	Reno
	Wellington	bedded	unknown	A	Smith Valley
	White Throne Mountain	bedded	moderate to high	B	Fallon
	Wilson	bedded	unknown	A	Smith Valley

TABLE 11. POTENTIAL FOR THE OCCURRENCE OF INDUSTRIAL MINERAL RESOURCES (continued)
BLM Carson City District

Commodity	Mining district/area	Deposit type	Level of potential	L/C	30' by 60' quadrangle
pumice	Pilot Mountains	bedded	moderate	B	Excelsior Mountains
	Rainbow Mountain	bedded	high	C	Fallon
quartz crystal	Eagleville	skarn	low	B	Fallon
	Eagleville	skarn	low	B	Walker Lake
quartz crystal	Pamlico	skarn	low	B	Excelsior Mountains
silica	Gabbs Valley area	bedded	moderate	C	Walker Lake
silica	Lucky Boy	quartz segregation	moderate	B	Excelsior Mountains
	Pine Grove Hills	quartz segregation	moderate	B	Smith Valley
	Steamboat Springs	hot-spring	moderate	B	Carson City
silica, silver, gold	Gardnerville	quartz-adularia vein	high	C	Smith Valley
sulfur	Steamboat Springs	hot-spring	low	C	Carson City
talc	Lodi	skarn	low to moderate	B	Smith Cr. Valley
volcanic cinder	Flowery Range	bedded	high	B	Carson City
	Jumbo	bedded	high	C	Carson City
	Steamboat Springs	bedded	high	C	Carson City
zeolite	Eastgate	bedded	high	C	Smith Cr. Valley
	Smoke Creek Desert area	bedded	unknown	A	Kumiva Peak

resource potential for the discovery and development of deposits of vein barite may be present in three other districts.

CLAY

Potential for the discovery and development of several varieties of clay may exist in at least nine areas within the BLM Carson City district. Most inferred levels of potential are low to moderate, but there may be high potential for development of additional resources of halloysite clay in the Sand Pass area of Washoe County. Other areas, such as the Desert Mountains of Lyon County, continue to record clay production but so little information is available on the mode and extent of the occurrence that it can only be rated as "unknown".

CRUSHED STONE AND DIMENSION STONE

Deposits of crushed stone, dimension stone, flagstone, or marble are reported from four districts within the BLM Carson City district. Additional resources may exist in these districts.

DIATOMITE

Extensive deposits of diatomite are known to be present in the general area of Clark Station, Fernley, and Hazen, Storey, Lyon, and Churchill counties. This area has high potential for the development of additional diatomite resources. The geologic setting of the entire Lahontan basin is favorable for discovery

of diatomite, but too little information is available to assign anything but an "unknown" potential rating. Other areas favorable for discovery and development of diatomite resources are located along the southern and eastern borders of Mineral County.

FELDSPAR

Feldspar is a common accessory mineral in granitic rocks but it has been reported as a mineral commodity in only one deposit within the BLM Carson City district. This area is inferred to have low potential for development of feldspar resources.

FLUORSPAR

Four mining districts within the BLM Carson City district are inferred to have low to high potential for the discovery and development of additional fluorspar resources.

GEM STONES

Five separate mining areas within the BLM Carson City district have low, moderate, or high potential for the discovery of additional amounts of gem turquoise. Wonderstone is reported from one district.

GRAPHITE

Graphite is reported to be present in two widely separated areas within the BLM Carson City district. While one of these occurrences produced small quantities of graphite over several years, neither area is assessed at having more than low potential for the discovery of additional graphite resources.

GYPSUM

Gypsum is mined from one location within the BLM Carson City district and, in the past, has been mined from two other deposits. These three areas are assessed as having moderate to high potential for the discovery and development of additional gypsum resources.

KYANITE GROUP ALUMINOUS MINERALS

Minerals of this group occur in two separate districts within the BLM Carson City district. Each area is inferred to have only low potential for the development of minable resources of these commodities.

LIGHTWEIGHT AGGREGATES

In this area, this commodity category is generally restricted to pumaceous rhyolitic rocks which are known to occur as small plugs and domes in the Virginia, Carson, Flowery, and southern Pah Rah Ranges. There is high potential for the development of additional resources of this type adjacent to the known producing areas and the entire area of the listed mountain ranges is inferred to have moderate to high potential for similar discoveries.

MICA

Mica has not been mined from the BLM Carson City district. It is reported present as a specific commodity in only one area, and is inferred to have only low potential for the development of minable resources.

PERLITE

Moderate to high potential exists in at least two localities within the BLM Carson City district for the development of perlite resources. Other localities could be present within the extensive areas of volcanic rock within the district, but not enough is known of these areas to allow them to be classified.

PUMICE AND VOLCANIC CINDER

Moderate to high potential exists in at least two localities within the BLM Carson City district for the development of resources of pumice and volcanic cinder. Other localities could be present within the extensive areas of volcanic rock within the district, but not enough is known of these areas to allow them to be classified.

QUARTZ CRYSTAL

Quartz crystal, as a unique commodity, is reported in only two areas within the BLM Carson City district. Neither of these areas has reported production of quartz crystal, and both are inferred to have low potential for the development of minable resources of quartz crystal.

SILICA

Low to moderate potential for development of resources of silica is inferred to be present in four areas within the BLM

Carson City district, and high potential is present in one additional area. Other resources could be present, especially in some of the areas of dune sand in Churchill County, but too little information is available to allow potential ratings to be assigned to any of these areas.

SULFUR

Sulfur is present in hot-spring deposits at Steamboat Springs in Washoe County, and could be present in other similar occurrences. The Steamboat Springs occurrence has low potential for the development of sulfur resources.

TALC

Low to moderate potential for the development of minable resources of talc minerals may be present in skarn deposits in the Lodi district, Nye County.

ZEOLITE

High potential for the development of zeolite resources is present in the Eastgate district of Churchill County. Zeolite minerals are known to be present in the Smoke Creek Desert area of Washoe County, but too little is known of the occurrences to allow resource potential classifications to be assigned.

SAND AND GRAVEL AND CRUSHED ROCK AGGREGATES

Most of the alluvial-covered areas along the lower flanks of the mountain ranges in the BLM Carson City district as well as alluvium deposited by the Truckee, Walker, and Carson rivers and their tributaries contain potential sand and gravel resources. Terrace sand and gravel deposits left along the various levels of ancient Lake Lahontan provide a resource potential that may sometime be of more than local value. These materials, however, do not have unique values, other than location in relation to potential markets, and no single deposit will be far superior to any other in the economics of its operation or in the final product obtained. Because of their low unit value, sand and gravel deposits are generally not transported long distances, however, and sand and gravel operations in the BLM Carson City district will continue to be developed as close to consuming areas as possible. Since deposits of sand and gravel are more or less ubiquitous and their potential for development will depend on market and political situations; no potential ratings can be assigned.

POTENTIAL FOR THE OCCURRENCE OF MINERAL RESOURCES, DISCUSSION BY 30' BY 60' QUADRANGLE

The following comments regarding mineral resources potential are organized by 30' by 60' quadrangle map; mining districts and areas are described alphabetically within each quadrangle. Adjacent and related districts and areas are sometimes discussed together for clarity. Each area discussed is shown on a map included within the mineral assessment map set. The general assessment category that each area is assigned applies only to the area outlined; no assessment is implied for lands outside the specific marked areas or, for the more general categories, outside of the district/area outlines. Table 12 lists the mineral resources potential, by mining district and commodity, for each of the fourteen 30' by 60'quadrangles within the BLM Carson City district.

BENTON RANGE 30' BY 60' QUADRANGLE

MOUNT MONTGOMERY DISTRICT

This district has had only limited mining activity; one small skarn tungsten occurrence, several small precious-metals-bearing quartz vein deposits, and vein deposits of fluorite are found in the district. The most recent work in the district has been precious metals exploration.

The district has low potential for development of skarn tungsten deposits, moderate potential for discovery of vein or stockworks deposits of precious metals, and moderate potential for discovery of small deposits of vein fluorite.

BRIDGEPORT 30' BY 60' QUADRANGLE

MASONIC DISTRICT

The historic mines of the Masonic district are located in Mono County, California, west of the BLM, Carson City District boundary. Mining at Masonic, California, was done on epithermal, precious-metals-bearing quartz veins formed along north- and northeast-trending shear zones and breccias in altered volcanic rocks. Exploration is currently underway in the Masonic area for

TABLE 12. POTENTIAL FOR THE OCCURRENCE OF MINERAL RESOURCES, LISTED BY 30' BY 60' QUADRANGLE AND MINING DISTRICT

BLM Carson City District

Mining district/area	Deposit type	Commodity	Level of potential	L/C
Benton Range				
Basalt	bedded	diatomite	high	C
Mount Montgomery	quartz-adularia vein	gold, silver	moderate	B
	skarn	tungsten	low	B
	vein fluorspar	fluorspar	moderate	B
Bridgeport				
Masonic	quartz-adularia vein	gold, silver	moderate to high	B
	skarn	tungsten	low to moderate	B
Washington	polymetallic vein	gold, silver	low	B
	vein uranium	uranium	low	B
Carson City				
Buckskin	polymetallic vein	gold, copper	low to moderate	B
	porphyry	copper	moderate to high	C
	skarn	iron	moderate to high	B
Carson	bedded	dimension stone	high	C
Castle Peak	hot-spring	clay	low	B
	not-spring	mercury	moderate	B
	intrusive	lightweight aggregates	high	C
	quartz-alunite vein	gold, silver	low to moderate	B
Churchill	skarn	tungsten	low to moderate	B
Churchill Valley	evaporite	salines and brines	unknown	A
Como	quartz-adularia vein	gold, silver, copper	moderate to high	B
Comstock	bedded	diatomite	moderate	C
	quartz-adularia vein	silver, gold	moderate to high	C
Delaware	epithermal manganese	manganese	low	B
	polymetallic vein	gold, silver, copper	low	B
	skarn	gold	low to moderate	B
	skarn	iron	moderate	C
	skarn	tungsten	moderate	C
Desert Mountains	bedded	diatomite	unknown	A
Desert Mountains area	bedded	clay	unknown	A
	bedded	diatomite	unknown	A
	polymetallic vein	gold, silver, copper	low to moderate	B
	porphyry	copper	low to moderate	B
Eagle Valley, Carson Valley	geothermal	geothermal resources	moderate	B
Eldorado	bedded	coal	low	B
Flowery Range	bedded	volcanic cinder	high	B
	intrusive	lightweight aggregates	high	C
Galena	polymetallic vein	lead, zinc, silver	moderate to high	B
	skarn	tungsten	low	B
Jumbo	bedded	volcanic cinder	high	C
	quartz-adularia vein	gold, silver	moderate to high	B
Lahontan Basin	geothermal	geothermal resources	moderate	B
Misfits Flat	evaporite	salines and brines	unknown	A
Moana Springs	geothermal	geothermal resources	high	D
Mound House	bedded	gypsum	high	D
Ramsey	quartz-adularia vein	gold, silver	moderate to high	C
	quartz-alunite vein	gold, silver	medium to high	C
Red Mountain	polymetallic vein	gold, silver, lead, copper	low	B

TABLE 12. POTENTIAL FOR THE OCCURRENCE OF MINERAL RESOURCES, LISTED BY 30' BY 60' QUADRANGLE AND MINING DISTRICT (continued)
BLM Carson City District

Mining district/area	Deposit type	Commodity	Level of potential	L/C
Carson City (continued)				
Red Mountain	skarn	gold	low	B
	skarn	iron	high	D
	skarn	tungsten	low to moderate	B
Steamboat Springs	bedded	volcanic cinder	high	C
	geothermal	geothermal resources	high	D
	hot-spring	clay	low	B
	hot-spring	gold	low	B
	hot-spring	mercury	low to moderate	C
	hot-spring	silica	moderate	B
	hot-spring	sulfur	low	C
Talapoosa	quartz-adularia vein	gold, silver	moderate to high	C
	quartz-alunite vein	gold, silver	moderate to high	C
Truckee Meadows	geothermal	geothermal resources	high	B
Virginia Range, Carson Range,	bedded	clay	unknown	A
southern Pah Rah Range	intrusive	lightweight aggregates	unknown	A
Voltaire	metamorphic, disseminated	graphite	low	B
	polymetallic vein	gold, silver, copper	low to moderate	B
Wabuska Hot Spring	geothermal	geothermal resources	high	D
Wabuska Marsh	evaporite	sodium sulfate	moderate	B
	geothermal	geothermal resources	high	C
Yerington	polymetallic vein	gold, silver, copper	low to moderate	B
	porphyry	copper	low to moderate	B
	porphyry	copper	moderate to high	C
	quartz-adularia vein	gold	low to moderate	B
	skarn	copper	low to moderate	B
	vein and nodule turquoise	gem stone (turq.)	moderate	B
Carson Sink				
Carson Sink	evaporite	sodium chloride (halite)	low	C
Carson Sink, Dixie Valley	oil and gas	oil and gas	low	C
Copper Kettle	skarn	iron	moderate to high	B
Dixie Valley	quartz-adularia vein	gold, silver	high	C
I.X.L.	polymetallic vein	silver, gold	moderate	B
	replacement fluorspar	fluorspar	moderate	C
	skarn	silver, gold	moderate	B
Lahontan Basin	geothermal	geothermal resources	moderate	B
Shady Run	sediment-hosted gold-silver	gold	moderate to high	C
Soda Lakes	evaporite	sodium carbonate, borate	low	C
southern Dixie Valley	geothermal	geothermal resources	moderate	B
Stillwater-Soda Lake	geothermal	geothermal resources	high	C
Edwards Cr. Valley				
Alpine	quartz-adularia vein	silver, gold	moderate to high	B
Bernice	sediment-hosted gold-silver	gold	moderate	B
	vein antimony	antimony	high	C
Carson Sink, Dixie Valley	oil and gas	oil and gas	low	C
Corral Canyon	albitite dike gold-titanium	gold	moderate	B
	albitite dike gold-titanium	titanium	low	B
Dixie Hot Spring KGRA	geothermal	geothermal resources	high	C
Dixie Marsh	evaporite	sodium chloride (halite), sodium sulfate, sodium carbonate, borate	moderate	C

TABLE 12. POTENTIAL FOR THE OCCURRENCE OF MINERAL RESOURCES, LISTED BY 30' BY 60' QUADRANGLE AND MINING DISTRICT (continued)

BLM Carson City District

Mining district/area	Deposit type	Commodity	Level of potential	L/C
Edwards Cr. Valley (continued)				
Dixie Valley	geothermal	geothermal resources	high	B
Dixie Valley (KGRA's)	geothermal	geothermal resources	high	D
Edwards Creek Valley	evaporite	salines and brines	unknown	A
McCoy	geothermal	geothermal resources	high	C
Table Mountain	synorogenic-synvolcanic nickel-copper	nickel, cobalt, copper	low	B
Tungsten Mountain	polymetallic vein	gold, silver	moderate	B
	skarn	tungsten	high	C
Wild Horse	replacement, disseminated	mercury	moderate	C
	sediment-hosted gold-silver	gold	moderate to high	B
	vein antimony	antimony	moderate	B
Excelsior				
Alkali Valley	evaporite	salines and brines	unknown	A
Aurora	bedded	flagstone	moderate	B
	bedded	perlite	moderate	B
	quartz-adularia vein	gold, silver	high	C
Candelaria	bedded	barite	moderate to high	B
	polymetallic replacement	silver, gold, lead, copper, antimony, zinc	high	C
Eastside area	polymetallic vein	copper	low	B
	porphyry	copper	low	C
	replacement, disseminated	mercury	low to medium	B
	vein and nodule turquoise	gem stone (turquoise)	low	B
Garfield	bedded	marble	low	B
	polymetallic vein	silver, copper, lead	moderate	B
	skarn	copper	low	B
	skarn	gold	moderate	B
Garfield Flat	evaporite	salines and brines	unknown	A
Huntoon Valley	evaporite	salines and brines	unknown	A
Huntoon Valley area	polymetallic vein	silver, gold	moderate	B
Lucky Boy	polymetallic vein	silver, gold, lead	moderate	B
	quartz segregation	silica	moderate	B
	quartz-adularia vein	gold, silver	high	C
	quartz-alunite vein	gold, silver	high	C
	skarn	tungsten	low	B
Marietta	polymetallic vein	silver, lead, gold	moderate	B
	skarn	gold	moderate	B
	skarn	iron	low	B
	skarn	tungsten	moderate	B
	vein uranium	uranium	low	B
Mount Grant	placer	gold	low to moderate	C
	polymetallic vein	gold, silver, lead, copper	low to moderate	B
Pamlico	polymetallic vein	gold, silver	moderate	B
	sediment-hosted gold-silver	gold	moderate	B
	skarn	gold	moderate to high	B
	skarn	quartz crystal	low	B
	vein antimony	antimony	low	B
Pilot Mountains	bedded	pumice	moderate	B
Rhodes Marsh	bedded	clay (montmorillonite)	moderate	B
Rhodes Marsh	evaporite	borate, sodium sulfate, sodium chloride (halite)	moderate	B
Santa Fe	porphyry	copper, molybdenum	moderate	B
	sediment-hosted gold-silver	gold	high	C
	skarn	gold	moderate to high	B
	skarn	iron	low	B
	skarn	tungsten	moderate	B

TABLE 12. POTENTIAL FOR THE OCCURRENCE OF MINERAL RESOURCES, LISTED BY 30' BY 60' QUADRANGLE AND MINING DISTRICT (continued)

BLM Carson City District

Mining district/area	Deposit type	Commodity	Level of potential	L/C
Excelsior (continued)				
Silver Star	quartz-adularia vein	gold	moderate to high	B
	quartz-alunite vein	gold	moderate to high	B
	skarn	copper	low	B
	vein and nodule turquoise	gem stone (turquoise)	unknown	A
	vein antimony	antimony	low	B
	vein tungsten	tungsten	low to moderate	B
Soda Spring Valley	bedded	clay (montmorillonite)	moderate	B
	evaporite	salines and brines	unknown	A
southern Walker Lake Basin	geothermal	geothermal resources	moderate	B
Teels Marsh	evaporite	borate, sodium chloride (halite)	low	B
Washington	bedded	coal	low	C
	bedded	diatomite	low	B
	polymetallic vein	gold, silver	low	B
	vein uranium	uranium	low	B
Whisky Flat	skarn	copper, tungsten, gold	moderate	B
Fallon				
Allen Hot Springs area	hot-spring	gold	low to moderate	B
Bell Mountain	quartz-adularia vein	silver	moderate to high	C
Benway	polymetallic vein	copper	low to moderate	B
	porphyry	copper	low	B
Broken Hills	quartz-alunite vein	silver, gold	moderate to high	B
Broken Hills	vein fluorspar	fluorsoar	moderate to high	C
Carson Lake	evaporite	salines and brines	unknown	A
Carson Sink, Dixie Valley	oil and gas	oil and gas	low	C
Chalk Mountain	polymetallic replacement	lead, silver, zinc	moderate to high	B
	porphyry	copper, molybdenum	moderate	B
skarn	gold	low to moderate	B	
	skarn	iron	low	B
Dead Camel Mountains area	bedded	diatomite	moderate to high	B
	bedded	gem stone (wonderstone)	moderate	B
	hot-spring	gold	low to moderate	C
Eagleville	polymetallic vein	gold, copper	low to moderate	B
	quartz-adularia vein	gold, silver	moderate to high	B
	skarn	quartz crystal	low	B
	vein barite	barite	moderate to high	C
Eightmile Flat	geothermal	geothermal resources	moderate	C
Fairview	porphyry	copper, molybdenum	moderate	B
	quartz-adularia vein	silver, gold	moderate to high	B
	skarn	tungsten	low to moderate	B
Fallon	geothermal	geothermal resources	high	C
Gold Basin	quartz-adularia vein	gold, silver	moderate to high	B
Holy Cross	polymetallic vein	silver, gold, lead, zinc	moderate to high	B
	quartz-alunite vein	gold, silver	moderate to high	B
	quartz-alunite vein	mercury	moderate	B
King	polymetallic vein	gold, silver, lead, copper	moderate to high	B
La Plata	polymetallic vein	silver, copper, lead	low	B
	porphyry	molybdenum	low to moderate	B
	quartz-adularia vein	gold, silver	low to moderate	B
	replacement fluorspar	fluorspar	low to moderate	B
	skarn	tungsten	low	B
Labou Flat	evaporite	salines and brines	unknown	A
Lahontan Basin	geothermal	geothermal resources	moderate	B
Lee Hot Springs	geothermal	geothermal resources	moderate	C
Leonard	skarn	tungsten	moderate to high	C
Mountain View	porphyry	copper	low	C
	quartz-adularia vein	gold	low to moderate	B
Rainbow Mountain	bedded	pumice	high	C

TABLE 12. POTENTIAL FOR THE OCCURRENCE OF MINERAL RESOURCES, LISTED BY 30' BY 60' QUADRANGLE AND MINING DISTRICT (continued)
BLM Carson City District

Mining district/area	Deposit type	Commodity	Level of potential	L/C
Fallon (continued)				
Rawhide	quartz-adularia vein	gold, silver	high	C
	quartz-alunite vein	alunite	low	B
Rawhide Flats	evaporite	salines and brines	unknown	A
Russell Pass area	bedded	diatomite	moderate to high	B
Salt Wells	evaporite	borate	low	B
Sand Springs	quartz-adularia vein	silver, gold	moderate	B
	replacement, disseminated	mercury	moderate	B
	sediment-hosted gold-silver	gold	low to moderate	B
	skarn	tungsten	moderate	B
Sand Springs Marsh	evaporite	sodium chloride (halite)	high	C
southern Dixie Valley	geothermal	geothermal resources	moderate	B
Stillwater-Soda Lake	geothermal	geothermal resources	high	C
White Throne Mountain	bedded	perlite	moderate to high	B
Wonder	quartz adularia vein	clay (illite)	unknown	A
	quartz-adularia vein	silver, gold	moderate to high	B
Yerington	polymetallic vein	gold, silver, copper	low to moderate	B
	porphyry	copper	low to moderate	B
	porphyry	copper	moderate to high	C
	quartz-adularia vein	gold	low to moderate	B
	skarn	copper	low to moderate	B
Ione Valley				
Bell	bedded	diatomite	moderate	C
	polymetallic replacement	silver, lead, zinc	moderate	B
	quartz-alunite vein	gold, silver	moderate	B
	skarn	copper	moderate	B
Bell	skarn	tungsten	moderate to high	B
Gabbs (Downeyville)	polymetallic replacement	silver, lead, zinc, copper	moderate to high	B
Gabbs Valley area	hot-spring	gold	low to moderate	B
	hot-spring	mercury	low to moderate	B
	skarn	gold, copper	moderate	B
Lodi	polymetallic replacement	silver, lead, zinc	moderate to high	B
Kumiva Peak				
Sand Pass area	bedded	clay (halloysite)	high	C
	bedded	marl	high	C
	bedded	perlite	unknown	A
Smoke Creek Desert area	bedded	zeolite	unknown	A
Reno				
Clark Station	bedded	diatomite	high	C
Clark-Derby area	hot-spring	mercury	low	A
	quartz-adularia vein	silver, gold	moderate	A
	quartz-alunite vein	silver, gold	moderate	A
Cold Spring Valley	evaporite	salines and brines	unknown	A

TABLE 12. POTENTIAL FOR THE OCCURRENCE OF MINERAL RESOURCES, LISTED BY 30' BY 60' QUADRANGLE AND MINING DISTRICT (continued)
BLM Carson City District

Mining district/area	Deposit type	Commodity	Level of potential	L/C
Reno (continued)				
Freds Mountain area	placer	titanium	low	B
	polymetallic vein	copper, gold	low	B
	skarn	copper, gold	low	B
Hazen	bedded	diatomite	high	C
	geothermal	geothermal resources	high	C
Lahontan Basin	geothermal	geothermal resources	moderate	B
Moana Springs	geothermal	geothermal resources	high	D
Olinghouse	quartz-adularia vein	gold, silver	moderate	B
	quartz-alunite vein	gold, silver	moderate	B
	skarn	tungsten	low	B
	stratabound uranium	uranium	low	B
Peavine	bedded	coal	low	B
	porphyry	copper	moderate to high	B
	quartz-alunite vein	gold, silver, copper	low to moderate	B
	skarn	copper	low	B
	skarn	gold	low to moderate	B
Pyramid	porphyry	copper, silver, gold	low to moderate	B
	volcanogenic uranium	uranium	moderate	B
southern Pah Rah Range	bedded	diatomite	moderate to high	B
Stateline Peak	intrusive	feldspar	low	B
	skarn	copper	low	B
	stratabound uranium	uranium	low to moderate	B
Talapoosa	quartz-adularia vein	gold, silver	moderate to high	C
	quartz-alunite vein	gold, silver	moderate to high	C
Truckee Canyon	bedded	perlite	unknown	A
Truckee Meadows	geothermal	geothermal resources	high	B
Virginia Range, Carson Range,	bedded	clay	unknown	A
southern Pah Rah Range	intrusive	lightweight aggregates	unknown	A
Warm Springs Valley	geothermal	geothermal resources	moderate	B
Wedekind	porphyry	copper	moderate to high	B
	quartz-alunite vein	gold, silver	low to moderate	B
	skarn	copper	low	B
	skarn	gold	low to moderate	B
Smith Cr. Valley				
Alpine	quartz-adularia vein	silver, gold	moderate to high	B
Bruner	quartz-adularia vein	gold, silver	moderate to high	C
Eastgate	bedded	zeolite	high	C
	quartz-adularia vein	gold, silver	moderate to high	B
Lodi	polymetallic replacement	silver, lead, zinc	moderate to high	B
	porphyry	molybdenum	moderate	B
	skarn	gold	moderate	B
	skarn	talc	low to moderate	B
	skarn	tungsten	high	C
Smith Creek Valley	evaporite	salines and brines	unknown	A
	geothermal	geothermal resources	moderate	B
Smith Valley				
Artesia Lake	evaporite	salines and brines	unknown	A
Buckskin	metamorphic, disseminated	kyanite group aluminous minerals	low	C
	polymetallic vein	gold, copper	low to moderate	B
	porphyry	copper	moderate to high	C
	skarn	iron	moderate to high	B
Eagle Valley, Carson Valley	geothermal	geothermal resources	moderate	B
Gardnerville	polymetallic vein	copper	low to moderate	B
	porphyry	molybdenum	high	C
	quartz-adularia vein	silica, silver, gold	high	C
	skarn	gold	low to moderate	B
	skarn	tungsten	high	C

TABLE 12. POTENTIAL FOR THE OCCURRENCE OF MINERAL RESOURCES, LISTED BY 30' BY 60' QUADRANGLE AND MINING DISTRICT (continued)

BLM Carson City District

Mining district/area	Deposit type	Commodity	Level of potential	L/C
Smith Valley (continued)				
Mountain House	polymetallic vein	gold, silver, lead	low to moderate	B
	skarn	gold, silver, copper	moderate	B
	skarn	tungsten	low	B
Pine Grove Hills	quartz segregation	silica	moderate	B
Red Canyon	polymetallic replacement	gold, lead, copper	moderate	B
	polymetallic vein	silver, gold, lead, copper	moderate	B
	skarn	copper	low	B
	skarn	gold	moderate	B
Risue Canyon	polymetallic replacement	copper, lead, zinc, gold	moderate	B
	skarn	tungsten	low	B
Wellington	bedded	perlite	unknown	A
	replacement fluorspar	fluorspar	low	B
	sediment-hosted gold-silver	gold, silver	moderate to high	B
	skarn	tungsten	low	B
west Smith Valley	geothermal	geothermal resources	moderate	B
Wilson	bedded	diatomite	unknown	A
	bedded	perlite	unknown	A
	polymetallic replacement	silver, lead, zinc	moderate	B
	quartz-adularia vein	gold, silver	moderate to high	B
	skarn	tungsten	low	B
Wilson Hot Springs	geothermal	geothermal resources	high	C
Yerington	bedded	gypsum	moderate	C
	polymetallic vein	gold, silver, copper	low to moderate	B
	porphyry	copper	low to moderate	B
	porphyry	copper	moderate to high	C
	quartz-adularia vein	gold	low to moderate	B
	skarn	copper	low to moderate	B
Tonopah				
Bell	polymetallic replacement	silver, lead, zinc	moderate	B
	quartz-alunite vein	gold, silver	moderate	B
	skarn	tungsten	moderate to high	B
Dicalite Summit area	bedded	diatomite	moderate to high	C
Pilot Mountains	polymetallic replacement	silver, copper, lead, zinc	low to moderate	B
	replacement, disseminated	mercury	moderate to high	C
	sediment-hosted gold-silver	gold	moderate	B
	skarn	tungsten	high	D
	vein and nodule turquoise	gem stone (turquoise)	moderate to high	B
	porphyry	copper, molybdenum	moderate	B
	sediment-hosted gold-silver	gold	high	C
	skarn	gold	moderate to high	B
	skarn	tungsten	moderate	B
Walker Lake				
Bovard	quartz-alunite vein	alunite	low	B
	quartz-alunite vein	gold, silver	moderate to high	B
	skarn	copper	moderate	B
	skarn	gold	moderate	B
	vein and nodule turquoise	gem stone (turquoise)	unknown	A
Buckley	skarn	copper	moderate to high	C
	skarn	gold	moderate	B
	skarn	iron	high	C
	skarn	tungsten	high	B
	vein barite	barite	moderate	B
Double Spring Marsh	evaporite	sodium carbonate	low	B
Eagleville	skarn	quartz crystal	low	B
Fitting	bedded	clay	low to moderate	B
	metamorphic, disseminated	kyanite group aluminous minerals	moderate to high	C
	quartz-adularia vein	silver, gold	moderate	B
	skarn	copper, gold	moderate	B
	skarn	mica	low	B
	skarn	tungsten	low	B

TABLE 12. POTENTIAL FOR THE OCCURRENCE OF MINERAL RESOURCES, LISTED BY 30' BY 60' QUADRANGLE AND MINING DISTRICT (continued)
BLM Carson City District

Mining district/area	Deposit type	Commodity	Level of potential	L/C
Walker Lake (continued)				
Fitting	vein	graphite	low	B
	vein barite	barite	low to moderate	B
Gabbs Valley	evaporite	salines and brines	unknown	A
	geothermal	geothermal resources	moderate	B
Gabbs Valley area	bedded	silica	moderate	C
	hot-spring	gold	low to moderate	B
	hot-spring	mercury	low to moderate	B
	porphyry	copper	moderate	B
	skarn	gold, copper	moderate	B
Hawthorne	geothermal	geothermal resources	high	C
Hawthorne area	bedded	clay (montmorillonite)	moderate	B
Mount Grant	polymetallic vein	gold, silver, lead, copper	low to moderate	B
Mountain View	porphyry	copper	low	C
	quartz-adularia vein	gold	low to moderate	B
Pamlico	bedded	barite	low to moderate	B
	polymetallic vein	gold, silver	moderate	B
	sediment-hosted gold-silver	gold	moderate	B
	skarn	gold	moderate to high	B
Santa Fe	bedded	marble (terrazo)	moderate	B
	porphyry	copper, molybdenum	moderate	B
	sediment-hosted gold-silver	gold	high	C
	skarn	gold	moderate to high	B
	skarn	tungsten	moderate	B
southern Walker Lake Basin	geothermal	geothermal resources	moderate	B
Washington	bedded	coal	low	C
	bedded	diatomite	low	B
	polymetallic vein	gold, silver	low	B
	vein uranium	uranium	low	B
Wilson	quartz-adularia vein	gold, silver	moderate to high	B
Yerington	polymetallic vein	gold, silver, copper	low to moderate	B
	porphyry	copper	low to moderate	B
	porphyry	copper	moderate to high	C
	quartz-adularia vein	gold	low to moderate	B
	skarn	copper	low to moderate	B

bulk-minable precious metals deposits. Most of this work is being done in California, but work also extends into Nevada where alteration and zones of discoloration extend along a northeast trend from the state line to the "Elbow" area of the Carson River Canyon (Washington district, Lyon County). To the south of this area, small copper- and tungsten-bearing skarn deposits occur within a small outcrop of pre-Tertiary rocks; aeromagnetic maps of this area indicate the presence of a buried intrusive which accounts for the skarn outcrops.

The northern part of the Masonic district has moderate to high potential for the discovery of vein and stockwork deposits of precious metals. The southern part of the district has low to moderate potential for the discovery of additional small skarn tungsten deposits.

WASHINGTON DISTRICT

(see comments, Excelsior Mountains quadrangle)

CARSON CITY 30' BY 60' QUADRANGLE

BUCKSKIN, YERINGTON DISTRICTS, DESERT MOUNTAINS AREA

These districts have produced iron and copper from skarn deposits, copper from porphyry deposits, and placer gold.

Reserves of copper ore are known to exist in porphyry deposits at the MacArthur mine, iron reserves may remain at the Minnesota mine, and the placer gold deposits contain reserves of unknown magnitude and grade. Polymetallic veins, associated with skarn and porphyry copper mineralization, are found in several localities in this area. Large porphyry copper reserves exist in deposits in the vicinity of the old Yerington tailings and in the area of the Yerington airport, along the southern edge of the quadrangle.

Deposits of clay and diatomite are known to exist in the Desert Mountains, north of Wabuska. Montmorillonite clay has been mined from a deposit east of U.S. 95 in the northwest part of the mountains; this extent of this deposit is unknown, but reserves remain at the site. Deposits of diatomite occur in along the southern mountain front northeast of Wabuska. These deposits have not been mined and their extent is not known.

Moderate to high potential remains for the discovery of additional deposits of skarn iron and copper in the vicinity of the Minnesota mine and for porphyry copper deposits in the entire area extending from the Buckskin Range across Mason Valley into the northern Wassuk Range. This area has moderate to low potential for the discovery of gold-bearing polymetallic veins associated with the distal portions of the porphyry copper systems.

Low to moderate potential exists for discovery of porphyry deposits in the area extending north into the Desert Mountains, and this area may have low potential for discovery of gold-silver-bearing veins in metamorphic rocks. Potential also exists in this area for development of deposits of clay and diatomite; the magnitude of this potential is unknown.

CASTLE PEAK, COMO, COMSTOCK, JUMBO, RAMSEY, TALAPOOSA DISTRICTS

Epithermal silver and gold vein deposits, both quartz-adularia and quartz alunite, and epithermal mercury deposits have been mined

or prospected in these districts.

Castle Peak has had mercury production, but large areas of alteration in the district, related to quartz-alunite hydrothermal systems, continue to be explored for precious metals.

Como has produced silver and gold from what may be a quartz-alunite vein occurrence.

The Comstock and related quartz-adularia vein systems have produced large amounts of precious metals and significant but unknown ore reserves remain in the southern part of the Comstock district as well as in the Flowery subdistrict to the east. It is difficult to outline specific areas of favorability as much of the entire Virginia Range displays widespread hydrothermal alteration.

The Jumbo district, located adjacent to the Comstock in Washoe County, has a geologic setting similar to that of the Comstock. Jumbo has moderate to high potential for the discovery of precious metals-bearing vein deposits. Cinder cones, located along the crest of the Virginia Range in the southern part of this district have high potential for development as sources of both red and black cinder for landscaping and other commercial uses.

The adjacent and somewhat related districts of Talapoosa and Ramsey, including the Gooseberry portion of the Ramsey district, contain both quartz-adularia and quartz-alunite gold-silver deposits and small occurrences of mercury. Defined reserves of gold-silver are known to exist at Talapoosa, Ramsey, and Gooseberry.

Deposits of light-weight aggregate, useful for cement block manufacturing and other construction purposes, have been developed in the Castle Peak district and in the eastern part of the Flowery Range, east of the Comstock district. Sources for the aggregate are geologically-young rhyolitic intrusive plugs which cut the older volcanic rocks in these districts. The value of these occurrences is a function of physical and chemical properties of the rocks and their location in regard to potential transportation routes and markets. Several cinder cones occur along the crest of the Virginia Range in the southern part of the Jumbo district; these cones are potential sources of both red and black cinder useful for landscaping and other general construction purposes.

The Castle Peak and Como areas have low to moderate potential for the discovery of precious metal deposits. The Comstock, Jumbo, Ramsey, and Talapoosa districts all have moderate to high potential for discovery of additional deposits of precious metals. Castle Peak has moderate potential for discovery of additional small deposits of mercury. The Castle Peak and other parts of the Virginia and Flowery Ranges have high potential for discovery and development of deposits of rhyolite aggregate material and volcanic

cinder useful in the construction trade in both the Reno and Carson City areas.

CHURCHILL DISTRICT

This area has produced small amounts of tungsten from skarn deposits. The skarns also contain minor copper, lead, and zinc.

Low to moderated potential exists for discovery of additional small skarn tungsten deposits in this district.

DELAWARE DISTRICT

Skarn occurrences of copper, tungsten, and iron, and gold-bearing polymetallic veins associated with the skarns have been prospected and mined in this district. An occurrence of epithermal-vein manganese, with associated tungsten values, has been prospected in this district; this occurrence is small and has no reported production.

This district has moderate potential for the development of skarn occurrences of both iron and tungsten and may also have low to moderate potential for the discovery of gold-bearing skarns.

GALENA DISTRICT

Ore deposits in this district consist of polymetallic veins occurring in shear zones in Mesozoic metamorphic rocks, and tungsten skarns which occur in contact zones between metamorphic rocks and granodiorite.

The district has low to moderate potential for the development of silver-bearing, polymetallic vein deposits similar to those at the Union mine. Low potential also exists for the development of small skarn deposits of tungsten. The urban development of Pleasant Valley and New Washoe City would probably prevent exploitation of any deposits found in this district.

RED MOUNTAIN DISTRICT

Developed reserves of skarn iron ore are known to exist in this district. In addition to iron, small scarn occurrences of tungsten and lead-zinc are reported, along with gold-bearing polymetallic veins associated with the skarn deposits.

The area has high potential for development of additional skarn iron ore, and low to moderate potential for discovery of small deposits of tungsten or base-metal-rich skarns. Moderate

gold values were reported in samples taken in the district, and there may be a low potential for discovery of gold-bearing polymetallic veins or skarn deposits.

STEAMBOAT SPRINGS DISTRICT

Hot-spring occurrences of mercury have been mined from deposits located on the north side of the present flowing spring area in the past; these could again be exploited if market conditions improve for mercury. The mercury deposits occur in sinter and altered granitic rock at Steamboat Springs, and in altered volcanic rock miles to the north along the front of the Carson Range. Areas of mercury potential can be detected by wide zones of bleaching and alteration in the host rock. The district has low to moderate potential for the development of minable deposits of mercury. There are trace amounts of gold being deposited by the active hot spring system at Steamboat Springs, and there is low potential for the discovery of quartz-alunite (hot-spring) gold deposits along the Carson Range between Steamboat Springs and the Wheeler Ranch area. Urban development in this area would, no doubt, prevent exploitation of any deposits that might be found.

VOLTAIRE DISTRICT

Precious-metal-bearing polymetallic veins and metamorphic deposits of graphite occur in this district.

This district has low to moderate potential for the development of small, gold-bearing, polymetallic vein deposits similar to the Premier mine deposit. Although graphite was mined for a longer period time than any other mineral product from this district, the occurrence is felt to be limited and the potential for development of additional resources is low.

CARSON SINK 30' BY 60' QUADRANGLE

COPPER KETTLE, DIXIE VALLEY, I.X.L., SHADY RUN, WHITE CLOUD DISTRICTS

The largest types of deposits mined and prospected in these districts include skarn iron deposits in the Copper Kettle district, disseminated gold in shear zones at Fondaway Canyon in the Shady Run district, skarn tungsten at Fondaway Canyon, vein gold from a fossil hot-spring system in the Dixie Valley district, and polymetallic replacement and base-metal rich skarn deposits at Silver Hill in the I.X.L. district. Fluorite has also been mined from deposits in the western part of the I.X.L district.

There is moderate to high potential for the development of additional deposits of iron in the northern part of this area, north of White Cloud Canyon on the west side of the Stillwater Range. Moderate to high potential exists for the discovery of small- to medium-sized gold deposits similar to the deposit in Fondaway Canyon. The Silver Hill area has moderate potential for the discovery of precious-metals-rich skarn deposits. Moderate potential exists for development of small- to medium-sized deposits of fluorite in the vicinity of Cox Canyon on the west side of the Stillwater Range.

EDWARDS CREEK VALLEY 30' BY 60' QUADRANGLE

ALPINE DISTRICT

Small deposits of silver and gold have been mined from epithermal quartz-adularia veins in this district, and there has been exploration for larger, stockworks deposits of this type.

This district has moderate to high potential for discovery of moderate- to large-tonnage precious-metals-bearing epithermal deposits.

BERNICE DISTRICT

Antimony has been mined from polymetallic vein deposits in this district. In addition to antimony, many of the occurrences contain values in silver and gold as well as lead and zinc. Antimony is mined from this district in times of high metal prices and reserves remain in several deposits within the district. Exploration for bulk-minable deposits of gold has been carried out here in the past, and is underway at the present time. Geologic conditions here are favorable for both sediment-hosted disseminated gold occurrences and deposits formed along shear zones similar to that at Fondaway Canyon in the Stillwater Range.

This district has moderate to high potential for development of additional moderate-size deposits of antimony ore and moderate potential for discovery of bulk-minable deposits of gold.

CORRAL CANYON DISTRICT

Gold has been found in this district in formed in fault zones associated with albite dikes. Exploration for bulk-minable gold deposits has taken place in the district, and there is moderate potential for discovery. There has been prospecting for titanium minerals in the same general area; the potential for discovery of minable deposits of titanium is very low.

TABLE MOUNTAIN DISTRICT

Small deposits of copper, nickel, and cobalt, associated with a mafic intrusive complex, occur in this district. Very little is known of the mode of occurrence of these metals. There may by, however, low potential for the discovery of similar, small deposits in the district.

TUNGSTEN MOUNTAIN DISTRICT

Tungsten has been mined from skarn deposits in this district, gold has been mined from epithermal quartz vein deposits, and small amounts of silver have apparently been mined from polymetallic vein deposits.

There is high potential for development of additional tungsten reserves in the area of the known deposits. Moderate potential exists for the development of small vein deposits of gold in the canyons north of the tungsten skarn area, and there is moderate potential for the development of small tonnages of silver ore in polymetallic veins which cut the intrusive rock associated with the skarn deposits.

WILD HORSE DISTRICT

Two widely-separated areas have been mined and prospected in this district. Mercury has been produced from replacement deposits in the north part of the district, and prospecting for antimony has been done in the southern part of the district.

Based on geologic settings and trace element associations present in ore samples collected from this district, both portions of the district have moderate to high potential for the discovery of sediment-hosted gold deposits. There may also be moderate potential for discovery of small deposits of mercury in the north area and small deposits of antimony in the southern area.

EXCELSIOR MOUNTAINS 30' BY 60' QUADRANGLE

AURORA DISTRICT

Gold and silver deposits have been mined from epithermal quartz-adularia veins and stockworks in the Aurora district.

This district contains known reserves of bulk-minable gold-silver ore, and there is high potential for the discovery and development of additional medium-size gold-silver deposits.

CANDELARIA DISTRICT

Silver deposits in the Candelaria district occur in polymetallic vein and replacement deposits associated with shear zones in an area of complex thrust faulting. Large reserves of bulk-minable ore are present in the district, and the deposit is presently being mined. Deposits of bedded barite occur in a unit of the Palmetto Formation within the district, and mining has occurred in an area west of the camp of Candelaria.

This district has known reserves of silver, and there is moderate to high potential for these reserves to be increased as mining progresses. There is also moderate to high potential for the development of additional small- to medium-sized deposits of barite west of the area of the silver deposits.

EASTSIDE AREA

Oxide copper mineralization crops out within an altered area about 1 mile long, north-south, and about 1 1/2 miles wide, east-west at the Eastside mine. Small vein occurrences within this zone have been mined in the past, and turquoise occurs locally. To the west several miles, mercury mineralization occurs in a narrow, northeast-trending shear zone.

This area has been extensively explored for porphyry copper mineralization with largely negative results. There is moderate potential in the district for discovery of additional small copper ore bodies, but the potential for discovery of porphyry-type copper deposits is low. There is low to medium potential for discovery of additional small mercury ore bodies in the area west of the Eastside mine.

GARFIELD DISTRICT

Deposits of silver, copper, and lead have been mined from polymetallic veins in the western part of the district, and small copper skarn deposits have been prospected and mined in the eastern part of the district.

This district has moderate potential for the discovery of additional small- to medium-sized polymetallic vein deposits similar to those mined. There also may be moderate potential for the discovery of gold-bearing, polymetallic skarn deposits at depth beneath the vein deposits or in the area of the intrusive contact.

HUNTOON VALLEY AREA

Small-scale mining has been done in this area on silver-gold-bearing quartz veins following shear zones. Although some of the mineralized areas contain multiple veins, the veins appear to be lenticular and discontinuous.

This area has moderate potential for the discovery of additional small- to medium-sized silver-gold-bearing vein deposits similar to those exposed in old mine workings.

LUCKY BOY DISTRICT

Two major deposit types have been mined within the Lucky Boy district; polymetallic quartz vein deposits in pre-Tertiary rocks, and epithermal gold-silver mineralization in both quartz-adularia and quartz-alunite systems formed in Tertiary volcanic rocks. A deposit of silica has been mined at times from an occurrence on Lucky Boy Pass.

There may be moderate potential for development of small silver-rich, polymetallic vein deposits on the east side of the district. There are known ore reserves in at least two small epithermal gold-silver deposits located in the vicinity of the Borealis mine on the west side of the district. There is high potential in this same area for the discovery of other small- to medium-sized epithermal precious metals deposits.

MARIETTA DISTRICT

Polymetallic vein and replacement deposits and iron and tungsten skarns have been prospected and mined within the Marietta district. The vein deposits were mainly mined for their silver and lead content, but some veins, notably those at the Moho mine, were mined for gold. Uranium mineralization occurs within the district, but the occurrences are mainly as a trace element associated with base and precious metal vein deposits.

There may by moderate potential in this district for the development of additional small- to medium-sized polymetallic vein or replacement deposits in the vicinity of the old mines. Moderate potential may exist for discovery of bulk-minable silver and gold in skarn deposits. Moderate potential also exists for the development of small skarn tungsten deposits in the hills west of Teel's Marsh. The uranium potential in the district is rated as very low.

MOUNT GRANT DISTRICT

Mines and prospects in the Mount Grant district were developed on narrow, gold-bearing quartz veins which follow shear zones in granitic rocks. Placer gold deposits have been mined in canyons draining some of the veined areas.

This district has low to moderate potential for discovery of small gold ore bodies in vein deposits, and there may be limited potential for development of small gold placer deposits.

PAMLICO DISTRICT

Gold has been mined in this district from quartz veins and stockworks deposits formed in Mesozoic metasedimentary and metavolcanic rocks, and copper has been mined from skarn and replacement deposits associated with Cretaceous intrusive rocks.

There is moderate to high potential in this district for discovery of gold-bearing skarn and replacement deposits associated with the Cretaceous intrusive-limestone contact areas. Moderate potential also exists for discovery of stockworks gold deposits along some of the prominent shear structures that cross the district. Moderate potential remains in the areas adjacent to the old mines for discovery of small vein ore bodies similar to those mined in the past.

SANTA FE DISTRICT

Silver, copper, and tungsten have been mined from skarn deposits throughout the Santa Fe district. Extensive copper mineralization associated with skarns and related intrusive rocks has encouraged exploration for porphyry copper-molybdenum mineralization at many locations throughout the district; no porphyry deposits have been found, however. Disseminated gold is presently being mined at the north end of the district (within the portion of the district in the Walker Lake quadrangle) from a large, epithermal replacement deposit formed along a major shear zone.

The Santa Fe district contains known reserves of bulk-minable gold and moderate to high potential exists of discovery of other deposits of this type within the district. There is also moderate to high potential for discovery of gold-bearing skarn deposits located in areas formerly prospected for copper and base metals. Porphyry copper-molybdenum exploration has not been successful in the district, but moderate potential still exists for discovery of these deposits and exploration will, no doubt, resume when metal prices improve. There is moderate potential for development of small skarn tungsten deposits in the district.

SILVER STAR DISTRICT

Silver and gold has been mined from epithermal quartz-adularia and quartz-alunite veins systems in the Camp Douglas area, and silver and tungsten have been mined from epithermal quartz veins at Silver Dyke, south of Camp Douglas.

There is moderate potential for discovery of small- to medium-sized gold deposits in epithermal veins in the area of Camp Douglas. Moderate to high potential exists for the discovery of vein and stockworks precious metals deposits associated with the areas of quartz-adularia and quartz-alunite mineralization north and east of Camp Douglas. There is also low to moderate potential for development of additional tungsten ore bodies in the Silver Dyke area.

WASHINGTON DISTRICT

Narrow quartz veins and silicified zones in this district have been prospected for precious metals and uranium. This district is located on trend with structures and alteration patterns that extend northeasterly from the Masonic district (see comments on Masonic district, Bridgeport quadrangle).

This area has moderate to high potential for discovery of vein or stockwork precious metal deposits. The potential for discovery of minable uranium deposits is low.

WHISKY FLAT DISTRICT

Small deposits of skarn copper and tungsten have been mined from this district.

The district has moderate potential for development of additional small ore bodies within the vicinity of the Qualey mine. These deposits could contain gold in recoverable amounts.

FALLON 30' BY 60' QUADRANGLE

ALLEN HOT SPRINGS AREA, HOLY CROSS DISTRICT

At Cinnabar Hill, in the northern part of the Holy Cross district, deposits of mercury containing trace amounts of gold occur associated with areas of quartz-alunite alteration. The Allen Hot Springs area, to the northwest of Cinnabar Hill, displays similar mineralization and alteration. The mineralization exposed

in these two areas, located on outcrops of volcanic rocks exposed on the northwest and southeast of an area covered by dune sand, may be related. In the southern part of this area, in the main part of the Holy Cross, or Terrill, district, gold-silver mineralization occurs in epithermal and polymetallic quartz veins.

There is moderate to high potential for the discovery of epithermal gold-silver deposits in the area of Cinnabar Hill, in the north part of the Holy Cross district. These deposits, however, would very likely be within lands currently withdrawn or now being considered for withdrawal by the U.S. Navy. The southern part of the Holy Cross district also has moderate to high potential for the discovery of quartz-alunite and polymetallic gold-silver-bearing deposits; these deposits, if present, would very likely be within the Walker River Indian Reservation lands.

BELL MOUNTAIN, GOLD BASIN DISTRICTS

These districts have been mined and prospected for epithermal vein and stockwork deposits of silver and gold in volcanic rocks. Prospecting for placer gold has been done in the Gold Basin district, but no production has resulted. Recent work in the Bell Mountain district has resulted in the definition of a large, vein-stockwork silver deposit. Exploration for similar deposits is now in progress in the Gold Basin district.

The Bell Mountain district contains known reserves of silver and there is moderate potential for the discovery of additional deposits. There is also moderate potential for discovery of epithermal precious-metal-bearing vein or stockwork deposits in the Gold Basin district.

BENWAY DISTRICT

Two types of ore deposits have been explored in the Benway district; copper-silver-gold-bearing quartz veins, and disseminated sulfide deposits. The district was explored for porphyry copper mineralization in the 1960's, but no economic deposits were found. This district has low potential for the discovery and development of copper deposits and low to moderate potential for discovery of additional small polymetallic vein deposits.

BROKEN HILLS DISTRICT

Silver has been mined from epithermal quartz-alunite veins and stockworks in andesitic volcanic rocks, and fluorite has been mined from vein and stockwork deposits in rhyolite.

The eastern part of the Broken Hills district, in the area of the old mines, has moderate to high potential for the development of additional vein and stockworks silver-gold deposits. Similar potential also exists to the east, in the part of the Broken Hills district within the Smith Creek Valley 30' by 60' quadrangle.

There are known reserves of fluorite within the western part of the Broken Hills district, near the Kaiser mine; this area also has moderate to high potential for development of additional small- to medium-size fluorite deposits.

CHALK MOUNTAIN, WESTGATE DISTRICTS

Polymetallic replacement deposits and base-metal skarn deposits have been mined and prospected in these districts. Most mining has taken place in the Chalk Mountain district.

The trace element suite displayed in ore samples collected in this district may indicate the presence of undiscovered base metal or copper skarn, or porphyry copper or molybdenum mineralization in this district. Gold skarn deposits could also exist.

The Chalk Mountain district has low to moderate potential for discovery of base metal or gold-bearing skarns and moderate potential for discovery of porphyry copper or molybdenum deposits.

DEAD CAMEL MOUNTAINS AREA

This area has been prospected for hot-spring-type gold deposits associated with extensive areas of hot-spring alteration and discoloration. Anomalous gold values, associated with arsenic, antimony, are present, but no extensive gold mineralization has been found. Only limited information is available on this area, but it is assessed as having low to moderate potential for discovery of hot spring-type gold mineralization.

EAGLEVILLE DISTRICT

Quartz-adularia veins have been mined for gold in this district, and barite has been mined from vein deposits. Both types of vein systems appear to be related; the barite veins contain trace amounts of gold, and the gold deposits occur in a gangue of brecciated barite cemented with later quartz. In the northern part of the district, gold has been mined from small gold- and copper-bearing polymetallic veins.

This district has moderate to high potential for discovery of additional deposits of vein barite and gold-bearing quartz-adularia

veins. There may also be moderate potential for the discovery of larger, gold-bearing quartz-barite stockwork deposits, and low to moderate potential for discovery of small gold-copper veins in the northern part of the district.

FAIRVIEW DISTRICT

Epithermal vein deposits of silver and gold have been mined from the northern and central parts of the Fairview district, and skarn tungsten deposits have been mined in the Slate Mountain area, in the southern part of the district.

The Fairview district has moderate to high potential for the discovery and development of silver-gold deposits throughout the area. The areas of highest potential may lie west of the old mines, along the western front of Fairview Peak. There is moderate potential for the discovery of polymetallic replacement or vein deposits, and copper-molybdenum porphyry deposits, especially along the west side of the district.

In the south end of the district, near the Slate or Midday mine, there is low to moderate potential for development of small skarn tungsten deposits.

KING DISTRICT

Gold and silver has been mined from epithermal vein deposits in this district. The mineralized veins occur in shear zones associated with rhyolitic intrusions. This district has moderate to high potential for discovery of vein or stockwork deposits of precious metals.

LA PLATA DISTRICT

Silver has been mined from small, polymetallic vein deposits at the old camp of La Plata, tungsten occurs in small skarn deposits in the same area, and fluorite has been mined from small replacement deposits in limestone south of La Plata. Recent exploration in the district has been for porphyry molybdenum.

The La Plata district has low to moderate potential for the discovery of porphyry molybdenum in the area generally between La Plata and Eleven Mile Canyons and extending to Dixie Valley on the east. Low potential exists for discovery of small polymetallic vein deposits containing silver, and for small skarn tungsten deposits. There also may be low potential for development of additional small replacement deposits of fluorite south of La Plata.

LEONARD DISTRICT

This district has produced substantial amounts of tungsten from skarn deposits and has been explored for porphyry molybdenum deposits.

There are known resources of tungsten located within the former producing properties, and the district has moderate to high potential for development of additional reserves of tungsten in skarn deposits.

MOUNTAIN VIEW, YERINGTON DISTRICTS

Small deposits of gold in quartz veins have been mined in the northern Mountain View district and in the adjacent part of the eastern Yerington district. There is low to moderate potential for the discovery of additional small deposits of this type in the parts of these two districts that fall within the Fallon quadrangle. There is also low to moderate potential for the discovery of skarn or porphyry copper deposits in the small portion of the Yerington district that extends into this quadrangle.

RAWHIDE DISTRICT

Gold and silver has been mined from epithermal quartz-adularia vein and stockworks systems. Recent exploration in this district has been successful in defining large reserves of gold-silver in disseminated and stockworks deposits. The district has high potential for discovery of additional deposits of this type.

SAND SPRINGS DISTRICT

Epithermal, gold-bearing, quartz-sulfide vein deposits have been mined in the north part of this district, and skarn tungsten deposits have been mined in both the north and south parts of the district. Mercury occurs in shear zones in metamorphic rocks in the western part of the district, associated with trace amounts of gold.

The Sand Springs district has moderate potential for discovery of gold deposits east and west of the known deposits at the Dan Tucker mine. There is also moderate potential for discovery of additional small skarn tungsten deposits in both the north and south ends of the district. There is low to moderate potential for discovery of a deposit of disseminated gold along the western side of the range, in the area of the small mercury occurrences.

WONDER DISTRICT

Epithermal quartz-adularia precious-metals-rich vein and stockwork deposits have been mined in the Wonder district. Considerable exploration has been done in the central part of the district, but large areas to the north and west of the old camp of Wonder may warrant exploration.

The entire Wonder area, including the old camps of Hercules and Victor, has moderate to high potential for the discovery of vein or stockwork deposits of silver and gold.

IONE VALLEY 30' BY 60' QUADRANGLE

BELL DISTRICT

Silver and base metals have been mined from polymetallic replacement deposits and skarns in the central part of this district, gold has been mined from epithermal quartz-calcite veins in the northern part of the district, and tungsten-bearing skarn deposits have been prospected and mined along the south end of the district.

This district has moderate potential for the development of additional silver-rich polymetallic replacements deposits similar to that exploited at the Simon mine. There is moderate potential for the discovery of epithermal vein or stockworks gold deposits in the north portion of the Cedar Mountains, north of Simon, and along the east side of the range east of Simon. Potential for discovery and development of moderate- to large-size skarn tungsten deposits in the central and southern part of the district is rated moderate to high.

GABBS VALLEY AREA

In this area, mercury has been mined from several small epithermal deposits along shear zones in volcanic rocks associated with areas of quartz alunite mineralization. This area is on the western margin of quartz-alunite alteration associated with the Paradise Peak gold deposit, located to the east in the Fairplay district of Nye County. Most of the area surrounding and including the mercury mines and prospects is now being explored for deposits of disseminated gold.

The Gabbs Valley area has moderate to high potential for discovery of deposits of disseminated gold associated with centers of quartz-alunite alteration.

LODI AND GABBS (DOWNIEVILLE) DISTRICTS

(see comments on Smith Creek Valley quadrangle for Lodi district, comments also apply to the Gabbs district)

SANTA FE DISTRICT

(see comments on Excelsior Mountains and Walker Lake quadrangles)

KUMIVA PEAK 30' BY 60' QUADRANGLE

SAND PASS AREA

Calcium carbonate (marl) and clay have been mined intermittently from a number of small deposits in this area.

The sedimentary and volcanic rocks that contain these deposits cover extensive areas and there is high potential for the development of similar deposits in the surrounding area.

SMOKE CREEK DESERT AREA

Very little is known of this area. Scattered zeolite occurrences have been prospected but their potential is unknown.

RENO 30' BY 60' QUADRANGLE

CLARK-DERBY, OLINGHOUSE, TALAPOOSA DISTRICTS

Epithermal silver and gold vein deposits, both quartz-adularia and quartz alunite, and epithermal mercury deposits have been mined or prospected in these districts. Placer gold deposits occur in the Olinghouse district, a small skarn tungsten deposit has been mined in one locality in the Truckee River canyon, and diatomite is currently being mined from large deposits in the Virginia Range south of Clark Station.

All of the area of Tertiary volcanic rock outcrop within these three districts has moderate potential for the discovery and development of epithermal silver and gold deposits. Low potential exists for discovery of small epithermal mercury deposits, and very low potential is present for discovery of additional small skarn tungsten deposits. The area has known resources of diatomite, but

the potential for additional reserves of this commodity is unknown. Low to moderate potential for development of additional reserves of placer gold may exist within the Olinghouse district.

FREDS MOUNTAIN AREA AND STATELINE PEAK DISTRICT

Small copper-bearing quartz veins in metamorphic rocks have been mined and prospected in these areas. Ore samples collected show high copper values associated with other base metals, including bismuth, and anomalous gold values. This geochemical association could indicate potential for discovery of skarn gold deposits in the areas. Placer deposits of rutile (titanium) have been prospected in the southeastern part of the Freds Mountain area, and occurrences of uranium are reported in the area; these deposits are small, however, and have very little economic potential.

PEAVINE, WEDEKIND DISTRICTS

Epithermal quartz-alunite-enargite-gold deposits have been mined and prospected in these districts, and tourmaline-magnetite-copper skarn deposits have been mined in the Peavine district. The known epithermal mineralization and associated alteration zones within these two districts has been interpreted as the surface expression of porphyry copper deposits present at depth. This potential has never been tested due to the current, but temporary, low interest in porphyry copper exploration.

A number of the ore samples taken in this district showed anomalous base metals, including bismuth, associated with high gold-silver values. This element association indicate potential for discovery of skarn gold occurrences.

This area has moderate to high potential for the discovery of large porphyry copper deposits at depth, and low to moderate potential for discovery of additional epithermal precious metal deposits. There is low potential for discovery additional skarn copper deposits, and low to moderate potential for discovery of skarn gold deposits.

PYRAMID DISTRICT

Epithermal quartz-alunite-enargite-silver-base-metal vein deposits have been mined and prospected in this district. Numerous uranium deposits occur on the periphery of the district, and some production of uranium has been reported. The base-metal-rich quartz alunite veins and associated alteration could be indications of the presence of a copper porphyry system at depth in the southern part of the Pyramid district.

There is low to moderate potential for the discovery of porphyry copper mineralization in the Pyramid district and moderate potential for the discovery of additional small deposits of uranium.

Geothermal resources are known to exist in several locations within the Reno 30' by 60' quadrangle, and large areas of the Truckee Meadows and Lahontan Basin have potential for development of additional resources.

SMITH CREEK VALLEY 30' BY 60' QUADRANGLE

ALPINE DISTRICT

Small deposits of silver and gold have been mined from epithermal quartz-adularia veins in this district. Exploration for larger, stockworks deposits of this type has taken place within the district.

This district has moderate to high potential for discovery of moderate- to large-tonnage precious-metals-bearing epithermal deposits.

BROKEN HILLS DISTRICT

(see comments, Fallon quadrangle)

BRUNER DISTRICT

Gold and silver has been mined in this district from epithermal quartz-adularia veins and stockwork systems.

This district has moderate to high potential for discovery and development additional vein or stockwork precious metal deposits.

EASTGATE DISTRICT

Gold and silver has been mined in this district from epithermal quartz-adularia veins and stockwork systems. The district is currently being explored for bulk-minable deposits of this type. Zeolite deposits have been explored in a basin area on the western side of the Eastgate district, and one property in this area is now producing small amounts of this material.

This district has moderate to high potential for discovery and development of bulk-minable deposits of silver and gold, and high potential for zeolite production.

LODI DISTRICT

Polymetallic replacement deposits, containing mainly lead and silver but with some zinc and copper as well, and skarn tungsten deposits have been mined in this district. The district has been explored for porphyry molybdenum.

This district has high potential for the development of skarn tungsten deposits as well as the development of additional tungsten ore reserves within the limits of the known properties. There is moderate potential for discovery of polymetallic replacement deposits rich in silver and lead, and porphyry molybdenum deposits. There may also be moderate potential for the discovery of skarn gold deposits in this district.

SMITH VALLEY 30' BY 60' QUADRANGLE

BUCKSKIN DISTRICT

The northern part of the Buckskin has been discussed in the section on the Carson City quadrangle.

In the southern part of the Buckskin district, a corundum-andalusite deposit has been evaluated by the U.S. Bureau of Mines. Their work indicated that the area has little potential for abrasive-grade corundum, but material present may be suitable for manufacturing high-alumina refractories. The area is assessed as having low potential for development of reserves of material suitable for high-alumina refactories.

GARDNERVILLE DISTRICT

Mines in this district have produced copper from vein and stockworks deposits, tungsten from skarn deposits, and gold from quartz-calcite veins associated with low-grade skarns. A large porphyry molybdenum deposit has been defined by drilling in the central part of the district, but, at present, it is not a minable resource. Silica is intermittently mined from one large deposit in the southern part of the district; nothing is known about the reserves at this deposit.

The large porphyry molybdenum deposit that has been defined in the central part of the district may, depending on the market for

molybdenum, be an important resource. Small reserves of tungsten remain in skarn occurrences located in the same area as the buried porphyry molybdenum deposit and there is high potential for the development of additional small skarn tungsten deposits. There is low to moderate potential for discovery of small- to moderate-sized gold-bearing skarns or vein deposits in the north part of the district. Potential is high for the continued mining of silica at the Veta Grande deposit.

MOUNTAIN HOUSE DISTRICT

Small deposits of gold, base metals, and tungsten in quartz vein and skarn deposits have been prospected in this district.

This district has low potential for discovery of skarn occurrences of tungsten. There is moderate potential for discovery of small deposits of gold-bearing copper skarn deposits.

RED CANYON DISTRICT

Precious metals-bearing polymetallic vein and replacement deposits and precious metals-bearing copper skarn deposits have been mined in this district.

There is moderate potential in this district for the discovery of small gold-bearing polymetallic replacement deposits and gold-bearing skarn deposits.

RISUE CANYON DISTRICT

Copper, gold, lead, and zinc have been mined from small polymetallic replacement deposits in this district; tungsten has also been mined from small skarn deposits in the same area as the base metal deposits.

This district has low potential for discovery of additional small polymetallic replacement or skarn deposits.

WELLINGTON DISTRICT

Small amounts of gold ore have been mined in this district from quartz veins and siliceous replacement deposits; tungsten is present in some of the vein deposits and in small skarn deposits. Replacement deposits of fluorite have been prospected in the southern part of the district, but none has been produced.

The southern part of this district, along the east side of the Wellington Hills, has moderate to high potential for discovery of

precious metals deposits associated with the extensive areas of silicification. The potential for development of economic deposits of fluorspar in the same area is low.

WILSON DISTRICT

In this district, gold and silver have been mined from quartz veins; lead, zinc, and silver have been mined from polymetallic replacement and vein deposits; and tungsten has been mined from skarn deposits.

This district contains moderate potential for development of small polymetallic replacement deposits in northwestern part of the Pine Grove Hills. There is moderate to high potential for the discovery of precious-metals-bearing quartz vein and stockwork deposits in the Pine Grove-Rockland area; the Cambridge Hills may have moderate potential for discovery of small gold deposits in veins. There is low potential for discovery of additional small tungsten skarn deposits along the west side of the Pine Grove Hills.

YERINGTON DISTRICT

Yerington is predominantly a copper district, and copper has been mined from vein, skarn, and disseminated, porphyry deposits. Placer gold has been recovered from deposits in the northwestern part of the district, and gypsum has been mined from two separate localities within the district. Large reserves of copper remain in the district in deposits in the Singatse Range, under Mason Valley, and in Pumpkin Hollow in the eastern part of the district. The Pumpkin Hollow area also has large, but generally undefined, reserves of iron in skarn deposits. Small reserves of placer gold may remain in deposits along the flanks of the northern Singatse Range, and small reserves of gypsum may remain in deposits in the Singatse and Wassuk Ranges.

Most of the Yerington district has been extensively explored, and its potential is fairly well defined. The areas underlain by known deposits cover large parts of the district, but moderate to high potential remains for defining new deposits and for expanding reserves in known deposits.

TONOPAH 30' BY 60' QUADRANGLE

BELL DISTRICT

Comments on the Bell district are included in the section on the Ione Valley quadrangle.

In addition, the portion of the Bell district within the Tonopah 30' by 60' quadrangle contains deposits of diatomite in an area near Dicalite Summit; this area has moderate to high potential for development of minable deposits of diatomite.

PILOT MOUNTAINS DISTRICT

Deposits of mercury, tungsten, and gold have been mined from separate areas within the Pilot Mountains district. Mercury ores occur associated with low-angle thrusts and shear zones in a generally east-west-trending belt across the center of the district. Gold-bearing veins and shear zones occur associated with some of the mercury deposits, but are mainly in the area of the old camp of Eddyville, on the south central flanks of the Pilot Mountains. Skarn tungsten deposits occur along the eastern margin of the district. The mercury mines operate when mercury prices are high; the properties probably do not contain blocked reserves of ore, but development would resume in times of high metal prices. The gold ores at Eddyville were high-grade, near-surface pockets, mainly of free gold. One of the largest known reserves of tungsten ore in Nevada has been blocked out by drilling and sampling in the eastern part of this district. While not economic at the present time, this deposit will be mined when the price of tungsten again rises. Parts of the tungsten ore body contain considerable amounts of silver, and it is possible parts of the skarn occurrence will be mined with silver and tungsten as coproducts.

This district has moderate to high potential for the development of additional small to medium sized mercury ore bodies along the zone of thrust faulting in the central part of the district, and there is moderate potential for discovery of stockworks deposits of gold in the district. The district contains known reserves of tungsten, but there is high potential that these reserves will be increased. There is low to moderate, but largely undefined, potential for discovery of polymetallic replacement deposits of silver-copper-lead-zinc somewhere in the district, associated with the zone of thrusting and intrusive activity.

SANTA FE DISTRICT

The portion of the Santa Fe district that falls within the Tonopah 30' by 60' quadrangle contains small skarn tungsten occurrences and an gold-bearing polymetallic replacement deposits.

This district has low potential for discovery of skarn tungsten deposits. Geochemical associations in ore samples collected in this part of the Santa Fe district indicate that there may be moderate to high potential for the discovery of skarn gold deposits with associated silver and base metal values.

WALKER LAKE 30' BY 60' QUADRANGLE

BOVARD DISTRICT

Copper has been mined from skarn and replacement deposits in the north part of this district, and gold and silver have been mined from epithermal quartz vein deposits in the southern part of the district.

Gold and silver are reported to be present in ores from the Copper Mountain part of this district and there is moderate potential for discovery of gold-bearing skarn deposits in the area. There is moderate to high potential for discovery of vein and stockwork precious metals deposits associated with the areas of quartz-alunite mineralization in the southern part of the district. Turquoise is reported to be present in the oxidized outcrops of some of the copper deposits; the potential for recovery of turquoise as a gem stone is unknown.

BUCKLEY DISTRICT

Copper and tungsten have been mined from skarn deposits in this district, and gold has been mined from quartz vein deposits which cut granitic rocks. Reserves of iron-copper ores in skarn deposits have been drilled out in the northern part of the district. Small deposits of vein barite have also been mined from this district.

There are known reserves of copper and iron skarn ores in this district, but they are not economic at the present time. Mining will, no doubt, be done at some time in the future when metal prices improve. The district has moderate to high potential for development of additional copper and iron skarn deposits, and there is moderate potential for discovery of gold-bearing skarn deposits. There is high potential for development of small deposits of tungsten skarn ore in the vicinity of the known tungsten occurrence. There is moderate potential for development of small deposits of vein barite in the district.

FITTING DISTRICT

Gold, silver, and copper have been mined from quartz veins, breccias, and skarn deposits in this district. Small vein deposits of barite have been mined near Kinkaid, and corundum and andalusite have been mined from small deposits on the south flank of the Gillis Range.

There is moderate potential in this district for discovery of vein and stockwork precious metals deposits associated with large areas of silicification and alteration in both pre-Tertiary rocks and Tertiary volcanic rocks. There may also be moderate potential for discovery of small copper- and/or gold-bearing skarn deposits in the Ryan Canyon area. Low to moderate potential exists for discovery of additional small deposits of vein barite in the Kinkaid area.

GABBS VALLEY AREA

Epithermal mercury deposits associated with areas of argillic alteration in Tertiary volcanic rocks, and copper- and gold-bearing quartz veins in pre-Tertiary rocks associated with dioritic intrusive rocks have been prospected and mined in this area.

There is low to moderate potential for the discovery of hot-spring, or quartz-alunite, gold deposits associated with the altered areas in Tertiary volcanic rocks in the western part of the area. In the Black Hills and Fissure Ridge area, along the Mineral-Nye county line, there is moderate potential for discovery of small to medium-sized gold deposits associated with copper-bearing endoskarns and skarns.

MOUNT GRANT DISTRICT

Mines and prospects in the Mount Grant district were developed on narrow, gold-bearing quartz veins which follow shear zones in granitic rocks. Placer gold deposits have been mined in canyons draining some of the veined areas.

This district has low to moderate potential for discovery of small gold ore bodies in vein deposits, and there may be limited potential for development of small gold placer deposits.

MOUNTAIN VIEW DISTRICT

Small gold-silver-copper deposits in quartz veins occur in this district, mainly along a northwesterly-trending shear zone. On the north end of this area, near Black Mountain, and area of surface alteration and oxide copper mineralization was explored, without success, for porphyry copper deposits.

The porphyry copper potential of this area has been largely tested, and there is only low potential for a porphyry discovery. There is low to moderate potential, however, for discovery of stockwork gold deposits associated with major fault structures that extend from the Penrod and Reese River Canyon area on the southeast to north of Black Mountain.

PAMLICO DISTRICT

(see Pamlico District, Excelsior Mountains quadrangle)

SANTA FE DISTRICT

Silver, copper, and tungsten have been mined from skarn deposits throughout the Santa Fe district. Extensive copper mineralization associated with skarns and related intrusive rocks has encouraged exploration for porphyry copper-molybdenum mineralization at many locations throughout the district; no porphyry deposits have been found, however. Disseminated gold is presently being mined at the north end of the district from a large, epithermal, sediment-hosted, replacement deposit formed along a major shear zone.

The Santa Fe district contains known reserves of bulk-minable gold and moderate to high potential exists of discovery of other deposits of this type within the district. There is also moderate to high potential for discovery of gold-bearing skarn deposits located in areas formerly prospected for copper and base metals. Porphyry copper-molybdenum exploration has not been successful in the district, but moderate potential still exists for discovery of these deposits and exploration will, no doubt, resume when metal prices improve. There is moderate potential for development of small skarn tungsten deposits in the district.

WASHINGTON DISTRICT

Silver, gold, copper, and lead have been mined from quartz vein deposits at one location in the part of the Washington district lying within this quadrangle. A short distance east of the vein deposits, coal has been mined from thin seams in a Tertiary lacustrine sequence. Uranium mineralization has been reported in this district associated with some polymetallic veins and also with shear zones in granitic rocks.

This area has low potential for discovery of vein deposits of precious metals and uranium. The potential for development of the coal deposits is very low.

RECOMMENDATIONS FOR ADDITIONAL WORK

This report presents an inventory of mines, prospects, and mineral occurrences within the BLM, Carson City District. The

effort was mainly directed at metallic mineral occurrences and coverage was restricted by time and resources available. The data herein presented provides a good framework for assessing the metallic mineral resources of the area; to prepare detailed assessments of mineral potential of areas within the district would, however require collection of much more data. It is recommended that future work in the district be concentrated within smaller areas such as a resource area, a specific mountain range, or perhaps by 30' by 60' or 7 1/2' quadrangle. The smaller area would allow effort to be focused on a more attainable goal.

With only minor exceptions, no new information was generated on nonmetallic or industrial mineral occurrences during this project. Neither funding nor time was available to investigate these commodities during the current study. These deposits are of sufficient distribution and importance to warrent separate inventory studies.

During this study, we have collected a suite of representative ore samples from mines and prospects throughout the district. The trace element analyses now available on these ores will provide valuable data to study trace element trends and mineral associations, and may point out potential for occurrence of unsuspected types of ore deposits within the district. Studies of the analyses of these ores, including statistical studies, should be made. The U.S. Geological Survey has completed studies of two 1° by 2° quadrangles (Walker Lake and Tonopah) and is now in process of collecting data on a third (Reno). Stream sediment geochemical samples are collected as part of these studies. Careful comparisons between the ore-sample geochemistry resulting from our work, with the stream-sediment sample geochemistry from the U.S.G.S. work could provide valuable information on mineralization potential.

REFERENCES AND SELECTED BIBLIOGRAPHY

Angel, M. R., 1881, ed, History of Nevada: Oakland, California, Thompson and West, publishers.

Archbold, N. L., 1966, Ashby mine, Mineral County, Nevada: Nevada Bureau of Mines and Geology Mining District Files, File 204, item 2.

Archbold, N. L., 1966, Industrial mineral deposits of Mineral County, Nevada: Nevada Bureau of Mines and Geology Report 14.

Archbold, N. L., 1969, Industrial mineral deposits, in Moore, J.C., 1969, Geology and mineral deposits of Lyon, Douglas, and Ormsby Counties, Nevada: Nevada Bureau of Mines and Geology Bulletin 75.

Archbold, N. L., and Paul, R. R., 1970, Geology and mineral deposits of the Pamlico mining district, Mineral County, Nevada: Nevada Bureau of Mines and Geology Bulletin 74.

Asemera Inc., 1983, Gooseberry mine, Asamera Minerals (U.S.) Inc.: Nevada Bureau of Mines and Geology Mining District File 183, Item 5.

Athena Gold Corporation, 1986, Oxide gold and silver ore reserves outlined: News Release, Athena Gold Corporation, January 24, 1986, Nevada Bureau of Mines and Geology Mining District File 185, Item 2.

Bailey, E. H., and Phoenix, D. A., 1944, Quicksilver deposits in Nevada: Nevada Bureau of Mines and Geology Bulletin 41.

Beal, L. H., 1963, Investigation of titanium occurrences in Nevada: Nevada Bureau of Mines and Geology Report 3.

Bennett, R. E., 1973, Mineral resources inventory and analysis of the Pine Nut Planning Unit, Carson City District, Nevada and California: Bureau of Land Management unpublished document.

Bennett, R. E., 1975, Mineral resources inventory and analysis of the Fort Churchill Planning Unit, Carson City District, Nevada and California: Bureau of Land Management unpublished document.

Bennett, R. E., and Mallery, H. W., 1973, Mineral resources inventory and analysis of the Pyramid Resource Area, Carson City District, Nevada and California: Bureau of Land Management unpublished document.

Bennett, R. E., and Mallery, H. W., 1973, Mineral resources inventory and analysis of the Long Valley Resource Area, Carson City District, Nevada and California: Bureau of Land Management unpublished document.

Bennett, R. E., and Hoke, C. L., 1975, Mineral resources inventory and analysis of the Clan Alpine Planning Unit, Carson City District, Nevada and California: Bureau of Land Management unpublished document.

Bingler, E. C., 1978, Geologic map of the Schurz quadrangle: Nevada Bureau of Mines and Geology Map 60.

Binyon, E. O., 1946, Exploration of the Blue Metal corundum property, Douglas County, Nevada: U.S. Bureau of Mines Report of Investigations 3895.

Bonham, H. F., Jr., 1969, Geology and mineral deposits of Washoe and Storey Counties, Nevada: Nevada Bureau of Mines and Geology Bulletin 70.

Bonham H. F., Jr., 1984, The Nevada mineral industry, 1983: Nevada Bureau of Mines and Geology Special Publication MI-1983, p. 15-16.

Bonham, H. F., Jr., 1989, in The Nevada mineral industry, 1988: Nevada Bureau of Mines and Geology Special Publication MI-1988, p. 19-26.

Bruce, J. L., 1980, Fallon geothermal exploration project, Naval Air Station, Fallon, Nevada: Naval Weapons Center Technical Publication 6194, Naval Weapons Center, China Lake, California.

Bruner, F., 1974, Some remembered...some forgot, Life in central Nevada mining camps: Carson City, Nevada, Nevada State Park Natural History Association.

Burgess, J. A., 1914, Report on the Atlas Wonder mine, Wonder mining district: unpublished private report, NBMG files.

Butler, R. S., 1979, Geology of La Plata Canyon, Stillwater Range, Nevada: M.S. thesis, University of Nevada, Reno.

Carrillo, F. V., and Price, J. G., 1988, The mineral industry of Nevada, in Minerals Yearbook, 1988: U.S. Bureau of Mines.

Carlson, H. S., 1974, Nevada place names, a geographical dictionary: Reno, Nevada, University of Nevada Press.

Castor, S. B., 1989, Industrial minerals, in The Nevada mineral industry 1988, p. 27-30: Nevada Bureau of Mines and Geology Special Publication MI-1988.

Chaffee, M. A., Hill, R. H., and Sutley, S. J., 1988a, Maps showing distribution of copper, lead, zinc, cadmium, and silver in samples of minus-60-mesh (0.25-mm) stream sediment and nonmagnetic heavy-mineral concentrate, Walker Lake 1° x 2° quadrangle, California and Nevada: U.S. Geological Survey Map MF-1382-G.

Chaffee, M. A., Hill, R. H., and Sutley, S. J., 1988b, Maps showing distribution of molybdenum, tin, boron, tungsten, and gold in samples of minus-60-mesh (0.25-mm) stream sediment and(or) nonmagnetic heavy-mineral concentrate, Walker Lake 1° x 2° quadrangle, California and Nevada: U.S. Geological Survey Map MF-1382-H.

Chaffee, M. A., Hill, R. H., and Sutley, S. J., 1988c, Maps showing distribution of iron, cobalt, barium, strontium, arsenic, antimony, and bismuth in samples of minus-60-mesh (0.25-mm) stream sediment and(or) nonmagnetic heavy-mineral concentrate, Walker Lake 1° x 2° quadrangle, California and Nevada: U.S. Geological Survey Map MF-1382-I.

Chaffee, M. A., Hill, R. H., and Sutley, S. J., 1988d, Maps showing distribution of 12 selected elements in samples of rock, Walker Lake 1° x 2° quadrangle, California and Nevada: U.S. Geological Survey Map MF-1382-J.

Chaffee, M. A., 1988a, Maps showing distribution of anomalies based on the use of R-Mode factor analysis for selected groupings of elements in samples of minus-60-mesh (0.25-mm) stream sediment and nonmagnetic heavy-mineral concentrate, Walker Lake $1^{\circ} \times 2^{\circ}$ quadrangle, California and Nevada: U.S. Geological Survey Map MF-1382-K.

Chaffee, M. A., 1988b, Maps showing distribution of anomalies based on the use of scoresum plots for selected groupings of elements in samples of minus-60-mesh (0.25-mm) stream sediment, Walker Lake $1^{\circ} \times 2^{\circ}$ quadrangle, California and Nevada: U.S. Geological Survey Map MF-1382-L.

Chaffee, M. A., 1988c, Maps showing distribution of anomalies based on the use of scoresum plots for selected groupings of elements in samples of nonmagnetic heavy-mineral concentrate, Walker Lake $1^{\circ} \times 2^{\circ}$ quadrangle, California and Nevada: U.S. Geological Survey Map MF-1382-M.

Clark, W. B., 1970, Gold Districts of California: California Division of Mines and Geology Bulletin 193.

Cook, H. E., 1987, National petroleum assessment, Western Basin and Range Province: U. S. Geological Survey Open-File Report 87-450L.

Couch, B. F., and Carpenter, J. A., 1943, Nevada's metal and mineral production (1859-1940, inclusive): Nevada Bureau of Mines and Geology Bulletin 38.

Crowder, D. F., Robinson, P. F., and Harris, D. L., 1972, Geologic map of the Benton quadrangle, Mono County, California, and Esmeralda and Mineral Counties, Nevada: U.S. Geological Survey Map GQ-1013.

Dane, C. H., and Ross, C. P., 1942, The Wild Horse quicksilver district, Lander County, Nevada: U. S. Geological Survey Bulletin 931-K.

Dilles, P. A., 1983, Final report, Red Camel project: private report, Noranda Exploration, Reno, Nevada.

Dobson, P. G., 1939, Paper presented to the American Institute of Mining, Metallurgical, and Petroleum Engineers, Northern Nevada Section: Reno, Nevada, December 4, 1939.

Dohrenwend, J. C., 1982, Surficial geologic map of the Walker Lake $1^{\circ} \times 2^{\circ}$ quadrangle, Nevada-California: U.S. Geological Survey Map MF-1382-C.

Einaudi, M. T., 1982, Description of skarns associated with porphyry copper plutons, <u>in</u> Titley, S. R., ed, Advances in geology of the porphyry copper deposits, southwestern North America: Tucson, The University of Arizona Press, p. 7-183.

Ekren, E. B., Byers, F. M. Jr., Hardyman, R. F., Marvin, R. F., and Silberman, M. L., 1980, Stratigraphy, preliminary petrology, and some structural features of Tertiary volcanic rocks in the Gabbs Valley and Gillis Ranges, Mineral County, Nevada: U.S. Geological Survey Bulletin 1464.

Ekren, E. B., and Byers, F. M., 1986a, Geologic map of the Murphys Well, Pilot Cone, Copper Mountain, and Poinsettia Spring quadrangles, Mineral County, Nevada: U. S. Geological Survey Map I-1576.

Ekren, E. B., and Byers, F. M., 1986b, Geologic map of the Mount Annie NE, Mount Annie, Ramsey Spring, and Mount Annie SE quadrangles, Mineral and Nye counties, Nevada: U. S. Geological Survey Map I-1579.

Ekren, E. B., and Byers, F. M., 1985a, Geologic map of the Gabbs Mountain, Mount Ferguson, Luning, and Sunrise Flat quadrangles, Mineral and Nye Counties, Nevada: U.S. Geological Survey Map I-1577.

Ekren, E. B., and Byers, F. M., 1985b, Geologic map of the Win Wan Flat, Kinkaid NW, Kinkaid, and Indian Head Peak quadrangles, Mineral County, Nevada: U. S. Geological Survey Map I-1578.

Engineering and Mining Journal, March, 1989, commodity review section.

Erwin, J. W., 1970, Gravity map of the Yerington, Como, Wabuska, and Wellington quadrangles, Nevada: Nevada Bureau of Mines and Geology Map 39.

Erwin, J. W., and Berg, J. C., Bouguer gravity map of Nevada--Reno Sheet: Nevada Bureau of Mines and Geology Map 58.

Fleming, K. L., and Jones, R. B., 1989, in The Nevada mineral industry, 1988: Nevada Bureau of Mines and Geology Special Publication MI-1988, p. 31-44.

Ferguson, H. G., 1939, Nickel deposits in Cottonwood Canyon, Churchill County, Nevada: Nevada Bureau of Mines and Geology Bulletin 32.

Ferguson, H. G., Muller, S. W., and Cathcart, S. H., 1954, Geology of the Mina quadrangle, Nevada: U.S. Geological Survey Map GQ-45.

Fiannaca, M., 1987, Geology of the Santa Fe gold-silver deposit, Mineral County, Nevada in Johnson, J. L., ed., Bulk mineable precious metal deposits of the western United States: The Geological Society of Nevada, Guidebook for Field Trips, p. 233-239.

Frost, K. S., 1984, The New Boston-Blue Ribbon polymetallic skarn in Johnson, J. L., ed, Exploration for ore deposits in the north American cordillera: The Association of Exploration Geochemists 1984 Regional Symposium, Field Trip Guidebook, p. FT10 25-29.

Garside, L. J., 1973, Radioactive mineral occurrences in Nevada: Nevada Bureau of Mines and Geology Bulletin 81.

Garside, L. J., 1979, Geologic map of the Camp Douglas quadrangle, Nevada: Nevada Bureau of Mines and Geology Map 63.

Garside, L. J., 1982, Geologic map of the Moho Mountain quadrangle, Nevada: Nevada Bureau of Mines and Geology Map 74.

Garside, L. J., 1984, in Johnson, J. L., ed, Exploration for ore deposits in the north American cordillera: The Association of Exploration Geochemists 1984 Regional Symposium, Field Trip Guidebook, p. FT4 11-12.

Garside, L. J., 1986, Geochemical reconnaissance of Camp Douglas and Moho Mountain quadrangles, Mineral County, Nevada: Nevada Bureau of Mines and Geology Report 42.
Garside, L. J., 1986, Geothermal energy, in The Nevada mineral industry, 1985: Nevada Bureau of Mines and Geology Special Publication MI-1985.
Garside, L. J., and Schilling, J. H., 1979, Thermal waters of Nevada: Nevada Bureau of Mines and Geology Bulletin 91.
Garside, L. J., and Papke, K. G., 1980, A preliminary first stage study of Nevada coal resources: Nevada Bureau of Mines and Geology Open-File Report 80-5.
Garside, L. J., Hess, R. H., Fleming, K. L., and Weimer, B. S., Oil and gas developments in Nevada: Nevada Bureau of Mines and Geology Bulletin 104.
Gianella, V. P., 1936, Geology of the Silver City district and the southern portion of the Comstock Lode, Nevada: Nevada Bureau of Mines and Geology Bulletin 29.
Grabher, D. E., 1984, Union Carbide's Pilot Mountain project, geologic setting and field trip guide in Johnson, J. C., ed., Exploration for ore deposits of the North American Cordillera: The Association of Exploration Geochemists, 1984 Regional Symposium, Guidebook, Field Trip 10, p. 5-24.
Grauberger, G. L., 1971, Preliminary study of the geology and copper-molybdenum mineralization of the Eastside mine area, Mineral County, Nevada: Nevada Bureau of Mines and Geology mining district file 195, item 21.
Green, W. R., 1964, Structural control of mineralization at the Aurora mining district, Mineral County, Nevada: University of Nevada, Reno, M.S. thesis.
Grose, T. L. T., 1984, Geologic map of the State Line Peak quadrangle, Nevada-California: Nevada Bureau of Mines and Geology Map 82.
Hardyman, R. F., Brooks, W. E., Blaskowski, M. J., Barton, H. F., Ponce, D. A., and Olson J. E., 1988, Mineral resources of the Clan Alpine Mountains Wilderness Study Area, Churchill County, Nevada: U. S. Geological Survey Bulletin 1727B.
Hardyman, R. F., 1980, Geologic map of the Gillis Canyon quadrangle, Mineral County, Nevada: U.S. Geological Survey Map I-1237.
Healey, D. L., Wahl, R. R., and Currey, F. E., 1980, Bouguer gravity map of Nevada--Goldfield and Mariposa sheets: Nevada Bureau of Mines and Geology Map 68.
Healey, D. L., Snyder, D. B., and Wahl, R. R., 1981, Bouguer gravity map of Nevada--Tonopah sheet: Nevada Bureau of Mines and Geology Map 73.
Hess, F. L., and Larsen, E. S., 1921, Contact-metamorphic deposits of the United States: U.S. Geological Survey Bulletin 725-D.
Hess, R. H, and Garside, L. J., 1989, in The Nevada mineral industry, 1988: Nevada Bureau of Mines and Geology Special Publication MI-1988, p. 53-58.

Hildenbrand, T. G., and Kucks, R. P., 1988a, Total intensity magnetic anomaly map of Nevada: Nevada Bureau of Mines and Geology Map 93A.

Hildenbrand, T. G., and Kucks, R. P., 1988b, Filtered magnetic anomaly maps of Nevada: Nevada Bureau of Mines and Geology Map 93B.

Hill, J. M., 1911, Notes on the economic geology of the Ramsey, Talapoosa, and White Horse mining districts, in Lyon and Washoe Counties, Nevada: U.S. Geological Survey Bulletin 470, p. 99-108.

Hill, J. M., 1915, Some mining districts in northeastern California and northwestern Nevada: U. S. Geological Survey Bulletin 594.

Horton, F. W., 1916, Molybdenum, its ores and their occurrence: U.S. Geological Survey Bulletin 111, p. 87.

Hudson, D. M., 1977, Geology and alteration of the Wedekind and part of the Peavine districts, Washoe County, Nevada: M.S. thesis, University of Nevada Reno.

Hudson,D. M., and Oriel, W. M., 1979, Geologic map of the Buckskin Range, Nevada: Nevada Bureau of Mines and Geology Map 64.

Hudson, D. M., 1987, in Johnson, J. L., Bulk minable precious metal deposits of the western United States, a symposium, April 6-8, 1987: Geological Society of Nevada, Guidebook for Field Trips, p. 413-418.

Humphrey, F. L., and Wyatt, M., 1958, Scheelite in feldspathized granodiorite at the Victory mine, Gabbs, Nevada: Economic Geology, v. 53, p. 38-64.

Jennings, T. L., 1978, South Fairview district, Churchill County, Nevada: unpublished company report, Tenneco Minerals.

John, D. A., 1987, Map showing the distribution and characteristics of plutonic rocks in the Tonopah 1° by 2° quadrangle, central Nevada: U.S. Geological Survey Map MF-1877-J.

Johnson, M. G., 1973, Placer gold deposits of Nevada: U.S. Geological Survey Bulletin 1356.

Johnson, M. J., 1977, Geology and mineral deposits of Pershing County, Nevada: Nevada Bureau of Mines and Geology Bulletin 89.

Johnson, J. M., 1978, Geology and mineralization of the Marietta area, Mineral County, Nevada: M.S. thesis, University of Nevada, Reno.

Jonson, D. C., 1986a, An evaluation of the mineral potential of the northern Fairview mining district: unpublished report prepared for Tenneco Minerals.

Jonson, D. C., 1986b, An evaluation of the South Fairview district, Churchill Co, Nevada: unpublished report prepared for Tenneco Minerals.

Katzenstein, A. M., and Danti, K. J., 1982, Evaluation of geothermal potential of the Naval Weapons Training Complex, Fallon, Nevada: Naval Weapons Center Technical Publication 6359, Naval Weapons Center, China Lake, California.

Katzenstein, A. M., and Bjornstad, S. C., 1987, Geothermal resource evaluation at Naval Air Station Fallon, Nevada: Naval Weapons Center Technical Publication 6808, Naval Weapons Center, China Lake, California.

Kerr, P. F., 1936, The tungsten mineralization at Silver Dyke, Nevada: Nevada Bureau of Mines and Geology Bulletin 28.

Kleinhampl, F. J., and Ziony, J. I., 1984, Mineral resources of northern Nye County, Nevada: Nevada Bureau of Mines and Geology Bulletin 99B.

Kleinhampl, F. J., Davis, W. E., Silberman, M. L., Chesterman, C. W., Chapman, R. H., and Gray, C. H., Jr., 1975, Aeromagnetic and limited gravity studies and generalized geology of the Bodie Hills region, Nevada and California: U. S. Geological Survey Bulletin 1384.

Knopf, A., 1918, Geology and ore deposits of the Yerington district, Nevada: U.S. Geological Survey Professional Paper 114.

Knopf, A., 1921, Ore deposits of Cedar Mountain, Mineral County, Nevada: U.S. Geological Survey Bulletin 725-H.

Kral, V. E., 1951, Mineral resources of Nye County, Nevada: Nevada Bureau of Mines and Geology Bulletin 50.

Krason, J., Wodzicki, A., Cruver, S. K., Juilland, J. D., King, p., and Jonas, W., 1987, Geology, energy, and mineral resources assessment of the Socorro area, New Mexico: Bureau of Land Management Geology, Energy and Mineral Resources Assessment Series, Report No. 1.

Lawrence, E. F., 1963, Antimony deposits of Nevada: Nevada Bureau of Mines and Geology Bulletin 61.

Lawrence, E. F., and Wilson, W. L., 1966, Exploration of the Hottentot prospect, Walker Lake Indian Reservation, Nevada: Nevada Bureau of Mines and Geology Report 13A, p. 143-158.

Leigh, R. W., 1964, Nevada place names, their origin and significance: Salt Lake City, Utah, Deseret News Press.

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

Lowe, N. T., Raney, R. G., and Norberg, J. R., 1985, Principal deposits of strategic and critical minerals in Nevada: U.S. Bureau of Mines Information Circular 903

McKee, E. H., Barton, H. F., Conrad, J. E., Ponce, D. A., and Benjamin, D. A., 1987, Mineral resources of the Desatoya Mountains Wilderness Study Area, Churchill and Lander Counties, Nevada: U. S. Geological Survey Bulletin 1727A.

McKee, E. H., and John, D. A., 1987, Sample locality map and potassium-argon ages and data for Cenozoic igneous rocks in the Tonopah 1° by 2° quadrangle, central Nevada: U.S. Geological Survey Map MF-1877-I.

Miller, B. M., ed., 1983, Petroleum potential of Wilderness Lands in the Western United States: Geological Survay Circular 902-A-P.

Mining and Scientific Press, 1906, Ramsey, Nevada: Mining and Scientific Press, September 15, 1906, p. 227-228.

Moller, S. A., 1987, Geology and mineralization in the Candelaria district, Mineral County, Nevada, in Bulk minable precious metal deposits of the western United States, p. 240-242, Johnson, J. L., ed: Geological Society of Nevada, Guidebook for Field Trips.
Moore, J. G., 1969, Geology and mineral deposits of Lyon, Douglas, and Ormsby Counties, Nevada: Nevada Bureau of Mines and Geology Bulletin 75.
Morrison, R. B., 1964, Lake Lahontan: Geology of Southern Carson Desert, Nevada: U.S. Geological Survey Professional Paper 401, 156 p.
Morrissey, F. R., 1968, Turquoise deposits of Nevada: Nevada Bureau of Mines and Geology Report 17.
Nash, J. T., Siems, D. F., and Budge, S., 1985, Geochemical signatures of ore deposits and mineralized rocks from the Pilot Mountains, Mineral County, Nevada: U.S. Geological Survey Open-File Report 85-388.
Nash, J. T., Siems, D. F., and Hill, R. H., 1985, Geochemical signatures of ore deposits and mineralized rocks in the Cedar Mountains, Mineral and Nye Counties, Nevada: U.S. Geological Survey Open-File Report 85-260.
Nash, J. T., and Siems, D. F., 1988, Regional geochemical maps of the Tonopah 1° by 2° quadrangle, Nevada, based on samples of stream sediment and nonmagnetic heavy-mineral concentrate: U.S. Geological Survey Map MF-1877-B.
Nevada Bureau of Mines and Geology, 1977, Aeromagnetic map of Nevada--Reno sheet: Nevada Bureau of Mines and Geology Map 54.
Oliveira, J. L., 1984, Gooseberry mine in Johnson, J. C., ed., Exploration for ore deposits of the North American Cordillera: The Association of Exploration Geochemists, 1984 Regional Symposium, guidebook, field trip 12, p. 1.
Oriel, W. M., 1978, Exploration of enhanced sulfide mineralization at the Buckskin porphyry copper prospect, Douglas and Lyon Counties, Nevada: Nevada Bureau of Mines and Geology Mining District File 35, item 15.
Osborne, M. A., 1987, in Johnson, J. L., Bulk minable precious metal deposits of the western United States, a symposium, April 6-8, 1987: Geological Society of Nevada, Guidebook for Field Trips, p. 245-249.
Overton, T. D., 1947, Mineral Resources of Douglas, Ormsby, and Washoe Counties: Nevada Bureau of Mines and Geology Bulletin 46.
Page, B. M., 1959, Geology of the Candelaria mining district, Mineral County, Nevada: Nevada Bureau of Mines and Geology Bulletin 56.
Page, B. M., 1965, Preliminary geologic map of a part of the Stillwater Range, Churchill County, Nevada: Nevada Bureau of Mines and Geology Map 28.
Paher, S. W., 1970, Nevada ghost towns and mining camps: Berkeley, California, Howell-North Books.

Palmer, W. S., 1935, Gold in petrified wood: Rocks and Minerals, v.10, no. 7, p. 102-103.
Papke, K. G., 1969, in Bonham, H. F., Jr., Geology and mineral deposits of Washoe and Storey Counties, Nevada: Nevada Bureau of Mines and Geology Bulletin 70.
Papke, K. G., 1970, Montmorillonite, bentonite, and Fuller's earth deposits in Nevada: Nevada Bureau of Mines and Geology Bulletin 76.
Papke, K. G., 1972, Erionite and other associated zeolites in Nevada: Nevada Bureau of Mines and Geology Bulletin 79.
Papke, K. G., 1976, Evaporites and brines in Nevada playas: Nevada Bureau of Mines and Geology Bulletin 87.
Papke, K. G., 1979, Fluorspar in Nevada: Nevada Bureau of Mines and Geology Bulletin 93.
Papke, K. G., 1984, Barite in Nevada: Nevada Bureau of Mines and Geology Bulletin 98.
Papke, K. G., 1987, Gypsum deposits in Nevada: Nevada Bureau of Mines and Geology Bulletin 103.
Payne, A. L., 1985, Geological report on the Centurian prospect, Fairview mining district, Churchill County, Nevada: unpublished report.
Pease, R. C., 1980, Genoa quadrangle geologic map: Nevada Bureau of Mines and Geology Map 1Cg.
Phoenix, D. A., and Cathcart, J. B., 1952, Quicksilver deposits in the southern Pilot Mountains, Mineral County, Nevada: U.S. Geological Survey Bulletin 973-D.
Plexus Resources Corporation, 1986, Rawhide gold mine: Plexus Resources Corp., promotional brochure, April 1986.
Plouff, D., 1984, Bouguer gravity map of Nevada--Walker Lake sheet: Nevada Bureau of Mines and Geology Map 83.
Plouff, D., 1988, Aeromagnetic map of Nevada--Walker Lake sheet: Nevada Bureau of Mines and Geology Map 90.
Proffett, J. M., Jr., and Dilles, J. H., 1984, Geologic map of the Yerington district, Nevada: Nevada Bureau of Mines and Geology Map 77.
Quade, J., and Tingley, J. V., 1987, Mineral resource inventory, Fallon U.S. Navy Master Land Withdrawal area, Churchill County, Nevada: Nevada Bureau of Mines and Geology Open-File Report 87-2.
Reeves, R. G., Shawe, F. R., and Kral, V. E., 1958, Iron ore deposits of Nevada, Part B. Iron ore deposits of west-central Nevada: Nevada Bureau of Mines and Geology Bulletin 53.
Reid, J. A., 1904, Preliminary report on the building stones of Nevada, including a brief chapter on road metal: Nevada Bureau of Mines and Geology Bulletin 1.
Robinson, A. C., and Kistler, R. W., 1986, Maps showing isotopic dating in the Walker Lake $1^\circ \times 2^\circ$ quadrangle, California and Nevada: U.S. Geological Survey Map MF-1382-N.
Roman , O. J., 1973, Eastside story: Nevada Bureau of Mines and Geology mining district file 195, item 21.

Rose, R. L., 1969, Geology of parts of the Wadsworth and Churchill Butte quadrangles, Nevada: Nevada Bureau of Mines and Geology Bulletin 71.
Ross, D. C., 1961, Geology and mineral deposits of Mineral County, Nevada: Nevada Bureau of Mines and Geology Bulletin 58.
Rowan, L. C., and Purdy, T. L., 1984, Map of the Walker Lake 1° by 2° quadrangle, California and Nevada, showing the regional distribution of hydrothermally altered rocks: U.S. Geological Survey Map MF-1382-Q.
Roylance, J. G., 1966, The Dayton iron deposits, Lyon and Storey counties, Nevada in Papers presented at the AIME Pacific Southwest mineral industry conference, Sparks, Nevada, May 5-7, 1965: Nevada Bureau of Mines and Geology Report 13A, p. 125-141.
Saltus, R. W., 1988a, Bouguer gravity anomaly map of Nevada: Nevada Bureau of Mines and Geology Map 94A.
Saltus, R. W., 1988b, Regional, residual, and derivative gravity maps of Nevada: Nevada Bureau of Mines and Geology Map 94B.
Satkoski, J. J., Lambeth, R. H., White, W. W., III, and Dunn, M. D., 1985, Field inventory of mineral resources and compilation of exploration data, Walker River Indian Reservation, Nevada: U.S. Bureau of Mines Report BIA No. 21-II.
Saunders, F. T., 1978, Preliminary geological examination, South Fairview mining district, Churchill County, Nevada: unpublished company report, Tenneco Minerals.
Schilling, J. H., 1968, Copper mountain mine, Rand mine, Bovard mine: Nevada Bureau of Mines and Geology Mining District File 191B, items 17-19.
Schilling, J. H., 1976, Metal mining districts of Nevada: Nevada Bureau of Mines and Geology Map 37.
Schrader, F. C., 1947, Carson Sink area, Nevada: U.S. Geological Survey Open-File Report.
Shamberger, H. A., 1970, The story of Rawhide: Nevada Historical Press, Carson City, Nevada.
Shamberger, H. A., 1974, The Story of Wonder: Nevada Historical Press, Carson City, Nevada.
Shamberger, H. A., 1973, The story of Fairview: Nevada Historical Press, Carson City, Nevada.
Shawe, F. R., Reeves, R. G., and Kral, V. E., 1962, Iron deposits of Nevada, Part C. Iron deposits of northern Nevada: Nevada Bureau of Mines and Geology Bulletin 53.
Silberling, N. J., and John, D. A., 1989, Geologic map of pre-Tertiary rocks of the Paradise Range and southern Lodi Hills, west-central Nevada: U.S. Geological Survey Map MF-2062.
Silberman, M. L., 1977, Proposal for evaluating alunite resources of the Bovard (Rand, Copper Mountain) mining district, Mineral County, Nevada: Nevada Bureau of Mines and Geology Mining District File 191A, item 9.

Smith, M. R., 1984, The Pumpkin Hollow magnesian iron-copper skarn, in Johnson, J. C., ed., Exploration for ore deposits of the North American Cordillera: The Association of Exploration Geochemists, 1984 Regional Symposium, Guidebook, Field Trip 10, p. 41-42.

Smith, P. L., Tingley, J. V., Bentz, J. L., Garside, L. J., Papke, K. G., and Quade, J., 1983, A mineral inventory of the Esmeralda-Stateline resource area, Las Vegas district, Nevada: Nevada Bureau of Mines and Geology Open-File Report 83-11.

Stager, H. K., and Tingley, J. V., 1988, Tungsten deposits in Nevada: Nevada Bureau of Mines and Geology Bulletin 105.

Stewart, J. H., 1980, Geology of Nevada: Nevada Bureau of Mines and Geology Special Publication 4.

Stewart, J. H., McKee, E. H., and Stager, H. K., 1977, Geology and mineral deposits of Lander County, Nevada: Nevada Bureau of Mines and Geology Bulletin 88.

Stewart, J. H., Carlson, J. E., and Johannesen, D. C., 1982, Geologic map of the Walker Lake 1° by 2° quadrangle, California and Nevada: U.S. Geological Survey Map MF-1382A.

Stoddard, C., 1932, Notes on Summit Springs, Mineral County, Nevada: Nevada Bureau of Mines and Geology Memorandum for the Press, September 5, 1932, NBMG File 205, item 5.

Stoddard, C., and Carpenter, J.A., 1950, Mineral resources of Storey and Lyon counties, Nevada: Nevada Bureau of Mines and Geology Bulletin 49.

Strachan, D. G., 1985, Geologic discussion of the Borealis gold deposit, Mineral County, Nevada in Tooker, E. W., ed., Geologic characteristics of sediment- and volcanic-hosted disseminated gold deposits--search for an occurrence model: U.S. Geological Survey Bulletin 1646, p. 89-94.

Strachan, D. G., 1986, A prospectus, the Rex gold property, Fairview district, Churchill County, Nevada: unpublished report for Spectrum Exploration.

Stretch, R. H., 1867, First annual report of the State Mineralogist of the State of Nevada for 1866: Carson City, Nevada State Printing Office.

Tenneco Minerals, 1987, The Borealis project, in Johnson, J. L., ed., Bulk minable precious metal deposits of the western United States: The Geological Society of Nevada, Guidebook for Field Trips, p. 243.

The Anaconda Co., 1976, Proxy statement: New York, The Anaconda Co., p. 66-68.

Thorstenson, D. C., 1968, Geology of Chalk Mountain, Churchill County, Nevada: Northwestern University, unpublished thesis.

Tingley, J. V., and Smith, P. L., 1983, A mineral inventory of the Shoshone-Eureka resource area, Battle Mountain district, Nevada: Nevada Bureau of Mines and Geology Open-File Report 83-3.

Tingley, J. V., 1970, Minnesota mine, Buckskin mining district, Douglas and Lyon Counties, Nevada: unpublished private report.

Tingley, J. V., and Quade, J., 1986, A mineral inventory of the Tonopah Resource Area, Battle Mountain District, Nevada: Nevada Bureau of Mines and Geology Open-File Report 86-14.
Trexler, D. T., 1977, Carson City folio, geologic map: Nevada Bureau of Mines and Geology, Map 1Ag.
Trexler, D. T., Flynn, T., Koenig, B. A., and Ghusn, G., Jr., 1983, [Map of] geothermal resources of Nevada; National Geophysical Data Center, National Oceanic and Atmospheric Administration, 1:500,000.
U.S. Geological Survey and Nevada Bureau of Mines and Geology, 1964, Mineral and water resources of Nevada: Nevada Bureau of Mines and Geology Bulletin 65.
U.S. Bureau of Mines, 1980, Mineral facts and problems, 1980 edition.
U.S. Bureau of Mines, 1988, Mineral commodity summaries.
Vanderburg, W. O., 1936, Placer mining in Nevada: Nevada Bureau of Mines and Geology Bulletin 27.
Vanderburg, W. O., 1936, Reconnaissance of mining districts in Pershing County, Nevada: U.S. Bureau of Mines Information Circular 6902.
Vanderburg, W. O., 1937, Reconnaissance of mining districts in Mineral County, Nevada: U.S. Bureau of Mines Information Circular 6941.
Vanderburg, W. O., 1940, Reconnaissance of mining districts in Churchill County, Nevada: U.S. Bureau of Mines Information Circular 7093.
Vitaliano, C. J., and Callaghan, E., 1963, Geology of the Paradise Peak quadrangle, Nevada: U.S. Geological Survey Map GQ-250.
Wallace, A. B., 1975, Geology and mineral deposits of the Pyramid district, southern Washoe County, Nevada: Ph.D. dissertation, University of Nevada Reno.
Weaver, S. G., 1982, The geology of the Bovard mining district, Gabbs Valley Range, Mineral County, Nevada: University of Nevada Reno M.S. thesis.
Whelan, J. A., Rodgers, C. R., Bown, J., and Neffew, J., 1980, Evaluation of geothermal potential of Range Bravo 17 and the Shoal Site, Naval Air Station, Fallon: Naval Weapons Center Technical Publication 6142, Naval Weapons Center, China Lake, California.
White, A. F., 1869, Report of the State Mineralogist of Nevada for the years 1867 and 1868: Carson City, Nevada
White, D. E., Thompson, G. A., and Sandberg, C. H., 1964, Rocks, structure, and geologic history of Steamboat Springs thermal area, Washoe County, Nevada: U.S. Geological Survey Professional Paper 458-B.
Whitehill, H. R., 1879, Biennial report of the State Mineralogist of the State of Nevada for the years 1877 and 1878: Carson City, Nevada.
Willden, R., and Speed, R. C., 1974, Geology and mineral deposits of Churchill County, Nevada: Nevada Bureau of Mines and Geology Bulletin. 83.

Wilson, J. R., 1963, Geology of the Yerington mine: Mining Congress Journal, June 1963, p. 30-34.
Wren, J. H., 1963, Preliminary report, King mine, Mineral County, Nevada: unpublished report, NBMG files.