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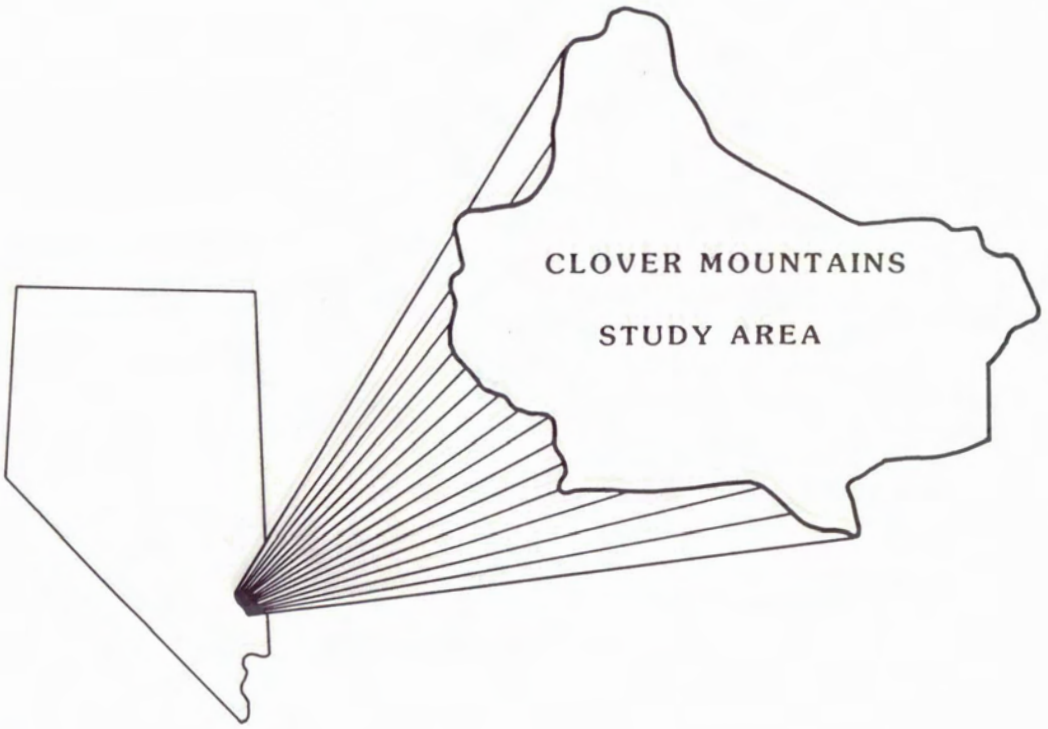
Mineral Land Assessment/1987
Open File Report

Mineral Resources of the Clover Mountains Study Area, Lincoln County, Nevada



BUREAU OF MINES
UNITED STATES DEPARTMENT OF THE INTERIOR

MINERAL RESOURCES OF THE CLOVER MOUNTAINS STUDY AREA, LINCOLN COUNTY, NEVADA

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UNITED STATES DEPARTMENT OF THE INTERIOR
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PREFACE

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and U.S. Bureau of Mines to conduct mineral surveys on U.S. Bureau of Land Management administered land designated as Wilderness Study Areas ". . . to determine the mineral values, if any, that may be present . . . ." Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a Bureau of Mines mineral survey of a portion of the Clover Mountains Wilderness Study Area (NV-050-139), Lincoln County, NV.

This open-file report will be summarized in a joint report published by the U.S. Geological Survey. The data were gathered and interpreted by Bureau of Mines personnel from Western Field Operations Center, E. 360 Third Avenue, Spokane, WA 99202. The report has been edited by members of the Branch of Mineral Land Assessment at the field center and reviewed at the Division of Mineral Land Assessment, Washington, DC.

CONTENTS

ILLUSTRATIONS

TABLES

SUMMARY

In 1984, at the request of the Bureau of Land Management, the U.S. Bureau of Mines studied an 84,165-acre portion of the 84,935-acre Clover Mountains Wilderness Study Area (NV-050-139) in order to evaluates its identified mineral resources. The area studied is in Lincoln County, NV, about 90 miles north of Las Vegas, NV. No mineral resources were identified in the study area.

Volcanic rocks are the most common in the study area, consisting mainly of a thick sequence of ignimbrites in a cauldron complex. Cambrian to Triassic marine sedimentary rocks and Cretaceous to Oligocene clastic rocks are along and partly inside the west and south sides of the study area. No mineral production has come from the study area, but gold, silver, copper, and fluorspar have been mined nearby. Eleven mines and prospects in or adjacent to the study area were examined. Workings inside the study area include two shafts, 10 and 60 ft deep, and eleven shallow prospect pits at four sites along the west edge.

At the Pennsylvania mine, just west of the study area, limestone is intruded by diorite. The mine owner estimates that a replacement quartz-breccia zone in the diorite contains a 700,000-ton resource with 0.039 oz/ton gold and less significant amounts of silver and copper. Preliminary cost estimates based on the owner's production plan suggest that the gold resources are marginal reserves. Development work to mine higher-grade segments of the deposit by open pit and heap leach the ore on site was begun in April 1986. By October 1986, about 2,000 oz gold and 15,000 oz silver had been recovered. The mineralized breccia zone apparently does not extend into the study area.

Ten other prospects are in or just outside the study area, but no resources were identified. At three of the prospects, drilling or other methods of subsurface investigation might reveal silver, lead, gold, or molybdenum resources: the Bobcat prospect is inside the western part of the study area, and the Gold Chance and Cherokee 1-12 prospects are outside the southern boundary.

No evidence of metallic or energy mineral resources was found inside the study area where moderate to intense hydrothermal alteration and apparently anomalous thorium levels were described in published reports. More intensive study, including stream sediment and soil or rock geochemistry, might reveal targets for additional evaluation. Clinoptilolite, a zeolite mineral, occurs near Fountain of Youth Spring in the central part of the study area; detailed mapping and sampling might disclose zeolite resources. Deposits of stone, sand, and gravel in the study area are suitable for local construction uses, but distances to large markets make development unlikely.

INTRODUCTION

This report describes the USBM (U.S. Bureau of Mines) portion of a cooperative study with the USGS (U.S. Geological Survey) to evaluate mineral resources and resource potential of the Clover Mountains study

area at the request of the BLM (U.S. Bureau of Land Management). The USBM examines individual mines, prospects, claims, and mineralized zones, and evaluates identified mineral and energy resources. The USGS evaluates potential for undiscovered resources based on areal geological, geochemical, and geophysical surveys. Results of the investigations will be used to help determine the suitability of the study area for inclusion into the National Wilderness Preservation System. Although the immediate goal of this and other USBM mineral surveys is to provide data for the President, Congress, government agencies, and the public for land-use decisions, the long-term objective is to ensure the Nation has an adequate and dependable supply of minerals at a reasonable cost.

Setting

The study area consists of 84,165 acres within the 84,935-acre Clover Mountains Wilderness Study Area in southeastern Nevada. The study area is in eastern Lincoln County about 90 mi (miles) north of Las Vegas and 20 mi south of Caliente, NV (fig. 1). The study area is bounded on the west by Meadow Valley Wash and Pennsylvania Canyon, on the north and east by roads on Sheep Flat and along Sams Camp Wash, and on the south by roads from the Tule Desert. Elevations within the study area range from about 3,040 ft (feet) at the southwest corner of the study area in Meadow Valley Wash to 7,555 ft on Sawmill Mountain in the northeast corner. Much of the study area at elevations above 5,000 ft is covered by pinon-juniper forest with groves of cottonwood and ponderosa pine along some drainages; sparse desert vegetation, mainly creosote bush, is below 5,000 ft.

Previous Studies

C. M. Tschanz and E. H. Pampeyan (1970) described geology and mineral deposits in and near the study area in their report on Lincoln County. Tertiary geology of the county was further described by Ekren and others (1977). Two reports prepared for the BLM discuss geology, energy, and minerals (Great Basin GEM Joint Venture, 1983) and a reconnaissance geochemical assessment (Hoffman and Day, 1984) of the study area and vicinity.

Present Study

Work by the USBM, Western Field Operations Center, Spokane, WA, entailed prefield, field, and report preparation phases that spanned the years 1984 through 1986. Prefield studies included a search of pertinent literature and examination of Lincoln County and BLM mining and mineral lease records. Data from USBM, state, and other production records were compiled. Claim owners and lessees were contacted, when possible, for permission to examine properties and publish the results. Field studies involved searches for all mines, prospects, and claims. Those found were examined, and where warranted, were mapped and sampled. Mines and prospects outside, but near the study area also were studied to determine whether mineralized zones might extend into the study area, and to establish guides to mineral deposits in the region.

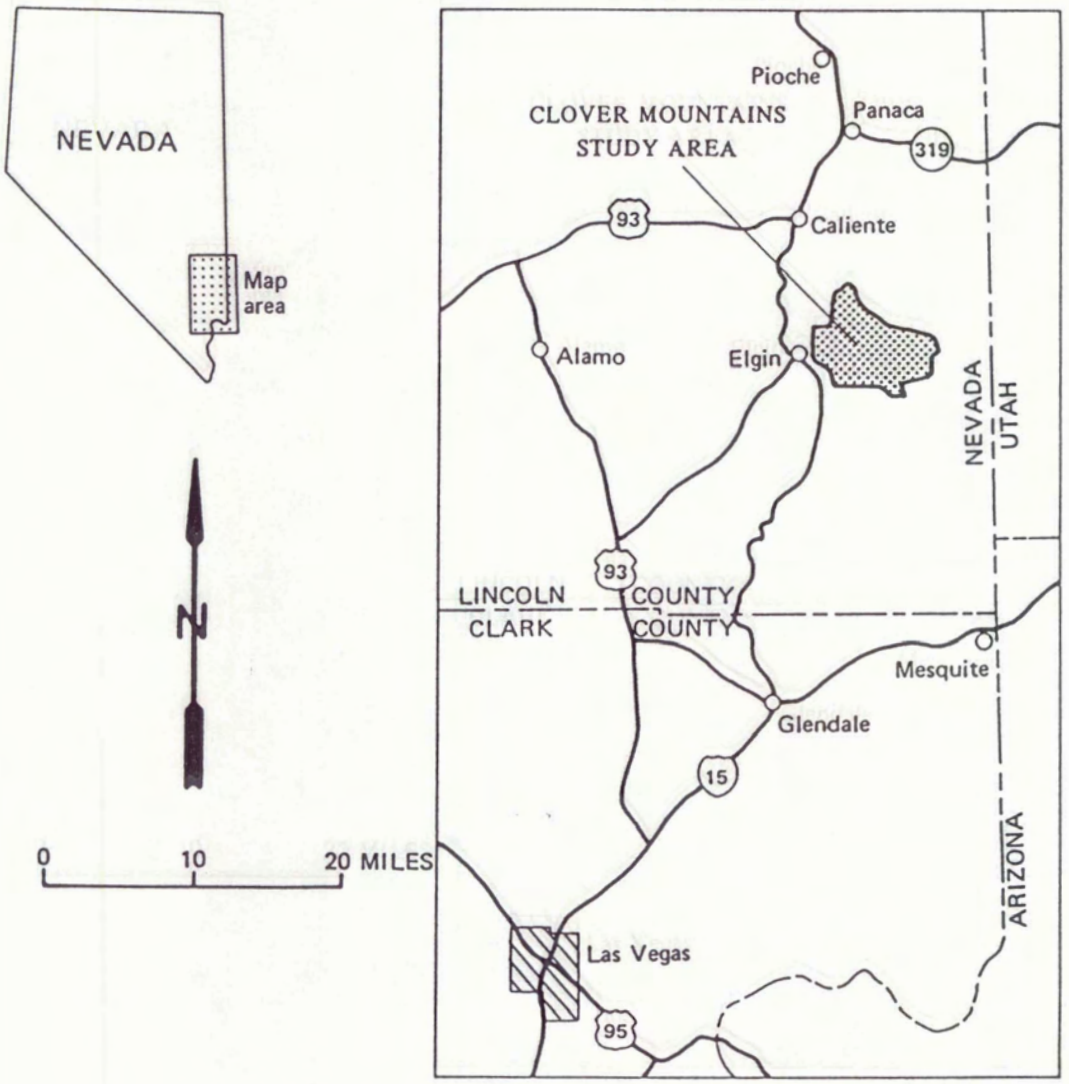

FIGURE 1. – Location of the Clover Mountains study area, Lincoln County, NV

One hundred thirty-two rock samples collected at mines, prospects, and mineralized sites were of four types: (1) chip - a regular series of rock chips taken in a continuous line across a mineralized zone or other exposure; (2) random chip - an unsystematic series of chips taken from an exposure of apparently homogeneous rock; (3) grab - rock pieces taken unsystematically from a dump, stockpile, or of float (loose rock lying on the ground); and (4) select - pieces of rock chosen, generally, from the apparently best mineralized parts of a pile or exposure, or of any particular fraction (e.g., quartz, host rock).

Rock samples were analyzed at the USBM laboratory in Reno, NV, for gold and silver by fire assay or combined fire assay-ICP (inductively coupled plasma) methods. Presence and abundance of identified or suspected elements of possible economic significance were determined by ICP, atomic absorption, fluorometric, radiometric, x-ray fluorescence, or other quantitative method. At least one sample from each locality was analyzed for 40 1/ elements by semiquantitative emission spectrography to detect unsuspected elements of possible significance. Petrographic examinations were used to identify alteration suites and mineral assemblages. A monitoring scintillometer was used to test for radioactivity in the field.

ACKNOWLEDGEMENTS

Geologists Richard Rains and Terry Neumann, USBM, aided greatly during field investigations. Information and assistance provided by BLM personnel in Caliente and by Thomas Johnston, owner of the Pennsylvania mine, are very much appreciated.

GEOLOGIC SETTING

The Clover Mountains study area is underlain mainly by Tertiary volcanic rocks that range from rhyolite to basalt in composition. Cambrian marine sedimentary rocks, including quartzite, shale, limestone, and dolomite and Cretaceous to Oligocene clastic rocks are exposed along Pennsylvania Canyon. Permian to Triassic limestone, mudstone, and red beds crop out in a fault block along the southern boundary and partly inside the study area. Two other fault blocks south of the study area consist of lower Mississippian limestone and Pennsylvanian limestone and sandstone. Several small exposures of lower Paleozoic carbonate rock are just east of the study area.

The overlying volcanic rocks consist mainly of a thick sequence of ignimbrites centered near Caliente in a cauldron complex, the southern margin of which passes through the study area. The boundary of the complex is marked by alteration of the ash-flow tuffs and rhyolite

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1/ Aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, gallium, gold, iron, lanthanum, lead, lithium, magnesium, manganese, molybdenum, nickel, niobium, palladium, phosphorus, platinum, potassium, scandium, silicon, silver, sodium, strontium, tantalum, tellurium, tin, titanium, vanadium, yttrium, zinc, and zirconium.

flows near the Boyd clay mine in Meadow Valley Wash (fig. 2). The boundary parallels a series of rhyolite dikes near the head of Pennsylvania Canyon and to the east, in the center of the study area, coincides for several miles with a major northwest-trending fault (Ekren and others, 1977).

Mineralized rocks are concentrated along the west and south sides of the study area. At the west side, in the Pennsylvania mine area, Cambrian limestone and quartzite were intruded by a diorite stock. A gently dipping, silicified breccia zone in the diorite at the Pennsylvania mine contains gold, silver, and copper. Calc-silicate alteration of the sediments produced epidote and calcium garnet; oxidized parts of the altered zones contain malachite and hematitic pseudomorphs after chalcopyrite. Shear zones in carbonate rocks along the east side of Pennsylvania Canyon contain silver, lead, and zinc.

In the Viola (Cherokee) district, along the southern margin of the study area, faulted blocks of Paleozoic and Mesozoic carbonate rocks, shale, and quartzite have been locally mineralized. Sedimentary rocks inside the study area are mostly covered by Tertiary extrusive rocks. Masses of jasperoid are along the sedimentary-volcanic rock contact. Limestone units in the Viola district contain silver, copper, lead, zinc, and mercury; some occurrences also contain appreciable quantities of cadmium, antimony, and molybdenum (Tschanz and Pampeyan, 1970, p. 162). Gypsum occurs in red beds, and manganese and fluorspar deposits are in limestone 1 to 4 mi south of the study area.

MINING HISTORY

Eleven mines and prospects are in or just outside, but no mineral production has come from the study area. Mine development in the Clover Mountains began in the Pennsylvania district, just west of the study area, in 1871 (Carlson, 1974, p. 188); low-grade ore had been produced from the Pennsylvania mine by 1881 (Angel, 1958, p. 485). The Viola (Cherokee) mining district is outside the southern boundary of the study area and was active by the 1880's.

Total production from the Pennsylvania district until 1986 was approximately $70,000 in gold, silver, lead, and copper. About 190 claims have been located in the district since 1889; 139 claims were current in July 1984. The current claims blanket the old Pennsylvania mine and nearby workings, and some extend into the study area (in secs. 14, 23, and 26-28, T. 6 S., R. 67 E.) A proposal to mine by open pit and heap leach gold resources on site was approved by BLM in 1984; resource evaluation by the owners continued at the Pennsylvania mine through 1985. Development work was begun in April 1986, and by October 1986 about 2,000 oz (ounces) gold and 15,000 oz silver had been recovered.

More than 400 claims were located south of the study area in the Viola district between 1891 and 1947. Production of silver and copper ore from the patented Cherokee mine probably totaled less than 500 tons (Tschanz and Pampeyan, 1970, p. 164-5). The Wells Cargo fluorspar mine, about 4 mi south of the study area, was discovered in 1957. In 1958, 11,500 tons of fluorspar valued at $363,000 were mined from the deposit. The mines were idle in 1985.

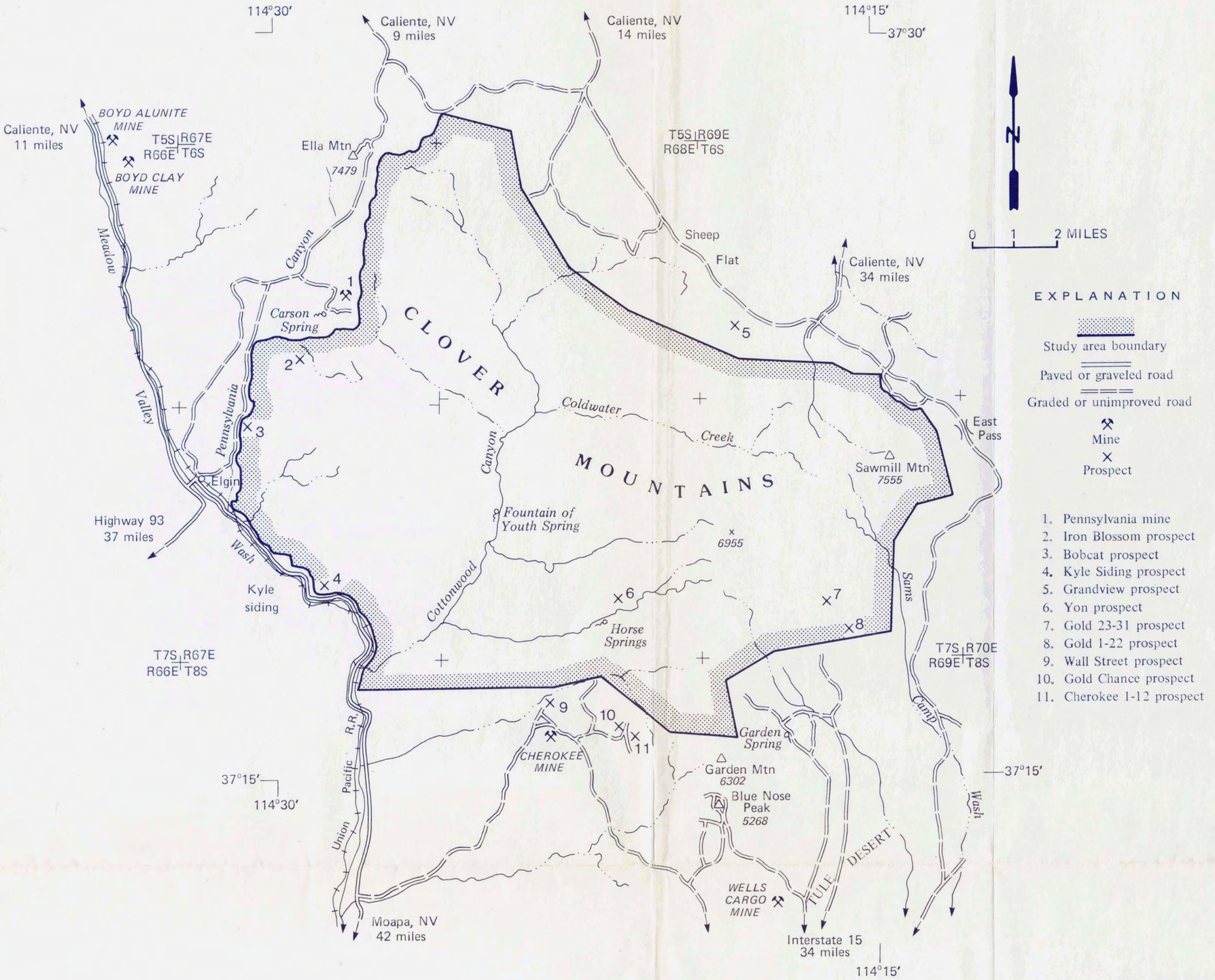


FIGURE 2.— Mines and prospects in and adjacent to the Clover Mountains study area, Lincoln County, NV

Mining activity along Meadow Valley Wash includes the Boyd clay mine, 5.7 mi west of the study area, which was worked intermittently between 1920 and 1930, and the Boyd alunite mine, which produced three carloads of alunite for use as fertilizer (Hewett and others, 1936, p. 146, 174). About 43 claims were located in or near the study area between the mouth of Pennsylvania Canyon and Kyle Siding from 1904 to 1958; none were active in 1984.

More recent exploration activity includes drilling of a molybdenum target about 1 mi northwest of Blue Nose Peak in the mid-1970's (William Walker, Canyon Resources Corp., personal commun., 1985); no development ensued. In 1980, Houston International Minerals Corporation located 147 claims (Yon prospect, fig. 2, No. 6) inside the southern part of the study area (secs. 22-27 and 34-36, T. 7 S., R. 68 E.). The claims were reportedly for molybdenum and have been subsequently dropped (Great Basin GEM Joint Venture, 1983, p. 15). Also in 1980, the Bethex Corporation located two blocks of claims (Gold 1-22 and Gold 23-31, fig. 3, Nos. 7 and 8) mostly inside the southeast part of the study area (secs. 27, 28, and 33-35, T. 7 S., R. 69 E.). These claims have also been abandoned.

Silver and gold targets were identified in the vicinity of Blue Nose Peak by Canyon Resources Corporation, Golden, CO. A block of 151 current claims covers many of the old workings and extends to within 1 mi of the study area. Mineralization is associated with silicified zones in limestone near contacts with overlying extrusive rocks. Evaluation of the property continued in 1985 (William Walker, Canyon Resources Corp., written commun., 1985).

Earth Sciences, Inc. of Golden, CO, applied for a permit to prospect for alunite 2 mi east of the study area (Great Basin GEM Joint Venture, 1983, p. 15). The possible alunite resources, an extension of deposits to the east in Utah, were to be part of a pilot project to evaluate processes and assess the economics of alumina recovery from alunite (Parkinson, 1974, p. 75).

COMMODITY HIGHLIGHTS

Information in this section is from USBM summaries (U.S. Bureau of Mines, 1986) unless otherwise noted.

Gold

Domestic gold mine production in 1985, approximately 2.40 million oz, was the highest since 1950. High levels of exploration activity and new mine development were focused on California and Nevada. Domestic mines include about 180 major lode mines, nearly all in western states; several dozen large placer mines, nearly all in Alaska; and hundreds of small lode and placer mines. About 7 percent of domestic mine production was as a by-product of base metal mining, mainly copper.

Apparent consumption in 1985 was about 4.30 million oz. The gold was used in jewelry and arts, 52 percent; industrial products, mainly for electronics, 35 percent; dental work, 12 percent; and small bars etc., mainly for investment, 1 percent. Net import reliance was 31 percent of apparent consumption; major import sources were Canada, 56 percent; Uruguay, 9 percent; and Switzerland, 6 percent. From a 1983 base, demand for gold is expected to increase at an average annual rate of about 2.4 percent through 1990.

Gold ranged in price during 1985 from $284/oz in February to $341/oz in August; averaging approximately $318/oz for the year. In December 1986, gold price (Handy and Harman) averaged $391.225/oz (Metals Week, January 12, 1987, p. 10).

Silver

U.S. production of silver declined in 1985 because of temporary closures and reduced operations at a number of mines in response to continuing low silver prices. An estimated 43.0 million oz of silver were produced domestically from about 150 mines in 16 states; value was approximately $267 million. Five states accounted for 87 percent of 1985 production: Idaho, 49 percent; Nevada, 14 percent; Montana, 9 percent; Arizona, 9 percent; and Missouri, 5 percent.

Apparent consumption in 1985 was about 192.0 million oz, mainly for end uses in photography, 48 percent; electrical and electronic products, 25 percent; sterlingware, electroplated ware, and jewelry, 12 percent; and brazing alloys and solders, 5 percent. Net import reliance was 64 percent of apparent consumption; major import sources were Canada, 28 percent; Mexico, 24 percent; Peru, 17 percent; and United Kingdom, 15 percent. From a 1983 base, demand for silver is expected to increase at an average annual rate of about 0.8 percent through 1990.

The average daily price for silver declined from $8.14/oz in 1984 to $6.20/oz in 1985. Prices in 1985 ranged from a low of $5.57/oz in March to $6.72/oz in April. Speculator and investor activity, as distinguished from industrial demand, was the primary factor in silver price movements. In December 1986, silver price (Handy and Harman) averaged $5.36/oz (Metals Week, January 12, 1987, p. 10).

Copper

Domestic mine production for 1985 was 1.05 million metric tons (estimate) valued at $1.5 billion. The principle mining states are Arizona, New Mexico, and Utah. Apparent domestic consumption in 1985 is estimated at 2.166 million metric tons; net reliance on imports was 27 percent. Sources of imported copper include Chile, 39 percent; Canada, 25 percent; Peru, 9 percent; and Mexico, 7 percent. Average copper price in 1985 was $0.669/lb (pound). Copper is used mainly in building construction, 39 percent; electrical and electronic products, 25 percent; industrial machinery and equipment, 15 percent; transportation, 11 percent;

and consumer and general products, 10 percent. From a 1983 base, demand for copper in the U.S. is expected to increase at an average annual rate of 1.9 percent through 1990. Despite increased consumption in 1985, production and prices for copper remained depressed; U.S. producers are at a disadvantage in both domestic and international markets. A substantial portion of U.S. mine capacity remained idle; several mines and plants closed or cut back production.

MINES, PROSPECTS, AND MINERALIZED SITES

Evidence of mining or prospecting activity was found at 11 sites in or just outside the study area (fig. 2). Descriptions of the most significant sites follow. Prospects where geologic exposures and sample data provide little indication of resources are briefly described at the end of this section (table 4).

Pennsylvania Mine (Culverwell, Jumbo)

The mine is near the head of Pennsylvania Canyon (fig. 2, No. 1) in secs. 14, 15, 22, and 23, T. 6 S. R. 67 E. (projected), and is owned by Thomas C. and Cecile Johnston, Eureka, NV. Elevation is 5,800 ft. The mine is about 22 mi south from Caliente, NV, on graded gravel roads by way of Ella Mountain, or 22 mi from Caliente on the paved road in Meadow Valley Wash to Elgin, NV, then 9 mi up Pennsylvania Canyon on gravel roads.

The Pennsylvania mine was discovered by Philip Klingensmith who began development in 1871 (Carlson, 1974, p. 188). A small pan amalgamation mill was installed in about 1890 but ore was apparently not sufficiently free-milling to operate successfully (Marshall, 1948, p. 5; Tschanz and Pampeyan, 1970, p. 172).

Some low-grade ore had been produced by 1881, which yielded $20-25/ton (Angel, 1958, p. 485). Two shipments of ore from the Pennsylvania mine were made to a smelter in 1914 (Marshall, 1948, p. 6). USBM production records list 74 tons of ore from the Pennsylvania mine (also known as the Hope) in 1941-1942 that yielded 50 oz gold, 691 oz silver, 1,280 lb copper, and 192 lb lead. Workings just south of the Pennsylvania shaft on claims of the Culverwell and Jumbo groups produced about 1,500 tons of ore between 1932 and 1953 that averaged 1.75 oz/ton gold, 7.6 oz/ton silver, 0.5 percent lead, and 0.08 percent copper.

Exploration work was carried out in 1951-1953 under a DMEA (Defense Minerals Exploration Administration) loan in an effort to block out enough copper reserves for erection of a mill. A total of 656.7 ft of drifting from the 550-ft level of the north inclined shaft (fig. 3) failed to disclose sufficient mineralized rock along the vein to justify additional development (Gentry and Tschanz, 1953, p. 2). Since 1953, several companies have conducted exploration activities on the site including trenching and drilling, mostly directed toward discovery of gold and silver resources.

Fisher-Watt Mining Company, under a lease agreement, began preproduction stripping of the deposit in April 1986. Since then about 90,000 tons of ore have been mined that averaged 0.11 oz/ton gold and 1.0 to 1.5 oz/ton silver. The ore was mainly from the Jumbo pit, which is south of the old Pennsylvania workings. Heap leaching of the ore continued in October 1986, by which time about 2,000 oz gold and 15,000 oz silver had been recovered.

The old Pennsylvania mine workings include two inclined shafts (fig. 3) 620 and 265 ft deep, a 110 ft-deep vertical shaft, and several pits and open cuts (Trengove, 1950). Workings in limestone on the ridge south of the Jumbo pit include at least nine pits or open cuts and two adits. The lower, longer adit is caved; the upper adit has about 80 ft of workings.

The deposit consists of a quartz breccia replacement body along a zone of shearing in Tertiary diorite. The zone strikes generally N. 20° W. and dips about 20° NE. Ore apparently occurs where northeast-trending, steeply dipping feeder veins intersect the zone. The quartz is commonly banded, has zones of sugary texture and comb structures, and, in places, contains isolated, partly assimilated diorite inclusions. The diorite is porphyritic and commonly chloritic near the mineralized zone. Minor amounts of limonite, malachite, and chrysocolla line fissures where the quartz body is exposed in outcrop. Argentite, free-milling gold, bornite, chalcopyrite, chalcocite, and covellite have been reported in subsurface, unoxidized parts of the mineralized zone (Marshall, 1948, p. 6). The quartz zone has been traced at the surface and in workings for 3000 ft along strike and to a depth of 620 ft. The zone is 3 to 7 ft thick in the old Pennsylvania workings (Trengove, 1950, p. 4) and as much as 70 ft thick in the vicinity of the Jumbo pit (B. Hillemeyer, Fisher-Watt Mining Co., personal commun., 1985).

The diorite is overlain by ash-flow tuff and rhyolite to the east. Cambrian limestone, quartzite, and shale crop out along a ridge south of the diorite. Contact deposits of calcium silicates are along the eastern end of the ridge. Ekren and others (1977) show a northwest-trending fault cutting the volcanic rocks just east of the mine area and converging with the rim of the cauldron complex to the southeast.

Thirty-five samples, mainly from surface exposures, were collected for this study prior to the start of open pit mining operations. Sample locations are shown on figure 3; analyses are in table 1. Most contained small amounts of gold and silver. Those from the area of the Jumbo pit averaged 0.01 oz/ton gold and 0.2 oz/ton silver. Others ranged from 0.0002 to 0.0927 oz/ton gold.

Most of the 34 samples collected from the Pennsylvania workings during the DMEA exploration program contained detectable gold, ranging from a trace (less than 0.005 oz/ton) to 0.02 oz/ton. Two delineated resource blocks in the north inclined shaft, totaling 11,000 tons, average 1.61 percent copper and 8.3 oz/ton silver (Gentry and Tschanz, 1953, p. 9).

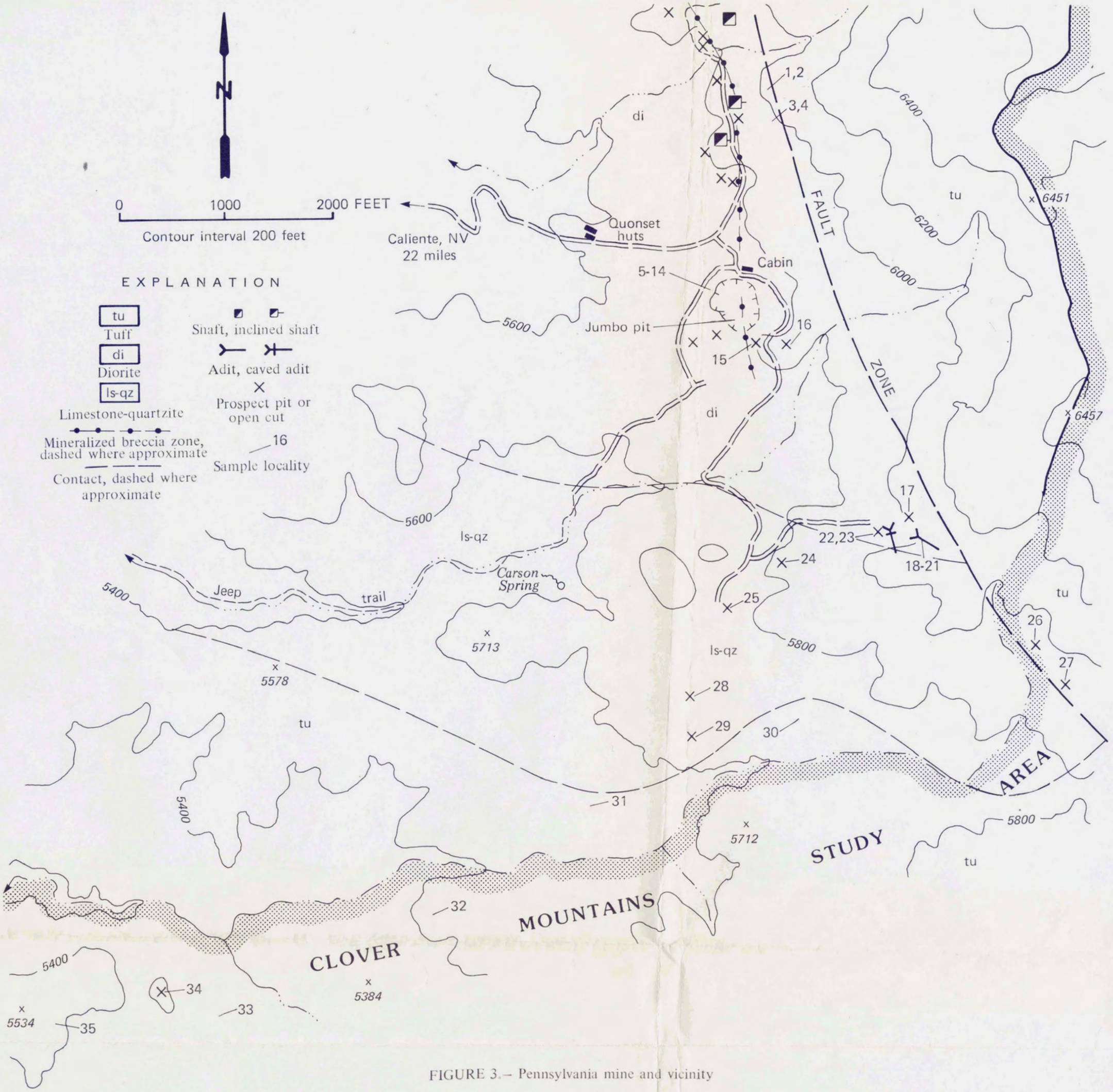


FIGURE 3.– Pennsylvania mine and vicinity

TABLE 1.--Data for samples from the Pennsylvania mine

(Tr, trace; N, none detected; --, not analyzed; NA, not applicable) 1/

No.	Type	Sample length (ft)	Description	Gold (oz/ton)	Silver (oz/ton)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
1	Chip	4.0	Weathered diorite at contact with overlying rhyolite----------	0.0009	N 2/	--	--	--
2	do--	4.5	do----------	.0006	N 2/	--	--	--
3	do--	5.8	Argillized rhyolite breccia at contact with underlying brown, argillic rhyolite-------	.0006	N 2/	--	--	--
4	do--	5.5	Argillic, tuffaceous rhyolite, minor hematite stain----------	.0005	N 2/	--	--	--
5	do--	2.6	Quartz breccia zone in chloritic diorite. Quartz is banded; contains comb structures and minor limonite, malachite, and chrysocolla----------	Tr	N	28	41	30
6	do--	5.0	do----------	Tr	N	37	86	32
7	do--	6.3	do----------	Tr	0.1	88	35	43
8	do--	7.5	do (continuation below sample 7)----------	Tr	.2	130	63	48
9	do--	4.0	Quartz breccia zone in chloritic diorite---	.01	.1	130	30	51
10	do--	3.5	do----------	.06	.8	82	44	28
11	do--	4.6	do----------	.01	1.1	1300	440	240
12	do--	3.0	do----------	Tr	N	14	16	22

TABLE 1.--Data for samples from the Pennsylvania mine

No.	Type	Sample length (ft)	Description	Gold (oz/ton)	Silver (oz/ton)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
13	Chip	2.9	Quartz breccia zone in chloritic diorite---	Tr	N	17	N	36
14	do--	1.5	do----------	0.02	N	N	N	19
15	do--	4.4	Quartz breccia replacement zone in diorite, limonitic on weathered surfaces----------	.0017	0.020	--	--	--
16	do--	2.5	do----------	.0033	.113	--	--	--
17	do--	4.6	Siliceous, limonite-stained diorite at contact with overlying tuff----------	N 2/	.027	46	38	44
18	do--	4.3	Limonitic shear zone with quartz stringers and lenses in diorite----------	.0004	.027	--	--	--
19	do--	3.2	Sheared diorite----------	.0004	.014	32	81	93
20	do--	3.8	Sheared, limonitic diorite----------	.0014	.019	42	26	86
21	do--	4.0	Quartz stringers along shear zone in diorite	.0008	.027	--	--	--
22	do--	4.8	Sheared contact of diorite with overlying dolomite----------	.0003	.094	--	--	--
23	do--	1.1	Earthy, black to red hematite lens with secondary copper minerals along diorite-dolomite contact----------	.0038	.046	2300	850	610
24	do--	1.8	Silicified zone in limestone, contains malachite and hematite pseudomorphs after chalcopyrite----------	.0095	.085	--	--	--

TABLE 1.--Data for samples from the Pennsylvania mine

No.	Type	Sample length (ft)	Description	Gold (oz/ton)	Silver (oz/ton)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
25	Grab	NA	Chloritic, hematitic diorite dike in dolomite contains secondary copper minerals. Stockpile at small pit----------	0.0927	0.109	8400	25	110
26	Chip	6.0	Silicified breccia along faulted contact of limestone with tuff----------	.0002	.029	19	170	110
27	Grab	NA	Dump of sloughed pit at tuff-limestone contact----------	N 2/	N 2/	N	45	38
28	Chip	3.0	Limonite-stained shear zone in limestone, with lenses of white quartz----------	.0132	.634	47	8300	2600
29	do--	3.5	Limonitic shear zone in limestone, manganese oxides along fissures----------	.0174	.671	88	13000	3100
30	Random chip--	NA	Argillically altered tuff with pervasive hematite staining and silicification; about 200 ft from underlying limestone----------	N 2/	.013	--	--	--
31	do--	NA	Bleached, hematitic tuff with oxidized pseudomorphs after pyrite, some comb quartz in float----------	N 2/	N 2/	--	--	--
32	do--	NA	Dark gray tuff with plagioclase and sanidine phenocrysts----------	N 2/	N 2/	--	--	--
33	do--	NA	Silicified, hematite-stained tuff--------	N 2/	N 2/	--	--	--
34	Chip	6.0	Siliceous chert-pebble conglomerate with pervasive hematite stain----------	.0017	.034	11	47	41

TABLE 1.--Data for samples from the Pennsylvania mine

No.	Type	Sample length (ft)	Description	Gold (oz/ton)	Silver (oz/ton)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
35	Random chip--	NA	Gray, sandy limestone, bedding strikes N. 15° W., dips 33° SW.----------	0.0006	0.011	--	--	--

1/ Detection limits, unless otherwise noted: gold 0.005 oz/ton, silver 0.05 oz/ton, copper 6 ppm, lead 15 ppm, zinc 5 ppm.

2/ Detection limits: gold 0.0002 oz/ton, silver 0.009 oz/ton.

Thomas Johnston (personal commun., 1985) estimated a resource at the deposit of 700,000 tons with 0.039 oz/ton gold. General cost estimates based on the owner's extraction plan suggest that the deposit is a marginal reserve. A reserve block within the deposit of 100,000 tons with 0.11 oz/ton gold was identified by the current operators and partly mined in 1986. Continuing resource evaluation by the operators is expected to identify additional ore (B. Hillemeyer, personal commun., 1986).

Bobcat Prospect

The Bobcat prospect (fig. 2, No. 3) is on the east side of Pennsylvania Canyon in SE 1/4 sec. 5, T. 7 S., R. 67 E. Elevation is 4,440 to 4,700 ft. The prospect is about 2.5 mi up Pennsylvania Canyon from Elgin, NV. The Bobcat claim was located by James and Bill Bradshaw in August 1971, but some of the workings are much older.

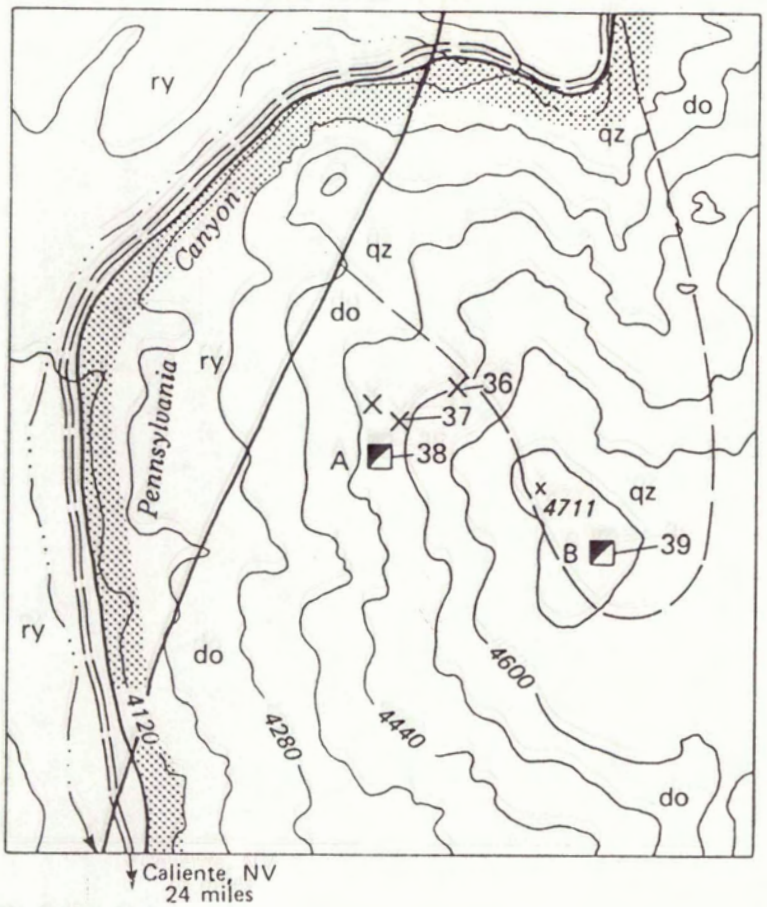
A porous, hematitic breccia zone in dark-gray, fine-grained dolomite is vertical and strikes N. 30° W. The breccia contains quartz, pyrite, stringers of translucent opal, and disseminated blebs of galena as much as 5 mm across. The breccia zone, exposed in a vertical shaft about 60 ft deep, is irregular and discontinuous (fig. 4, shaft A). The zone is 6 ft thick in the shaft but crops out for less than 30 ft along strike. Segments of hematitic breccia zones to the northeast are exposed in three shallow, partly sloughed pits. These zones are 1 to 5.2 ft thick and are subparallel but apparently not continuous with the main breccia zone.

Silicified chert-pebble conglomerate, exposed in a 10-ft-deep shaft (fig. 4, shaft B) 800 ft southeast of shaft A, contains pyrite. The pyrite is both disseminated and in oxidized blebs. The conglomerate consists mainly of gray-white to black chert with intricate networks of comb quartz. Exposure of the pyritic zone is poor and orientation is undetermined.

Samples from the hematitic breccia zones contained gold, silver, lead, and zinc. Sample localities are shown on figure 4, analytical results are in table 2.

Gold Chance Prospect

The Gold Chance prospect (fig. 2, No. 10) is on the south slope of the Clover Mountains in the SW 1/4 sec. 11, T. 8 S., R. 68 E. (projected). Elevation is 5,200 ft. Access is by road about 33 mi south from Caliente, NV along Meadow Valley Wash then 8.5 mi northeast up dry washes and along jeep roads. The Gold Chance claims were located by James W. Cole, Pioche, NV, in 1981.



EXPLANATION

Study area boundary

ry — Rhyolite

do — Dolomite

qz — Quartzite and conglomerate

Approximate contact

Fault

Shaft

Prospect pit

—36 Sample locality

N

0 1000 FEET

Contour interval 80 feet

FIGURE 4.– Bobcat prospect

TABLE 2.--Data for samples from the Bobcat prospect

(--, not analyzed; NA, not applicable)

No.	Type	Sample length (ft)	Description	Gold (oz/ton)	Silver (oz/ton)	Copper (pct)	Lead (pct)	Zinc (pct)
36	Chip	5.2	Sheared, limonitic zone in silicified limestone----------	0.003	0.09	--	--	--
37	Grab	NA	Hematitic breccia from shear zone in dolomite contains blebs of galena to 5mm across------	.017	1.20	0.016	4.40	2.70
38	Chip	6.0	Irregular, discontinuous breccia zone in dolomite at shaft A; hematitic with veinlets of opal----------	.022	1.37	.008	4.10	1.50
39	Grab	NA	Pyritic chert-pebble conglomerate on dump----	.0004	.05	.001	.004	.02

A contact of gray, medium-grained limestone with overlying andesite is sheared, silicified, and brecciated. The contact zone is limonite stained and subparallel with bedding in the limestone, which strikes N. 30° to 40° W. and dips 35° NE. The zone is about 6 ft thick and exposed for 400 ft along strike. Limestone-shale contacts within the sedimentary section are also limonite stained. Cubic limonite pseudomorphs after pyrite are scattered through the limestone. Quartz is present as coarsely crystalline stringers along joints in limestone and as cherty bands in shale. A steeply dipping felsic dike obliquely transects the sedimentary beds, striking generally N. 20° W. The dike is as thick as 20 ft but averages 10 ft thick.

Four shallow prospect pits and two trenches 30 and 40 ft long are along limonitic contact zones. At least one drillhole is near the pits; depth is unknown. One of four chip samples taken from the pits contained 0.0153 oz/ton gold and 160 ppm molybdenum; each sample contained silver (0.012 to 0.103 oz/ton). No other elements were found to be anomalous. Three samples from outcrops of limestone, near its contact with overlying volcanic rock north of the pits, contained 0.011 to 0.019 oz/ton silver.

Cherokee 1-12 Prospect

The Cherokee 1-12 prospect (fig. 2, No. 11) is on the south side of the Clover Mountains, about 0.5 mi outside the study area in SW1/4 sec. 11, T. 8 S., R. 68 E. (projected). Elevation is 5,300 ft. Access is by road about 33 mi south from Caliente, NV, along Meadow Valley Wash, then 8.6 miles northeast up dry washes and along jeep roads. The Cherokee 1-12 claims are owned by Golden Triangle Exploration, Pioche, NV, and were located in 1981.

A shear zone strikes N. 43° E. and dips 30° NW in white to purple, fine-grained, silicified limestone. The zone consists of brecciated quartz in a hematitic, partly silica-cemented matrix. The zone is 1.5 to 4.2 ft thick, averaging 3.0 ft, and is exposed for 40 ft in a 62-ft-long adit and partly sloughed pit (fig. 5). Two of three samples from the zone contained 0.016 and 0.020 oz/ton silver (Table 3). One sample from a secondary, hematitic shear in the adit contained 0.025 oz/ton silver.

The silicified limestone is overlain by andesite which is in turn overlain to the east by welded ash-flow tuff. Three shallow pits and an inclined shaft are in or just below an argillized zone in the tuff. The shaft was driven N. 80° E. about 40 ft, downward at 25°. The locally silicified, limonite-stained argillized zone is 65 to 80 ft wide and exposed for 300 ft. The zone trends N. 10° W. and dips 30° NE; two of four samples from the zone contained 0.047 and 0.052 oz/ton silver.

None of the eight samples from the prospect contained detectable gold or antimony or more than 19 ppm copper, 60 ppm lead, or 120 ppm zinc. Six samples were analyzed for barium and molybdenum; they contained 82 to 490 ppm barium (average 278 ppm) and 24 to 140 ppm molybdenum (average 72 ppm). Tin in the six samples averaged 8.2 ppm.

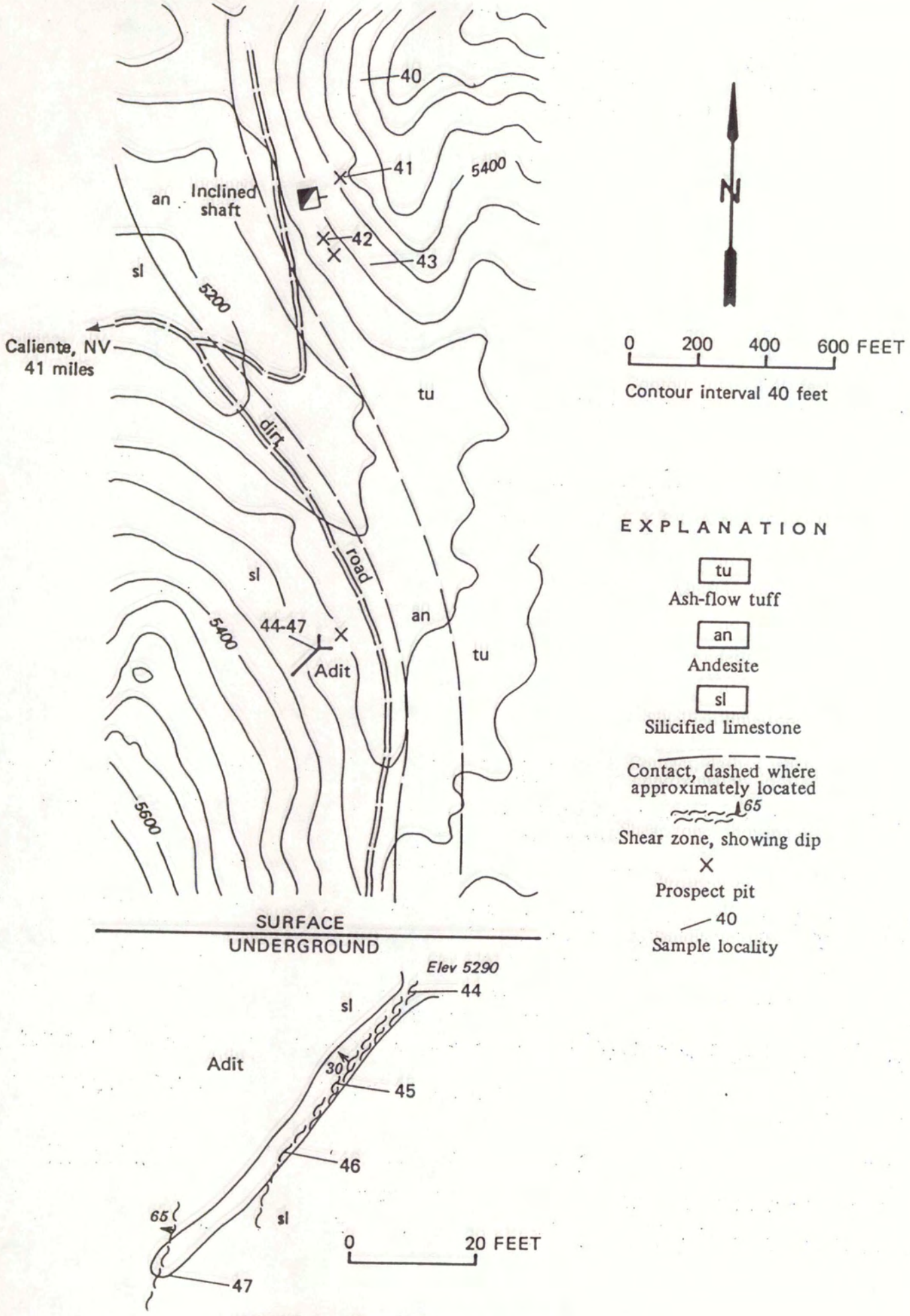


FIGURE 5.– Cherokee 1–12 prospect

TABLE 3.--Data for samples from the Cherokee 1-12 prospect

(N, none detected; --, not analyzed)

No.	Type	Sample length (ft)	Description	Silver (oz/ton)	Arsenic (ppm)	Molybdenum (ppm)	Barium (ppm)	Tin (ppm)
40	Chip	65.0	Argillized, limonitic zone in ash-flow tuff.	0.047	--	37	480	N
41	do--	15.0	Silicified, limonitic ash-flow tuff---------	N	N	--	--	--
42	do--	6.0	Argillized, silicified zone in ash-flow tuff.	N	N	--	--	--
43	do--	80.0	do----------	.052	--	24	490	4.6
44	do--	3.5	Hematitic shear zone in silicified limestone.	.020	24.2	100	200	5.2
45	do--	4.2	Hematite- and silica-cemented quartz breccia along shear zone----------	.016	11	65	83	7.7
46	do--	1.5	do----------	N	--	140	82	12
47	do--	.5	Secondary shear zone in silicified limestone, minor limonite----------	.025	--	64	330	20

Other Mineralized Sites

Paleozoic sedimentary rocks and Tertiary volcanic rocks such as are found in the Clover Mountains study area are known in other parts of the region to host precious-metal mineralization. Areas of moderate to intense hydrothermal alteration inside the study area were identified by Ekren and others (1977). The alteration generally circumscribes the inferred boundary of the Caliente cauldron complex, and affects both Paleozoic and Tertiary rocks. Rock chip samples were collected from outcrops both in and outside the delineated altered areas. Two of 27 samples contained detectable gold 3/, 0.043 and 0.135 ppm; all but six samples contained silver, 0.35 to 3.939 ppm. Seven samples contained 4 to 14.3 ppm arsenic. None contained detectable antimony.

A zone northeast of the Pennsylvania mine in the northwest corner of the study area appears to be anomalous in thorium on the U.S. Department of Energy aerial radiometric survey maps (Geolife, 1980, table 8). Fourteen of the 27 outcrop samples were from the zone; they contained 5.3 to 7.8 ppm uranium and 30 to 55 ppm thorium. Scintillometer traverses revealed no anomalous levels of radioactivity in the study area.

One sample of altered tuff from near Fountain of Youth Spring was analyzed by x-ray diffraction for zeolites; it contained about 65 percent clinoptilolite. No concentrations of alunite were found in the study area.

Deposits of stone, sand, and gravel within the study area could be used for local construction. The most readily accessible deposits are in drainages along Meadow Valley Wash as in Cottonwood and Pennsylvania Canyons.

3/ For elements expected to be present only in low amounts, detection limits were 0.007 ppm for gold, 0.3 ppm for silver, 2 ppm for arsenic, 2 ppm for antimony, and 2 ppm for mercury.

TABLE 4.--Mines and prospects in and adjacent to the Clover Mountains study area

[* indicates outside study area]

Map no.	Name	Summary	Workings and production	Sample and resource data
1*	Pennsylvania mine (Culverwell, Jumbo)	Mineralized quartz breccia in Tertiary diorite is along a sheared zone that strikes N. 20° W. and dips 20° NE. The replacement quartz breccia has been traced for 3000 ft along strike and to a depth of 620 ft in workings. The zone is 3 to 7 ft thick in the old Pennsylvania workings and as much as 70 ft thick in the vicinity of the proposed Jumbo pit. The diorite is in contact with Cambrian sedimentary rocks to the south and is overlain by Tertiary volcanic rocks to the east. The quartz breccia contains limonite, malachite, and chrysocolla; diorite-carbonate contacts to the south contain mineralized calc-silicate pods.	The Pennsylvania mine was developed by three shafts 620, 265, and 110 ft deep; eight pits and open cuts. Ore mined before 1881 yielded $20-25/ton (Angel, 1958, p. 485); additional shipments were made in 1914 (Marshall, 1948, p. 6). USBM records show that 74 tons of ore mined in 1941-42 yielded 50 oz gold, 691 oz silver, 1,280 lb copper, and 192 lb lead. Shallow shafts and trenches are just south of the Pennsylvania shafts at the old Culverwell and Jumbo workings where about 1,500 tons of ore that averaged 1.75 oz/ton gold, 7.6 oz/ton silver, 0.5% lead, and 0.08% copper were mined between 1932 and 1953. About 90,000 tons of ore that averaged 0.11 oz/ton gold and 1.0 to 1.5 oz/ton silver were mined in 1986 for heap leaching. By October 1986, about 2,000 oz gold and 15,000 oz silver were recovered. At least nine pits and two adits with no record of production are south of the Jumbo workings.	Thirty-five samples were taken. Twelve samples of quartz breccia from the Jumbo pit area contained as much as 0.06 oz/ton gold and 1.1 oz/ton silver, and averaged 0.01 oz/ton gold, 0.2 oz/ton silver, 181 ppm copper, 75 ppm lead, and 52 ppm zinc. Thirteen of 23 other samples, mainly of tuff or diorite along contacts with carbonate rocks contained detectable gold, 0.0002 to 0.0927 oz/ton. A 700,000-ton resource of leachable ore that contains 0.039 oz/ton gold was estimated by the owner. The current operators identified a 100,000-ton resource that was mostly mined in 1986.
2	Iron Blossom prospect	A massive to porous limonite and hematite zone along bedding in limestone strikes N. 20° W., dips 20° SW, and is 1.5 to 2.4 ft thick. The zone is exposed for 20 ft in workings and intermittently for 70 ft to the southeast where it is jasperoidal near its contact with overlying rhyolite.	Two trenches, 18 and 20 ft long, are each about 6 ft wide and 3 ft deep.	Three samples were taken. One of two samples from the workings contained 0.0069 oz/ton gold; none was detected in the other. The samples also contained 0.015 and 0.031 oz/ton silver, 15 and 19 ppm copper, less than 10 and 66 ppm lead, and 42 and 190 ppm zinc, respectively. A third sample from the jasperiod in outcrop contained no detectable gold and 0.013 oz/ton silver.
3	Bobcat prospect	A vertical, hematitic breccia zone in dolomite strikes N. 30° W. The zone contains quartz, opal, pyrite, and sparse galena, and is 6 ft thick in the main shaft but exposed for less than 30 ft along strike. Segments of other, similar, subparallel shear zones are exposed to the north and east; they are narrow and discontinuous.	The main breccia zone is exposed in a 60 ft deep vertical shaft. Three shallow trenches and a 10 ft deep vertical shaft are on the other subparallel zones.	Four samples were taken. A sample from the main breccia zone contained 0.0220 oz/ton gold, 1.37 oz/ton silver, 0.008% copper, 4.1% lead, and 1.5% zinc. Three samples from the other zones contained 0.0004 to 0.017 oz/ton gold, 0.05 to 1.20 oz/ton silver, 0.001% to 0.016% copper, 0.004% to 4.4% lead, and 0.02% to 2.7% zinc.

TABLE 4.--Mines and prospects in and adjacent to the Clover Mountains study area--Continued

Map no.	Name	Summary	Workings and production	Sample and resource data
4	Kyle Siding prospect	A limonitic shear zone in andesite strikes N. 65° W. and dips 70° NE. The zone contains quartz lenses and stringers and is stained with manganese oxides. It is exposed for 140 ft along strike; thickness averages 3 ft. Argillic alteration in overlying ash-flow tuff is pervasive, and iron oxide staining is intense along a N. 70° W. striking sheared zone.	Four prospect pits are along the shear zone in andesite. One sloughed pit may have been 10 ft deep.	Seven samples were taken. Gold was detected (0.0002 oz/ton) in one of two samples from the shear zone in andesite. No silver or significant amounts of other elements were detected. Of five samples o ash-flow tuff, one contained 0.0008 oz/ton gold. No other elements of economic significance were detected.
5*	Grandview prospect	Claims were staked in 1963, they are underlain by ash-flow and ash-fall tuff. Stringers of opaline silica in the tuff are as thick as 2 in.	None.	One grab sample of opaline silica contained 14.0 ppm arsenic and no detectable gold, silver, antimony, mercury, or thallium.
6	Yon prospect	Welded ash flow tuff is bleached, silicified, and stained with hematite along fissures. Rhyolite dikes as much as 40 ft thick strike northwesterly through the tuff and locally contain disseminated pyrite.	None.	Fifteen samples were taken. Six of eleven samples of altered ash-flow tuff contained 0.011 to 0.020 oz/ton silver, and two of four samples from rhyolite dikes contained 0.010 and 0.011 oz/ton silver. None contained detectable gold or antimony; 13 contained 3 to 12.8 ppm arsenic. No other elements were anomalous.
7	Gold 23-31 prospect	Bleached and silicified intermediate lava and tuff are 2 mi south of the projected rim of the Caliente cauldron complex. Fissures are commonly stained with hematite.	None.	Ten samples were taken. Five of ten outcro samples contained 0.0011 to 0.0018 oz/ton gold; six contained 0.011 to 0.012 oz/ton silver. None contained anomalous arsenic, antimony, or other elements of economic significance.
8	Gold 1-22 prospect	Altered lava and tuff are 2 mi south of the projected rim of the Caliente cauldron complex. Quartz stringers to 2 in thick are common.	None.	Ten samples were taken. One of ten outcrop samples contained 0.0005 oz/ton gold; two contained 0.016 and 0.024 oz/ton silver. None contained anomalous arsenic, antimony or other elements of economic significance
9*	Wall Street prospect	Poorly exposed quartz veins and coarse calcite stringers strike northwesterly in white, recrystallized limestone. The quartz veins are as much as 2.5 ft thick, and contain lenses of limonitic boxwork.	Four shallow prospect pits and a 20-ft-long adit are in the quartz-bearing limestone.	Four samples were taken. A chip sample of massive quartz contained 0.013 oz/ton silver. A sample of coarse calcite contained 0.050 oz/ton silver, 0.20% lead, and 0.81% zinc. A grab sample of vein quartz in talcose limestone contained 0.014 oz/ton silver. A grab sample of limonitic boxwork contained 0.0007 oz/ton gold and 0.049 oz/ton silver.

TABLE 4.--Mines and prospects in and adjacent to the Clover Mountains study area--Continued

Map no.	Name	Summary	Workings and production	Sample and resource data
10*	Gold Chance prospect	A contact zone of limestone with overlying andesite is sheared, brecciated, and silicified. The zone is limonite stained; it strikes N. 30-40° W. and dips 35° NE. Quartz stringers are along joints, and pyrite is scattered through the limestone. Shale interbeds contain cherty bands. A 10-ft-thick felsic dike strikes N. 20° W. through the sedimentary beds.	Four shallow prospect pits and two trenches 30 and 40 ft long are along limonitic contact zones. At least one drillhole is near the pits; depth is unknown.	Seven samples were taken. One of seven chip samples from near the limestone-andesite contact contained 0.0153 oz/ton gold, and 160 ppm molybdenum. Each sample contained silver (0.011 to 0.103 oz/ton). No other elements were found to be anomalous.
11*	Cherokee 1-12 prospect	A shear zone in silicified limestone strikes N. 61° E. and dips 30° NW. Brecciated limestone in the zone is in a hematitic, siliceous matrix. Average thickness of a 40 ft exposure is 3 ft. Argillized, silicified rhyolitic ash-flow tuff north of the shear zone is 65-80 ft wide and exposed for 300 ft along a N. 10° W. trend.	A 62-ft adit and sloughed shaft are on the shear zone in silicified limestone. Three shallow pits and a 40 ft inclined shaft are in the altered ash-flow tuff zone 1,300 ft north of the adit.	Eight samples were taken. Three of four samples from the hematitic, sheared silicified limestone contained 0.016 to 0.025 oz/ton silver. Two of four samples from the altered ash-flow tuff contained 0.047 and 0.052 oz/ton silver. None of the samples contained detectable gold or antimony. Six samples contained 82-490 ppm barium (average 278 ppm), and 24-140 ppm molybdenum (average 72 ppm).

APPRAISAL OF MINERAL RESOURCES

Samples from surface exposures in the Pennsylvania mine area disclosed no resources but revealed consistently anomalous amounts of gold and silver in the mineralized quartz breccia zone. Resource estimates by the owner are based on extensive geologic mapping, drilling, and sampling. General cost estimates based on the owner's extraction plan suggest that the deposit is a marginal reserve, although portions of this deposit are currently (1986) being mined. No evidence was found that the mineralized breccia zone extends into the study area along strike to the south of the mine. The downdip extension of the zone, assuming continuity and constant northeasterly dip, would be about 1,800 ft deep at the study area boundary. The faulted blocks of Paleozoic sedimentary rocks to the south are altered and locally contain gold and base metals, but no substantial mineralized structure was found. The study area boundary excludes nearly all of the sedimentary rocks near the Pennsylvania mine.

Only small amounts of gold, silver, or other elements that might suggest mineral resources were detected at other prospects or altered zones inside the study area. The mineralized zones at the Bobcat prospect are too discontinuous and gold and silver content too low to constitute resources.

Outside the south boundary of the study area, silver was consistently anomalous at the Wall Street, Gold Chance, and Cherokee 1-12 prospects. However, the silver values were well below what could be recognized as resources, and no significant mineralized structures were found. Anomalous amounts of molybdenum were also found in samples from the prospects which, along with the presence of silver and base metals nearby and substantial amounts of fluorspar and manganese to the south (Wells Cargo mine), suggests that a disseminated molybdenum body may underlie the area.

Although slightly anomalous amounts of thorium were found in the study area, samples were too low-grade to suggest the presence of resources. Thorium markets are small. Because thorium is a byproduct of titanium, rare earth, and uranium mining, supplies of thorium have exceeded demand for many years. Uranium content in the samples were within the range expected for felsic igneous rocks (Rose, 1977, p. 303).

Stone, sand, and gravel inside the study area along Meadow Valley Wash could be used in road and railroad construction and maintenance. Development of such construction materials at other sites in the study area is unlikely because of their inaccessibility and remoteness.

RECOMMENDATIONS FOR FURTHER STUDY

Although preliminary sampling of altered volcanic and sedimentary rocks in the study area did not disclose resources, a thorough geochemical survey, focused on a possible low-grade, large-tonnage gold and silver resource, is required to discount or substantiate such a deposit. Drilling of silver and molybdenum targets outside the study area in the Viola district might reveal resources. Clinoptilolite occurs in the study area; detailed mapping and sampling of altered volcanic rock might reveal zeolite resources.

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