Mineral Resources of the Golden Valley Wilderness Study Area, San Bernardino County, California

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STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Golden Valley Wilderness Study Area (CDCA-170), California Desert Conservation Area, San Bernardino County, California.

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By Michael F. Diggles, Robert E. Tucker, and Diane E. Clemens
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SUMMARY

Abstract

In 1982 and 1983 the U.S. Geological Survey and the U.S. Bureau of Mines conducted a mineral resource appraisal and assessment of the Golden Valley Wilderness Study Area (CDCA-170) which covers 29,887 acres in the northwestern Mojave Desert near Ridgecrest, Calif. (fig. 1). Four areas have been identified as having mineral resource potential, one area has geothermal energy resource potential, and two areas have both mineral and geothermal energy resource potential. The Steam Well, located near but outside of the south-central boundary of the wilderness study area is an active hot spring. The area 1 mi northwest of the Steam Well has high resource potential for gold and silver, moderate resource potential for geothermal energy, and low mineral resource potential for sodium. An adjacent area to the west which includes the rest of the southwestern lobe of the study area has low mineral resource potential for gold and silver. The area 1.5 mi northeast of the Steam Well is interpreted as a hot-spring-type mineral occurrence with high mineral resource potential for gold and silver, moderate geothermal energy resource potential, and low mineral resource potential for sodium. Zones of propylitic alteration occur along both the southern and northern boundaries of the study area (fig. 2). The north-central part of the study area, 2 mi southeast of the Summit Range, is the most intensely propylitically altered and contains an area with moderate mineral resource potential for silver, lead, and zinc; a low mineral resource potential for gold exists in the area that extends northwest to the study area boundary (fig. 2). An area located west of the Browns Ranch fault zone and in the middle of the Lava Mountain claims has a moderate mineral resource potential for gold and possibly silver and tungsten. There is a low potential for geothermal energy resources in nearly the entire wilderness study area, with the exceptions of the northwest corner and areas that have higher designations for geothermal energy resources mentioned above.

Character and Setting

The Golden Valley Wilderness Study Area comprises 29,887 acres approximately 12 mi southeast of Ridgecrest, Calif. (fig. 1). Gravel roads and jeep trails from the Trona road provide access to the study area. It has elevations that range from 2,600 ft along the northern edge to nearly 5,000 ft at the top of Dome Mountain. The mountains are generally rounded with steep slopes. The study area derives its name from the annual blooming of bright-yellow Coreopsis in a narrow valley that separates the Lava Mountains and Almond Mountain. The study area lies at the northern edge of the Mojave Desert two miles south of the Garlock fault (fig. 2), a major east-west structure that forms the southern boundary of the Basin and Range physiographic province. The oldest rock unit is the Cretaceous(?) Atolia Quartz Monzonite, which forms low hills in the northwest corner of the Lava Mountains. Overlying this intrusive unit are volcanic and sedimentary rocks ranging in age from Miocene or early Pliocene through Pleistocene and Holocene. In the western part of the study area the late Pliocene Almond Mountain Volcanics have been propylitically altered by hydrothermal processes. The majority of the prospects, including those from which samples yielded anomalous geochemical values, are within hydrothermally altered zones.

Mineral Resources and Resource Potential

Gold mineralization, probably of the hot-spring epithermal type, has occurred near the Steam Well, on the RAK claims, and in the Browns Ranch fault zone on the Lava Mountain claims. Although no resource estimates were made, wide-spread alteration and

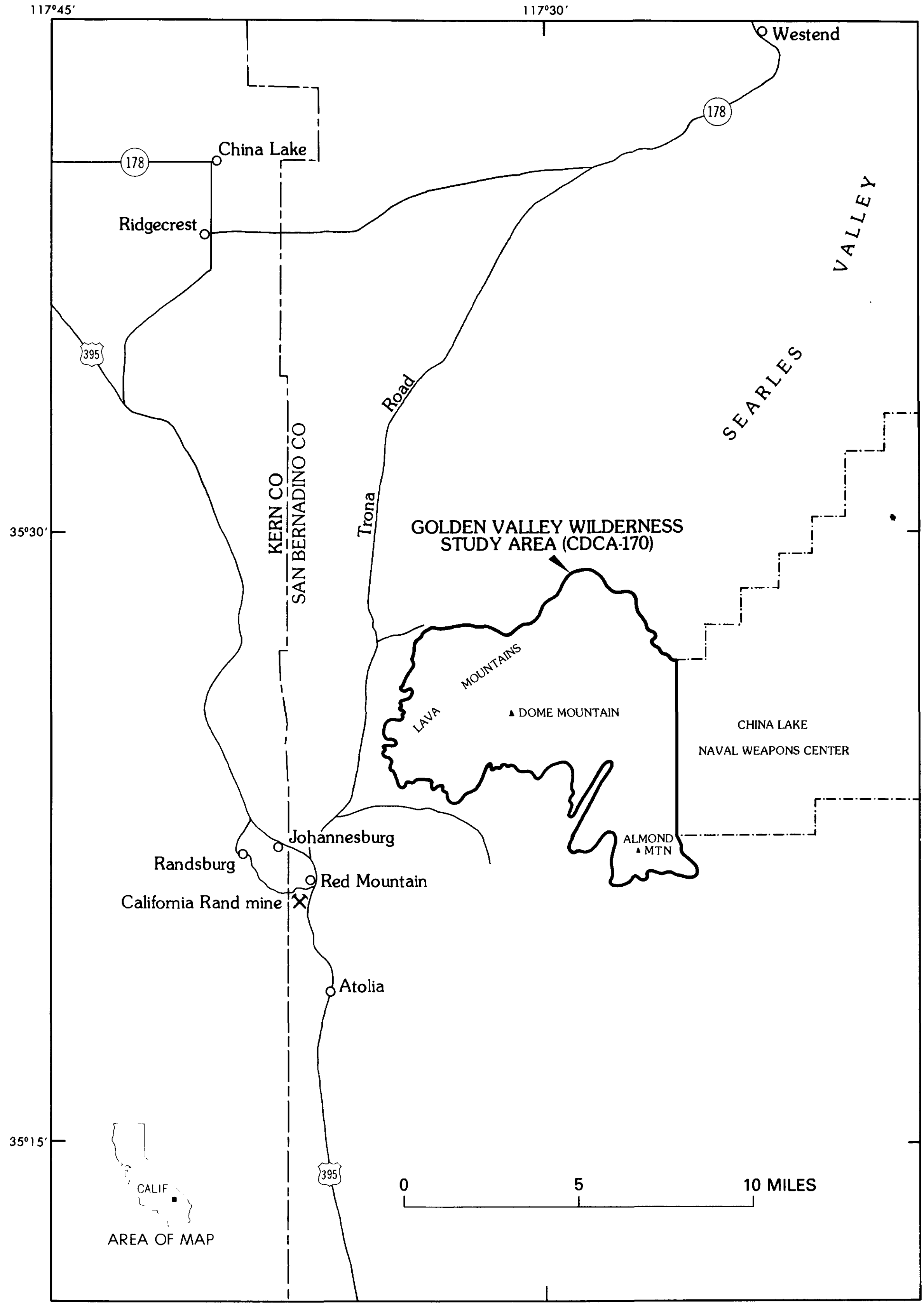

Figure 1. Index map showing location of the Golden Valley Wilderness Study Area, San Bernardino County, California

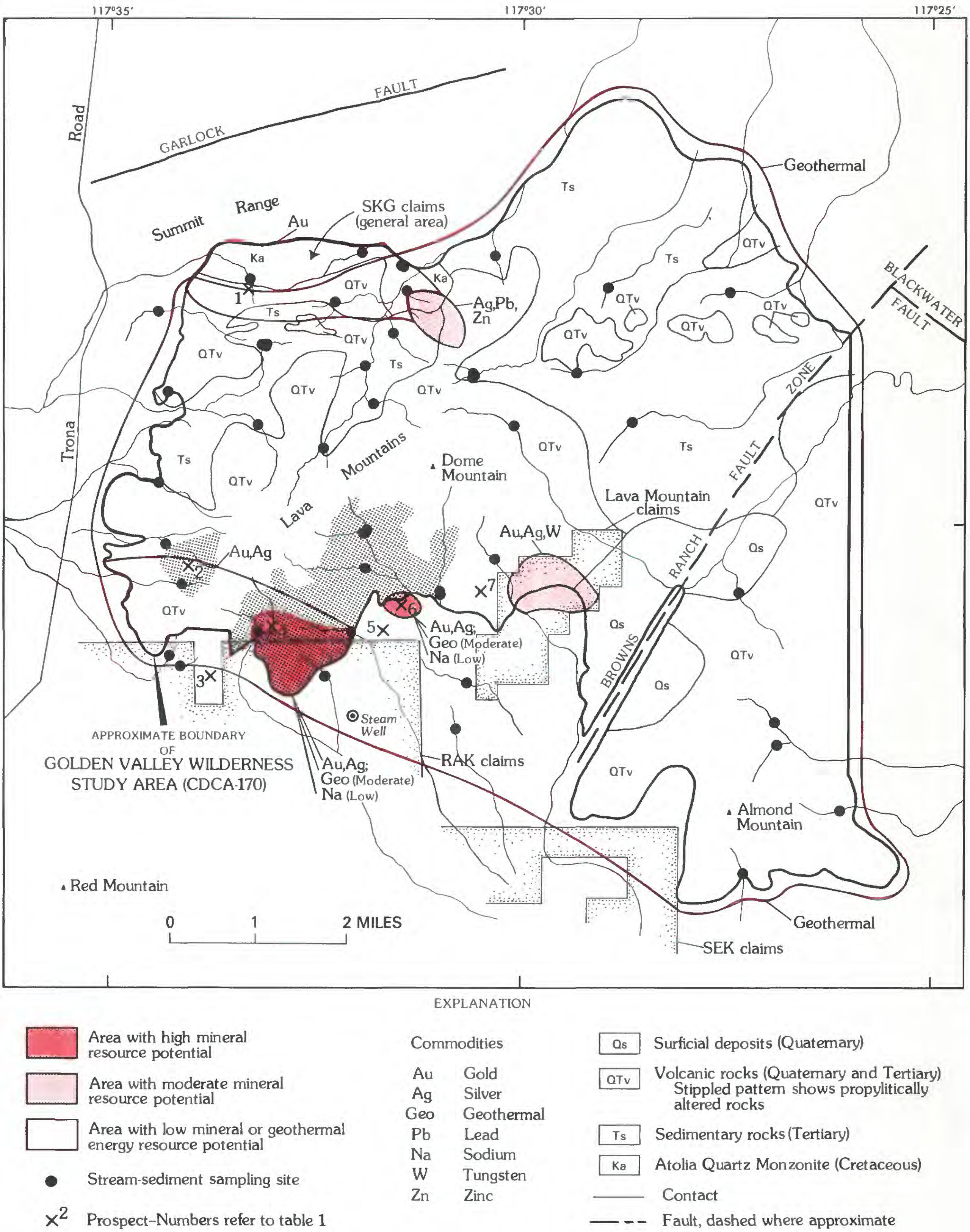

Figure 2. Areas of mineral resource potential in the Golden Valley Wilderness Study Area, San Bernardino County, California

presence of anomalous concentrations of gold, silver, and arsenic as well as some antimony, tungsten, and mercury were observed in those claims. Gold was detected in two alluvial samples from the northwest corner of the study area where recent claim staking (SKG claims) has taken place.

Four areas have been identified as having mineral resource potential, one area has geothermal energy resource potential, and two areas have both mineral and geothermal energy resource potential. The Steam Well, located near but south of the wilderness study area is an active hot spring. The area 1 mi northwest of the Steam Well has high resource potential for gold and silver, moderate resource potential for geothermal energy, and low mineral resource potential for sodium. An adjacent area to the west which includes the rest of the southwestern lobe of the study area has low mineral resource potential for gold and silver.

Gold was detected in anomalously high amounts in samples from a small area, which has been identified as the site of possible ancient hot-spring activity, about 1.5 mi northeast of the Steam Well. This area has a high mineral resource potential for gold and silver, moderate resource potential for geothermal energy, and low resource potential for sodium.

An intensely altered region in the north-central part of the wilderness study area, about 2 mi southeast of the Summit Range, has a moderate resource potential for silver, lead, and zinc; and an area extending west from the altered zone has low resource potential for gold. The area in which much of the Lava Mountain claim block is located has a moderate mineral resource potential for gold and possibly silver and tungsten.

Much of the study area is located within the Randsburg Known Geothermal Resource Area (KGRA) which includes the Steam Well, an active hot spring. Much of the southern and central parts of the study area been explored for geothermal energy potential. There is a low potential for geothermal energy resources in nearly the entire wilderness study area. Exceptions are the northwest corner which is underlain by the Atolia Quartz Monzonite, and areas with higher designations for geothermal energy mentioned above.

INTRODUCTION

Location and Physiography

The Golden Valley Wilderness Study Area (CDCA-170) comprises 29,887 acres located approximately 12 mi southeast of Ridgecrest, Calif. The wilderness study area is accessible from the nearby Trona road by gravel roads and jeep trails. Elevations range from 2,600 ft along the northern edge to nearly 5,000 ft at the top of Dome Mountain. The mountains are generally rounded with steep slopes. Golden Valley derives its name from the annual blooming of bright-yellow Coreopsis in a valley separating the Lava Mountains from the Almond Mountain. Other flora include greasewood, sagebrush, and Joshua trees.

Sources of Data

The initial geologic work pertaining to the study area was done by Hess (1910) in the Randsburg 15-minute quadrangle. He described the general geology of parts of the quadrangle, which include the western part of the Golden Valley Wilderness Study Area and the adjoining Randsburg gold mining district. The first geologic map of the Randsburg quadrangle was published by Hulin (1925) Other published reports covering the general geology of the region include Thompson (1929), Jenkins (1938), and Hewett (1954). Detailed geologic mapping and a petrologic study of the volcanic rocks in the Lava Mountains was conducted by Smith (1964). Additional field mapping, regional geochemical sampling, and site-specific sampling were conducted by the authors for this study.

Geologic Setting

The Golden Valley Wilderness Study Area lies at the northern edge of the Mojave Desert physiographic province. The Garlock fault, a major east-west structure that forms the southern boundary of the Basin and Range physiographic province is located 2 mi north of the study area. The major structural feature in the area is the Browns Ranch fault zone. The oldest rock unit in the study area is the Atolia Quartz Monzonite which is overlain by volcanic and sedimentary rocks ranging in age from Miocene or early Pliocene through Pleistocene and Holocene (Smith, 1964). The Almond Mountain Volcanics and Lava Mountains Andesite underlie most of the area and form the higher peaks.

West of the Browns Ranch fault zone, the Almond Mountain Volcanics have been propylitically altered. Many of the prospects found within the study area, including those from which samples yielded geochemically anomalous values, are within these altered zones (fig. 2).

Acknowledgements

U.S. Geological Survey field work was done with the assistance of Nancy L. Parduhn, David A. Dellinger, and James E. Conrad. U.S. Bureau of Mines personnel assisting in the field work included J. Douglas Causey, Terry R. Neumann, and J. Mitch Linne. Margaret Phillips and Mark Lawrence of the Ridgecrest Resource Area Office, U.S. Bureau of Land Management, provided logistical support and significant information on current mineral related activities. Douglas R. Wood, Houston international Minerals Corporation, provided valuable information about the mineralization at the Lava Mountain claim group during a one day tour of the property.

APPRAISAL OF IDENTIFIED RESOURCES

By Richard S. Gaps, U.S. Bureau of Mines

Methods

Work by the U.S. Bureau of Mines entailed library research and review of San Bernardino County and U.S. Bureau of Land Management mining claim and mineral lease records. U.S. Bureau of Mines, state, and other production records were searched for pertinent data. Claim owners were contacted, when possible, for permission to examine properties and publish the results. Field studies included a search for all mines, prospects, and claims within the study area. In addition, ground and air reconnaissance was done in zones of obvious rock alteration.

Samples collected at mines, prospects, and mineralized zones included 73 rock and 16 alluvial samples. All samples were analysed by semiquantitative spectroscopy for 40 elements (Ag, Al, As, Au, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Ga, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Pd, Pt, Sb, Sc, Si, Sn, Sr, Ta, Te, Ti, V, Y, Zn, and Zr). Those elements indicated to be present in anomalous concentrations were then analyzed by one of the quantitative methods. The samples were assayed for gold and silver using a combined fire assay-ICP (Inductively Coupled Plasma) method, for tungsten by both colorimetric and x-ray fluorescence methods, and arsenic, mercury, and antimony by atomic-absorption spectroscopy. Petrographic examinations were performed to identify selected rock types, alteration suites, and mineral assemblages. Complete results of the U.S. Bureau of Mines' work on these study areas is included in Gaps (1985).

Mining and Exploration History

Mining activity was initiated in this region with the discovery of gold 10 mi southwest of the Lava Mountains in 1893. Then in 1895, gold was discovered near Randsburg (fig. 1). Just after the turn of the century tungsten was discovered at Atolia, and subsequently silver was found in 1919 at the California Rand silver mine at Red Mountain. The workings in the southern part of the study area were probably dug in the early 1920's, in search of extensions of the California Rand silver mine ore. Total production from mines near Randsburg and Atolia has been about one half million oz of gold, 10 million oz of silver (Hulin, 1925), and nearly 920,000 short ton units of tungsten trioxide (Wetzel, 1981).

The Lava Mountain, SKG, and SEK claims as well as mines in the Red Mountain-Randsburg-Atolia district were being explored in 1983. Workings on other properties found within one mile of the southern boundary of the study area may have had some production.

Natroalunite, a sodium-aluminum sulfate mineral, occurs at the Steam Well. Smith (1964) estimated the natroalunite resources at and near the Steam Well to be 3 million tons. The Steam Well was drilled in 1920 as a prospect for mercury (Smith, 1964).

Parts of the study area are within the Randsburg KGRA and some temperature gradient drilling has been done (Sass and others, 1978).

Sites Examined for This Study

Two large claim groups, the Lava Mountain claims and the RAK claims, as well as seven prospects with unknown names, were examined and sampled during the study (fig. 2; pl. 1; see Gaps, 1985). In 1984, subsequent to the U.S. Bureau of Mines' field work, the SKG group of claims was located in the northwest corner of the study area in the vicinity of prospect No. 1. A fourth claim block, the SEK group, is located southwest of Almond Mountain, just outside of the wilderness study area. Table 1 summarizes the information on three claim groups and seven prospects provided by Gaps (1985).

Lava Mountain claims

The Lava Mountain claims, located in 1982, are owned by Houston International Minerals Corporation. Access to the claims is by unimproved gravel road. The mineralized zone found within this claim group is located in a tuff or tuffaceous sandstone unit within the western facies of the Almond Mountain Volcanics, as mapped by Smith (1964). The zone displays an opaline silica cap, chalcedony dikes, and argillic alteration, all characteristic of hot-spring-type epithermal mineralization (Buchanan, 1981). Outcrops of the host rock are tan to buff on weathered surfaces. Minor excavations expose manganese oxide staining and fracture filling. Liesegang banding is common. The majority of the claim areas are covered by alluvium. Analysis of samples showed anomalous values of gold, silver, tungsten, arsenic, antimony, and mercury (see table 1).

An exploration hole 415.6 ft deep was drilled at the Steam Well in 1920. This hole produces water vapor which comes to the surface at 205° F (Smith, 1964). Two other wells, about 2,000 ft north-northwest of Steam Well, contain tepid water. They may have been dug by hand.

RAK claims

The RAK claims, located in 1982, are owned by Westland Mineral Exploration Company. Access to the claims is by a network of unimproved gravel roads. Workings are in propylitically altered volcanic rocks, mostly andesites. Some of the workings also expose argillic alteration, possible alunitic alteration, and occasional silicification. The more intense alteration is concentrated along shear structures. Analyses of samples showed anomalous values of gold, silver, arsenic, antimony, and mercury (see table 1). The widespread alteration and anomalous metal associations are typical of precious-metal deposits.

Alluvial samples

Nine alluvial samples were taken from drainages throughout the study area exclusive of the Lava Mountain claims. Of the nine, two from drainages in the SKG claims contained 0.038 ppm and 0.064 ppm gold.

Conclusions

Gold mineralization, probably of the hot-spring epithermal type, has occurred near the Steam Well, on the RAK claims, and in the Browns Ranch fault zone on the Lava Mountain claims. Although no resources were identified within the Golden Valley Wilderness Study Area, nor resource estimates made, wide-spread alteration and presence of anomalous concentrations of gold, silver, and arsenic as well as some antimony, tungsten, and mercury were observed in those claims. Gold was detected in two alluvial samples from the northwest corner of the study area where recent claim staking (SKG claims) has taken place.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

By M.F. Diggles, R.E. Tucker, and D.E. Clemens, U.S. Geological Survey

Geology

The Atolia Quartz Monzonite, named by Hulin (1925), forms the rugged topography in the northwestern section of this study area which was uplifted during major late Cenozoic faulting. Badland topography has formed in regions of extreme brecciation whereas low hills and flat lands occur between the scarps. Grayish-pink to grayish-orange, grussy-weathering quartz monzonite and granodiorite make up 75 percent of the unit. The remainder of the unit is made up of seriate, leucocratic quartz monzonite (20 percent) and highly resistant aplite (5 percent). The Atolia Quartz Monzonite is assigned a Cretaceous(?) age (Smith, 1964) based upon lead-alpha age determinations of similar batholitic rocks from the southwestern Basin and Range and Mojave Desert provinces, but its absolute age is unknown.

The Bedrock Spring Formation, named by Smith (1964), consists of arkosic conglomerate, sandstone, siltstone, claystone containing small amounts of limestone, evaporites, tuff, and volcanic breccia. The unit attains a maximum thickness of over 1,000 ft in its central part; but its total thickness, estimated to be over 5,000 ft, is unknown because its upper surface is everywhere erosional. Sedimentary rocks cropping out in the central part of the area underlain by the formation are dominantly siltstone and claystone. The Bedrock Spring Formation was deposited in a downwarped basin bordered by the Garlock fault and Browns Ranch fault zones. The sedimentary and fossil records indicate that this was a closed valley in the Pliocene, surrounded by alluvial fans and alternately occupied by fresh-water lakes and saline playas.

Tertiary volcanic rocks dominate the geology of the study area. These rocks include the Almond Mountain Volcanics and the Lava Mountains Andesite described in detail by Smith (1964) along with minor occurrences of both older and contemporaneous volcanic rocks and interbedded sedimentary rocks. The older rocks include heavily brecciated lapilli tuff, tuff-breccia, tuffaceous arkosic sandstone, and conglomeratic sandstone. The Almond Mountain Volcanics is divided into an eastern facies erupted from Almond Mountain and a western facies erupted from Dome Mountain which are interbedded along their common boundary. This interbedding demonstrated the contemporaneous eruption of the two facies. An incomplete section was measured to be 900 ft thick. The younger dark-gray, porphyritic Lava Mountains Andesite caps most of the topographically higher areas in the Lava Mountains.

Propylitically altered volcanic rocks consisting mostly of rocks of the Almond Mountain Volcanics crop out as steep-sided and hummocky hills in the southwest part of the study area; similar rocks extend approximately 2 to 3 mi further to the southwest. These altered rocks underlie three areas of mineral resource potential. The colors of these rocks are distinctive, being pale olive to olive gray in the highly altered regions and purplish blue to pale purple and reddish purple where less altered. Unaltered volcanic rocks in the study area are very light blue-green, green, and gray in color. The intensity of alteration is greatest at depth and in the central part of the exposure; alteration is less intense both higher up and farther out from the central zone. The propylitic rocks formed from three volcanic rock types: (1) a dominantly intrusive, heavily brecciated porphyritic andesite underlying 90 percent of the outcrop area; (2) minor, thinly bedded lapilli tuff, and; (3) less brecciated, more resistant, porphyritic andesite dikes which crosscut the other two rock types. The propylitic rocks probably formed during introduction of hot waters containing carbon dioxide, hydrogen sulfide, and additional minor components that produced a temperature-dependent alteration halo.

Quaternary sills, dikes, plugs, and flows of olive- to dark-greenish-gray, porphyritic andesite crop out in an east-trending line at the north end of the Browns Ranch fault zone. These rocks are highly resistant to weathering, forming steep-sided hills and cliffs and locally retaining large-scale columnar jointing.

Surface material consists of the boulder conglomerate facies of the Christmas Canyon Formation (Smith, 1964), old gravels, and modern alluvium.

The structure of the Lava Mountains is defined by three fault sets: the Garlock and Blackwater faults and the Browns Ranch fault zone. The left-lateral Garlock fault trends approximately east-northeast along the northern boundary of the Lava Mountains separating the Mojave Desert from the Basin and Range province. Related vertical displacement along two associated parallel faults, the Garlock and Blackwater faults, is believed responsible for producing abrupt facies changes and erosional breaks in the sedimentary record within the study area. The 10-mi-long Browns Ranch fault zone, trending roughly northeastward, cuts through the study area forming a downdropped graben. The 30-mile-long, right-lateral Blackwater fault trends southeastward from near the northeastern edge of the wilderness study area. This fault belongs to a parallel set of faults running throughout the entire Mojave Desert. Field relations indicate that the relative sequential order of initial fault movement is Garlock-Browns Ranch-Blackwater, but all three have been intermittently active during the Quaternary (Smith, 1964).

Fault movement has produced not only the topography to which sedimentary and volcanic deposition has conformed, but also strain-related folding. Intermittent folding along with concurrent uplift and erosion have contributed greatly to the present-day attitudes and extent of the Lava Mountains volcanic and sedimentary deposits.

Geochemistry

Methods

Samples of rock, stream sediment, and nonmagnetic heavy-mineral concentrates were collected by the U.S. Geological Survey in the spring and summer of 1982 from 49 sites within the Golden Valley Wilderness Study Area (fig. 2; pl. 1). The results and interpretation of the geochemical study are taken from detailed work by R.E. Tucker and M.F. Diggles (unpub. data, 1985). The stream-sediment samples represent eroded material from within the drainage basins. The chemical analyses of the minus-80-mesh fraction and the panned concentrate fraction of the stream-sediment can be useful in identifying areas of mineral potential by delineating geochemically anomalous basins (Tucker and others, 1981, 1982; Diggles, 1983). The panned concentrate fraction selectively concentrates many minerals related to metallization processes because they are more dense than most rock-forming minerals.

Samples were analyzed for 31 elements (Ag, As, Au, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, La, Mg, Mn, Mo, Nb, Ni, Pb, Sb, Sc, Sn, Sr, Th, Ti, V, W, Y, Zn, and Zr) using a six-step semiquantitative emission spectrographic method (Grimes and Marranzino, 1968). Results of the analyses from the study area are given by Detra and others (1985).

Seventeen of the 31 elements for which the samples were analysed are most useful as possibly being related to hydrothermal alteration and (or) mineralization. Anomalous limits were determined by a statistical treatment of the data and comparison with data from other work in similar rocks (Detra and others, 1984).

Results and Interpretation

The Golden Valley Wilderness Study Area is situated between two intensely mineralized regions. The Spangler Hills mining district lies to the north and the Red Mountain-Randsburg-Atolia mining district lies to the southwest. Mineralizing events which formed the deposits in these two districts may also have been responsible for the geochemical anomalies of the wilderness study area.

The most pronounced geochemical anomaly is present between the Summit Range and the Lava Mountains. This zone is underlain by selectively propylitized Miocene Bedrock Spring Formation and the Cretaceous(?) Atolia Quartz Monzonite. The altered sedimentary rocks reflect permeability differences and (or) thermal gradients. The most obvious feature is a distinct, thick band of propylitized rock that crops out extensively in the northern part of the study area. This band, which crops out within Tertiary volcanic rocks, is too small to map.

Sites from which samples containing anomalous lanthanum (1,000 parts per million (ppm)), strontium (10,000 ppm) and yttrium (700 ppm) concentrations were collected were plotted on a map of the study area (not shown). The resulting pattern described a broad band or halo that surrounds anomalous strontium concentrations extending across the northern part of the wilderness study area. Anomalous copper concentrations closely follow the anomalous strontium concentrations. The detected copper values are relatively low (10-300 ppm) and may reflect background concentrations in the country rock within some drainage basins. Anomalous lead concentrations generally occur in basins containing old prospects located in the southern part of the study area, but are also found in two basins within the northern lanthanum and yttrium halo region. Sample number 15 collected in the southwestern part of the wilderness study area (pl. 1) contains more than 10,000 ppm lead and more than 200 ppm antimony. However, because there is no other indication of mineralization at that site, the lead and antimony concentrations probably indicate cultural contamination.

Sample 24, in the north-central part of the wilderness study area (pl. 1), yielded results which suggest the nearby presence of an unmapped intrusive body. This sample contains anomalous concentrations of silver, iron, arsenic, cobalt, lead, strontium, and zinc (Detra and others, 1985) and is surrounded by a small anomalous strontium zone. There calcite and quartz veins crosscut the country rocks, and small blebs of sulfide minerals were found in one sample of calcite float.

Argillic alteration and fine-grained silica-vein and -cap material was found at sampling site eight near the Lava Mountain claim block. The zone may represent an ancient hot springs environment. In additional studies carried out 0.5 mi southeast of sampling site eight in 1983, samples of highly altered rock with anomalous gold concentrations (R.E. Tucker and M.F. Diggles, unpub. atomic absorption data, 1984) were collected from one traverse along the southern side of a small gully that cuts the altered zone. Two samples were collected from relatively unaltered rock and four samples were collected from within the mineralized zone. The additional detailed sampling in and around this zone was helpful in appraising the potential for gold resources as sampling sites 6, 7, 8, 45, and 46 are some distance removed from the gold anomaly. However, samples number 6, 7, and 45 contain anomalous concentrations of lanthanum, yttrium, and copper.

The minus-80-mesh stream-sediment data were also used for interpretation of anomalies, despite lower contrast in elemental concentrations in these samples (Detra and others, 1985). There are a few silver values that may reflect adsorption on iron-manganese coatings that occur at sampling sites 11, 19, and 25. These sampling sites are present within the lanthanum, yttrium, and strontium halos region and may reflect metal-rich, migrating fluids. This corroborates the interpretation from the nonmagnetic fraction.

Discussion

There is good geochemical evidence that pervasive but subtle elemental overprinting of the country rock can be genetically related to the emplacement of an intrusive body at depth. The intensity and complexity of the superimposed elemental halos depends on such factors as initial elemental concentrations in the melt, the composition of the country rock, thermal gradient, and solution chemistry (Tischendorf, 1972).

Geologic observations combined with the presence of lanthanum and yttrium halos surrounding a zone of anomalous strontium and copper suggest that an unexposed intrusive body was emplaced beneath the north-central flank of the Lava Mountains. The central apex of the pluton would probably focus near the strontium-copper zone. The presence of lead, silver, arsenic, and zinc in samples 24, 10, 11, 23, 24, and 25 and other samples collected to the north of the study area suggest the postulated intrusive mass was associated with mineralizing fluids and may represent a precious-metal, vein-type mineralization system.

A zone of argillic alteration in the southern part of the study area, in and near the Lava Mountain claim block, yielded samples containing anomalous concentrations of silver, gold, antimony, and tungsten. This zone appear to have been caused by ancient hot springs or places in which hydrothermal fluids concentrated minerals. There are anomalous lead and copper concentrations in samples one and two collected in the RAK claim block (pl. 1) The absence of extensive mining activity in drainage basins containing anomalous metal concentrations suggests that there is minimal surface expression of mineralization. The anomalous lead and copper concentrations may reflect the mineralizing event that occurred near Red Mountain.

Conclusions

West of the Browns Ranch fault zone the Almond Mountain Volcanics has been hydrothermally altered to various degrees. The most common alteration zones are propylite and sub-propylite, as defined and mapped by Smith (1964). In addition, alunitic alteration is present near the Steam Well, and argillic alteration is present in the western part of the Lava Mountain claims. The majority of the prospects, including all those having significantly anomalous sample results, are located within the zones of greatest alteration (pl. 1).

An aeromagnetic map (U.S. Geological Survey, 1970) covers the northwest two thirds of the study area. A distinctive feature on this map is a broad magnetic low extending southeast from Dome Mountain across the northern part of the Lava Mountain claim block. This low is interpreted (Andrew Griscom, written commun., 1985) to be caused probably by the alteration of a large volume of volcanic rocks such that the magnetic minerals (magnetite) have been destroyed.

Four areas have been identified as having mineral resource potential, one area has geothermal energy resource potential, and two areas have both mineral and geothermal energy resource potential. The area 1 mi northwest of the Steam Well is the site of hydrothermal alteration. The southern part of this area is covered by the RAK claims and there is geochemical evidence of mineralization in this area. Smith (1964) presented information concerning the sodium resources present there in the form of natroalunite. The proximity to the Steam Well, the probable hot-spring nature of the source of the geochemical anomaly, and the presence of natroalunite are indications that resource potential for geothermal energy is likely. The area has high mineral resource potential for gold and silver with a certainty of C, a moderate potential for geothermal energy with a certainty of C, and a low mineral resource potential for sodium with a certainty of D.

Gold was detected in anomalously high amounts in samples from a small area which has been identified as the site of possible ancient hot-spring activity about 1.5 mi northeast of the Steam Well. The hot-spring-type ore-deposit model applied here does not lend itself to the formation of large deposits. The silica cap in the area is truncated on the north. This area has a high mineral resource potential for gold and silver with a certainty of C, moderate resource potential for geothermal energy with a certainty of C, and low resource potential for sodium with a certainty of D.

The northern part of the study area is the most intensely altered. It has conspicuous propylitic alteration easily seen cropping out in broad, colored bands along the hillsides and cliffs. Although signs of accompanying mineralization are less obvious, there is convincing geochemical evidence that it did occur. The north-central part of the wilderness study area has a moderate mineral resource potential for silver, lead, and zinc with a certainty of C. See Appendix 1 and figure 3 for explanation for mineral resource potential/certainty classification.

The area north of the south end of the Browns Ranch fault zone in the center of the Lava Mountain claims has been argillically altered and mineralized. The geology, mineralogy, alteration products, and anomalous metal associations there are typical of epithermal precious metal deposits (Rose and Burt, 1979). The geochemical study shows anomalous values of gold, silver, and tungsten. Aeromagnetic data suggest a large volume of rocks in this area has undergone alteration. The area has a moderate mineral resource potential for gold with a certainty of C and a moderate mineral resource potential for minor silver and tungsten with a certainty of B.

The area extending west from near prospect No. 4 to the western boundary of the wilderness study area near the Trona road has low mineral resource potential for gold and silver with a certainty of B.

There is a fairly large area extending west from the propylitically altered zone in the northern part of the study area into which mineralization may extend. Two samples collected by the U.S. Bureau of Mines contained anomalous levels of gold. The presence of gold in the alluvium and the favorable geologic environment would indicate the potential for gold resources. The SKG claims are located here. The area has low mineral resource potential for gold with a certainty of B.

Much of the study area is located within the Randsburg KGRA. There is an active hot spring at the Steam Well, and much of the region has been explored for geothermal energy. There is geologic favorability for thermal activity at depth in this region of young extrusions. There is a low potential for geothermal resources with a certainty of C in nearly the entire wilderness study. Exceptions are northwest corner and areas with higher designations mentioned above.

Because the rocks in the Mojave Desert region have been subjected to intense tectonism with resulting structural complexities, there is little chance for the presence of source rocks, reservoir rock, and suitable trapping mechanisms (Scott, 1983a, b). There are no known source rocks or trapping mechanisms in the Golden Valley Wilderness Study Area, and therefore, no resource potential for oil and gas.

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APPENDIX 1. Definition of levels of mineral resource potential and certainty of assessment

Mineral resource potential is defined as the likelihood of the presence of the mineral resources in a defined area; it is not a measure of the amount of resources or their profitability.

Mineral resources are concentrations of naturally occurring solid, liquid, or gaseous materials in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

Low mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment where the existence of resources is unlikely. This level of potential embraces areas of dispersed mineralized rock as well as areas having few or no indications of mineralization. Assignment of low potential requires specific positive knowledge; it is not to be used as a catchall for areas where adequate data are lacking.

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 chance for resource accumulation, and where an application of genetic and (or) occurrence models indicates favorable ground.

High mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resources, where interpretations of data indicate a high likelihood for resource accumulation, where data support occurrence and (or) genetic models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential requires positive knowledge that resource-forming processes have been active in at least part of the area; it does not require that occurrences or deposits be identified.

Unknown mineral resource potential is assigned to areas where the level of knowledge is so inadequate that classification of the area as high, moderate, or low would be misleading. The phrase "no mineral resource potential" applies only to a specific resource type in a well defined area. This phrase should not be used if there is the slightest possibility of resource occurrence; it is not appropriate as the summary rating for any area.

Expressions of the certainty of the mineral resource assessment incorporate a consideration of (1) the adequacy of the geologic, geochemical, geophysical, and resource data base available at the time of the assessment, (2) the adequacy of the occurrence or genetic model used as the basis for a specific evaluation, and (3) an evaluation of the likelihood that the expected mineral endowment of the area is, or could be, economically extractable.

Levels of certainty of assessments are denoted by letters, A-D (fig. 3).

A. The available data are not adequate to determine the level of mineral resource potential. Level A is used with an assignment of unknown mineral resource potential.

B. The available data are adequate to suggest the geologic environment and the level of mineral resource potential, but either evidence is insufficient to establish precisely the likelihood of resource occurrence, or occurrence and (or) genetic models are not known well enough for predictive resource assessment.

C. The available data give a good indication of the geologic environment and the level of mineral resource potential, but additional evidence is needed to establish precisely the likelihood of resource occurrence, the activity of resource-forming processes, or available occurrence and (or) genetic models are minimal for predictive applications.

D. The available data clearly define the geologic environment and the level of mineral resource potential, and indicate the activity of resource-forming processes. Key evidence to interpret the presence or absence of specified types of resources is available, and occurrence and (or) genetic models are adequate for predictive resource assessment.

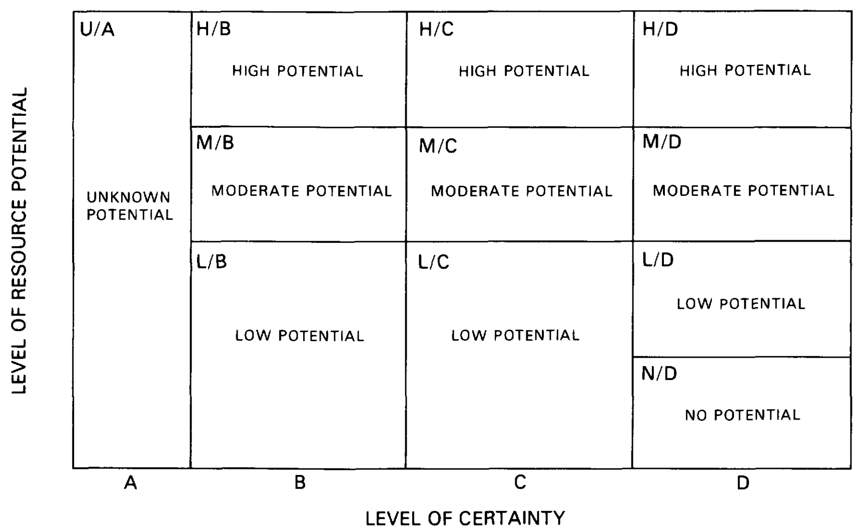

Figure 3. Major elements of mineral resource potential/certainty classification

Table 1.—Summary description of claims and prospects in and adjacent to the Golden Valley Wilderness Study Area

[*, claims partly inside study area; **, prospects outside study area]

Map no.	Name	Geology	Workings and production	Sample data
	*Lava Mountain claims	The primary host rock is tuffaceous sandstone. Outcrops of andesite show extensive argillic alteration. The tuffaceous sedimentary rocks are covered by an opal cap and are silicified. Manganese- and iron-oxide minerals fill fractures. The majority of the claim area is covered by alluvium.	One 5-ft-long adit and two small pits.	Nineteen of 29 rock samples contained measurable gold, from 0.024 parts per million (ppm) to 0.920 ppm and 23 contained silver, from 0.37 ppm to 12.04 ppm. Twenty-six samples had anomalous tungsten values, 24 had anomalous arsenic and antimony values, and 13 had anomalous mercury values. Two of seven alluvial samples contained 0.008 and 0.421 ppm gold and one contained 1.026 ppm silver.
—	*RAK claims	The host rocks are volcanic, mostly andesite. Propylitic alteration is widespread with localized argillic alteration and silicification and, possibly, alunitic alteration concentrated in shear zones.	Three adits 10, 12, and approximately 100 ft long; three shafts, one 12 ft deep and two of unknown depth; and at least 14 small pits.	Twenty-five rock samples taken. Sixteen contained 0.0002 to 0.0255 oz/ton gold, and 0.013 to 3.40 oz/ton silver. Seventeen contained arsenic, seven contained mercury, and two contained antimony.
—	SKG claims	Quartz monzonite is overlain by volcanic rocks, the Bedrock Spring Formation, Almond Mountain Volcanics, Lava Mountains Andesite, and younger andesite.	No workings. Claims were located in January 1984 in the vicinity of prospect No. 1.	Two alluvial samples (pan concentrates) contained 0.038 ppm and 0.064 ppm gold, and one sample contained 2 ppm mercury.
1	Prospect (name unknown)	Pods and stringers of coarse-grained calcite in quartz monzonite country rock.	One pit.	One chip samples contained no significant metal values.
2	Prospect (name unknown)	Country rock is propylitically altered andesite agglomerate or flow breccia.	One adit and one incline; each about 25 ft long.	Two chip samples contained 0.0002 and 0.0003 oz/ton gold.
3	**Prospect (name unknown)	Country rock is propylitically altered volcanic rocks, mostly andesite.	One shaft of unknown depth.	One grab sample from dump contained 0.0003 oz/ton gold.
4	Prospect (name unknown)	Area underlain by silicified, iron-oxide-stained and bleached andesite. Some zones are brecciated and contain casts of sulfide minerals.	One shaft of unknown depth.	Two samples, one grab from the dump and one chip from an outcrop nearby contained 0.00561 and 0.00622 oz/ton gold, 0.0782 and 0.0290 oz/ton silver, and 0.063 percent and 0.055 percent arsenic.
5	**Prospect (name unknown)	Country rock is propylitically altered andesite flows, and possibly some highly altered tuffaceous sedimentary rocks. Quartz monzonite is exposed adjacent to the shaft.	One adit, 6 ft long, and one shaft, 10 ft deep.	Three of the five samples contained 0.0012 to 0.00336 oz/ton gold; four samples contained 0.013 to 0.018 oz/ton silver, and four contained 0.003 percent to 0.12 percent arsenic.
6	**Prospect (name unknown)	Host rock is propylitized andesite with minor amount of volcanic tuff or breccia. Veinlets of calcite with pyrite casts are in the tuff.	One adit, 4 ft long, and several pits and trenches.	One of five samples contained 0.0025 oz/ton gold, 0.358 oz/ton silver and 0.037 percent arsenic.
7	Prospect	Area underlain by argillically altered volcanic rocks; some are brecciated, silicified, and iron- and manganise-oxide-stained.	One adit, 5 ft long, and one trench.	Two chip samples were taken. One sample contained 0.0023 oz/ton gold. Silver values were 1.40 and 0.0884 oz/ton, arsenic content was 0.028 percent and 0.029 percent and tungsten content was 0.0006 and 0.0012 percent.

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