CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

The following file is part of the Grover Heinrichs Mining Collection

ACCESS STATEMENT

These digitized collections are accessible for purposes of education and research. We have indicated what we know about copyright and rights of privacy, publicity, or trademark. Due to the nature of archival collections, we are not always able to identify this information. We are eager to hear from any rights owners, so that we may obtain accurate information. Upon request, we will remove material from public view while we address a rights issue.

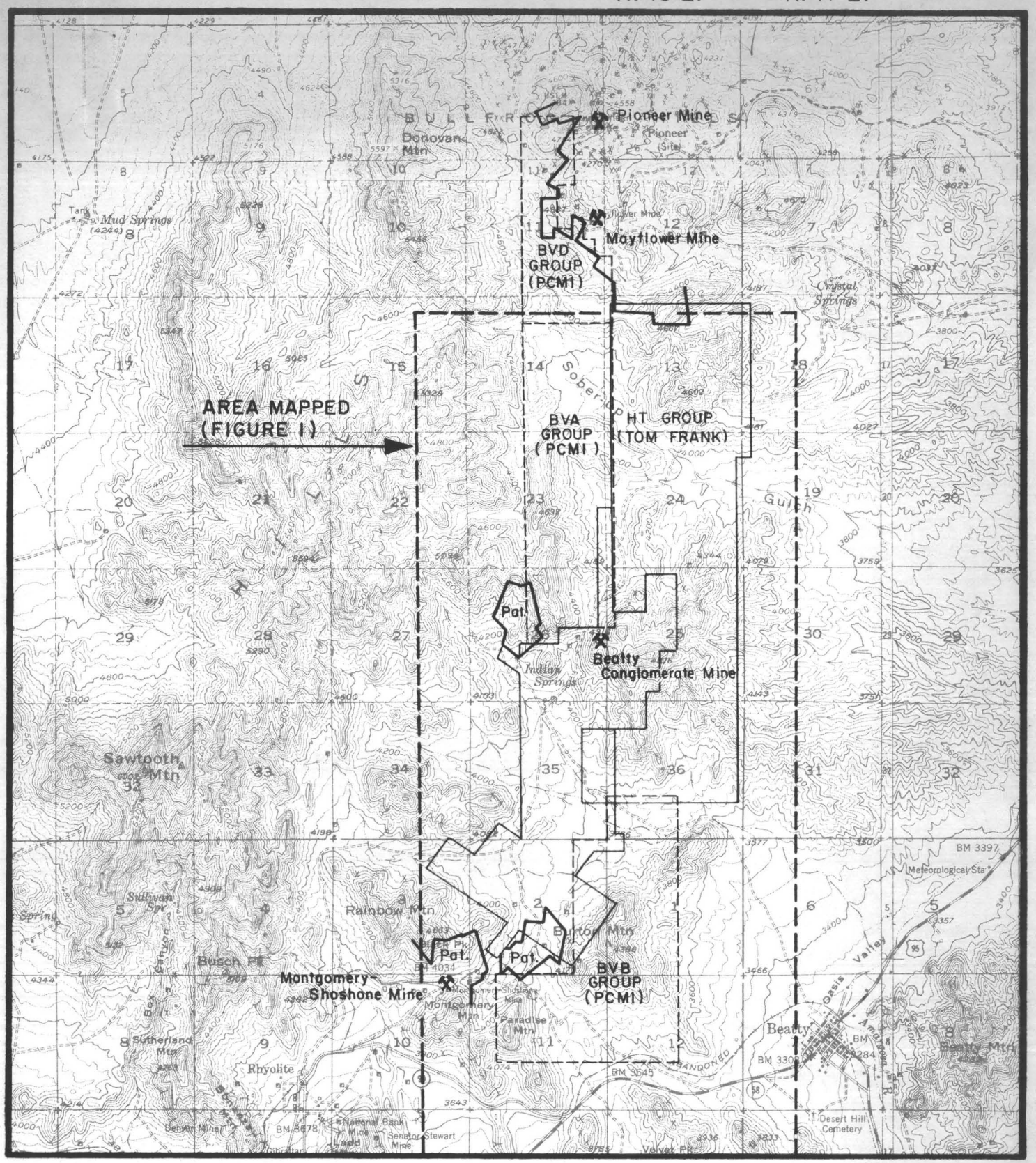
CONSTRAINTS STATEMENT

The Arizona Geological Survey does not claim to control all rights for all materials in its collection. These rights include, but are not limited to: copyright, privacy rights, and cultural protection rights. The User hereby assumes all responsibility for obtaining any rights to use the material in excess of "fair use."

The Survey makes no intellectual property claims to the products created by individual authors in the manuscript collections, except when the author deeded those rights to the Survey or when those authors were employed by the State of Arizona and created intellectual products as a function of their official duties. The Survey does maintain property rights to the physical and digital representations of the works.

QUALITY STATEMENT

The Arizona Geological Survey is not responsible for the accuracy of the records, information, or opinions that may be contained in the files. The Survey collects, catalogs, and archives data on mineral properties regardless of its views of the veracity or accuracy of those data.



CLAIM GROUPS IN THE CONGLOMERATE AREA
BEATTY VOLCANIC PROJECT

NYE COUNTY, NEVADA

Pat. — PATENTED CLAIMS

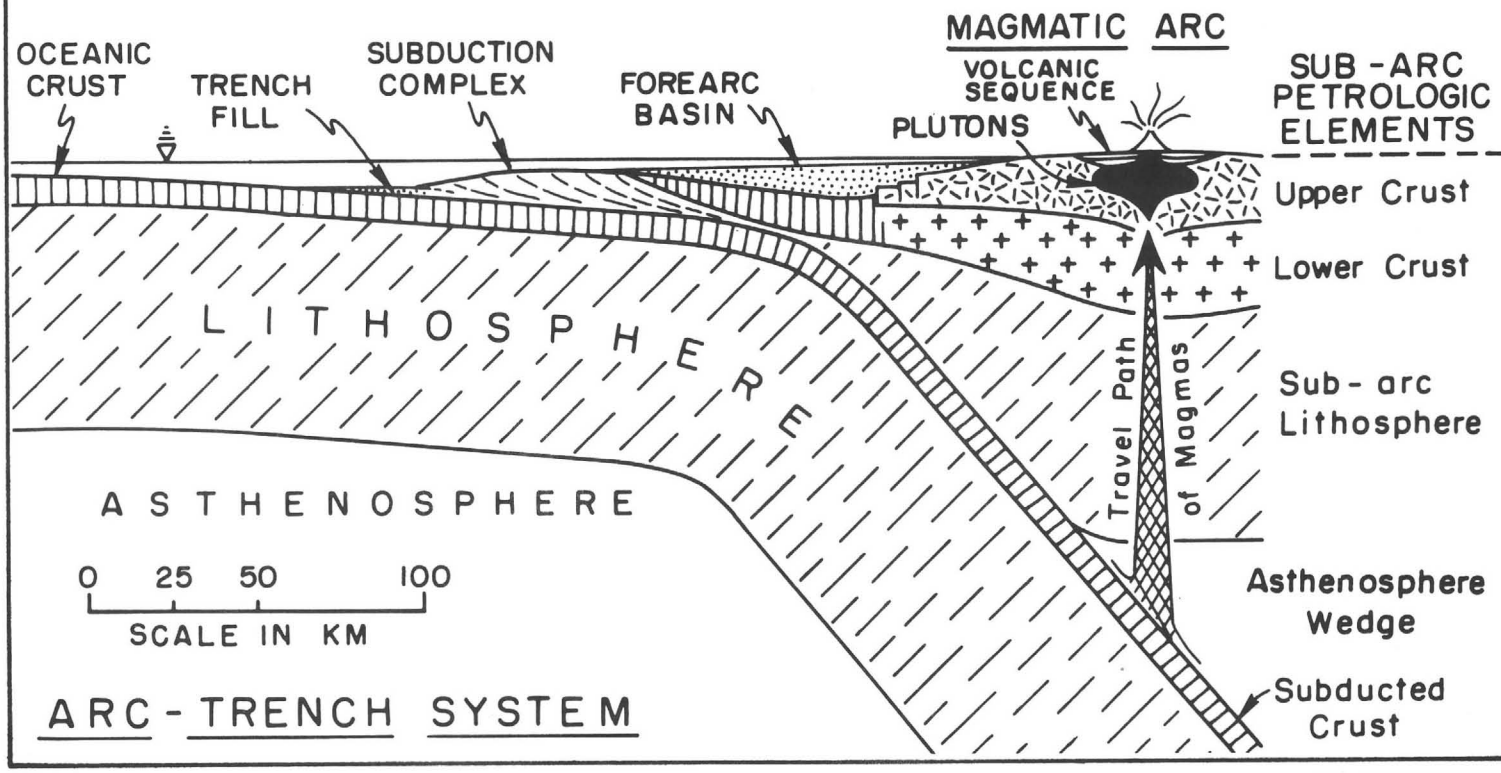
UNPATENTED CLAIMS — PCMI; FRANK, NORANDA OPTION; BOLMAN

N

1:62500

Relations of Tectonics to Ore Deposits in the Southern Cordillera

Edited by
William R. Dickinson & William D. Payne



ARIZONA GEOLOGICAL SOCIETY DIGEST VOLUME XIV

Tucson, Arizona 1981

MINERALIZATION RELATED TO THE VOLCANIC CENTER AT BEATTY, NEVADA

Richard Ahern and Russell M. Corn

ABSTRACT

Epithermal lithophile element and precious metal mineralization near Beatty, Nevada is associated with a volcanic center characterized by repeated volcanism and structural disruption during the Middle and Late Tertiary. The mineralization is restricted to the older more intensely deformed rock units. The geologic and structural features associated with mineralization are believed to reflect a position near the top of a zone of epithermal mineralization. In our opinion, the erosion surface at the time of mineralization is reflected by the unconformity between the older, deformed, and altered volcanics and the overlying younger volcanics of similar composition.

The distribution and extent of mineralization at Beatty has been obscured by repeated near-surface volcanic and tectonic processes similar to other areas in the Great Basin. The relationships described at Beatty may be helpful in exploration for non-outcropping "blind" mineralization elsewhere.

INTRODUCTION

In the future, mineral exploration will be increasingly directed toward "blind" non-outcropping ore deposits that are hidden beneath post-ore gravels and volcanics or where mineralization and associated major alteration features do not extend upward to the present surface. Epithermal deposits that are "blind" will be particularly difficult to explore for because they generally occur in complex volcanic environments and have a limited vertical range of productive mineralization which is accompanied by very sharp zoning changes in associated alteration. The epithermal deposits of the Bullfrog and Fluorine mining districts that are related to the volcanic center near Beatty, Nevada are an example of mineralization occurring in this type of complex volcanic environment. Evaluation of mineralization in the area has been handicapped because the relative zoning position and the relative age of mineralization within the sequence of similar appearing rhyolitic volcanics was not fully appreciated. Therefore, a review of the geologic and structural features that are associated with mineralization in the Beatty Area might be helpful in recognizing characteristics that can be used as guides in exploration for epithermal deposits in similar environments elsewhere.

GEOLOGIC SETTING

The Beatty Volcanic Center is located in southern Nevada along the projection of the Las Vegas Shear Zone and the Walker Lane where deep-seated structures have localized repeated episodes of volcanism through Middle and Late Tertiary time. The volcanic center includes a complex of "nested calderas" as well as one or two smaller outlying calderas, all located within 40 miles of Beatty (Figure 1). These calderas have been described by U. S. Geological Survey investigators (Christiansen and others, 1977) and are shown on the recent set of volcanic maps published by the Nevada Bureau of Mines and Geology (Stewart and Carlson, 1976). The accompanying geologic sketch map (Figure 2) illustrates the widespread distribution of the Tertiary volcanic rocks, particularly if they are viewed as one combined unit, in contrast to the limited distribution of major mines, prospects, and porphyry intrusives.

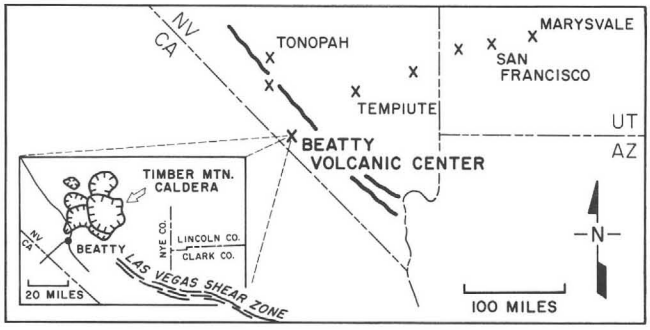


Figure I. Index Map to the Beatty Volcanic Center

VOLCANIC STRATIGRAPHY

As a result of the U. S. Geological Survey investigations of the Timber Mountain and other calderas located on the Nevada Test Site east of Beatty, the rhyolitic ash flow tuffs and related rocks in the Beatty Area have been separated into detailed stratigraphic groups according to their source caldera (Byers and others, 1976). However, with at least five separate calderas and related ash flow tuff sequences recognized in the area, it is difficult for the reconnaissance geologist to separate the lithologically similar rhyolitic volcanics and to place isolated exposures in their correct stratigraphic position.

A more useful grouping of rock units for mineral exploration purposes would be one separating the volcanic rocks into generalized stratigraphic groups differing from each other in those features related to ore deposition such as the intensity of structural deformation, intrusive activity, alteration, and mineralization. This type of generalized subdivision of the volcanics reflecting the relative age of the rock units with respect to mineralization would be compatible with the detailed stratigraphic classification used by the U. S. Geological Survey since it is based on the same sequential relationships of volcanism and structural deformation. An identifying subdivision of this type, however, is simpler and will emphasize the time relationship and position of tectonic events, subvolcanic intrusive activity, and mineralization with respect to the volcanic units.

As shown on Figure 2, we have separated the Tertiary volcanics near Beatty into two generalized groups. This separation is based on readily observable features: (1) the intensity of structural deformation, (2) the intensity and nature of hydrothermal alteration and associated mineralization, and (3) the extent and type of devitrification. The older group of volcanics includes those units characterized by steep, non-uniform dips of 40 to 65 degrees, numerous high-angle and low-angle faults that are often accompanied by substantial offset and deformation, and

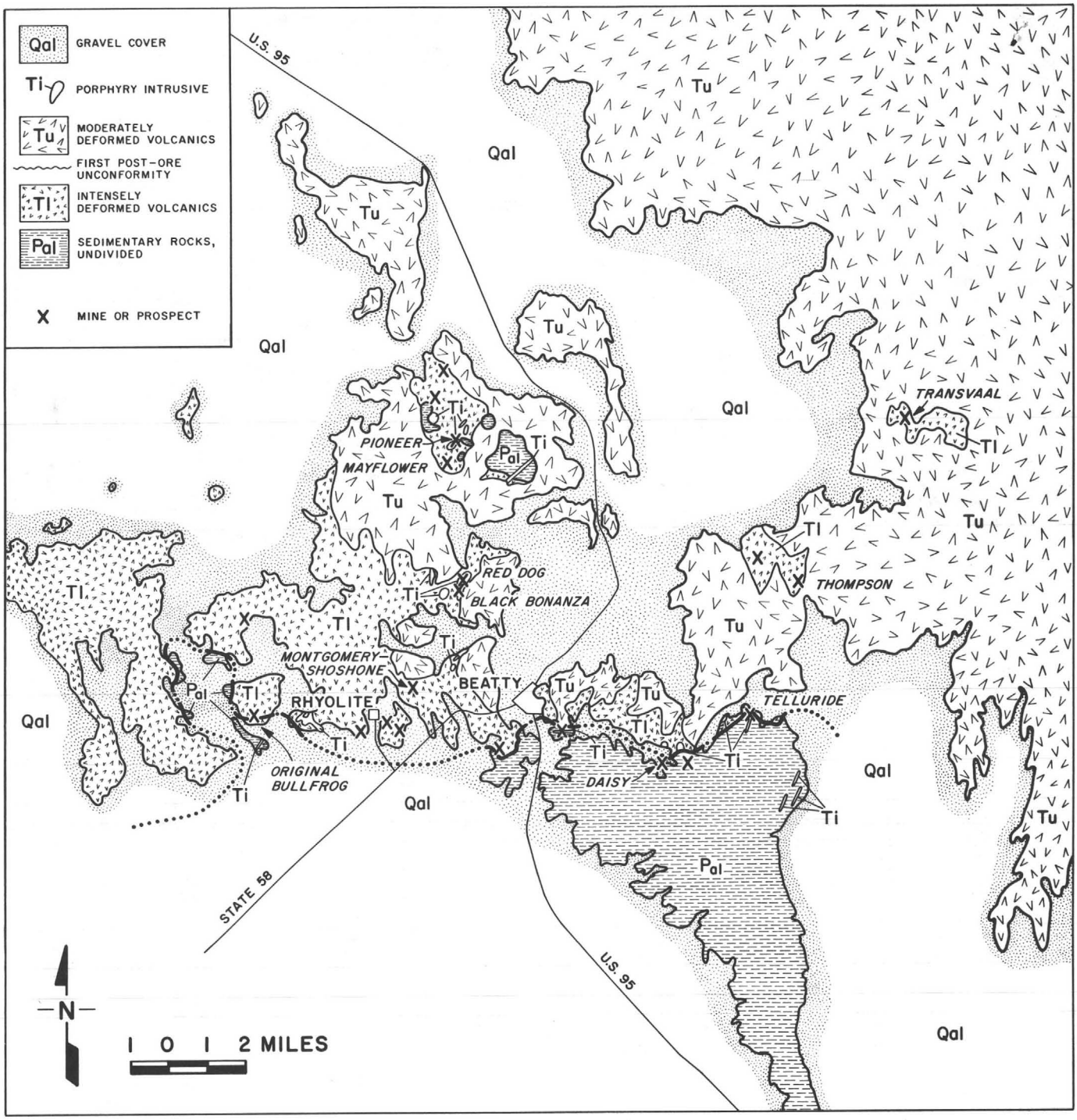


Figure 2. Generalized Geologic Map of the Beatty Area

frequent low-angle fault slivers and glide blocks of Paleozoic rocks. This group of volcanic rocks exhibits widespread hydrothermal propylitic and argillic alteration with associated introduced metals, has very little preserved glass, and is cut by porphyry intrusives. In contrast, the younger group includes those volcanic units distinguished by moderate structural deformation with uniform gentle-to-moderate dips of 9 to 30 degrees and limited offset on both high-angle and low-angle faults. They are characterized by abundant volcanic glass and widespread preserved vitrophyre, hot spring type alteration that is not associated with anomalous introduced metals, and a lack of porphyry intrusives. The older, intensely deformed volcanics and volcanic sediments date from about 11 my back to 22 my, while the moderately deformed volcanic rock units have been dated between 6 my and 10 my (Byers and others, 1976, and Marvin and others, 1973). Comparison of the distribution of mines and prospects to the two groups of volcanics on Figure 2 indicates

that the older group of intensely deformed volcanics is pre-ore while the younger, moderately deformed volcanics that lack porphyry intrusives post-date mineralization. These geologic relationships are also shown on the diagrammatic section (Figure 3). This distinction was recognized by the early gold prospectors, all of whose prospects were in the older, intruded and altered volcanics. Ransome also noted this relationship in 1910. He numbered the volcanic sequence from the bottom up and stated that "gold ores were not known to occur above rhyolite No. 12" (Ransome and others, 1910, p.17). His descriptions also contrast the abundant and widespread volcanic glass above rhyolite No. 12 in his volcanic sequence with the limited remnant glass beneath.

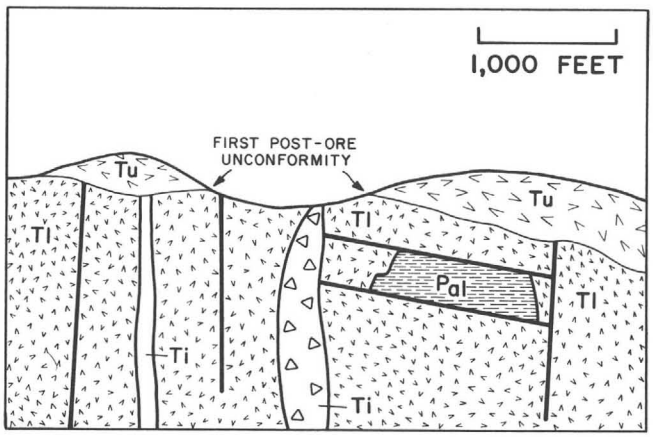


Figure 3. Diagrammatic Cross-Section Illustrating Geologic Relationships

FIRST POST-ORE SURFACE

The younger post-ore volcanics are separated from the older volcanics by a locally inconspicuous unconformity that is characterized by (1) angular discordance between the volcanic units, (2) the presence of major unaltered glass domes resting on the older altered rocks and buried beneath the younger units, and (3) local exposures of old surfaces of continental weathering and oxidation beneath much fresher flows. This unconformity represents the first post-ore erosion surface and marks the hiatus separating rock units characterized by major structural deformation and features associated with mineralization from those that are post-ore.

This first post-ore erosion surface is the highest stratigraphic position in which vertically zoned mineralization can be found. Our field work indicates that this post-ore surface was not deeply eroded prior to being covered and preserved by the overlying volcanics. Alteration and mineralization features noted near this surface reflect a high level zoning position within individual mineralized structures, and subtle and seemingly insignificant alteration features may reflect productive mineralization at depth.

MINERALIZATION

During the early 1900s the Beatty Area was extensively prospected for precious metals. There was later interest in mercury and fluorite prospects, and fluorite production has continued for more than 50 years. In the past five years there has been substantial uranium exploration activity, renewed interest in gold exploration, and some additional gold production. At first glance, the various occurrences of mineralization in the area appear to be quite diverse; however, with detailed field examination, it can be seen that the ores all reflect epithermal precious metal and lithophile element mineralization. Mineralized zones are structurally controlled, tabular zones of sheeting, brecciation, and fracturing that are filled with thin veins and veinlets, and/or tabular replacements of shattered argillized former dikes or permeable rocks. Uranium occurs as epithermal uranium - molybdenum mineralization and is similarly localized in fractured and brecciated zones.

Surface exposures indicate a general association of mineralization with a low sulfide, argillic-grade alteration that has a limited intensity and extent. Megascopically, the mineralization is characterized by thin, open, vuggy quartz veins and veinlets and fine-grained quartz, calcite and/or clay gangue. The ores contain minor amounts of the more mobile minerals and elements such as F, Hg, and As, a high gold-to-silver ratio, and little or no associated base metals. These characteristics indicate ore deposition near the top of the zone of epithermal mineralization and are similar to features that have been noted in other districts in the southwest where it was also believed that ore deposits formed near the top of the zone of epithermal mineralization (Wisser, 1965).

Most of the individual mines and mineral occurrences in the Beatty Area have been described previously by various authors (Ransome and others, 1910, Kral, 1951, Garside, 1973, Cornwall, 1972, and Cornwall and Kleinhampl, 1961 and 1964) and only a brief summary of features noted in selected larger mines and prospects is presented in the accompanying table.

MINE OR PROSPECT	COMMODITY	GANGUE	STRUCTURAL CONTROL	HOST ROCKS	ALTERATION
ORIGINAL BULLFROG	Au	QUARTZ-CALCITE	LOW-ANGLE BULLFROG FAULT	VOLCANICS	WIDESPREAD, INCOMPLETE ARGILLIZATION AND SELECTIVE SILICIFICATION
MONTGOMERY-SHOSHONE	Au	QUARTZ-CALCITE	HIGH-ANGLE SHOSHONE FAULT	VOLCANICS	WIDESPREAD, INCOMPLETE ARGILLIZATION AND SELECTIVE SILICIFICATION
MAYFLOWER-PIONEER	Au	QUARTZ-CALCITE	HIGH AND LOW-ANGLE FAULTS AND FRACTURES	QUARTZ-FELDSPAR PORPHYRY, VOLCANICS, AND PALEOZOICS	WIDESPREAD, INCOMPLETE ARGILLIZATION AND SELECTIVE SILICIFICATION
BLACK BONANZA - RED DOG	U	ARGILLIZED AND SILICIFIED BRECCIA AND QUARTZ PORPHYRY	STRUCTURAL BRECCIA	BRECCIATED VOLCANICS AND QUARTZ PORPHYRY	WIDESPREAD, INCOMPLETE ARGILLIZATION AND SELECTIVE SILICIFICATION
DAISY	F	CALCITE-CLAY	HIGH AND LOW-ANGLE FAULT INTERSECTIONS	PALEOZOIC DOLOMITE	SELECTIVE ARGILLIZATION AND INCOMPLETE RECRYSTALLIZATION OF CARBONATES
TELLURIDE	Hg (Au)	QUARTZ-CALCITE-CLAY	HIGH-ANGLE SHEAR ZONE	PALEOZOICS AND PORPHYRY DIKES	SELECTIVE ARGILLIZATION AND RECRYSTALLIZATION OF CARBONATES
THOMPSON	Hg	CHALCEDONY	PERMEABLE TUFF	VOLCANICS	SELECTIVE SILICIFICATION AND INCOMPLETE ARGILLIZATION
TRANSVAAL	Au	CLAYS	HIGH-ANGLE FAULT	VOLCANICS	SELECTIVE ARGILLIZATION

Table. Features of Selected Mines near Beatty

Many of the mines and prospects listed in the table have a relatively close spatial relationship to small quartz porphyry or quartz-feldspar porphyry intrusives as noted in the following examples. The Black Bonanza - Red Dog uranium prospect west of Beatty, a representative of the epithermal uranium - molybdenum type of mineralization (Modnikov, 1978), is localized in a silicified quartz porphyry dike and adjacent breccia. Both uranium - molybdenum and precious metal mineralization accompanied by fluorite occur in the vicinity of the Daisy Mine southeast of Beatty and are associated with small plugs and dikes of quartz-feldspar porphyry. Gold mineralization in

the Mayflower-Pioneer area northwest of Beatty occurs in the general vicinity of a cluster of small quartz-feldspar porphyry plugs, and the productive veins at the Pioneer Mine were in and adjacent to the quartz-feldspar porphyry.

CONCLUSION

Precious metal and lithophile element mineralization related to the volcanic center near Beatty, Nevada exhibits characteristics indicative of deposition near the upper part of the epithermal zone. These characteristics include a low sulfide content, the virtual absence of base metals and a high gold-to-silver ratio. The precious metal, fluorite, uranium, and mercury deposits and occurrences are localized in structurally prepared permeable zones that often are spatially associated with small quartz porphyry and quartz-feldspar porphyry intrusives.

The mineralization that is related to the volcanic center and that can be observed in the Bullfrog and Fluorine mining districts is restricted to the older, more intensely deformed units of the volcanic sequence. It was emplaced prior to extensive renewed eruption of lithologically similar volcanics and continuing but less intense structural deformation. These lithologically similar pre-ore and post-ore volcanics can be separated by readily apparent differences in structural deformation and hydrothermal alteration. Separation of the volcanics on this basis emphasizes the time relationship of deformation and mineralization and the position of mineralization with respect to the two groups of volcanics.

The inconspicuous unconformity between these two groups of volcanics is the first post-ore erosion surface, and this surface reflects the paleosurface existing at the time of mineralization that was of major importance to ore deposition. This first post-ore surface is the highest stratigraphic position in which a vertically zoned sequence of mineralization can be found, and at Beatty, mineralization near this surface exhibits features characteristic of the upper part of the epithermal zone. A subtle surface expression of mineralization at this high-level position could indicate potential exploration targets at depth or beneath post-ore cover. Recognition of the structural significance of this unconformity, its time relationship to mineralization, and its position with respect to vertical zoning would enable the geologist to intelligently evaluate the surface expressions of mineralization and to explore areas obscured by later volcanics.

ACKNOWLEDGEMENTS

We wish to express our appreciation to U. S. Borax for permission to publish this paper and to Barry N. Watson for his critical review of the manuscript. We are particularly grateful to H. L. Newman for manuscript typing and the preparation of slides and diagrams.

REFERENCES CITED

Byers, F. M., Jr., Carr, W. J., Orkild, P. P., Quinlivan, W. D., and Sargent, K. A., 1976, Volcanic suites and related caldrons of Timber Mountain-Oasis Valley Caldera Complex, southern Nevada, USGS Prof Paper 919.

Christiansen, R. L., et.al., 1977, Timber Mountain-Oasis Valley Caldera Complex of southern Nevada, GSA Bull, vol.88, p. 143-156.

Cornwall, H. R., 1972, Geology and mineral deposits of southern Nye County, Nevada, Nevada Bureau of Mines and Geology Bull 77.

Cornwall, H. R., and Kleinhampl, F. J., 1961, Geology of the Bare Mountain Quadrangle, Nevada, USGS GQ-157.

Cornwall, H. R., and Kleinhampl, F. J., 1964, Geology of Bullfrog Quadrangle and ore deposits related to Bullfrog Hills Caldera, Nye County, Nevada and Inyo County, California, USGS Prof Paper 454J.

Garside, L. G., 1973, Radiometric mineral occurrences in Nevada, Nevada Bureau of Mines and Geology Bull 81.

Kral, V. E., 1951, Mineral resources of Nye County, Nevada, Nevada Bureau of Mines and Geology Bull 50.

Marvin, R. E., Mehnert, H. H., and McKee, E. H., 1973, A summary of radiometric ages of Tertiary volcanic rocks in Nevada and eastern California, Part III, southeastern Nevada, Isochron/West, No. 6, p. 1-30.

Modnikov, I. S., et.al., 1978, Distribution patterns of uranium-molybdenum mineralization in volcanic-tectonic complexes of regions of continental volcanism, International Geology Review, vol. 21, no.1, p. 11-23.

Ransome, R. L., Emmons, W. H., and Garrey, G. H., 1910, Geology and ore deposits of the Bullfrog District, Nevada, USGS Bull 407.

Stewart, J. H., and Carlson, J. E., 1976, Cenozoic rocks of Nevada (four maps and brief description of distribution, lithology, age, and centers of volcanism), Nevada Bureau of Mines and Geology Map 52.

Wisser, Edward, 1965, The epithermal precious metal province of northwestern Mexico, Nevada Bureau of Mines and Geology Report 13, Part C, p. 65-92.