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Applied Geochemistry, Geology, and Mineralogy of the Northernmost Carlin Trend, Nevada

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Abstract

Investigations in the northernmost Carlin trend were undertaken to advance understanding of the geochemical signatures and genesis of precious metal deposits in the trend. Two fundamental geologic relationships near the trend significantly affect regional geochemical distributions: a remarkably intact lower Paleozoic stratigraphic sequence of siliceous rocks in the upper plate of the middle Paleozoic Roberts Mountains thrust, and the widespread repetition of rocks high in the upper plate during late Paleozoic thrusting that thickens the cover above mineralized rock in the lower plate. A compilation of previously published chemical analyses of 440 stream sediment samples and 115 rocks from two 7½-minute quadrangles, as well as new chemical analyses of approximately 1,000 drill core samples in a 1,514 m (4,970 ft) hole through the Rodeo Creek deposit were used to construct three-dimensional element distribution models that highlight metal zonation in the mineralized systems. The Rodeo Creek deposit comprises deep Ag base-metal ± Au-mineralized rock below the Roberts Mountains thrust and contains an unusually high Ag/Au ratio greater than 30. Stacked geochemical halos related to the deposit are confined to the lower plate of the Roberts Mountains thrust and include two horizons of Hg, Cu, and Zn anomalies—as much as 180 m above the deposit—that mostly result from mercurian sphalerite. Extremely subtle indications of mineralization in the upper plate of the Roberts Mountains thrust above the deposit include arsenopyrite overgrowths on small pyrite crystals in 50- to 75-μm-wide clay-carbonate veinlets that lack alteration halos, arsenical rims on small disseminated crystals of recrystallized diagenetic pyrite, and partial replacement of diagenetic pyrite by tennantite. Some of these minerals contain anomalously high Au. However, these As-(Au)–bearing rocks most likely represent another locus of largely untested mineralized rock rather than distal halos related to either the Rodeo Creek or the nearby Dee and Storm gold deposits. Application of micromineralogic techniques helped to identify mineral assemblages that are specific to mineralization and provided an empirical foundation for interpretations of geochemical halos in the Carlin trend.

District-scale geochemical patterns of several elements in stream sediments and surface rocks coincide with the northernmost Carlin trend and can be used to explore for Carlin-type deposits. Concentrations of elevated As and Sb in stream sediments (as much as 54 ppm As) have northwest-elongate lobate patterns that clearly outline the trend across a width of approximately 4 km. Arsenic contents of exposed rocks (as much as 90 ppm As) strongly correlate with As contents of derivative stream sediments, and rock contents of Sb show a somewhat lesser but nonetheless strong and similar correspondence. Factor analysis of stream-sediment data shows that those factor scores that are correlated with As, Sb, Au, and Pb also are high along the trend and suggest that mineralized rocks may be present. Although As was not detected by scanning electron microscope-energy dispersive spectrometer (SEM-EDS) studies in heavy mineral concentrates of high-As stream sediments in the Carlin trend, X-ray absorption near-edge spectra (XANES) of selected light fractions of stream sediment samples indicate that Al-bearing phases, such as gibbsite, amorphous Al oxyhydroxides, or aluminosilicate clay minerals host most of the As(V). The best fit, visually and in terms of the lowest residual, was obtained by a model compound of As(V) sorbed to gibbsite. Thus, most As in stream sediments derived from altered rock within the Carlin trend apparently is contained in light fractions.

The geochemical character of young, unconsolidated, postmineral deposits that cover mineralized rocks on the Carlin trend partly results from mineralized sources along the trend. Concentration of As in the Miocene Carlin Formation shows an exceptionally well developed progressive increase to about 30 ppm As as altered rock surrounding the trend is approached. Mineralized and/or altered rock fragments probably have been shed directly into the sedimentary basin of the Carlin Formation, and migration of As, now fixed as As(V), also may have occurred in the supergene environment after material was recycled out of the Carlin Formation and into present-day gulleys.

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