

## Alteration Associated with Gold Deposition at the Getchell Carlin-Type Gold Deposit, North-Central Nevada

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### Abstract

Wall-rock alteration at the Getchell underground deposit was examined to determine the effects of Au-bearing fluids on host lithologies and the relationship between K-bearing alteration minerals and Au deposition. The major, minor, and trace element geochemistry of highly altered and mineralized to unmineralized rocks from the Getchell deposit was quantified for more than 50 samples collected along 13 transects through calcareous siltstone and carbonaceous limestone and along one transect through a rhyodacite dike. Each transect in sedimentary rocks was collected along a single homogeneous bed that could be followed from high-grade ore to moderately altered rock or waste rock. Analyses were obtained for 39 elements, 10 oxides, and loss on ignition, using multiple techniques. Petrographic studies were integrated with geochemistry and X-ray diffraction and electron microbeam analyses to identify ore and alteration minerals and to correlate mineralogy with geochemical fluxes.

Geochemical analyses indicate that Ti, Al, Zr, and Th behave as immobile elements. Immobility isocon diagrams show that significant Hg, Sb, Se, Te, Tl, and Cs are typically added to the wall rocks with Au. Fe is immobile in some transects, added to wall rocks in others, and removed from rhyodacite host rocks. Minor S and W are usually added to the rock, whereas minor Cu and Mo are variably added or removed. SiO<sub>2</sub> appears to be either added during alteration or remain constant. Elements that are consistently removed during alteration include Ca, Mn, Sr, and Sc and minor Mg, Ba, and K. Na was significantly removed from the rhyodacite. Au correlates positively with Ag, Hg, Sb, Se, Si, Te, and Tl and negatively with Ca, Mn, and Sc.

Element fluxes correspond with observations of mineral abundances and show that sulfidation and decarbonitization are spatially associated with gold mineralization. Au, Hg, Sb, Tl, Cu, and possibly Te and W were incorporated in trace element-rich pyrite as host-rock Fe was sulfidized. Fe was added to mineralized rocks in some transects, indicating that pyritization occurred in addition to sulfidation. Cs is a component of galkhaite, a trace mineral that is relatively common in some parts of the Getchell system. Decarbonitization removed as much as 95 wt percent calcite from mineralized rocks in some transects and is responsible for loss of Ca, Mn, Sr, and Sc. Although SiO<sub>2</sub>, As, and S are significantly added to Carlin-type systems, they do not appear as major added components in the isocon diagrams. This is because the halos for these components are much larger than the areas examined by the sample transects.

X-ray diffraction analyses identified minerals in ore and waste samples and quantified clay minerals, including illite and montmorillonite. Kaolinite was not identified or is present in low abundances in both mineralized and unmineralized rocks. Montmorillonite does not correlate with gold and textures are consistent with pore-filling deposition of montmorillonite following Au deposition. Illite abundance exhibits a positive correlation with Au ( $r^2 = 0.80$ ). Intergrowths of illite with ore-stage pyrite support a genetic relationship between the two minerals and indicate that illite formed as part of the Au-related hydrothermal event. Mineral abundances and textures suggest that illite formed by alteration of K feldspar during Au deposition. Results show that dating of K-bearing phases in sedimentary rocks, other than illite, would provide ages unrelated to gold deposition.