Observations of Na-Ca, Ca, and K-Ca alteration at Battle Mountain and other districts in northern Nevada

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Mapping, petrography, and geochronology throughout the Battle Mountain district and reconnaissance elsewhere in northern Nevada reveal widespread intense Na-Ca and K-Ca metasomatism, an alteration suite heretofore unknown in the Eocene gold province of northern Nevada. In other parts of the world, these alteration types can occur with IOCGs and some porphyry systems, but their relationship to Eocene mineralization is uncertain. In the Battle Mountain district, detailed mapping at the Elder Creek porphyry system and in the Copper Basin area along with reconnaissance work in other intrusive centers and nearby areas allows both characterization and comparison of different settings. The objective is to gain perspective into the origins of these alteration types, their relationships to ore forming processes, and the timing of these events.

In conjunction with mapping, 45 new U-Pb in zircon ages were generated for igneous rocks at Battle Mountain and other intrusive centers in Lander and Elko counties. At Battle Mountain the ages delineate two periods of magmatism and mineralization, one in the Cretaceous from 90-100 Ma with Mo±Cu, and another in the Eocene from 38-42 Ma with Au±Cu. These results demonstrate that Na-Ca alteration is Eocene at Battle Mountain and elsewhere and is genetically related to skarns at Copper Basin that were formerly attributed to the Cretaceous Buckingham Mo±Cu system.

Hydrothermal alteration includes spatially restricted K and H+ metasomatism and more extensive Na-Ca-K metasomatism. The former is porphyry-style with locally intense quartz veining localized on particular intrusive phases: K alteration has Qz+Kf+Bi (Po+Py+Cpy+Au) and sericitic alteration has Qz+Ser with (Py±Cpy). Na-Ca (Plag±Scap+Act±Diop±Tit±Epid) and K-Ca (Kf-Act-Diop-Gar-Tit-Epid) alteration are more extensive. The former exhibits metal depletion, whereas the latter occurs with mineralization. The distribution of these alteration types varies: At Elder Creek, the Na-Ca and K-Ca alteration are found in the deeply exposed core of the composite stock. At Copper Basin, Na-Ca alteration is early and widespread but with proximal overprinting K-Ca alteration, breccias, and related garnet skarns with Cpy, Au, and Hm±Mt. Elsewhere Na-Ca-K types are common with or without associated mineralization and K-H metasomatism (e.g., Buffalo Valley, Copper Canyon, beyond Battle Mountain).

Early magmatic hydrothermal alteration forms are limited to distinct zones within and around particular intrusive phases and the abundances and types are consistent with formation from cooling magmatic fluids. In contrast Na-Ca(-K) alteration is far more extensive, it crosscuts the localized features, and does not correlate with any single stock. The abundance and geochemistry is inconsistent with magmatic fluids and implies an external brine source. The occurrence of these
types of alteration in many Eocene centers throughout northern Nevada begs for a re-examination of the Eocene environment and consideration of their significance in regional metallogeny.