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Geology and Geochemistry of the Deep Star Gold Deposit, Carlin Trend, Nevada

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Abstract

Deep Star is a high-grade Carlin-type gold deposit located in the northern part of the Carlin trend. The deposit averages 34.0 g/t Au and by year end 2000 had produced 37.8 t (1,217,000 oz) gold with a remaining reserve of 16.0 t (513,698 oz) gold. The deposit is primarily hosted in brecciated calc-silicate rocks of the Devonian Popovich Formation, with a minor amount of gold in the Jurassic Goldstrike diorite. Intrusion of the syn- and postore Deep Star rhyolite constrains the age of the mineralization. The postore rhyolite is compositionally and mineralogically similar to the synore dike and yielded an average $^{40}Ar/^{39}Ar$ isochron age of 38.3 Ma. Eocene rhyolite dikes intruded active, dilatant north- to northeast-striking faults and/or fractures, providing an important age constraint on the local stress regime at Deep Star during mineralization. Essentially horizontal, west-northwest-directed Eocene extension (291°) is consistent with dextral-normal oblique slip observed on north-south-striking, east-dipping portions of the Gen-Post fault system and dilation and sinistral shear on dike-filled, northeast-striking structures. A right-stepping, releasing bend in the Deep Star fault at its intersection with northwest- and north-northwest-striking subsidiary structures created a deep-tapping dilatant conduit for gold-bearing hydrothermal fluids.

Five stages of hydrothermal alteration are present at Deep Star. Stages 1 and 2 are related to thermal metamorphism, metasomatism, and possibly retrograde alteration associated with intrusion of the Goldstrike stock. Stage 3 consists of preore quartz-carbonate alteration. The carbonate minerals are zoned both laterally and vertically, with dolomite as the dominant mineral closest to ore. Stage 3 overlaps with stage 4 quartz-kaolinite alteration associated with the introduction of gold and is therefore interpreted to be part of the Eocene mineralizing event. Gold is hosted in As-rich rims on marcasite and pyrite within a kaolinite and quartz matrix. Postore stage 5 is dominated by calcite with lesser siderite and barite.

A three-dimensional geochemical model of the Deep Star deposit and its environs reveals that Carlin-type systems may have a geochemical expression involving a much broader suite of elements than previously recognized. Elements with distribution patterns considered to be related to the mineralizing event include Ag, As, Au, Ba, Bi, Ca, Cd, Co, Cu, Fe, Hg, Mg, Mo, Mn, Ni, P, Pb, S, Sb, Se, Te, Tl, U, V, W, and Zn. The multielement anomaly associated with the Deep Star deposit is best described as a vertical plume that is (1) focused between the Deep Star and Post faults below the deposit, (2) present in the footwall of the Deep Star fault and the Deep Star-Post fault corridor at the level of the deposit, and (3) broadly dispersed above, and to the west of, the deposit under the influence of northeast- and northwest-trending structural fabrics. Most closely associated with gold deposition are enrichments in As, Sb, Hg, Tl, Ag, and Zn within a halo of Ca, Mg, Ba, and Sr depletion. The elements Fe, Mn, Co, Ni, and P are most elevated in the immediate hanging wall of the Deep Star fault and above the deposit in a region where secondary carbonate veins (ankerite, kutnahorite, and Mn-rich dolomite); open-space-filling carbonate minerals (siderite, calcite) have been observed. Some lateral zonation is evident at levels above the deposit, with increases of Pb and Bi on its eastern margin and more Mo, U, V, and W west of the deposit.

Isotopic analyses of kaolinite are interpreted to indicate that gold-mineralizing fluids originated from either a magmatic or possibly a deep metamorphic source. Fluids range from near the magmatic water field for those near the center of the Deep Star orebody along a mixing path toward exchanged mid-Tertiary meteoric water as represented by the fluids near the eastern orebody margin.

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