Hydrological setting and geological controls on hydrothermal fluid flow in Carlin-type Au-deposits

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ABSTRACT

Carlin-type hydrothermal Au-deposits are typified by large tonnages and high-grades. They are a major source of the world's gold (~5% of annual global production). In North America, the majority of Carlin deposits occur in the classic Carlin-district of north-central Nevada. Recent exploration has also identified deposits in the Yukon, Canada. Previous research has shown that individual deposits in Nevada formed at ~0.5 to 3.5 km and were the product of hydrothermal fluid flow active on timescales of 10^4 to 10^5 years. However, the overall hydrology of the hydrothermal systems responsible for this deposit type is poorly defined.

Here we present mineralogical, geochemical and isotopic evidence for the path that hydrothermal fluids took through Carlin deposits in Nevada and the Yukon. Many of the deposits in Nevada are characterized by lateral fluid flow on a 10^3 m scale. Flow is controlled by shallow dipping stratigraphy, pre-existing shallow-dipping faults, and pre-existing shallow-plunging linear structures, such as boudin necks. Steep faults are important fluid conduits in some deposits, but they do not seem to be a critical component for ore formation. In the Yukon deposits there is little evidence for significant lateral flow, and fluids appear to have followed a steep path into the deposits. The fluids did not flow up large planar structures such as faults, but rather followed a discontinuous fracture mesh of joints, veins and small faults(?), many of which are confined within the hinge of steeply plunging folds.

The hydrological setting of Carlin deposits contrasts with that of low-sulfidation epithermal vein deposits that also form at shallow depths. The latter deposits involve fluid upwelling along active, steeply dipping, faults that act as high-flux conduits. The high flux results in little heat loss and the fluids typically undergo near-surface boiling that promotes Au-precipitation. Carlin hydrothermal systems are not associated with such high-flux conduits, did not undergo boiling, and are lower temperature than fluids in epithermal systems. We suggest Carlin deposits are the products of lower energy (smaller driving force), more permeability-sensitive, convective systems than in epithermal systems. Such convective systems are potentially amagmatic, and longer-lived than those that produce epithermal veins.