Carbonaceous matter and gold in Carlin deposits: How intimate was the relationship?

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Gold deposits in the Great Basin of Nevada are characterised by the presence of carbonaceous material in and around the orebodies. Some previous workers have generally considered hydrocarbon generation and emplacement to predate ore formation by >100 Myr (e.g Kuehn & Rose, 1992). Others suggests that oil is at least locally syn-mineralisation (Hulen & Collister, 1999

The presence of live oil during the Tertiary is attested to by the occurrence of comercially-exploited oil in Tertiary reservoirs (Scott et al., 1987), and by the Basin and Range age of the faults creating the traps in both the Blackburn and Bacon Flat-Grant Canyon oilfields. In the latter case, Teritary rocks also form the top seal to the reservoir.

Geochemical and petrographic data from the Jerritt Canyon and Screamer deposits clearly reveal that hydrocarbon was mobile and active at the time of ore formation. Analyses of country rocks surrounding ore reveal that organic carbon-rich domains are also associated with enrichments in Mo, V, Ni, U & Zn, and that there is a spatial relationship between these elements and ore. In situ organic matter is present adjacent to mineralisation together with migrated hydrocarbon in both host rocks and veins, and appears to have formed co-evally with ore-stage minerals including kaolinite and realgar. Compositional zonation of the hydrocarbon (principally S and As) unambigously points to its reactivity at ore stage, as do complexities in the reflectivity of the bitumens now preserved.

These observations extend tomajor areas of mineralisation the evidence for syn-mineralisation hydrocarbon mobility.

References

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Discovery and significance of gold-rich bitumen in the Rodeo Deposit, northern Carlin Trend, Nevada

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Laser ablation ICP-MS analyses reveal that bitumen in the Upper Zone of the Rodeo deposit contains up to 100 ppm Au, 0.7% V, and ca. 0.1% (Ni, As, Hg, Cu). This represents a previously unrecognized type of Au mineralization in the world's third largest Au producing district. Recent studies of the Rodeo deposit have shown that the deposit contains both Devonian sedimentary exhalative (sedex) Au and Eocene Carlin type mineralization. Sedex Au ore with up to 68 g/t Au is stratabound in the Devonian Upper Mud Member (UM) of the Popovich Fm. The UM is a carbonaceous mudstone that regionally contains 5-15% TOC. Burial diagenesis with emplacement of the Roberts Mountain Allochthon in early Mississippian time caused these carbonaceous ores to generate petroleum. Petroleum, now bitumen, occurs as veins that cut the sedex mineralization. The bitumen contains grains of cinnabar, pyrite, base metal sulfides and native Au (<1 μm).

Line scans across bitumen grains reveal two distributions of Au. A heterogeneous Au signal with discreet Au spikes indicates, as observed petrographically, the inclusions of native Au. A homogeneous signal suggests that Au and related elements are chemically bound in the bitumen. Au and related trace elements show no enrichment on outer margins of bitumen grains. This along with (1) the distinct chemical signature, (2) paragenetic relationships that constrain Au-rich bitumen to a Mississippian age, (3) the absence of hydrothermal alteration, and (4) the lack of Au in bitumen from high-grade Carlin ore outside the UM all suggests that metal enrichments are not the result of Carlin hydrothermal fluids.

Together these relationships suggest that Au and associated metals were remobilized and transported from sedex mineralization in petroleum as organo-metallic compounds during oil generation and migration. The Au concentration in bitumen in rocks containing up to 15 % TOC, suggest that substantial amounts of sedex Au were remobilized during petroleum formation and that a significant proportion of the Au mined from the Rodeo resides in bitumen. These observations demonstrate a new environment and mechanism of Au transport with significant implications for Au metallogeny.