

Still Stuck in the Mud: Reevaluation of Stratiform Gold in the Upper Popovich Formation, Northern Carlin Trend, Nevada

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A detailed study of whole-rock geochemistry, mineralogy, and pyrite composition through the uppermost Popovich Formation sheds further light on a contentious stratiform gold-bearing horizon in the Upper Mud unit. This horizon (herein termed the Upper Mud metalliferous horizon) contains elevated levels of V, Zn, Ni, Mo, Se, As, Sb, Ag, Tl, and Au over a large area on the northern Carlin trend, and forms part of the Rodeo upper orebody, where it locally contains up to 70 g/t Au. Although originally interpreted as the product of synsedimentary hydrothermal exhalation, some subsequent workers have suggested the gold is secondary and related to overprinting by Carlin-type pyrite deposited during Tertiary hydrothermal alteration. Others support primary enrichment, but by adsorption of metals from seawater during episodes of ocean anoxia, with metals ultimately provided by riverine fluxes of terrigenous material rather than hydrothermal exhalation.

New data from drill holes BSC168c and GA54c, collared 1 km and 2.5 km west of the Rodeo deposit, support an exhalative origin for the Upper Mud metalliferous horizon. In both drill holes, the Upper Mud metalliferous horizon coincides with a pronounced minimum in whole-rock Al, Fe, and Ti, indicating anomalously low terrigenous input during its accumulation. Existing conodont biostratigraphic data indicate Upper Mud sedimentation rates were highest during deposition of the Upper Mud metalliferous horizon, meaning time is definitely not on the side of models requiring adsorption of metals from “normal” seawater. Instead, biostratigraphic data indicate deposition of the Upper Mud metalliferous horizon and an underlying phosphate-rich interval, followed by a protracted depositional hiatus, marked by final drowning of the long-lived Bootstrap Limestone (bioherm). The abrupt nature of these transitions suggests that synsedimentary faulting—a necessary precursor to sedex mineralization—was the likely cause.

Much of the Upper Mud unit (including the Upper Mud metalliferous horizon) in BSC168c was affected by Tertiary hydrothermal alteration, although minor overgrowths of Carlin-type pyrite appear restricted to the only interval of ore-grade gold (2–10 ppm), coincident with the Upper Mud metalliferous horizon. Carlin-type pyrite was not identified in any Upper Mud samples from GA54c, including those from the Upper Mud metalliferous horizon, which contains levels of most trace elements similar to the Upper Mud metalliferous horizon in BSC168c, but <0.01 ppm Au. Superficially, these relations suggest gold in the Upper Mud metalliferous horizon indeed resides in Carlin-type pyrite. However, assuming all gold in the BSC168c Upper Mud metalliferous horizon samples is contained in arsenian pyrite, whole-rock Fe, Au, and As contents require average Au-As contents for pyrite that are close to or above the solubility limit for gold in arsenian pyrite. Essentially all of the pyrite would need to be gold-rich Carlin-type pyrite to explain the Au-As contents, and it constitutes at most ~5% of the pyrite in these samples. Other (preexisting) forms of gold must be present, if not dominant, in all of the Upper Mud metalliferous horizon samples from BSC168c. This is confirmed by the discovery of multiple gold grains, up to 15 µm across, and rare Ag-Au selenides disseminated through the matrix of the highest grade, highest Au/As ratio sample from the Upper Mud metalliferous horizon in BSC168c. The restriction of Carlin-type pyrite to the Upper Mud metalliferous horizon in BSC168c suggests this may reflect local remobilization of Au, As, Sb, and Tl previously deposited at this stratigraphic level.