

Structural Framework for Low-sulfidation Epithermal Deposits of Nevada: Mapping Open Pits in the Manhattan District Using Traditional and Digital Methods

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Precious metal mineralization in the low-sulfidation epithermal deposits of Nevada is strongly controlled by the fault architecture that developed during progressive Miocene extensional tectonics. This study aims to define the structure with which low-sulfidation gold mineralization is associated in the Manhattan district, Nevada. Here, mineralization is predominantly hosted by Paleozoic metasedimentary rocks and post-dates widespread Tertiary (~27-25 Ma) volcanism, with isotopic dating of adularia yielding Miocene ages (~19-17 Ma). Legacy open pits provide abundant exposures, although most are physically inaccessible. Thus, this study combines traditional field observations with orientation data derived from UAV-based, 3D models using Mira Geoscience's HiveMap software. Traditional mapping provided critical context for digital interpretations and facilitated kinematic analysis of observed fault generations, while the digital mapping was essential for defining decameter-scale structure. Pre-mineral structure includes widespread folding that relates to Mesozoic orogenesis, with limestone units forming a preferred host rock for later mineralization. Folds are isoclinal, recumbent, and NW-plunging. Local deviations are associated with secondary folds proximal to younger faults. Syn-mineralization faults are predominantly extensional, forming conjugate oblique-slip networks. Major ore zones occur along fault planes and/or form hanging wall replacement or stockwork zones. Bladed calcite and adularia are common within and adjacent to ore zones and commonly occur within dense to spaced, ~N-trending, and subvertical extensional fractures. The relative timing of these extensional fractures is unclear since their orientation is inconsistent with the observed normal faults. Two major fault groups are recognized, namely syn-mineralization normal faults and cross-cutting, subvertical strike-slip faults. Kinematic analysis indicates that the former formed during NNW-SSE-directed extension, while the latter represents a transition to sinistral transtension. This late phase of transtension is favorably oriented for the formation ~N-trending fracture zones. This suggests that the waning stages of epithermal mineralization spanned a transitional period of Miocene Basin and Range development.