Structural Controls on Low-Sulfidation Epithermal Deposit Formation in an Intra-Continental Rift Setting, the Northern Nevada Rift, USA

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Numerous epithermal deposits have been studied in detail. However, the combined understanding of an entire deposit network has not yet been attempted. This ongoing project is designed to answer specific questions regarding a genetically related series of low-sulfidation epithermal deposits, including the following: (1) Are there consistent themes controlling the deposit locations within a rift setting? (2) Is deposit formation affected by magmatic and/or seismic activity? (3) Do preferred geometric linkages of faults serve as channels for hydrothermal fluids? (4) Does basin geometry directly influence subterranean aquifers and have an affect on epithermal systems? In a rapidly evolving tectono-volcanic setting such as the mid-Miocene northern Nevada rift (NNR), epithermal systems are short-lived and their surface expressions can quickly be buried. By answering the proposed questions, exploration geologists can narrow their targeting to specific regions and researchers will be closer to understanding the driving mechanisms for deposit location and formation.

This study hypothesizes that rift architecture dictates deposit formation and location, and is a product of transtensional stresses interacting with hypabyssal magmatism, volcanism and basin development. Also proposing that the NNR formed a regional half graben depocenter composed of numerous asymmetrically subsiding tilt-blocks. Magmatism and hydrothermal fluids preferentially exploited portions of boundary fault systems. Furthermore, growth faults created isolated depocenters that eventually interlinked, serving as loci for migrating surface and subterranean waters. Collectively, these mechanisms are hypothesized to be scale-independent, suggesting that relationships between faults, veins, and dikes seen in the small scale are replicated on larger scales. If this is the case, a seemingly chaotic structural architecture may in fact be an orderly and predictable natural fractal. If successfully demonstrated, these mechanisms can be used to anticipate epithermal deposit location.

Observations from the NNR suggest three fundamental structural fabrics accommodated deformation. The first fabric is a boundary fault network on the rift's western margin (~340°) that links with a secondary network (~070°), and these work in concert to form tilt-blocks. Miocene strata display growth geometry toward both of these fault systems. The third structural fabric (~310°) is suggested to be synthetic to the 340° fabric, chiefly serving as linkages between en echelon boundary faults. The 310° and 340° fabrics combined host the majority of low-sulfidation epithermal vein mineralization and coeval dikes. Collectively, all three fabrics can form contemporaneously under transtensional stress as suggested by Riedel shear models. Multi-scaled manifestations of Riedel shears have been documented as cymoids at the stope to deposit scale, and up to district scale as relay-ramps between basin bounding normal faults.

Aiming to answer the stated questions, this study will document rift architectural development and its time-space relationship to epithermal deposits at multiple scales. Structural geometry of veins, faults, and dikes will be collected through detailed geologic mapping at individual deposits and across the entire NNR. Radiometric dating and ASTER mapping of phyllosilicates will support geologic mapping efforts. A model for rift evolution and associated mechanisms that influence epithermal deposit formation is the proposed outcome.