

Fault Control on Supergene Mineralization and Fluid Migration at the Morenci Porphyry Copper Deposit, Arizona

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The Morenci porphyry copper deposit is located within the transition zone between the Colorado Plateau and the Basin and Range Province in southeastern Arizona. Copper mineralization occurs as hypogene, supergene, and oxide minerals associated with Laramide porphyry intrusions emplaced into Precambrian granite. Approximately 51% of mineralization is hosted within the Laramide porphyries, with the remainder occurring primarily within the Precambrian basement complex (Enders, 2000).

Within the supergene zone, pyrite-chalcopyrite ratios reflect primary hypogene metal zoning. Previous work by Enders (2000) showed that pyrite-chalcopyrite ratios decrease within weak, structurally controlled quartz-sericite-pyrite alteration zones of northwest- and northeast-trending alignments coincident with the district-scale structural fabric. These observations suggest that fault architecture plays a significant role in supergene copper redistribution.

Faulting at Morenci records multiple deformation events. Laramide-age normal faults striking 020-040° reflect the evolving orientation of orogen-perpendicular extension during the Laramide orogeny. These faults are crosscut by mid-Tertiary northwest-striking normal faults related to regional post-Laramide extension. Reactivation of some northwest-striking faults during Basin and Range deformation locally offsets supergene enrichment.

This study examines the role of fault geometry and reactivation history in controlling supergene enrichment and fluid migration at the local scale. Observations of fault geometries, kinematics, relative timing, and fault rock properties are integrated with copper abundance data to identify permeability, dilatancy, and preferential fluid pathways. Structural data from drill core are used to quantify fracture density and constrain the local stress field to assess its interaction with the regional stress regime and influence on supergene fluid flow and copper redistribution.

These results highlight the importance of integrating detailed structural characterization with geochemical data to better constrain supergene enrichment models and inform efficient mine planning and resource extraction.

Enders, M.S., 2000, The Evolution of Supergene Enrichment in the Morenci Porphyry Copper Deposit, Greenlee County, Arizona, Ph.D. Dissertation, University of Arizona.