

Structural Controls and Metasomatic Evolution of the Mary Kathleen REE-U Skarn Deposit, Mount Isa Inlier, Australia

ALANIS OLESCH-BYRNE¹, MELANIE FINCH², ANDREW TOMKINS³ AND DR. BRUNO VIEIRA RIBEIRO, PHD⁴

¹The University of Melbourne

²University of Melbourne

³Monash University

⁴Timescales of Mineral Systems Group, Curtin University

Competency contrasts adjacent to high strain rate shear zones play a fundamental role in ore deposit formation by localising deformation, enhancing fluid flow, and promoting brecciation through fluid overpressure. This mechanism is observed in several world-class deposits, including Ernest Henry (Cu-Au) and Cannington (Ag-Pb), where mineralisation is structurally confined between shear zones. Despite its significance, the interplay between strain localisation, competency contrasts, and mineralising fluid flow continues to be an area of ongoing research.

The Mary Kathleen rare earth element-uranium (REE-U) deposit in the Mount Isa Inlier of northwestern Queensland provides an example of this process. Here, the ore body is bounded by the Eastern and Western Mary Kathleen Shear Zones, which serve as primary conduits for mineralising fluids. Previous geochronology has established a temporal gap between skarn formation (~1740 Ma) and ore deposition (~1510 Ma), indicating that mineralisation resulted from a later hydrothermal event rather than direct magmatic association.

Structural analysis and geochronology show an evolution of metasomatism and mineralisation, starting with pervasive potassic metasomatism, overprinted by garnet-diopside skarn formation, and finally, late-stage brittle allanite-uraninite veins crosscutting the skarn mineral assemblage. High strain rates within the bounding shear zones generated fractures and brecciation, increasing permeability and facilitating the formation of an extensive vein network restricted to the zone between the shear zones. Fluid overpressure played a key role in driving mineral precipitation within these structures.

This study describes models for structurally controlled REE-U systems by demonstrating how competency contrasts within high strain rate shear zones control ore deposition. These findings have broader implications for mineral exploration worldwide in shear zone-hosted ore systems.