Economic Geology, v. 107, p. 817-833 (pdf copy available on request)


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Abstract
The Maggie Hays Ni-Cu sulfide deposit, located in the ~2.9 Ga Lake Johnston greenstone belt of Western Australia, is hosted in a peridotitic to dunitic subvolcanic feeder that cuts felsic volcanic rocks and sedimentary units. Ore formation at Maggie Hays is attributed to assimilation of a sulfide-rich metasedimentary unit located above the subvolcanic feeder, which induced sulfide saturation within the feeder magmas. Massive and disseminated sulfides display chalcophile element fractionation trends indicative of in situ sulfide crystallization. Sulfide saturation and ore formation within the system generated enriched and depleted chalcophile elements ore-forming signatures in the silicate magmas. These ore-forming signatures are quantified as deviations from calculated background abundances and are spatially constrained to known mineralization within the system using a three-dimensional deposit model. Platinum group element (PGE) depletion and enrichment signatures occur approximately 300 m upstream from mineralization at the intersection of the feeder conduit and sulfide-rich sedimentary unit, interpreted to mark the point of sulfide saturation within the system. The magnitude of PGE enrichment increases with proximity to mineralization. PGE depletion signatures exhibit a more complex pattern, attributed to mixing between sulfide liquid, depleted silicate magma, and undepleted recharging magma.

The study of the Maggie Hays mineralization and its host sequence demonstrates that enrichment and depletion of the highly chalcophile PGEs, relative to abundances expected in sulfide-undersaturated mantle-derived magmas, is a powerful exploration tool. Constraining the spatial distribution of enrichment and depletion signatures in the context of a robust volcanic, stratigraphic, magmatic, and metallogenic model allows for quantification of the size of Ni sulfide-forming systems and targeting of Fe-Ni-Cu mineralization in komatiite-bearing sequences.