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Translithospheric Tracers of Ni-Cu-Co-PGE Mineralisation: a Geochemical Approach

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Sulfide deposits hosted by mafic-ultramafic magmatic rocks are an important source of Ni, Cu, Co and PGEs; metals essential for renewable energy (e.g. wind turbines) and electric vehicles batteries. However, discoveries of such deposits are decreasing and thus locating new metal resources is critical for ensuring a security of supply for green energy technologies.

Magmatic systems play a crucial role in enriching the crust with metals that reside primarily within the Earth's mantle e.g. Ni, Cu, Co, Pt, Pd, Te and Se. The nature of the mantle source, degree of partial melting, and tectonic setting is widely thought to control the initial metal and S concentrations of these ascending melts during the primary stages in the generation of Ni-Cu-PGE mineralisation. The behavior of chalcophile elements and partitioning effects between sulfide liquid, silicate melts, and hydrothermal fluids at varying depths in the lithosphere make them useful tracers for a variety of mantle and crustal processes.

Recent advances in the understanding of magmatic mineral systems have highlighted continuums between different sulfide deposit styles from the magmatic Ni-Cu systems to porphyry Cu-Au and hydrothermal Cu-Ni-Au through the lithosphere. We show how distinct variations in whole rock metal ratios (e.g. Ni/Cu/Pd/Te/Se), from a number of different mineral systems can be used as tracers of different lithospheric processes from initial metal enrichments during partial melting of the mantle, through sulfide fractionation on ascent and hydrothermal mobilization in the upper lithosphere. This appreciation of the divergent mantle-crustal metallogenic signatures can broaden our current understanding on the mineralising stages during magmatic sulfide genesis and help to vector towards ore deposits in distal expressions of mineralised magmatic systems.