The lithosphere and metallogeny: a 40-year evolution of concepts

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Earth is an experiment run once: finding a predictive pattern in its compositional and spatial domains and defining pathways and mechanisms for element transport will determine our future. Some progress has been made since the mid 70s when, e.g., the significance of peridotite xenoliths in basalts was still hotly debated (crustal cumulates? mantle wall-rocks?), there were only two types of geotherms (continental and oceanic), and both continental crust and lithospheric mantle had grown steadily with time.

New paradigms began to emerge in the 80s, and for each milestone, Schopenhauer's quote "*All truth passes through three stages. First it is ridiculed. Second, it is violently opposed. Third, it is accepted as self-evident"* has been a recurring motif. Xenolith- and garnet/chromite-based geotherms provided a spatial framework for lithosphere mapping and geochemical tomography; new *in situ* Hf (zircon) and Os (mantle sulfides) isotopic methods yielded convergent geochronology datasets indicating that ~80% of the subcontinental lithospheric mantle (SCLM) and its overlying crust formed at 3.0-3.5 Ga. Integration of geophysical, tectonic, geochemical and geochronologic datasets with thermodynamic modelling revealed the buoyancy of this ancient, Mg-rich and highly depleted SCLM, resulting in persistent low-density, rheologically coherent Archean domains that have been repeatedly rearranged through large-scale tectonic cycles. Over their >3b.y. history they have become metasomatically enriched reservoirs, carrying metallogenically fertile mantle impregnated with critical elements (e.g., Au, Cu, Ni and PGEs) and are potentially identifiable using seismic and electric signatures. Some exposed SCLM terranes, excavated from >400 km (mantle transition zone) also reveal evidence of highly reducing regimes along some mantle pathways. These variably refertilised Archean cratons provide an architectural mantle-scape of contrasting rheologies, compositions and basal topography. They are cohesive domains that control magma and fluid pathways around their margins and along old sutures between blocks, and may act as both sinks and sources for ore-forming elements depending on the geodynamic evolutionary stage. This Global Lithospheric Architecture (GLAM [1]) approach is proving a predictive tool for modern mineral exploration.

[1] Begg *et al*., (2009) ***Geosphere***, 5, 23-50.