In-situ growth and metallogenesis of Earth's largest Archean craton

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Archean crust underlies ~60% of Canada, and hosts the majority of Canadian Au, and significant base metal deposits (Lydon, 2007). Orogenic Au and magmatic Cu-Ni-PGE mineral systems have been linked to deep structures that serve as pathways to transfer mass, energy and metals from enriched mantle and lower crustal domains into the upper crust during favourable transient geodynamic stresses (Hronsky et al., 2012; McCuaig and Hronsky, 2014). Because granites yield information about the crust they largely constitute and the basement they commonly sample, their isotopic record can potentially resolve deep cratonic structures, identify enriched mantle domains and track tectonic evolution (Kemp et al., 2009), thereby providing mappable exploration criteria (Champion and Cassidy, 2007; Mole et al., 2014).

Models for the growth of Earth's largest Archean craton follow a decades-long paradigm of (re)assembly of exotic crustal fragments. However, new coherent isotope-time arrays of granites from terranes in the Superior Craton favours in-situ growth. The isotopic and stratigraphic records are consistent with long-lived Mesoarchean rifting followed by an extending Neoarchean arc-back arc subduction zone that culminated in Kenoran collision. Two south-younging subparallel Paleo – Meso – Neoarchean successions are reconciled by structural repetition along late dextral faults.

Mesoarchaean basalt and komatiite successions resemble oceanic plateaux, whereas Neoarchean basalts extend to arc-like chemistry reflecting a hydrated mantle. Arc basalt is more common in areas of young juvenile crust like the Abitibi terrane (e.g., Polat and Kerrich, 2001). Orogenic gold and VMS deposits concentrate in these juvenile domains, with the former clustered along lithospheric breaks (Robert et al., 2005). Deep, long-lived structures in Mesoarchean terranes localized 2.7 Ga Au-bearing fluids (e.g., Hammond Reef) and Cu-Ni-PGE enriched sanukitoid and ultramafic magmas. Syn-orogenic sanukitoid intrusions reflect a sediment-metasomatised mantle source, and their chemistry marks a turning point in Earth's evolution from sodic to potassic magmatism.