Behaviour of ore-forming elements in the subcontinental lithospheric mantle below the slave craton

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Metal enrichment likely begins in the mantle source regions for some ore deposit types. However, the fertility of the subcontinental lithospheric mantle as source region for metal-rich magmas remains poorly understood. Herein we report new major (EPMA), minor and trace element (LA-ICPMS) results for olivine mantle xenocrysts sourced from the Jericho, Muskox and Voyageur kimberlites. The kimberlite bodies are located in western Nunavut in the Slave Craton approximately 30 km north of the Lupin gold mine and are Middle Jurassic in age. Target elements include a suite of ore-forming elements that are unconventional for mantle petrology studies, but may represent important geochemical tracers for metal metasomatism at depth. Using single-grain aluminum-in-olivine thermometry, formation temperatures for the olivine grains were calculated and projected on to a mantle geotherm to estimate PT conditions. The suite of xenocrysts corresponds to mantle sampling between 100–190 km depth. The range in their Mg# indicates that all 3 kimberlites sampled variably depleted mantle peridotite . The patterns of trace element enrichments found in this study agree with those documented previously for mantle olivine xenocryst samples from the lithosphere below the Superior Craton in Kirkland Lake, Ontario. In both studies, some ore-forming elements of interests were found to partition into mantle silicates at high PT, notably copper, with concentrations varying from ≤ 1 ppm in shallow samples up to 11 ppm at the maximum depth sampled. Because the concentration of copper and other metals in melt-depleted lithospheric peridotite melted to sulfide-out is expected to be low (≤ 20 ppm Cu), mantle silicates likely become a significant host for some ore elements at depth. Precious metals (e.g., Au, Pt) do not show any consistent PT dependencies and maintain low concentrations at depth (≤2.5 ppb Au). High field strength elements, which are highly incompatible within olivine, yield decreasing concentrations with depth, possibly the result of mantle metasomatic processes. Fluid metasomatized mantle peridotite domains are also inferred from olivine xenocrysts that yield unexpected trace element concentrations (ppb to ppm) for other highly incompatible ore-elements (e.g., As, Mo, Sb, Se). We expect that some of these fluid-mobile and highly incompatible ore-elements represent trapped fluid and/or melt inclusions.

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