Destruction and regeneration of cratonic lithosphere roots: evidence from the Slave craton (Canada)

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Cratons are the ancient landmasses that remain stable for billions of years on Earth but also have experienced episodic events of modification and rejuvenation throughout their history [1]. These alteration processes have modified the cratonic lithospheric mantle roots to different extents, e.g., ubiquitous cryptic/modal metasomatism, partial to entire loss of the mantle roots, to rifting apart of the craton. It remains unclear to what extent a cratonic mantle root can withstand modification and retain its integrity. We attempt to discuss this issue from the perspective of the Slave craton that has experienced the multiple impacts of major circum-cratonic Paleoproterozoic (1.93-1.84 Ga) orogenies and the intrusion of several 2.23-1.67 Proterozoic diabase dyke swarms. We use kimberlite-borne peridotite xenoliths to construct a N-S transect across the craton with an aim of probing the effects of these post-Archean events on the composition, age and depth of the lithospheric root. Chemically, all of these rocks are of typical cratonic refractory composition. P-T calculations and paleogeotherms show that they were derived from thick lithospheric mantle roots (>180 km), consistent with their diamondiferous nature. However, these peridotites exhibit variable N-S variation of modes in their Re-depletion Os model ages (T_{RD}). Neoarchean T_{RD} ages dominate in the Central and Southern Slave mantle. Progressing North there is a decreasing proportion of Archean T_{RD} ages through Jericho to Artemisa in the Northern Slave craton. About 70% of the peridotites at Artemisia give T_{RD} ages within error of the ~1.27 Ga Mackenzie LIP event, with the remaining (~ 30%) close to the Paleoproterozoic orogenic events. Combined with new data from regions to the N and NW of the Slave craton [2], the observed age spectrum in the far North of the craton indicates the likelihood of major new generation of lithospheric roots in both the Paleoproterozoic and Mesoproterozoic. Despite its complex history, the Northern Slave craton retains a ‘cratonic-like’ lithospheric root that allowed diamond mineralization.

[1] Foley, S.F., 2008. Nat. Geo. 1, 503-510. [2] Liu J.G. et al., 2018. GCA 239, 284-311.