Origin and Evolution of the Lithospheric Mantle beneath the Central Slave Craton (Canada)

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The subcontinental lithospheric mantle (SCLM) sampled by kimberlites beneath Lac de Gras (central Slave Craton) is strongly layered, with an ultra-depleted shallow and a less depleted deep layer. Some sulfides from the deep layer lie on a 3.27 ± 0.34 Ga isochron, which is interpreted as the formation age of this layer. The age shows that significantly older mantle resides beneath the 2.7 Ga crust of the eastern part of the Slave Craton (Contwoyto Terrane), possibly indicating underthrusting of ancient continental mantle from the neighbouring 4.0-2.7 Ga terrane (Central Slave Basement Complex, CSBC) during a 2.7 Ga collision.

The initial $^{187}Os/^{188}Os$ of the sulfide isochron is supra-chondritic and may be the signature of a high-Re/Os source, such as the lower mantle or outer core. Furthermore, whole-rock compositions are similar to experimental polybaric melting residues and there is a positive covariation of whole-rock Al_2O_3 and Cr_2O_3, which indicates that the formation of the SCLM beneath Lac de Gras involved large degrees of garnet-absent polybaric melting, such as may be expected during ascent of a plume. These results, along with the recognition of abundant ultra-deep diamonds by other workers of our group, suggest formation of the deep SCLM layer by subcretion of plume material derived from the lower mantle.

Nd-Hf isotope data on peridotites from the shallow layer suggest that it, too, is at least 3.2 Ga old and that it was part of the mantle package thrust beneath the 2.7 Ga eastern terrane. During this event the shallow arc-related SCLM coeval with the Contwoyto Terrane and shallow mantle of the CSBC may have been interleaved, allowing both mantle types to be sampled by the Lac de Gras kimberlites.

Subsequently, the SCLM experienced Proterozoic metasomatism by carbonatitic or similar melts, resulting in low Sm/Nd but high Lu/Hf, as inferred from the highly radiogenic Hf and unradiogenic Nd of some harzburgites. Other samples show evidence for metasomatism by silicate melts leading to HFSE addition and low $^{176}Hf/^{177}Hf$. The isotopic and trace-element relationships in garnets can be explained by interaction with silicate melts that progressively lost HREE and Y to the garnet-bearing mantle, becoming increasingly enriched in LREE and volatiles. Younger metasomatism, by melts that originated from a source similar to the host kimberlites, led to variable resetting of Nd and Hf isotope ratios. This young disturbance is inferred from negative internal isochron ages and near-constant εNd at variable Sm/Nd of some samples.