

Global oxygen isotope survey of lithospheric mantle: Implications for the evolution of cratonic roots

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The sub-continental lithospheric mantle (SCLM) forms the roots to the earliest crust and represents the most ancient mantle domain on Earth. Hundreds of oxygen isotope data have been reported for various mantle domains in the past three decades, yet the full geodynamic significance of these data is largely unappreciated. When coupled to the major element systematics, oxygen isotopes have the potential to illuminate the longstanding conundrum of the origin of highly depleted lithospheric roots beneath the Archean crust given that the current debate on their genesis is centred on quantifying the relative contributions of mantle plumes (asthenospheric source) and subduction zone processes (lithospheric source).

We present isotope analyses for 61 grains of olivines extracted from peridotite xenoliths entrained by kimberlites and peridotite basalts worldwide; the most extensive high-precision *in situ* $\delta^{18}\text{O}$ database to date. Olivines analysed by multi-collector SIMS in this study were collected at: Paleogene to Jurassic Diavik and Jericho kimberlites (Slave Province), Cretaceous Somerset Island kimberlites (Rae Craton), Late Neoproterozoic kimberlites of Western Greenland (North American Craton), Middle Cretaceous to Late Mesoproterozoic Kimberly, Finsch, Letseng-la-Terape and Premier kimberlites (Kaapvaal Craton), Early Carboniferous Udachnaya pipe (Siberian Platform), and Miocene Vitim alkaline basalts.

The SCLM $\delta^{18}\text{O}$ data are normally distributed about the mean value of 5.30 ‰ (± 0.22 ; 2σ) and largely corroborate previous upper mantle compilations [1]. There is no correlation between $\delta^{18}\text{O}$ and major or trace element chemistry, rhenium-depletion ages or equilibrium pressure-temperature conditions from which the mantle xenoliths were derived. Based on the new data we find no statistical difference between the oxygen isotope composition of cratonic peridotites and modern MORB-source mantle. These observations rule out an origin for SCLM via subcretion of serpentinised oceanic lithosphere [2]. However, we cannot discriminate between the subduction of relatively unaltered oceanic lithospheric mantle versus a plume origin. Furthermore, the overlap of the SCLM data with the mean global $\delta^{18}\text{O}$ value of MORBs of 5.17‰ (± 0.21 ; 2σ) has important implications for the long-term relationship between the convecting asthenospheric mantle and refractory cratonic roots.

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Improved Analytical Method for Determination of B Isotopes by Magnetic Sector ICP-MS

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The boron isotopic composition of seawater, as recorded by foraminifera, can be used as a tracer of past variations in atmospheric pCO_2 [1, 2]. However, widespread application of B isotopes in geochemical studies is limited by the large relative mass requirement for high precision measurements, large memory effect, high procedural blanks, artificial fractionation induced by matrix purification methods, and low matrix tolerance [3]. We present an improved method for B isotope ratio ($\delta^{11}\text{B}$) determination with low mass consumption (5 to 10 ng-B per quintuplicate analyses), high precision ($\pm 0.5\text{‰}$, 2σ), low blanks ($< 9 \text{ pg-B/ml}$), and high matrix tolerance using Element XR[®] Single Collector ICP-MS (*figure*). The present ICP-MS method is optimised for analysis of $< 0.5 \text{ mg}$ foraminifera samples.

Preliminary analyses of B standards following standard – sample bracketing technique gave external precision (quintuplicate) of $\pm 0.50\text{‰}$ independent of analyte concentration (4 ppb – 10 ppb). Moreover, this new ICP-MS method has relatively large tolerance for Na, Mg, and Ca – the dominant matrix elements in foraminiferal calcite and provides an improved methodology to investigate B isotopic variations of planktonic and benthic foraminifera samples over geologic timescales.

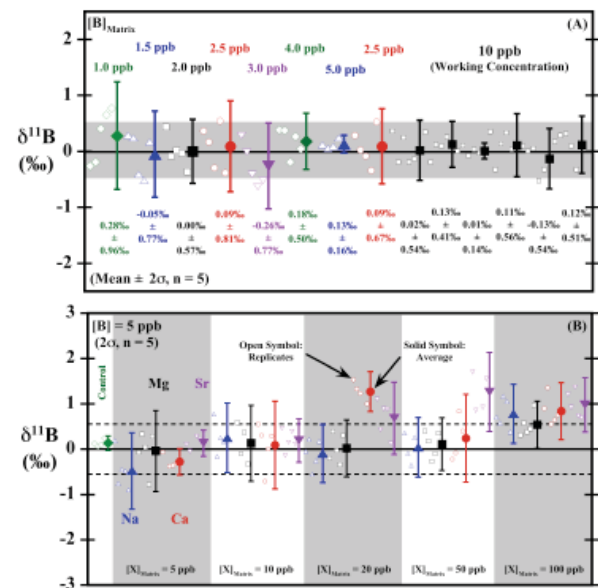


Figure: Results of (A) Boron concentration experiment, and (B) matrix experiment. All samples analysed following standard – sample bracketing technique. Analyses of sample in quintuplicates.

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