The B and Li isotopic compositions of MORB and the depleted mantle

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Stable isotopes of boron and lithium show variations of several tens of per mil in Earth's surface environments and are potentially powerful geochemical tracers for the secular evolution of the ocean-crust-mantle system. Yet, the isotopic compositions of the Earth's major reservoirs are still poorly constrained, in particular in the case of boron. Estimates for the isotopic composition of the mantle are dominantly based on analyses of MORB, and range from -10 ±2 ‰ to ~0 ‰ [1] [2]. This large uncertainty in the mantle reference value is due to analytical challenges of B isotope analyses at low concentrations and to possible assimilation of seafloor-altered materials by the basaltic magmas.

The first of these obstacles was recently overcome at the WHOI ionprobe lab by implementing an improved analytical protocol for B isotope analyses, which enables precise and accurate $\delta^{11}B$ analyses of MORB [3]. This improved method was employed in this study to analyse a range of 56 different MORB glasses from a range of settings and localities, including N-MORB and E-MORB from the EPR, MAR and SWIR. The samples had been characterised in a number of previous studies for major and trace elements and radiogenic isotopes. Here, we add B isotope data to this set of glasses. We also analysed a subset of these samples for Li isotopes by MC-ICP-MS, and added missing Cl and F concentration data.

Our results show a broad positive correlation between B and Li isotopes. $\delta^{11}B$ values exceeding -5 ‰ are restricted to glasses with high [Cl] and high Cl/K. No correlation exists between B (or Li) isotopes and Nd or Pb isotope ratios, but some high-$\delta^{11}B$ high-$\delta^{7}Li$ samples show elevated $^{87}Sr/^{86}Sr$. All this evidence taken together is interpreted to represent assimilation of seawater-altered materials or seawater-derived brines into the basaltic magmas, adding heavy B and Li, as well as Cl and radiogenic Sr to the melts. No differences were observed in $\delta^{11}B$ among low-Cl/K glasses from EPR, MAR and SWIR, and their average $\delta^{11}B$ is -7.5 ±0.7 ‰. This value represents our best estimate for average uncontaminated MORB. Differences exist in $\delta^{7}Li$ among different localities, but the best estimate for average uncontaminated MORB from this set of samples is +3.5 ±0.4 ‰.

[1] Chaussidon & Jambon (1994), *EPSL* **121**: 277–291. [2] Ishikawa & Nakamura (1992) *GCA* **56**: 1633–1639. [3] Marschall & Monteleone (2015), *GGR* **39**: 31–46.