What do boron isotopes tell us about mantle heterogeneity?

WALOWSKI, K.[1], KIRSTEIN, L.[2], DE HOOG C.J.[2], ELLIOTT, T.[3], SAVOV I.[4], JONES, R.[5]

[1]Middlebury College, Middlebury, VT, USA (kwalowski@middlebury. edu)
[2]University of Edinburgh, Edinburgh, UK
[3]University of Bristol, Bristol, UK
[4]University of Leeds, Leeds, UK
[5]University of Oxford, Oxford, UK

Boron isotopes are a valuable tracer of recycled material because they fractionate strongly at the surface of the Earth and during subduction, but are not perturbed during high-T mantle processes. Thus, we utilize the B concentration and isotope composition from end-member OIB to document how recycling contributes to mantle heterogeneity. We present the largest high-precision B isotope dataset from ocean island material (basaltic glasses and olivine-hosted melt inclusions measured by SIMS) to date, with data from 38 different samples derived from 9 different ocean island chains that represent the main end-member OIB compositions including: EMI (Pitcairn Islands); EMII (Ra Seamount; Tristan de Cunha Island; Sao Miguel, Azores); HIMU (St. Helena; La Palma, Canary Islands) and FOZO (Fogo, Cape Verde; La Reunion Island; Ascension Island). The B concentrations of the entire sample suite range from ~1.5-4 ppm with δ11B values from from -5.0±0.2‰ to -10.8±1.0‰. After careful screening for seawater contamination, we find that despite trace element and radiogenic isotope variability, OIB show little variation with respect to their B isotope compositions and B concentrations when compared with the range observed in mafic arc magmas (~ -15 to +20‰), and generally overlap with B isotope compositions and concentrations measured in mid-ocean ridge basalts (MORB; -7.1±0.9‰). Interestingly, EM2 and HIMU endmembers display distinctly lighter δ11B values and lower B/Zr and B/Ce, which are indicative of lower B concentrations relative to MORB and the primordial mantle. The results suggest little B is recycled into the deeper mantle because it is effectively stripped from recycled lithologies during upper mantle processes (e.g., subduction dehydration) or diluted during melting in the uppermost mantle. In addition, the results highlight the decoupling of B isotopes and traditional radiogenic isotopes and provide a new perspective on mantle source heterogeneity and volatile recycling in the deep mantle.