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Boron Isotopic Constraints on Chemical Transport into the Deep Earth

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The flux of surface material into the mantle is dependent on chemical and physical processes at subduction zones. Some material that enters the mantle in a subducting slab is lost into the mantle wedge. The rest of the material, however, continues deeper, where it can influence the chemical signature of parts of the mantle. The upper mantle is sampled by mid-ocean ridge basalts (MORBs), so MORB geochemistry can be used to characterize the composition of the upper mantle, and assess possible explanations for chemical variations among MORBs.

Here we present new B concentrations and isotopic compositions determined for a total of eight MORB glasses from the East Pacific Rise, the Mid-Atlantic Ridge, and the Southwest Indian Ridge. These samples were chosen for their spread in radiogenic lithophile isotope signatures, from a depleted MORB mantle (DMM) endmember to a HIMU endmember ("high μ," where μ is the U/Pb ratio). B isotope data from these samples was compared to radiogenic isotope ratios and trace element ratios, and contextualized within the existing literature measurements of typical MORBs.

The results of these comparisons, especially in two samples that exhibit the strongest HIMU signatures, support a HIMU origin model that includes the influence of both frozen low-degree partial melts, due to the samples' high degree of trace element enrichment, and recycled surface material from subducted slabs, due to the heavy B signature of surface material. We are also able to use the B isotopic values from our HIMU samples to shed light on recycling of surface materials into the mantle: heavy boron isotopes in HIMU MORBs indicate that volatile-rich components in subducting slabs were retained through the subduction zone and ultimately recycled into the mantle.