EGU21-12019, updated on 27 May 2022
https://doi.org/10.5194/egusphere-egu21-12019
EGU General Assembly 2021

Boron isotope systematics of Higashi-akaishi mantle wedge peridotites (Sanbagawa belt, Japan): implications for fluid recycling in subduction zones

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Boron provides an efficient tracer of fluids in subduction zones, due to its high concentration in surface reservoirs, low concentration in the mantle, and large isotope fractionation. The Higashi-akaishi peridotite body in Sanbagawa UHP belt, Japan, is composed of partially serpentinised dunites and harzburgites, which are interpreted to be exhumed mantle wedge peridotites. Compositions of olivine (Fo90-94, NiO 0.28-0.48 wt%, MnO 0.10-0.16 wt%) and chromite (Cr# >0.7, TiO_2 <0.4 wt%) confirm its origin as highly refractory fore-arc mantle. Several generations of olivine and serpentine can be recognised in the samples, and were analysed in-situ for their B content and B isotopic composition by SIMS. Coarse-grained primary mantle olivine has low [B] (1-3 µg/g), but is still significantly B-enriched compared to typical mantle olivine, and has $\delta^{11}B$ of -10 to -3 ‰. Lower B contents in olivine cores compared to rims suggests diffusive incorporation of B from slab-derived fluids at high temperature. Later fine-grained olivine neoblasts, products of dynamic recrystallization, have higher [B] (3-11 µg/g) and higher $\delta^{11}B$ (-7 to +2‰). Platy antigorite associated with the olivine neoblasts have similar [B] (4-12 µg/g) but higher $\delta^{11}B$ (-4 to +6‰). Late-stage greenschist-facies overprint resulted in lizardite veining with high [B] (18-52 µg/g) and a narrow range of $\delta^{11}B$ (-2 to -1‰).

We envisage the following scenario. Coarse-grained mantle olivine acquired B from slab-derived fluids when the peridotites were dragged down by mantle corner flow and positioned near the slab-mantle interface. The values of $\delta^{11}B$ (-10 to -3‰) are consistent with fluids from dehydrating slab at ca. 110-150 km depth, but are potentially affected by diffusion-controlled kinetic isotope fractionation. High temperatures (> 650-700°C) prevented the peridotites from serpentinisation. Subsequently the rocks were down-dragged in a subduction channel where olivine neoblasts formed first and platy antigorite crystallized later when temperature dropped below 650°C. Both phases show heavier $\delta^{11}B$ than coarse-grained olivine; the values are consistent with fluids from dehydrating slab at ca. 70-100 km depth. Finally, the peridotites were exposed to crust-derived B-rich fluids with low $\delta^{11}B$ during exhumation and amalgamation with crustal units, forming lizardite veining during greenschist-facies overprint.

This study shows that mantle olivine may scavenge significant amounts of B from percolating fluids by diffusive re-equilibration or dynamic recrystallisation, lowering the B content of such

fluids and potentially modifying their B isotopic composition.