Evidence of crustal recycling in the Troodos Ophiolite (Cyprus): Insights from B-Sr-Nd-Hf-Pb isotopes

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The Troodos igneous complex (Cyprus) is a ca. 90 Ma old, well preserved supra-subduction zone ophiolite. Troodos is unique in that it shows evidence of fluid-saturation throughout the complex, from its base (i.e. podiform chromitites) to its uppermost units - the Upper Pillow lavas (UPL). Fluid saturation is reflected by the presence of orbicular textures at all crustal levels, with orbs forming to minimize surface energy in one of the immiscible liquids. The UPL are no exception, with several outcrops in Troodos displaying decimetric orbs. However, it is unclear what the source of dissolved water in UPL tholeiites is, with possibilities including seawater, and recycled serpentinized oceanic crust, or pelagic sediments.

In order to identify and characterize these components we have carried out a detailed high-resolution study on tholeiitic lavas from the UPL in Troodos. Specifically, glassy orbs were measured individually for their Sr-Nd-Hf-Pb isotopic compositions. In addition to these isotope systems, orb sections were measured *in situ* for their B isotopes using LA-MC-ICP-MS. Boron isotopes are ideally suited to assess to which extent seawater may have mixed into the magmatic plumbing system of the UPL unit, and to test the possibility of a significant recycled crustal component.

UPL tholeiitic orbs display a very narrow range in εNd and εHf (+7 to +8 and +13 to +15, respectively) indicating a much depleted mantle source. Lead isotopes, specifically $^{207}Pb/^{204}Pb$ vs. $^{206}Pb/^{204}Pb$, form a mixing array with pelagic sediments. Furthermore, high-resolution characterization of individual orbicules revealed that UPL tholeiites display strong variability in $^{87}Sr/^{86}Sr$ (0.7039 to 0.7060) at the outcrop scale. Samples display $\delta^{11}B$ between -5 and +8 with an average B content of ca. 5 ppm. Contrary to expectation, altered orbs and hyaloclastite matrixes display lighter $\delta^{11}B$ (down to -10) and higher B contents (max. 200 ppm) when compared to fresh glass. When all isotope systems are taken into account, UPL lavas reflect melting of a depleted mantle source that was overprinted by fluid-like subduction components that in part originate from serpentinized oceanic crust. Subsequent low-temperature alteration then drove $\delta^{11}B$ to lighter values coupled with increased B uptake.