Depth of chlorite formation: quantitative determination using boron isotopes

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High-pressure hydrous minerals are known to play an important role in the transfer of volatiles and fluid mobile elements from the subducted lithosphere to the mantle wedge in subduction zones, as well as in arc magma genesis. Hydrous mineral formation (e.g. chlorite and serpentine) at pressure and temperature conditions corresponding to the slab-mantle interface is observed in experimental studies but has not yet been verified in natural high-pressure orogenic peridotites. However, there are few definitive tools to distinguish prograde high-pressure hydrous minerals from those formed during exhumation, aside from petrographic textrual studies. Here we investigate the utility of boron isotopes as a proxy for the depth of chlorite formation. The chlorite in this study is from ultramafic lithologies thought to represent an exhumed slab-mantle wedge interface, the Higashi-Akaishi (HA) peridotite body of the Sanbagawa metamorphic belt in southwest Japan. Garnet-orthopyroxene Al-barometry reveals garnet pyroxenites from the HA record a range of pressures and temperatures from 1.2-2.8 GPa, 581-744ºC according to our estimates. Secondary ion mass spectrometry of chlorite found in textural equilibirium with pyroxene and garnet overall record very light boron isotopic values (avg: −14.5±3.9‰) and relatively low boron concentrations (avg: 3.1 μg/g). Orthopyroxene and garnet adjacent to chlorite with a boron isotopic composition of −7.1±1.0‰ yield a pressure estimate of 2.0 GPa, while those adjacent to a chlorite with a $\delta^{11}B$ value of −20.7±2.9‰ record pressures of 2.6 GPa. These preliminary data suggest that boron isotopes show promise for quantitative determination of depth of hydrous mineral formation.