European Mineralogical Conference
Vol. 1, EMC2012-471, 2012
European Mineralogical Conference 2012

Effects of protolith composition, dehydration and metasomatism on the boron isotopic composition of high-pressure metamorphic rocks in subduction zones

R. Halama (1), S. Agostini (2), Z.D. Atlas (3), S. Tonarini (2), and J. Ryan (3)

(1) University of Kiel, Institute of Geosciences, Kiel, Germany (rh@min.uni-kiel.de), (2) Istituto di Geoscienze e Georisorse, CNR, Pisa, Italy, (3) Department of Geology, University of South Florida, Tampa, USA

High-pressure metamorphic rocks provide information about the chemical and isotopic evolution of subducting lithosphere. Boron (B) is a particularly useful tracer for slab-mantle-arc fluid transport and recycling processes in subduction zones due to its high mobility in hydrous fluids and its significant isotope fractionation by fluid-rock interaction. The combined decrease in δ^{11}B values and B concentrations in arc lavas with increasing depth of the Wadati-Benioff zone is thought to reflect the effects of B isotope fractionation during progressive dehydration, where the residual rock becomes isotopically lighter due to the preference of the heavy ^{11}B isotope for the fluid, and a steady decrease in slab-fluid flux toward the back arc [1]. Hence, B geochemistry provides key evidence for slab to arc transfer by aqueous fluids.

Despite these observations, B isotope data on natural high-pressure metamorphic rocks are still limited. SIMS analyses generally confirmed that slab dehydration significantly lowers δ^{11}B of subducted oceanic crust and sediments, but no systematic relationships with peak metamorphic conditions were observed [2]. Here, we investigate metabasaltic rocks from two subduction-related metamorphic terranes: Greenschists and blueschists from the Western Series of the Chilean Coastal Cordillera represent a fossil accretionary complex that has experienced peak P-T conditions of 8-10 kbar and 380-500 ˚C. and eclogites from the Raspas Complex, Ecuador, represent a HP-metamorphosed oceanic slab with peak P-T conditions of about 600˚C at 18-20 kbar.

Interlayered greenschists and blueschists show a range in δ^{11}B from +1 to -5‰ whereas eclogites tend towards more negative values down to $\approx$ -10‰Ḣence, all metabasaltic samples have B isotopic compositions that are distinctly lighter than those of altered oceanic crust, which generally exhibits positive values and has a bulk δ^{11}B of +8‰ [3]. These results confirm the postulated general trend of decreasing δ^{11}B values with increasing metamorphic grade. However, the range in B isotopic values of rocks that have experienced identical metamorphic conditions and distinct differences in pervasively metasomatized eclogites highlight that different protolith compositions and metasomatic effects can induce changes of several per mil in δ^{11}B. Additional B concentration data will be obtained to test whether the observed isotopic trends vary with B enrichment.

References: [1] Ishikawa & Nakamura, 1994, Nature 370: 205-208. [2] Peacock & Hervig, 1999, Chem. Geol. 160: 281-290. [3] Yamaoka et al., 2012, GCA 84: 543-559.