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Boron isotopes in mafic-ultramafic rocks as tracers of the fluids processes in subduction zones: preliminary data

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Subduction zones are the environments for the recycling of crustal plates into the deep Earth and for release of volatiles and fluid-mobile elements into the mantle. These processes drive the re-fertilization of Earth's mantle and trigger arc magmatism in the 'subduction factory'. The emplacement in mountain building of high and ultrahigh pressure rocks from fossil subduction zones discloses many inaccessible processes related to dehydration and to the element exchange occurring during the fluid-mediated mass transfer from slabs to the upper plates. A consequence of subduction fluid flow is the formation of several kilometers thick, low-velocity hydrated domains at the slab-mantle interface, as imaged by seismic data and reproduced by numerical models. These domains are now viewed as 'serpentinite channels' and regarded as major settings for tectonic mixing of slab- and mantle-derived materials, for fluid and mass transfer from slab to mantle and for development of seismic activity. Serpentines thus represent key lithologies for subduction dynamics and for volatile and incompatible-element transfer during subduction (Ulmer and Trommsdorff, 1995; Hattori and Guillot, 2002; Scambelluri and Tonarini, 2012). Field-based petrologic and geochemical studies enabling to define the behavior of serpentinites during subduction can allow to characterize the fluid produced, the main chemical exchange processes with the surrounding rocks and to design the plate interface environment. For these purposes, the use of geochemical tracers like boron (B) can provide relevant information. Metamorphic dehydration is accompanied by B isotope fractionation, with ^{10}B remaining in the rock and ^{11}B entering the fluid phase. This fractionation enables to distinguish isotopically light rocks that released ^{11}B-rich fluids (e.g. slab rocks) from isotopically heavy (supra-subduction) rocks that gained ^{11}B by interaction with ^{11}B-rich slab fluids. This fractionation thus allows fingerprinting the fluids, to determine their sources and to assess their circulation pathways. This study aims to contribute to the above processes by performing bulk-rock B and B isotope analyses of high-pressure ophiolitic serpentinites, garnet peridotites and chlorite harzburgites from the Alps, representing products of serpentinite dehydration at various stages. We have analyzed serpentinzed mantle rocks from the Western Alps (Voltri Massif and Lanzo) and peridotites from the Central Alps (Cima di Gagnone). The rocks from the Western Alps consist of antigorite + magnetite + olivine + Ti-chlinoumite ± clinopyroxene: metamorphic olivine overgrows antigorite-bearing structures and locally crystallizes in dehydration veins as the result of partial serpentinite dewatering at eclogite-facies conditions. Serpentinites from Voltri display bulk B contents characteristic of oceanic serpentintes (12 - 41 ppm) and quite variable enrichment in heavy B isotope (δ^{11}B up to 18 - 30‰). The serpentinized peridotites from Lanzo are enriched in bulk B with respect to the depleted mantle (from 2 to 30 ppm against 0.06 ppm) and display high δ^{11}B positive values (up to 30‰). Therefore the Western Alpine high-pressure serpentinites appear characterized by high-B contents and heavy B isotope segnatures. Some of them (Erro Tobbio) have been recently interpreted as slices of supra-subduction mantle infiltred by slab fluids during the prograde burial to 80 km and 550-600°C (Scambelluri and Tonarini, 2012). The Gagnone peridotites are enclosed in crustal rocks from Adula. In the garnet peridotite, olivine orthopyroxene, clinopyroxene and Mg-horneblende are in textural equilibrium. The garnet is unevenly distributed and poikiloblastic. Based on Evans and Trommsdorff (1978) and on recent results (Scambelluri et al., 2012) these rocks derive from serpentinite protoliths that underwent full antigorite dehydration. Their bulk B contents are higher than the depleted mantle (2 to 8 ppm) and δ^{11}B is negative (-7 to -9‰). Their signature may either reflect serpentinite dehydration or interaction with the host gneiss. Bulk Pb contents and Pb isotopes suggest an interaction with crust-derived fluids during prograde subduction metamorphism. However, in order to discriminate which process led to the B isotopic re-equilibration of Gagnone further field and laboratory investigations are necessary. An in depth analysis of the above listed serpentinized and de-serpentinized mantle rocks will enable to define and hopefully understand the main fluid release and fluid/rocks interactions involving the serpentinized mantle in subduction settings.