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Boron and Strontium isotope systematics in deeply subducted alpine-serpentinites: evidence of high-11B fluid flow

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Boron and strontium isotope systematics are widely applied tracers to understand recycling processes during subduction. However, very few studies are addressed to the geochemical behaviour of these isotope ratios in high (HP) to ultrahigh-pressure (UHP) serpentinites that experienced pressure-temperature conditions similar to those of modern subduction zones. Here we present delta-11B and 87Sr/86Sr ratios of the Erro-Tobbio peridotite (Ligurian Alps) a slice of serpentinized mantle involved in subduction and high-pressure recrystallization during the Alpine orogeny. The analyzed sample set includes serpentinized peridotite samples recrystallized at increasing P-T conditions: from relatively low P-T (chrysotile and lizardite are the dominant serpentine minerals) to eclogite-facies conditions (antigorite + olivine + Ti clinohumite form the stable paragenesis). During subduction, ductile deformation under HP conditions was focused in serpentinite mylonite shear zones (high-strain domains) surrounding volumes of HP serpentinized peridotite unaffected by plastic deformation (low-strain domains). The latter diffusely preserve serpentinized mantle peridotites with low P-T overprint retaining pristine mantle textures and assemblages. In general, the delta-11B in these products is heavy, with the majority of samples exceeding delta-11B of 16 permil and reaching extreme values of + 24 permil. The 87Sr/86Sr ratios range between 0.7044 and 0.7065, significantly lower than the values of serpentinites formed during interaction with seawater-dominated fluids and close to the seawater 87Sr/86Sr.
In more detail, the low P-T serpentinized peridotites are characterized by the wider range of delta-11B variability (+3.8 to +24 permil). The low-strain HP peridotites show a comparably wide range in delta-11B (+6.8 to +20 permil). More homogeneous and generally higher delta-11B were measured in HP mylonitic serpentinites (delta-11B between +16.7 and +24 permil): these rocks also display the highest Sr and, to a lesser extent, B contents. The bulk-rock oxygen and deuterium isotope ratios of all analyzed samples range from 4.4 to 8.0 permil and from -102 to -57 permil, respectively (Früh-Green et al., 2001). This suggests low-T (about 200 °C; characteristic of low P-T serpentinized peridotites and HP low-strain metaperidotites) as well as higher-T (below 300 °C, serpentinite mylonites) exchange with seawater. However, the high delta-11B and the low 87Sr/86Sr ratios of HP rocks are not consistent with mantle hydration by seawater-derived fluids at oceanic environments and with subduction dehydration such a serpentinized mantle. This because the 11B and Sr abundances of HP Erro-Tobbio peridotites are higher than those of low P-T serpentinized peridotites, instead of being depleted due to 11B and Sr fractionation in the released fluids. Moreover, the estimated composition of serpentinizing fluids are very similar to those found in Mariana forearc serpentinite seamounts (Benton et al., 2001) and in slab-derived fluids metasomatizing the high-pressure rocks from Syros (Marschall et al., 2006). Hence, the B and Sr isotope imprint of the Erro-Tobbio serpentinites does not suggest an oceanic setting, but appears consistent with a supra-subduction environment where serpentinite-forming fluids are sourced by the subducting slab.

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