Serpentinites and their role as tracer of fluid pathway in subduction zones

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Serpentinites are a key lithology for tectonic and chemical processes in subduction zones and play a key role in slab-mantle interface domains. Fluid-mediated mass transfer from sedimentary to ultramafic reservoirs can be traced by B, Sr and Pb isotopic systems and fluid-mobile elements, like As and Sb. As proposed by many authors, these geochemical interactions can be used as proxy for element recycling at convergent margins. Here we focus on the Voltri Massif case-study (Ligurian Western Alps), where oceanic serpentinites and associated mafic rocks underwent Alpine subduction and high pressure metamorphism. The texture of these ultramafic rocks allows to distinguish between undeformed and mylonitic serpentinite domains. Field relationships highlight that the undeformed rocks are enclosed in the deformed ones. Metamorphic olivine overgrew antigorite-bearing structures and locally crystallized in dehydration veins as the result of partial serpentinite dewatering at eclogite-facies conditions. Undeformed rocks are characterized by very high $\delta^{11}B$ (+30‰) and low Sr and Pb isotopic ratios (0.7053-0.7069 of $^{87}Sr/^{86}Sr$ and 18.131-18.205 of $^{206}Pb/^{204}Pb$) and low contents in As and Sb (0.1 and 0.01 ppm, respectively). By contrast, mylonitic serpentinites display lower values of $\delta^{11}B$ (down to +18‰), high radiogenic enrichment in Sr and Pb isotopes (up to 0.7105 of $^{87}Sr/^{86}Sr$ and up 18.725 of $^{206}Pb/^{204}Pb$) and enrichment in As and Sb (1.3-0.39 ppm, respectively). Based on the field occurrence, undeformed serpentinites still record oceanic geochemical fingerprint, whereas mylonitic serpentinites reset their stable and radiogenic isotopic signature and trace the interaction with sediment-derived fluids. As and Sb enrichments into mylonitic serpentinites confirm that elements exchange between sediment-derived fluids and serpentinites occur during prograde subduction of slab materials. These data document that serpentinites can trace the fluid pathways along major shear zones modifying their element budget with important implications on element recycling. In agreement with numerical modeling, the interaction processes recorded by these serpentinites suggest that the Voltri Massif could represent a slice of slab lithospheric mantle evolved at the plate interface domains during Alpine subduction.