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Channelized Fluid Flow and Metasomatism in Subducted Oceanic Lithosphere recorded in an Eclogite-facies Shear Zone (Monviso Ophiolite, Italy)

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The Monviso ophiolite Lago Superiore Unit (LSU) constitutes a well-preserved, almost continuous fragment of upper oceanic lithosphere subducted down to ca. 80 km (between 50 and 40 Ma) and later exhumed along the subduction interface. The LSU is made of (i) a variably thick (50-500 m) section of eclogitized mafic crust (associated with minor calcschist lenses) overlying a 100-400 m thick metagabbroic body, and of (ii) a serpentinite sole (ca. 1000 m thick). This section is cut by two 10 to 100m thick eclogite-facies shear zones, found at the boundary between basalts and gabbros (Intermediate Shear Zone: ISZ), and between gabbros and serpentinites (Lower Shear Zone: LSZ). Fragments of mylonitic basaltic eclogites and marbles were dragged and dismembered within serpentinite schists along the LSZ during eclogite-facies deformation [Angiboust et al., Lithos, 2011].

Metasomatic rinds formed on these fragments at the contact with the surrounding antigorite schists during lawsonite-eclogite facies metamorphism, testifying to prominent fluid-rock interaction along with deformation. We present new petrological and geochemical data on four types of metasomatically altered eclogites (talc-, chlorite-, lawsonite- and phengite-bearing eclogites) and on a (serpentinite-derived) talc schist from the block rind. Bulk-rock compositions, in situ LA-ICP-MS analysis and X-ray Cr/Mg maps of garnet demonstrate that (i) these samples underwent significant B, Cr, Mg, Ni and Co enrichment and Fe, V and As depletion during eclogite-facies metamorphism (while Li and Pb behaved inconsistently) and (ii) garnet composition and chemistry of inclusions show extreme variation from core to rim.

These compositional patterns point to a massive, pulse-like, fluid-mediated element transfer along with deformation, originating from the surrounding serpentinite (locally, with contributions from metasediments-equilibrated fluids). Antigorite breakdown, occurring ca. 10 km deeper than the maximum depth reached by these eclogites, could have provided significant amounts of fluid promoting extensive fluid/rock interaction. We therefore propose that the LSZ witnesses the existence of a highly anisotropic, large-scale, prominent, subduction-parallel fluid migration pathway within the subducted oceanic lithosphere, active at eclogite facies conditions (in line with recent permeability experiments; [Kawano et al., Geology, 2011]). The strongly focused deformation also enhanced fluid/rock interaction that significantly contributed to the mechanical weakening attested by the extreme degree of block fragmentation and disaggregation observed along the LSZ in the field.