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Serpentinite channel and the role of serpentinite buoyancy for exhumation of HP rocks. Constraints from the HP-Voltri metaophiolites (Western Alps, Italy)

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The high-pressure Voltri Massif outcrops at the eastern border of the Ligurian Western Alps. It consists of meta-ophiolites and metasediments recording blueschist (Palmaro-Caffarella Unit) to eclogite (Voltri Unit) peak conditions. The study of eclogite and blueschist metagabbro lenses within highly sheared serpentinite or metasediments reveals strong strain partitioning between host-rock and lenses, and between core and rims of the lenses. The cores still preserve magmatic textures statically overgrown by the high-pressure assemblages, whereas rims display tectonite and mylonite structures.

Coupling petrography and P-T pseudosections we obtained clockwise P-T paths for the metagabbro lenses. The Palmaro-Caffarella metagabbro recrystallized at peak conditions of 10-15 kbar and 450-500°C. The Voltri metagabbro reached peak metamorphic conditions in the lawsonite stability field, from about 21 kbar, 450-490°C to 22-28 kbar, 460-500°C. The decompression trajectory is isothermal to slightly cooling.

To constrain exhumation of the Voltri Massif, we performed 2D numerical models simulating an intraoceanic subduction, similar to the one developed in the Ligurian-Piedmontese Tethys in the Mesozoic. The initial setup of the oceanic basin (amplitude, spreading rate, structure) was derived from literature. We reproduce a non-layered lithosphere typical of slow and ultra-slow spreading ridges like the Jurassic Ligurian Tethys: the serpentinized lithospheric mantle hosts discrete gabbros bodies and is covered by a discontinuous basaltic layer. The oceanic basin is moreover surrounded by continental margins.

As the result of slab dehydration, a viscous serpentinite channel forms in the mantle wedge, whose evolution is strongly controlled by rheology of serpentine. Ductile deformation of serpentine within the channel enhances mixing of sediments, oceanic crust and mantle scraped off from the subducting slab. The model shows that parts of the overriding plate are included in the channel and subducted: therefore slab-derived serpentinite can be tectonically mixed with wedge serpentinite.

Our simulations show that serpentinites were fundamental to decrease the bulk density of HP terrains below the mantle value, thus causing exhumation of part of the serpentinite channel. The simulation also provides P-T paths of selected rock volumes that show remarkable correspondence with the P-T paths of the Voltri gabbroic lenses.

The preponderance of highly sheared serpentinite, the strong strain-partitioning, the different metamorphic peaks attained by the various rock volumes within the Massif, and the similarity of natural and simulated P-T paths, suggest that the Voltri Massif may represent a "fossil" serpentinite channel. Buoyancy could have played an important role for its final exhumation.