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The exhumation of an HP ophiolitic massif (Voltri Massif, Western Alps): insight from 3D numerical models

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The high-pressure ophiolitic Voltri Massif outcrops at the eastern sector of the Ligurian Western Alps. Highly deformed serpentinite and metasediments wrap eclogite to blueschist facies metagabbro and metabasalt bodies; these lenses have foliated rims and preserve undeformed textures in their cores revealing a strong strain-partitioning.

The mechanism that drove the exhumation of these high-pressure rocks has been already analyzed in detail using 2D numerical simulations (Malatesta et al., 2011). In particular they reproduce the subduction process that in the Mesozoic affected the Alpine branch of the Western Tethys. In the Ligurian area subduction was intraoceanic and involved a non-layered oceanic lithosphere with gabbro as discrete bodies inside serpentinized peridotites that were overlain by a limited basaltic cover. The comparison of field and petrologic evidence with model results showed that the exhumation of the high-pressure Voltri rocks was related to the formation of a serpentinite channel above the downgoing slab. This low-viscosity area formed after the hydration of the mantle-wedge rocks by the uprising fluids that migrate from the slab. Buoyancy of the high-pressure serpentinitic mélange that included slices of the slab finally triggered their exhumation.

Alpine subduction was however oblique (Marroni and Treves, 1998; Malusà et al., 2011) thus including a trench-parallel left-lateral motion and not only a trench-normal motion as in 2D simulations. We have studied this particular setting through 3D numerical simulations starting from the setup of 2D models. We therefore designed an oceanic basin (500 km-wide) surrounded by continental margins and floored by a non-layered oceanic lithosphere. Subduction starts at a prescribed weak zone in the mantle; the weak zone defines the plate margins geometry.

We test different “lateral” geometries of the weak zone (e.g. continuous, segmented). We designed “continuous” weak zones either parallel or increasingly moving away from the continental margins. Moreover, we tested the effect on subduction/exhumation dynamics of varying values of the trench-parallel component of convergence-rate vector. The comparison among field and petrologic data of the Voltri Massif rocks with 3D numerical models results will finally provide a more detailed description of the subduction dynamics acting in the Ligurian-Piedmontese basin and in particular will shed more light on the mechanism that drove the exhumation of the high-pressure ophiolitic Voltri Massif.

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