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Local earthquake tomography of the mantle wedge beneath the Dora-Maira dome, and implications for (U)HP rock exhumation

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In continental subduction zones, the behaviour of the mantle wedge during exhumation of (ultra)high-pressure [(U)HP] rocks provides a potential key to distinguish among competing exhumation mechanisms (Guillot et al. 2009; Malusà et al. 2015). However, in spite of the relevant implications for understanding orogenic evolution, a high-resolution image of the mantle wedge beneath the Western Alps was not available at the time of the CIFALPS experiment. In order to fill this gap, we performed a detailed analysis of the velocity structure of the Alpine belt beneath the Dora-Maira (U)HP dome, based on local earthquake tomography (Solarino et al. 2018) independently validated by receiver function analysis (Zhao et al. 2015). Our results point to a composite structure of the mantle wedge above the subducted European lithosphere (see Solarino et al. 2018 for details). We found that the Dora-Maira (U)HP dome lays directly above partly serpentinized peridotites (Vp ∼7.5 km/s; Vp/Vs = 1.70-1.72), documented from ∼10 km depth down to the top of the eclogitized lower crust of the European plate. These serpentinized peridotites, possibly formed by fluid release from the subducting European slab to the Alpine mantle wedge, are juxtaposed against dry mantle peridotites of the Adriatic upper plate along an active fault rooted in the lithospheric mantle (Malusà et al. 2017). We propose that serpentinized mantle-wedge peridotites were exhumed at shallow crustal levels during late Eocene transtensional tectonics, also triggering the rapid exhumation of (U)HP rocks, and were subsequently indented under the Alpine metamorphic wedge in the early Oligocene (Dumont et al. 2012; Malusà et al. 2015). Our findings suggest that mantle-wedge exhumation may represent a major feature of the deep structure of exhumed continental subduction zones. The deep orogenic levels here imaged by seismic tomography may be exposed today in older (U)HP belts, where mantle-wedge serpentinites are commonly associated with coesite-bearing continental metamorphic rocks.

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