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Imaging the deep structures of the alpine arc: a review of the CIFALPS experiment

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The combination of the CIFALPS results with the data collected from 527 broadband seismic stations at the scale of the entire alpine arc is an opportunity to integrate seismological observations into a single model of the western Alpine region. The P receiver function technique from the CIFALPS experiment provides the first seismic evidence for European continental crust at 75 km depth . Our data also provide evidence for a thick suture zone, demonstrating that the European lower crust underthrusts the Adriatic mantle (Zhao et al., 2015). Array analysis of seismic surface waves along the CIFALPS profile,using both data from permanent stations and the CIFALPS experiment, provides a 2-D Vs model confirming the eastward-dipping of the approximately 100 km thick European lithosphere (Lyu et al., 2017). The Vs is quite homogeneous and lower than 4.0 km.s^{-1} suggesting that the lower crust beneath the western Alps is dominantly felsic. Eastward, beneath the internal Alps, Vs increases up to 4.2 km.s^{-1}. compatible with the progressive eclogitization of a dominant felsic lower crust (Solarino et al., 2018). Local earthquake tomography points to a composite structure of the mantle wedge above the subducted European lithosphere (Solarino et al., 2018). We show that the Dora-Maira (U)HP dome lays directly above partly (50 to 75%) serpentinized peridotites documented from $\sim$10 km depth down to the top of the eclogitized lower crust Relocalisation of deep earthquakes along the CIFALPS profile (Malusà et al., 2017) shows that the partly serpentinized Ivrea body juxtaposed against the dry mantle peridotites of the Adriatic upper plate along an active fault rooted in the lithospheric mantle. At the broad alpine scale, high-resolution P-waves tomography (Zhao et al., 2016) document the lateral continuity of the European slab from the western Alps to the central Alps, and the downdip slab continuity beneath the central Alps, ruling out the hypothesis of slab break off. A low-velocity anomaly is observed in the upper mantle beneath the core of the western Alps. This low-velocity P-waves anomaly is also observed in the 2-D Vs model (Lyu et al., 2017). The combination of this low-velocity anomaly with seismic anisotropy analysis and geodetic data point to a dynamic topography effects potentially driven by lateral asthenospheric mantle influx driven by the rollback of the Apenninic slab (Salimbeni et al., submitted). Beneath the Eastern Alps, a NE dipping Adriatic slab, consistent with Dinaric subduction. A north south tear fault coinciding at the surface with the Judicarian fault, accommodates opposite-dipping subductions during Alpine convergence. To the south of the alpine arc, the laterally continuous Adriatic slab of the Northern Apennines shows major gaps at the boundary with the Southern Apennines and becomes near vertical in the Alps-Apennines transition zone suggesting that the Apennine slab is bent by Alpine slab (Zhao et al., 2016). Seismic anisotropy analysis show that the resulting mantle flow pattern was characterized by an asthenospheric counterflow at the rear of the unbroken western Alps slab and around its southern tip (Salimbeni et al., submitted).