Time for a change of paradigm for Alpine subduction?

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The prevailing paradigm of mountain building in the Alps entails subduction of European continental lithosphere some 100km thick beneath the Adriatic plate. Based on recent results of AlpArray, we propose a new model that involves subduction and wholesale detachment of locally much thicker (200-240 km) European lithosphere. Our approach combines teleseismic P-wave tomography and existing Local Earthquake Tomography (LET) to image the Alpine slabs and their connections with the overlying orogenic crust at unprecedented resolution. The images call into question the simple notion that slabs comprise only seismically fast lithosphere and suggest that the mantle of the downgoing European plate is compositionally heterogeneous, containing both positive and negative seismic anomalies of up to 5%. We interpret these as compositional rather than thermal anomalies, inherited from the Paleozoic Variscan orogenic cycle and presently dipping beneath the Alpine orogenic front. In contrast to the European Plate, the lithosphere of the Adriatic Plate is thinner (100-120 km) and has a more poorly defined lower boundary approximately at the interface between positive and negative Vp anomalies.

Horizontal and vertical tomographic slices reveal that beneath the Central and Western Alps, the downgoing European Plate dips steeply to the S and SE and is locally detached from the Alpine crust. However, in the Eastern Alps and Carpathians east of the central Tauern Window, the Alpine slab anomaly occupies the 150-400 km depth interval and dips steeply to the N-NE, having completely detached from the Alpine orogenic crust. This along-strike change coincides with an abrupt eastward decrease in Moho depth (Kind et al., this session), the Moho being underlain by a pronounced negative Vp anomaly reaching eastward into the Pannonian Basin area. This negative Vp anomaly is interpreted to represent hot upwelling asthenosphere that was instrumental in accommodating Neogene orogen-parallel lateral extrusion of the ALCAPA tectonic unit (upper plate crustal edifice of Alps and Carpathians) to the E. An Adriatic origin of the northward-dipping, detached slab segment beneath the Eastern Alps is unlikely since its imaged down-dip length (200-300 km) matches estimated Tertiary shortening in the Eastern Alps accommodated by south-dipping subduction of European lithosphere, whereas shortening in the south-vergent eastern Southern Alps is only ≤ 70 km.
A slab anomaly beneath the northernmost Dinarides, laterally adjoining the Eastern Alps, is missing. The slab anomaly beneath the northern Apennines, of Adriatic origin und dipping beneath the Tyrrenian backarc, hangs subvertically and appears to be almost detached from the Apenninic orogenic crust. Except for its westernmost segment where it meets the Alpine slab, this slab is clearly separated from the latter by a broad extent of upwelling asthenosphere located south of the Alpine slabs beneath the Po Plain, i.e., just south of the Alpine subduction zone. Considered as a whole, the slabs beneath the Alpine chain are interpreted as attenuated, largely detached sheets of continental margin and Alpine Tethyan lithosphere that locally reach down to a slab graveyard in the Mantle Transition Zone (MTZ).