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"Wrong-way" subduction of South Alpine (Adriatic) lithosphere beneath the Eastern Alps – a kinematic appraisal

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The junction of the Central and Eastern Alps coincides with a switch in subduction polarity as indicated by seismic tomography with high resolution locally down to 400 km (Lippitsch et al. 2003). Whereas the SE dip of the positive Vp slab anomaly beneath the Central Alps is consistent with subduction of European lithosphere, the correspondingly steep N to NE dip of the anomaly beneath the Eastern Alps has lead to speculation that it represents either Adriatic lithosphere subducted the "wrong way" beneath the Alpine orogen during Miocene oblique dextral convergence in the Dinarides (Kissling et al. 2006, Ustaszewski et al. 2008) or European lithosphere that was steepened and overturned during Miocene shortening of the Eastern Alps (Mitterbauer et al. 2011).

We tested the kinematic plausibility of an Adriatic origin for the slab beneath the Eastern Alps by straightening and horizontalizing its leading edge, then moving this edge backward to locations in Cenozoic to Late Cretaceous time. The motion is constrained by crustal shortening and extensional values across the Alpine chain which are applied as successive retrotranslations and backrotations of points on stable parts of the Adriatic microplate with respect to a European reference frame. This procedure yields a series of paleotectonic maps for critical time slices (20, 35, 67, 84 Ma) that show the location of the slab edge with respect to the evolving Alps-Carpathian-Dinaric Orogen.

Our reconstruction reveals that from 84 to 20 Ma the horizontalized northern edge of the slab was located beneath the Eastern Alps, just N of the current trace of the Periadriatic Fault. The eastern edge of the slab is interpreted to have delimited a major dextral transfer fault (Alps-Dinarides Transfer, ADT) that linked 84-35 Ma SE-directed subduction of Alpine Tethys and the European margin with oblique, N- to NE-directed subduction of Neotethys and the Adriatic margin. Post-35 Ma collision in the Alps triggered breakoff of the opposing slabs beneath the Alps and Dinarides. The fragment of the Adriatic slab presently beneath the Eastern Alps may have separated from the rest of the Adriatic slab beneath the Dinarides already in late Paleogene time. Its subduction beneath the eastern part of the Alpine orogen is attributed to counter-clockwise rotation (20°) and/or to N-ward subduction of this Adriatic slab fragment beginning at c. 20 Ma. This coincided with the onset of indentation, rapid exhumation and lateral escape in the Tauern Window and Eastern Alps, and shortening in the eastern part of the Southern Alps.

We attribute the lack of a tomographically imaged Adriatic slab beneath the Dinarides (Wortel & Spakman 2000) to asthenospheric upwelling and thermal erosion of the slab within a gap that opened along the ADT during late Paleogene to Miocene time. This gap resulted from progressive NW motion of the leading edge of Adria (i.e. the Adriatic Indenter) away from the foundering part of the broken Adriatic slab beneath the Dinarides. Today, this slab gap separates the Adriatic Indenter in the Alps from the actively subducting Adriatic slab beneath the western Hellenides.