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Kinematic model for decoupling orogenic crust from upper mantle during a switch in subduction polarity at the junction of the Alps, Carpathians and Dinarides

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We depict the Alpine belt in a series of tectonic maps for critical time slices (10, 20, 35, 67, 84 Ma) to show how its evolution can be related to the geometry of subducting lithosphere as imaged by seismic tomography. These maps are constructed by deriving shortening and extensional values from cross sections across key parts of the chain in a stepwise fashion (external to internal parts), then applying these values as successive retrotranslations of points on stable parts of the Adriatic microplate. All motions thus obtained for Adria are with respect to a European reference frame. This approach works best in the Alps due to an abundance of geologic data, but less so in parts of the Carpathians and Dinarides where age and structural information are still limited. To test the kinematic plausibility of a N- to NE-dipping slab fragment beneath the Eastern Alps (Lippitsch et al. 2003), we first horizontalized the presently inclined positive Vp-anomaly, then applied the above sequence of retrotranslations to this image (taken to be the leading edge of the subducted Adriatic margin) to obtain the putative trace of the Adriatic margin at the time slices above.

The following features characterize our model: (1) From 67-35 Ma, a N-S trending Alps-Dinarides Transfer (ADT) fault delimited the eastern end of the Alps, linking 465 km of SSE-directed "European" subduction of Alpine Tethys with a still unconstrained amount of oblique dextral convergence and N- to NE-directed "Dinaric" subduction of the Adriatic margin of Neotethys. The trace of the ADT in map view coincides with the reconstructed eastern edge of the future Adriatic slab fragment, suggesting that the ADT may have nucleated along an inherited structure (e.g., transform fault) of the Adriatic margin; (2) Beginning at c. 35 Ma, collision in the Alps coincided with an increased in the obliquity of dextral convergence in the Dinarides and with breakoff of the European slab beneath the Alps. Separation of the Adriatic slab fragment from the rest of the Adriatic slab beneath the Dinarides may have begun already in late Paleogene time; (3) Counter-clockwise rotation (20°) and oblique NE-ward subduction of the Adriatic slab fragment beneath the Alpine orogenic wedge began at c. 20 Ma as constrained by the onset of indentation, rapid exhumation and lateral escape in the Tauern Window and Eastern Alps, and shortening in the Southern Alps. We speculate that vertical tearing of this subducting lithospheric fragment led to asthenospheric upwelling and thermal erosion of the Adriatic slab beneath the northern Dinarides. This favoured wholesale decoupling of the crust and mantle in Miocene time, thereby facilitating lateral escape of orogenic crust in the Eastern Alps, rollback subduction of the Carpathian oceanic embayment and associated extension of the Pannonian Basin.