An independent plate motion path for the Adriatic microplate and its consequences for the tectonics of Alpine Tethyan subduction

M.R. Handy[1], R. Bousquet[2], E. Kissling[3], D. Bernoulli[4], S.M. Schmid[1]
1 = Freie Univ. Berlin, 2 = Univ. Potsdam, 3 = ETH-Zürich, 4 = Univ. Basel

We derive an independent motion path for the Adriatic microplate (Adria) from minimum estimates of shortening, extension, burial and exhumation in Alps and Dinarides, as well as from paleodeclination data (Marton et al. 2009). The translational and rotational pole for Adria is taken to be the city of Ivrea in the Ivrea-Verbano Zone which experienced only minor Alpine deformation after Jurassic extensional exhumation in the distal W passive margin of Adria. The motion of Adria is intimately related to spreading and subduction of the Alpine Tethyan basins (Piemont = P, Liguria = L, Valais = V) during three contrasting stages of plate motion (motions depicted in a series of maps with respect to stable Europe):

Stage 1: Differential E-W spreading of the P (400 km wide) and L (800 km) Basins was driven by opening of the C. Atlantic and E motion of Africa from 170-130 Ma. A sinistral E-W transform across Adria linked this differential spreading to subduction of part of the Triassic-Jurassic Neotethyan oceanic lithosphere further E (Meliata-Meliac-Vardar). From 130-84 Ma, spreading of the N. Atlantic lead to the individuation and clockwise (CW) rotation of the Iberian and Adriatic microplates. Conjugate E-W transform systems linked the N. Atlantic with oblique opening of the V Basin (100 km wide), as well as with SE-directed intra-continental subduction and NW-directed nappe stacking (Austroalpine orogen) in the N part of the Adriatic microplate. The convergence of Iberia and Adria was accommodated by SE-dipping intra-oceanic subduction of the western L Basin and the SW part of the P Basin (HP rocks of Morteda-Farinole Unit on Corsica, Lower Austroalpine units of E. Switzerland).

Stage 2: 600 km of NW motion and 5° CW rotation of Adria (84-35 Ma) was driven by “push” from Africa and “pull” of the NW-retreating European slab that comprised the entire N part of Alpine Tethys (P, V basins) including the Brianconnais promontory of Iberia. This SE-dipping subduction initially affected a thin continental fragment (Sesia Zone, 70-80 Ma) of the upper Adriatic plate and ended when the distal European continental margin (e.g., sub-Penninic units) entered the subduction zone in Late Eocene time. The subduction of Alpine Tethys is inferred to have been continuous (1-2 cm/yr) and involved exhumation of HP and UHP metamorphic rocks behind the retreating European slab. These rocks largely escaped thermal overprinting associated with subsequent collisional thickening and are exposed today in Penninic units of the W. and C. Alps, as well as in part of the Tauern Window, E. Alps.

Stage 3: 250 km of WNW translation and 20° CW rotation of Adria (35 Ma to present) during Alpine collision were driven primarily by the “pull” of gravitationally unstable, SE- to SW- retreating Adriatic and African slabs that consumed large, remaining parts of the L Basin as well as most of the Adriatic passive margins and the Ionian Basin. Whereas the upper European Plate extended to accommodated this slab retreat in a very mobile fashion (Alboran, Liguro-Provencal, Tyrrehnian back-arc basins), the continental core of the Adria microplate acted as a rigid indenter, effecting dextral transpression of the Alpine collisional zone along its northern margin.

The predicted locations and amounts of subducted lithosphere in our reconstruction can be correlated with high-velocity slab material imaged by seismic tomography at the base of the mantle transitional zone beneath the Alps and Apennines, as well as beneath parts of the Pannonian Basin, the Adriatic Sea and the W. Mediterranean. Comparison of observed and predicted slab volumes indicates a net loss of subducted lithosphere to the lower mantle.