Post-collisional mantle delamination in the Dinarides implied from staircases of Oligo-Miocene uplifted marine terraces

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The Dinarides fold and thrust belt on the Balkan Peninsula is the result of the long-lasting convergence between the Adriatic and Eurasian plates since the Mid-Jurassic. Late Jurassic obduction of ophiolites, Early Cretaceous composite nappe stacking, and subsequent continent-continent collision in the latest Cretaceous resulted in folding and thrusting that in the most external part of the Dinarides took place during the Middle Eocene – Oligocene. This extensive last phase of substantial crustal shortening and thickening was associated with flexural foreland basin deposition, resulting in Eo- to early Oligocene syntectonic units. These rocks and older Mesozoic carbonate platform units now form the mountain chain of the external Dinarides. So far, the driving mechanism behind the rock uplift was unknown and it was not clear when the present-day topography formed. Here we show that horizontal marine terraces preserved at elevations of up to 600 m in the external Dinarides are crucial to answer these questions.

We extracted horizontal surfaces, river incision profiles, and the Adriatic and Black Sea catchments from a digital elevation model (DEM). The extracted horizontal surfaces are interpreted as marine terraces because they are degradational, locally preserved in a staircase morphology, neither bedding- nor fault-related, and located close to the present-day Adriatic shoreline. The marine terraces stretch c. 600 km along-strike the entire Dinaric coastal region. Their spatial correlation agrees with the position of a reported positive P-wave tomography anomaly beneath the Dinarides. This up to 180 km deep anomaly correlates also with the thinnest part of the Adriatic lithosphere and the Adriatic-Black Sea drainage divide. The orogen-perpendicular river incisions profiles reveal a symmetric river incision pattern on both sides of the drainage divide. The mean amount of the river incision is equivalent to the mean elevation of the documented marine terraces. All results point to an orogen-wide surface uplift of the Dinarides.

Based on the geological record this post-collisional uplift event can be relatively dated to Oligocene-Miocene (28-17 Ma) and seems to be broadly contemporaneous with the emplacement of igneous rocks with mantle affinity (33-22 Ma) in the internal Dinarides. Previously published geophysical and petrological, as well as the new geomorphological data presented here suggest that the post-collisional reorganization of the Dinarides is attributed to an Oligocene-Miocene
mantle delamination event, which results in uplift event affecting the entire Dinarides. We also show that no significant, orogen-scale deformation affected the uplifted Dinarides after the Early Miocene.