



## **A Lower Miocene map-view restoration of the Alps-Dinarides-Carpathian system: evolution of lithosphere- and crustal-scale structures in time and space**

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We present a map-view palinspastic restoration of the tectonic units in the Alps-Dinarides-Carpathian system by retrodeforming movements that occurred since the Lower Miocene. This restoration was arrived at by semi-quantitatively restoring available shortening and extension amounts in the Alps, Carpathians and the Pannonian Basin. Paleomagnetically reported rotations were not considered.

Previous retrodeformations of the Pannonian-Carpathian part of the system largely disregarded the role of the Adriatic plate indenter, which forms a fundamental kinematic link during the interrelated motions in the entire Alpine-Carpathian-Pannonian-Dinaride system in the Mio- to Pliocene. The invasion of the Austroalpine-Carpathian-Pannonian (“ALCAPA”) and Tisza-Dacia mega-units into the Carpathian embayment was accompanied by significant counterclockwise and clockwise internal rotations, respectively. This invasion was primarily driven by the northward motion of the Adriatic indenter and was strongly facilitated by slab-pull and roll-back of the subducting European lithospheric slab in the Carpathians. The indentation and counterclockwise rotation of the Adriatic plate indenter triggered also the Neogene shortening in the external Dinarides and the Southern Alps, the exhumation of the Tauern Window and lateral extrusion of the ALCAPA block towards E. Up to 200 km of back-arc exten-

sion occurred in both the ALCAPA and Tisza-Dacia blocks concomitant with their invasion into the Carpathian embayment, leading to the formation of the Pannonian basin.

Our restoration yielded the following results: (a) ALCAPA fits into a relatively small area W of present-day Budapest, (b) the Periadriatic-Mid Hungarian Line is straightened out, strikes WNW-ESE and implies substantial components of strike-perpendicular shortening as well as strike-parallel extension (“stretching fault”), (c) Tisza-Dacia were already partly emplaced into the Carpathian embayment before the onset of lateral extrusion of ALCAPA. The total amount of N-S convergence between stable Europe and the Adriatic plate amounts to c. 190 km. This corroborates the results of Lippitsch et al. (2003), who estimated the Neogene convergence between Europe and the Adriatic plate to c. 200 km. Taking these values, the convergence velocity between the European and the Adriatic plates very roughly amounts to  $1\text{ cm yr}^{-1}$  in the considered time frame. The restoration also implies substantial post-20 Ma shortening in the external Dinarides, amounting to c. 200 km in southern Croatia and still increasing towards Montenegro and Albania. The pinch-out of the Dalmatian Zone towards NW can be explained by the NW-ward decrease of shortening. Substantial dextral wrench motions are implied along the Vardar Zone and the Timok faults.

#### References:

Lippitsch, R., Kissling, E. and Ansorge, J., 2003. Upper mantle structure beneath the Alpine orogen from high-resolution teleseismic tomography. *Journal of Geophysical Research*, 108(B8), 2376: doi:10.1029/2002JB002016.