Indentation and transfer of deformation between different orogenic systems: observations and models from the greater Adria - Pannonian - Carpathians system

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Indentation is used to define the collisional mechanics of small plates flanked by large subduction systems creating significant thickening and lateral escape of continental units. The close spatial proximity creates a situation where deformation is actively transferred between different subduction systems during their different stages of orogenic evolution. We study this transfer by observation and modelling of indentation and orogenic evolution in the Central Mediterranean system. The evolution of the greater Adriatic microplate has been described by studies in the Central and Eastern Alps, Apennines, their connection with the Dinarides and the lateral escape into the Pannonian Basin. We know that this lateral escape was partly accommodated by the Pannonian extension that ceased once the Carpathians subduction system was locked at ~ 8 Ma. In contrast, the kinematics and timing of deformation in the ~600 km long bounding Dinarides segment is generally over-simplified or looked through the present-day snapshot of horizontal movements, stress distribution or lithospheric structure, while this snapshot is less diagnostic in terms of orogenic mechanics and past kinematics. What do the Dinarides really tell us? The study of Miocene sediments deposited in the endemic Dinarides Lakes System demonstrates a generalized phase of Miocene, which was followed by inversion after 9 Ma by creating a coherent regional system of large offset dextral strike-slip faults, which transfer gradually their offsets to thrusts and high-angle reverse faults. This inversion system is oblique to the inherited orogenic nappe stack by transferring the large-offset deformation from internal orogenic areas in the NW to the (continental) subduction observed in the SE. Numerical modelling in the Dinarides and Carpathians demonstrates a mechanism of rapid slab roll-back followed by detachment and out-of-sequence crustal thickening during indentation and slab migration. These observations and models lead to the conclusion that the Adriatic indentation in the Alps and the shortening in the Apennines was accommodated at two different subduction systems (or plate margins) with an overlapping time at ~9-8 Ma. As long as the Miocene Carpathians subduction system was active until 8 Ma, most indentation was accommodated by the lateral escape into the Carpathians movement, while Dinarides recorded little to no deformation at its plate margins. After 9 Ma, the Adriatic indentation partitioned deformation mostly to oblique transpression in the Dinarides. This deformation accommodated the differential N- to NE-wards motion of Adria in respect to the rapid S- to SW- ward movement of a Hellenides area situated SE of the Kefalonia Fault, driven by the Aegean slab-roll back, facilitated by the thinned continental to oceanic nature of the Ionian lithosphere involved in the subduction system. The post-8 Ma system of strike-slip, reverse and thrust faults mapped in the Dinarides must be nothing else but a large-scale crustal horizontal drag zone accommodating the differential motion between the Adriatic indentation and Aegean slab roll-back, connecting the present-day deformation observed in the Alps and Hellenides.