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From orogenic buildup to extensional unroofing: the evolution of the Adria - Europe collisional zone in the Medvednica Mountains of Croatia

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Quantifying the kinematics of the Miocene extension in the Pannonian Basin is of critical importance for understanding the evolution of Adria-Europe collision in particular in the transitional zone from the Alps (Adria the upper plate) to the Dinarides (Adria the lower plate). Recent studies have demonstrated that large-scale extensional unroofing and core-complex formation affected the Europe-Adria contact in the Dinarides during Miocene times. The relationship between this extensional exhumation of Adriatic units and the roughly coeval Miocene extension affecting the Alpine-derived units during their E-ward extrusion into the intra-Carpathians ALCAPA block and the formation of the Pannonian basin is still unknown. One key area situated in the transitional zone is the Medvednica Mountains of Croatia, an area that benefits from already existing and extensive petrological and structural studies.

The area of the Medvednica Mountains has been targeted by the means of a field kinematic analysis complemented by low-temperature thermochronology, metamorphic petrology and sedimentological observations. The results demonstrate that two units, reflecting distinct Adriatic paleogeographical positions, make up the structural geometry of the mountains. The upper unit contains Paleozoic mostly fine clastic sequence metamorphosed in sub-greenschist facies, overlain by a proximal Adriatic facies consisting of Triassic shallow water carbonates. The lower unit is made up by a volcanic sequence overlain by gradual deepening Triassic carbonates metamorphosed in greenschist facies that bears a strong resemblance to the Triassic break-up volcanism and subsequent sedimentation affecting the distal Adriatic units observed elsewhere in the Jadar-Kopaonik unit of the Dinarides. The strong contrast between the Middle-Upper Triassic facies suggests large scale thrusting during Cretaceous nappe stacking.

Subsequently, the studied area has been affected by significant extensional deformation creating the present-day turtleback geometry. This resulted in the formation of brittle normal faults in both units, locally tilted by the uplift of the mountain core, which indicate mostly NE-SW extension. The lower unit is affected by a pervasive deformation characterized by a wide mylonitic shear zone with stretching lineations indicating consistently top-NE to E sense of shear. The present-day structural geometry of the mountains was established during the Pliocene-Quaternary inversion.

The exact ages of nappe-stacking and subsequent extensional exhumation will be clarified by the upcoming low-temperature thermochronology and absolute age dating study. However, available results demonstrate that the extensional geometry and sense of shear is typical for the Miocene extensional exhumation and basin formation that affected the Adria-Europe contact elsewhere in the Dinarids, e.g. Kozara-Prosara-Motajica and Fruska Gora extensional structures. By comparing similar extensional features observed in for instance the Rechnitz and Pohorje extensional structures, the combined study potentially demonstrates that the Miocene mechanism of extension and sense of shear is structurally coherent at the scale of the entire Dinaridic and Alpine margins.