The influence of the rotation of Adria and extension in the Pannonian Basin on lateral extrusion in the Alps: insights from crustal-scale models

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The influence of slab-pull induced extension in the Pannonian Basin and rotation of the Adriatic indenter on lateral extrusion processes in the Eastern Alps has been studied through analogue crustal scale modeling. Extension at high angle to the shortening direction has been implemented in the models; these are analogues for the northward convergence of the Adriatic plate and the coeval back-arc type extension in the Pannonian Basin.

Cross-sections and top-view images of the models have been analyzed in detail using particle tracing techniques (DPIV) which enables to calculate surface vector fields and visualize strain localization and block rotations. In the models the amount, timing and direction of extension have been the main variables together with a 20 degrees counter clockwise rotation of Adria. Additionally, a rigid buttress simulating the Bohemian Massif has been implemented, thereby decreasing the width of the area that can accommodate deformation.

The modeling results demonstrated that all models feature a compressional, strike-slip and tensional domain from west to east, respectively. The strike-slip (extruding) domain shows 'en-bloc' rotations in response to displacement velocity variations. The crustal blocks are bounded by conjugate strike-slip faults, which is indicative for lateral extrusion processes. When extension is present the amount of rotation increases, the extruding domains propagate further to the west and the direction of extrusion is parallel to the direction of extension. When extension was ceased whilst convergence continued the extruding domain decreased in size but remained active.

The models which included rotation of Adria, are characterized by the absence of conjugate strike-slip faults and the area that accommodated extrusion is decreased. Thus, it is probable that an indenter rotation has a negative effect on the lateral extrusion tectonics and amount of extension. However, when a Bohemian Massif type boundary was present, along with rotation of Adria, the amount of extension and development of conjugate sets of strike-slip faults are similar to models without rotation. Due to the increase in wrenching, in response to a narrow domain that could accommodate deformation, the models actually featured an increase in the amount of conjugate faults.

The results of this study imply that slab-pull driven extension in the Pannonian domain facilitates the lateral extrusion processes in the Eastern Alps and determines the direction of lateral displacements. A 20 degrees counter-clockwise rotation of Adria does not enhance lateral extrusion whereas the presence of the Bohemian Massif type boundary in the north does, as it fosters the formation of extrusion type fault systems. Furthermore, ongoing lateral extrusion despite stagnation of back-arc extension is in line with recent GPS data.

The Alps/Apennines boundary: structures and kinematics of interfering orogens and comparison with other modern analogues

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Although debated for more than one century, the relationship between the Alps and Apennines remains a puzzling geologic question.