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Kinematic analysis and analogue modelling of the Jaufen- and Passeier faults: How important is the rotation of Adria?

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Within the Alps, the N-S striking Giudicarie and the Brenner faults juxtapose major tectonic units. Between these lines exists another fault system comprised of the north trending Passeier line and the NE trending Jaufen line. This transition zone is of special interest because of: (1) its location near the Adriatic indenter tip and (2) the kinematics and timing of Passeier-Jaufen fault activity and their possible link to the Giudicarie- and Brenner systems. In this context, we combine a review on the kinematic evolution of the Giudicarie- and Brenner line with structural mapping of the Jaufen-Passeier area, and crustal-scale analogue models to gain insight into the deformation pattern related to different post-collisional plate motions (rotation vs. translation) of Adria.
From field studies we obtained ductile kinematic indicators along the 20 to 150 meter thick steeply dipping Jaufen shear zone, which reveal a dominant top-to-the-west shear. The Jaufen mylonites are overprinted by steep dipping brittle faults along which stress tensors indicate NW compression. Additionally, downward motion of the northern block between 30 and 15 Ma is supported by fission track data. Further southwards sinistral displacement along the Passeier fault occurred within brittle-ductile conditions. Due to poor outcrop conditions and the lack of marker horizons within the area the exact amount of fault-slip remains unclear. However, the kinematics of ductile deformation along the Jaufen line matches well with the relative displacement of the Austroalpine units during Brenner fault activity, and are consistent with a low-angle normal fault geometry of the latter.
Crustal-scale models, in which a rigid indenter representing Adria was pushed into a sand layer, show the importance of (1) The indenter geometry. Indenters with the present-day geometry or any triangular shape produce lateral shortening variations resulting in late-stage strike-slip motion perpendicular to the orogen. (2) Counterclockwise rotation of the indenter leads to rotation of Passeier-like faults. (3) Normal slip observed along the Jaufen- and Brenner line is not reproduced by these types of models.
All together, brittle deformation structures, fission track data, and our modelling study reveal that the Passeier line is a late-stage feature developing not before the late Miocene. In addition, analogue modelling shows that the Passeier line and its kinematics can be explained with only northward translation of Adria, and that there is no need to assume rotation of Adria for this area since the late Miocene. Furthermore, field evidence suggests a link between the Jaufen- and Brenner line in terms of kinematics. The lack of these structures in the analogue models, however, indicates a complex interaction between N-S compression and E-W extension.