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Evidence for activity of the Brenner normal fault zone (Tyrol, Austria) from seismological and GPS data

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Tectonic Setting

A two-stage history has to be considered for the Brenner Normal Fault (BNF). The ductile BNF is a low-angle W-dipping normal fault which compensated the exhumation of the western Tauern Window during Neogene convergence between the Adriatic and European plates (Behrmann, 1988; Selverstone, 1988). In addition, the contact between the foot- and hangingwall blocks is marked by a discrete brittle fault with a vertical displacement of 4-5 km after 13 Ma, as indicated by fission track studies (Fügenschuh et al., 1997).

Field data

The brittle BNF is scarcely exposed and can hardly be recognized on digital elevation models or in remote sensing due to its moderate dip angle, deep seated slope deformation and rocks with similar rheological behavior on either side of the fault. In an abandoned clay pit south of Innsbruck the brittle BNF separates paragneiss of the Ötztal crystalline basement in the hangingwall from quartzphyllites of the Lower Austroalpine in the footwall. Structural investigations revealed that the fault core zone is characterized by a foliated ultracataclasite of several 10s of meters which dips with 10 to 40˚ towards SW. The orientation of elongated porphyroclasts and NW- striking high angle faults indicates top to W(SW) movement on the moderately SW dipping master fault.

Earthquake data

The Austrian seismological survey (ZAMG) operates a microseismic network around

Innsbruck since 1990. The area W of the BNF and south of the Upper Inn Valley is seismically characterized by events with magnitude below 3. The strongest event which may be attributed to the BNF-system occurred in the transition between BNF and Passeier fault W of Sterzing in 1902 with an epicentral intensity of 6 (ML estimated to 4.2). Hypocenter depth information is available for 24 events and ranges between 5 and 18 km. Earthquake epicenters are scattered in a broad zone which extends up to 15 km west of the BNF. The density of epicenters continuously decreases towards W while the depth of hypocenters increases.

The data of 10 earthquakes were suitable for kinematic interpretation by focal plane solutions. The results can be split into 3 groups:

(1) Earthquakes in the footwall of the BNF probably indicate NE-directed sinistral wrench faulting of the units bordering the Tauern Window to the north.

(2) A second group of solutions proves E-W extension, possibly at the BNF.

(3) A third group of events was produced by thrust faults indicating N-S-shortening in different crustal levels.

GPS Data

Permanent GPS stations of the Austrian Academy of Science and the EUREF permanent network are located on both sides of the fault and in the north Alpine foreland. Preliminary data, covering a three years time span, indicate NW directed movement of the Alpine stations relative to the foreland in the order of $\sim$1 mm/yr and E-W extension across the BNF in the order of $\sim$0.5 mm/yr (not yet statistically significant).

Kinematic Interpretation

We suggest the following model for active crustal movements at the western margin of the Tauern Window:

-N(NW)-directed thrusting of the central Alpine nappe stack.

-Contemporaneous E-W extension which uses the weakness zone of the BNF.

-The geometry of NE-striking sinistral strike-slip faults at the northern margin of the Tauern Window fits into the lateral extrusion model of Ratschbacher et al., 1991. This could not be proved because of a lack of GPS data for the western Tauern Window.

References

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