Geophysical Research Abstracts, Vol. 7, 03921, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03921

Shear localisation due to fault breccia recycling in carbonates

W. Kurz, F.J. Brosch, R Rabitsch

Institute of Applied Geosciences, Graz University of Technology, Rechbauerstr. 12, A- 8010 Graz, Austria (kurz@egam.tugraz.at)

Upper crustal fault zones are structurally complex zones of brittle deformation. Deformation mechanisms within these zones, and therefore, the position of the brittle-ductile transition, are strongly controlled by the mechanical properties and the rheological parameters of the host rock. In the past decades, detailed knowledge of the internal structure of brittle fault zones as well as dicrete fractures has been accumulated from both field work (e.g., Sibson, 1986; Chester et al., 1993; Caine et al., 1996), laboratory fracture experiments, and numerical models. Generally, three structural elements may be distinguished within brittle fault zones (following Caine et al., 1996): (1) the protolith or host/country rock consisting of unfaulted rock mass bounding the fault-related structures; (2) the so-called damage zone, characterised by minor faults, fractures, veins, and fracture networks; these structures are generally related to the processes of fault zone formation and fault growth. (3) the fault core, where shear is assumed to be localised. In contrast to rocks rich in quartz and feldspar (quartzites and gneisses), carbonates show a signifaicantly contrasting deformational behaviour due to the susceptibility to pressure solution, and the subsequent precipitation of sparitic carbonate within veins and voids (cementation). In this study, we focus on two major strike-slip faults in the Eastern Alps (the Thalhof fault being a segment of the Salzach-Ennstal fault system, and the Lavanttal Fault). The Thalhof fault shows predominant left-lateral displacement,the Lavanttal fault shows right-lateral displacement. These faults are partly crusscutting carbonates (Triassic limestones and dolomites) of the Upper and Lower Austroalpine Unit, respectively. Within the transition from the host rock to the damage zone closely, millimeter- to centimeter- spaced fractures, 5-20 cm in length, at high angles (70-90°) to the fault zone boundaries are the major structural elements. In Mohr-Coulomb terms these may be described as R'-fractures bounding slender slab-like or columnar rock lamellae (“lithons”). Assuming that the fault zone is constant in thickness, the consequent synthetic rotation of these slabs results at first in the formation of kink bands parallel to the intersection of the fault zone boundary with the rock lamellae (i.e., subperpendicular to the displacement vector). Subsequently, fracturing along these kink bands and breaking-up to smaller fragments with independent rotational and translational movements may display the transition to the formation of breccias and cataclastic fault rocks. Bent and/or stylolithic fracture traces document pressure solution, sparitic cement within voids the presence of additional fluid phases. Continuous deformation along these zones may presumably result in the formation of either fault gouges or cataclasites. Zones of ultracataclasite, 1-2 cm in thickness, predominately form along the boundary between the damage zone and the fault core due to concentrated localised frictional wearing prior to gouge formation. Therefore, these zones are finally characterised by viscous flow and diminished friction,. with shear localisation during the final phases of fault zone evolution. In places, these discrete zones may shift from one side of the damage zone to the other, linked across the damage zone by discrete shears with an R- or P-shear geometry to the fault zone boundary. In contrast, cementation of fractured kinkbands immediately after brecciation results in strengthening of the rock mass and a resetting of the system, comparable to a crack-seal mechanism. Assuming a constant time-averaged state of stress, the formation of lithons may be re-initiated subsequent to cementation. Thus, previously formed fault breccias are going to be recycled within the brittle shear zone.

REFERENCES:

Caine, J.S., Evans, J.P., Forster, C.B., 1996. Fault zone architecture and permeability structure. Geology 24, 1025-1028.

Chester, F.M., Evans, J.P., Biegel, R.L., 1993. Internal structure and weakening mechanism of the San Andreas Fault. Journal of Geophysical Research 98, 771-786.

Sibson, R.H., 1986. Brecciation Processes in Fault Zones: Inference from Earthquake Rupturing. Pure and Applied Geophysics 124, 159-175.