Geophysical Research Abstracts,
Vol. 10, EGU2008-A-03019, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-03019
EGU General Assembly 2008

Permeability evolution in brittle shear zones: an example from the Eastern Alps

E. Kiechl (1), W. Kurz (1), G. Winkler (2)

(1) Instiut für Angewandte Geowissenschaften, Technische Universität Graz, walter.kurz@tugraz.at; (2) Institut für Erdwissenschaften, Universität Graz, gerfried.winkler@uni-graz.at

Faults play a key role in the hydrological, hydrogeological and geochemical cycle, where volatiles from the hydrosphere are transferred to wall and fault rocks. The hydrogeological assessment of a rock mass is significantly influenced by fault zones either acting as conduits, barriers, or a combined conduit-barrier system. For a case study we chose the Talhof-fault-system in the Eastern Alps (Austria), which represents a segment of the Salzach-Ennstal-Mariazell-Puchberg (SEMP) fault system. The subvertical, approximately E-W-striking Talhof fault shows left-lateral displacement. The length of the Talhof segment is approximately 15 km; it is cut by the NE-trending left-lateral Altenberg fault and the Mur-Mürz fault system in the west and east, respectively. Morphologically the trend of the fault zone is marked by trenches and ridges formed by subvertical to steeply dipping carbonate beds; at the intersection with the Giessgraben fault the Talhof fault separates Triassic fine grained layered marbles from quartzites, both being part of the Lower Austro-Alpine unit. These lithological units are characterised by contrasting deformational and rheological behaviour during faulting. Within the quartzites the protolith is almost totally disintegrated up to the formation of incoherent fault gouges, forming the fault core. Within the limestone marbles, the fault- related deformation has obviously been accommodated by multiple strike-slip shears along the nearly vertical discontinuities defined by a composite metamorphic foliation and sedimentary bedding, acting as slip planes. At a smaller scale, brittle structures within the carbonates are generally characterized by shear and extensional fractures at high angles to the SZB, and cemented tectonic breccia. The

width of the fault zone is hard to estimate due to the susceptibility of fault rocks and the highly disintegrated parts to weathering and erosion within the damage zone, but is estimated to range from a few to approximately 25 meters. The fault core was studied in detail by scan-line mapping to unravel its internal structure and to determine the hydraulic permeability. For this purpose oriented samples of fault rocks were taken with steel pipes. The samples were taken in three orientations with reference to a kinematic coordinate system (x-axis parallel to the displacement direction along the main fault; z- axis normal to the fault zone boundary; y-axis normal to the displacement direction and parallel to the fault zone boundary). These samples were analysed with respect to grain size distribution, mineralogical composition and permeability. Permeability was determined by the application of tri-axial penetration cells. The determined permeability values range from 1,7 x 10-7 m/s to 4,2 x 10-11 m/s, being significant for low to very low permeability. The mineralogical composition is characterised by dominating quartz (up to 80 %) and muscovite (up to 60 %) contents. Concerning the permeability, a relationship to the muscovite content can be deduced, showing decreasing permeability with increasing muscovite content. Additionally, the permeability is controlled by the content of fine-grained particles being in the range of the grain size of clay. The transition from low to very low permeability is marked by a critical value of 15% content of particles of clay grain size. When the clay fraction exceeds 15% the fraction of coarse-grained particles (sand, gravel) (partly up to 55%) has minor influence on the permeability evolution. A strong dependency of the hydraulic permeability on the sample orientation can be documented as well. Samples oriented parallel to the displacement direction (x- and y- axis) show a x * 102 higher permeability than samples taken normal to the displacement direction, being interpreted to result from a higher conductivity along fault-parallel major planes of shear. These results are in accordance with the results of hydraulic packer tests processed in boreholes with a maximum depth of 300 m below surface.