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Brittle structures and fault development in carbonatic rocks – a case study from the eastern alps (Austria)

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The structural evolution of cataclastic fault rocks was studied in different locations along the Oligocene-Miocene Salzach-Ennstal-Mariazell-Puchberg [SEMP] fault zone. The investigated sites are located within the Mürzalpen-nappe, which represents an undivided part of the Juvavic nappe systems in the Northern Calcareous Alps, and the Semmering-Wechsel nappe system, respectively.

The fault zones described in this study crop out in Triassic carbonates and represent different sedimentary facies and metamorphic stages. From East to West the lithology changes from Anisian fine grained layered marbles (Semmering-Wechsel-nappe) to Ladinian limestones and dolomites (Ramsau-limestone and –dolomite). A comparison was made between faults in these different host rocks at upper crustal conditions. Field data and sampling permit structural analysis in different scales.

Fault rocks in fine grained marbles derived from fault nucleation due layer-parallel shear, and the development of joint-bounded slices oriented at high angles (65 – 85°) with respect to the shear zone boundary (SZB). Slice rotation resulted in joint drag along the SZB, joint reactivation as antithetic shears, pervasive slice kinking, and breaking-up of the individual slices into smaller fragments. Subsequently cemented cataclasites underwent continuous shear deformation by refracturing (Hausegger et al., 2008).

The dolomite and limestone cataclasites, derived predominantly from the hosting carbonates, consist of fragments (0.5mm to 5cm in diameter) of dolomite, limestone and pre-existing cataclasite in a fine-grained matrix. Well developed fault cores (1-30cm in thickness) are preferably arranged subparallel to the strike direction of the fault zone or inclined in different angles, at intervals of 10cm to 300cm. Due to particle size analysis comminution processes are dominated by bulk crushing in an initial phase of deformation and change to abrasion with increasing displacement (Billi, 2005).

Depending on the stage of development fault zones indicate conduit behaviour (early stage without full developed fault core) or a form of combined conduit-barrier behaviour (mature structural architecture with full developed fault core) in a cross section perpendicular to the strike direction of the fault zone (Storti et al., 2003). Especially mature fault zones with thicknesses over 100cm appear in a typical asymmetric cross section, consisting of a distinct boundary fault and a well developed fault core which leads to a transition from the fault core to the damage zone. Palaeostress and particle analysis of fragments, consisting of host rock and cement of an earlier deformation event, indicate several phases of deformation and movement.