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Formation of cataclastic shear zones during layer-parallel shear in carbonates

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Brittle shear zones generally show a spatio-temporal evolution from the protolith to the fully developed fault with a zoned internal architecture. The spatial zonation corresponds approximately to the temporal evolution from the protolith to the core zone, including the development of fault rocks. In contrast to rocks rich in quartz and feldspar (quartzites and gneisses), carbonates show a significantly 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 in parts crosscutting layered carbonates (Triassic limestones and dolomites) of the Upper and Lower Austroalpine Unit, respectively. In particular we focus on the transition from the host rock to the damage zone in order to document the structures forming during the initial phases of fracturing and subsequent fault zone evolution, i.e., the fractures that formed prior to the formation of fault breccias and cataclasites. 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"). R- and P- fracture patterns obviously do not play a dominant role in the early stages of the generation of brittle deformation structures within these fracture zones. 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., subperpen-

dicular 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. Cataclastic shear zones with fault breccia along hinge of kinked lamellae probably form the future fault core with shear localisation during the final phases of fault zone evolution. This suggests that double-slide conjugate shearing and synthetic rotation of slabs in terms of a bookshelf mechanism play a major role during the initial phases of the evolution of a brittle fault zone. Bent and/or stylolithic fracture traces document pressure solution, sparitic cement within voids the presence of additional fluid phases. Cementation of fractured kinkbands immediately after brecciation results in strengthening of the rock mass and a re-setting 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.