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Shear zone development in a granitoid: From crack vein to mylonite (Zillertal nappe, Tauern Window, Eastern Alps)

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In “isotropic” rocks, shear zones classically arise from pre-existing irregularities (e.g., local variation of chemical/mineralogical composition or texture, fractures). The nature of such heterogeneities associated with subsequent fluid-rock-deformation interactions then determines how shear zones grow and thus their final geometry. However, the effective rheological impact of these processes (pre- and/or syn-kinematic) on shear zone development remains still poorly constrained.

We focus on shear zones from late Variscan metagranodiorite of the Zillertal unit (Tauern window, Austria). These shear zones are centimeter-wide and commonly extend through the relatively undeformed metagranodiorite along several meters to more than one hundred meters. They are underlined by biotite bands systematically associated with pre-ductile shear cracks. The field area displays various simple and paired shear zones associated with both healed fractures and ep-grt-qtz veins. These shear zones exhibit different intensities of shearing (from incipient biotite connections to anastomosed ultra-mylonitic bands) and can be studied as successive stages of development of localized shear zones.

In this study, we present a microstructural and metamorphic analysis realized on samples coming from several selected shear zones (from incipent to well developed shear zones). The complete structural analysis realized in the field associated with both chemical analyses and microstructural observations of these shear zones allowed us to constrain the P-T-ε evolution of the granodiorite. In addition, the study of the chemical and paragenetic evolution occurring within and around these shear zones allows us to explore their rheological evolution and to propose a mechanical model explaining their initiation and development.