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Role of brittle deformation during the initiation of ductile HP-LT shear zone in a metarhyolite (Suretta nappe, Eastern Central Alps).

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Although ductile shear zones are common deformation structures in the middle to deep continental lithosphere, the initiation of such structures among homogeneous and isotropic protolith (e.g. granitoid bodies) is still a matter of debate. Indeed, the lack of consensus concerns the presence and the nature of a preexisting heterogeneity (structural or compositional, such as dykes, joints or cracks). This is mainly due to the lack of observation of preserved precursors, which, if they were present initially, are generally obliterated by subsequent intense deformation. Different conceptual models require a structural precursor, which enables fluids to flow and promotes metamorphic and metasomatic reactions via fluid-rock interactions. Those fluid-rock interactions are commonly presented as a key factor controlling strain localization or lateral propagation. The main goal of this contribution is to present the first observations, to our knowledge, of a preserved brittle precursor of a millimeter scale shear zone under blueschist facies metamorphic conditions. This work provides new evidences into how ductile shear zones occurring within homogeneous and isotropic protolith nucleate and develop.

The present study exposes shear zones from the Roffna metarhyolite, a subvolcanic intrusion representing most of the northern part of the Suretta nappe (Penninic domain, Eastern Central Alps). This early Permian massif intruded an older basement and was affected only by Tertiary Alpine tectonics. The heterogeneous strain pattern consists, at all scales of anastomosing shear zones surrounding lenses of nearly undeformed rocks The investigated outcrop is characterized by the presence of a shear zone network from millimetric to plurimetric scale developed under blueschist facies conditions related to continental subduction of the European plate.

A combined study including field observations, EBSD analysis, SEM-CL and conventional imaging together with thermodynamic modeling of phase relations allow us to decipher the interplay between brittle and ductile deformation at the onset of shear zone development. At First, the field study shows that the strain pattern defined by millimeter to centimeter wide brittle precusors is identical with the strain pattern defined by plurimeter scale mature shear zones. This suggests that the initiation of the shear zone, via brittle deformation occurs in the same strain field as the development and widening of the shear zone under ductile conditions. Microtextural observations also clearly indicate a brittle component during the shear zone formation. An analysis of the chemical composition of white mica, biotite and epidote, which crystallize within the precursor, confirms that the crystallization of these phases has taken place under blueschist facies metamorphic conditions (T $\approx$ 450°C and P $\approx$ 10 kbar) although deformation was brittle. Moreover, high resolution X-ray mapping of the precursor shows that the rock in the vicinity of the precursor has undergone mass transfer, suggesting that fluid-rock interactions occurred during the first stage of the shear zone initiation and are not restricted only to the stage of shear zone widening.

Our observations confirm that ductile shear zones in the Roffna metarhyolite developed from a non-inherited brittle precursor involving a brittle-to-ductile behavior evolution under blueschist metamorphic facies conditions.