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Exploitation of unsuitably oriented foliation by localized mylonites and pseudotachylytes (Tauern Window, Eastern Alps)

Giovanni Toffol[1], Giorgio Pennacchioni[1], Luiz Fernando Grafulha Morales[2], and Simone Papa[1]
[1]Department of Geosciences, University of Padova, Padua, Italy
[2]Structural Geology and Tectonics Group, ETH Zürich, Zürich, Switzerland

During exhumation, metamorphic rocks change their rheological behavior from dominantly ductile to brittle. Especially at the "brittle-ductile transition" at the bottom of the brittle crust, which coincides roughly with the domain where most "shallow" earthquakes nucleate, rocks exhibit a close interplay between ductile flow and fracturing.

In the Neves area (Tauern window, Eastern Alps) the exhumation across the brittle-ductile transition of amphibolite-facies meta-granitoids during the Alpine cycle is recorded by the association of pseudotachylyte veins and localized low-grade mylonites (*stage-2* deformation). The *stage-2* structures exploited the precursor amphibolite-facies foliation within meter-thick mylonites (*stage-1* deformation) and were in turn overprinted by epidote-chlorite-bearing shear fractures and veins (*stage-3* deformation). The kinematics and orientation of *stage-1* and *stage-3* structures indicate a slight rotation of the regional shortening direction from 345° to about 360°. This implies that *stage-2* mylonites and pseudotachylytes developed at a high angle to the shortening direction.

The syn-kinematic metamorphic assemblage of *stage-2* mylonites includes quartz, oligoclase (Ab_{75}), biotite, epidote, and minor muscovite and K-feldspar; garnet was not stable. This assemblage constrains the deformation at upper greenschist facies condition and temperatures of around 400 °C. During mylonitization the coarse-grained (mm-sized) amphibolite-facies quartz recrystallized by subgrain rotation to ultra-fine (~ 3 μm average grain size determined from EBSD maps) aggregates. Such a small grain size yields differential stress > 200 MPa during *stage-2* mylonitization, considering the piezometer of *Cross et al., 2017* [1].

Pseudotachylytes are in a close spatial association with *stage-2* mylonites and share the same sense of shear. There is no evidence of a ductile overprint of pseudotachylytes. The *stage-2* structures developed at a very high angle to the inferred shortening direction, which implies that the coseismic slip occurred on planes with a very low friction coefficient (estimated <0.3), contradicting the high differential stress estimated for the mylonites. We infer a genetic relationship between *stage-2* mylonite and pseudotachylyte. Mylonites progressively formed the mica-rich foliation planes, continuous over large distances, that provided the weak mechanical anisotropy eventually leading to coseismic slip.

Reference:

1: Cross, et al., 2017, The recrystallized grain size piezometer for quartz: An EBSD□based calibration. Geophys. Res. Lett., 44(13), 6667-6674.