Geophysical Research Abstracts
Vol. 21, EGU2019-15625, 2019
EGU General Assembly 2019

Earthquake nucleation in the ductile field: microstructural study of a natural case of coeval pseudotachylyte/mylonite association

Simone Papa (1), Giorgio Pennacchioni (1), and Luca Menegon (2)

(1) Department of Geosciences, University of Padova, Padua, Italy, (2) School of Earth and Environmental Sciences, University of Plymouth, Plymouth, UK

The association of coeval pseudotachylytes and mylonites is generally regarded as the geological record of seismic events that transiently occurred during dominant ductile flow. Suggested models to explain this association involve (i) the downward propagation of seismic ruptures from the seismogenic upper crust or (ii) self-localising ductile instabilities. Though the model of ductile instability has been validated by numerical modeling, seismology, and experimental studies, a microstructural evidence for this process in natural samples is still missing.

In the Mont Mary unit (Western Alps), thin pseudotachylyte fault veins are associated with amphibolite-facies ultramylonites. These veins are concordant to the mylonitic foliation and are locally overprinted by ductile shearing. Therefore, the Mont Mary pseudotachylytes are a potential record of ductile instabilities in a natural mylonite.

We used Electron Backscatter Diffraction (EBSD) to investigate the quartz microstructure in the ultramylonite host of pseudotachylytes and in clasts within pseudotachylytes. The aim of the study was to understand the rheological evolution of the ultramylonite and to detect signs of localised accelerated creep rate that could eventually have evolved into pseudotachylytes.

The ultramylonite commonly includes layers of fine-grained (average recrystallised grain size of 3-5 micron) quartz, derived from pervasive recrystallisation by subgrain rotation of quartz ribbons, that make transition, through ultra-fine grained aggregates (2-3 micron), to a mixed quartz + biotite aggregate. The microstructures and recrystallised grain size of quartz clasts within the pseudotachylytes are very similar to those of ultra-fine grained aggregates in the host ultramylonite.
The transition from monocrystalline quartz to quartz + biotite aggregate occurred by a switch in the deformation mechanism from dislocation creep to dominant grain boundary sliding and pore opening along the grain boundaries accommodated by precipitation of biotite. This process represents the highest strain microstructural stage preserved in ultramylonites preceding pseudotachylyte formation. The finest grain size in recrystallised ribbons and quartz clasts indicates strain rate of 10^{-9} - 10^{-8} s^{-1}. However, the bulk rate of deformation during quartz disaggregation to mixed ultrafine quartz-biotite was controlled by the rate of synkinematic precipitation of biotite.

Creep along ultrafine grained quartz+biotite aggregates is the last recognised process preceding cataclasis and melting.