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Recrystallized ultrafine-grained quartz associated with pseudotachylyte-bearing faults

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Tectonic pseudotachylytes (pst), solidified friction-induced silicate melts, record coseismic slip and are mainly reported from the brittle crust and in association with cataclastic deformation. In this study, we report the close spatial association between crystal-plastic deformation of quartz, recorded by ultrafine-grained (grain size 1-2 μm) microshear zones, and pst and speculate about the possible origin of this association. This association appears to be frequent in nature and we present data from two different localities, namely: (1) Schneeberger Zug (Eastern Alps, Southern Tyrol, Italy) where the pst occur within amphibolite facies, impure quartzite, and (2) the Adamello (Southern Alps, Italy) where pst occur within tonalitie. In both cases, localized microshear zones (50-150 μm thick) of ultrafine recrystallized quartz occur adjacent, or within a few millimetres distance, to pst fault veins and are absent in the rest of host rock. The kinematics of the microshear zones is consistent with the sense of slip along the fault.

We have investigated the microstructure and the crystallographic preferred orientation (CPO) of the microshear zones by EBSD and TEM. The host rock quartz deformed along the microshear zones shows patchy undulatory extinction, deformation lamellae and lattice deflection around rational crystallographic axes coincident with the bulk vorticity axis. At the microshear zone margins subgrains make transition to a recrystallized aggregates of polygonal small (<2μm) new grains delineating the microshear zone. The CPO of the aggregates is random and the new recrystallized grains are almost dislocations free.

We refer the plastic deformation of quartz accompanied by dramatic grain size refinement to the coseismic stages of fault slip consistently with the observation of Ree et al. (2009) in Carrara calcite marble during high-speed torsion experiments. The development of quartz microstructure could have occurred during the accelerating stages of the seismic faulting and/or by strain rate partitioning during the coseismic slip along the principal pst-bearing plane.

Ree, J.-H., Ando, J.-I., Han, R., Kim. J.-W., Shimamoto, T., 2009. Coseismic microstructures of simulated fault zones in Carrara marble and halite revealed by electron microscopy. Abstract volume, Micro-Analysis, Processes, Time (MAPT) international meeting, 30th August – 4th September 2009, Edinburgh, 65.