Geophysical Research Abstracts
Vol. 15, EGU2013-3167, 2013
EGU General Assembly 2013

Ti-in-qtz signatures of pseudotachylyte-bearing crystalline rocks

Michel Bestmann (1), Giorgio Pennacchioni (2,3), Smail Moustefaoui (4), Mathias Göken (5), and Helga de Wall (1)

(1) GeoZentrum Nordbayern, University of Erlangen-Nuremberg, Germany (michel@geol.uni-erlangen.de), (2) Department of Geosciences, University of Padova, Italy (giorgio.pennacchioni@unipd.it), (3) INGV, Rome, Italy, (4) LMCM, Paris, France, (5) Department Werkstoffwissenschaften I, University of Erlangen-Nuremberg, Germany

Tectonic pseudotachylytes, i.e. quenched friction-induced silicate melts, record coseismic slip along faults. Bestmann et al. (2012) have shown that transient high temperature conditions related to frictional heating during coseismic faulting in the brittle crust promoted the dynamical recrystallization of quartz to ultrafine-grained (grain size 1-2 μm) aggregates along microshear zones in the host rock adjacent to pseudotachylyte veins. In this study we investigate if there is any geochemical signature associated with this transient high temperature event. With this aim we used Ti-in-quartz trace element data, which can be used as a thermometer (Wark and Watson, 2006).

Models of the temperature evolution of the host rock following coseismic slip and production of frictional melts show that temperatures >800 °C only last for a few minutes close to the vein walls (Bestmann et al., 2012). The experimental data on diffusion of Ti in quartz (Cherniak et al., 2007) seems to exclude that any detectable Ti diffusion could occur during the short-lived thermal event. However, the Ti-in-quartz investigation is motivated by the fact that Ti diffusion could be enhanced in the recrystallized quartz aggregates by pervasive lattice damage and by the percolation of melt along grain boundaries (Bestmann et al., 2012).

Micro-mapping of Ti trace amounts in quartz were carried out by using a nanoSIMS on two different pseudotachylyte-bearing samples already used in the study of Bestmann et al. (2012): (1) the Schneeberg Normal Fault Zone (SNFZ, Eastern Alps) within a muscovite-bearing quartzite, and (2) the Gole Larghe Fault Zone (Southern Alps) within tonalites of the Adamello pluton.

In the Schneeberg NFZ, the metamorphic (amphibolite facies) host quartz grains and the ultrafine grained recrystallized aggregates within microshear zones adjacent to pseudotachylytes both have an identical Ti signature of 4-6 ppm. In the Adamello tonalite the magmatic quartz host grains are fractured and show a sharp decrease in Ti from 40-55 ppm (magmatic host) to 11-15 ppm (healed fractures). This gives evidence of an extensive phase of fluid-rock interaction along the Adamello faults. Similar to the SNFZ, the ultrafine grained quartz aggregate along microshear zones mainly inherited the pre-seismic Ti signal from the fractured host quartz grains. There are, however, steep Ti gradients surrounding very small («1 μm) Ti-bearing 2nd phase particles present along the grain boundary of ultrafine grained aggregates as a result of melt infiltration. These haloes (1-2 μm) could reflect enhanced Ti diffusion in highly deformed quartz during the coseismic thermal transient.

References

Bestmann, M., Pennacchioni, S., Nielsen, G., Göken, M., de Wall, H., 2012. Deformation and ultrafine recrystallization of quartz in pseudotachylyte-bearing faults: a matter of a few seconds. Journal of Structural Geology, 38, 21-38.

Cherniak, D.J., Watson, E.B., Wark, D.A., 2007. Ti diffusion in quartz. Chemical Geology, 236, 65–74.

Wark, D.A., Watson, E.B., 2006. TitaniQ: a titanium-in-quartz geothermometer. Contribution to Mineralogy and Petrology, 152, 743-754.