Geophysical Research Abstracts
Vol. 16, EGU2014-12846, 2014
EGU General Assembly 2014

Cavitation bands control porosity and fluid flow in lower crustal shear zones

Luca Menegon (1), Florian Fusseis (2), and Holger Stunitz (3)

(1) Plymouth University, School of Geography, Earth and Environmental Sciences, Plymouth, United Kingdom (luca.menegon@plymouth.ac.uk, +44 (0)1752 584710), (2) The University of Edinburgh, School of GeoSciences, Edinburgh, United Kingdom, (3) University of Tromsø, Department of Geology, Tromsø, Norway

Shear zones channelize fluid flow in the Earth's crust. A number of mechanisms were suggested to control fluid migration pathways in upper- and midcrustal shear zones, amongst them creep cavitation, which is well-known from deforming metals and ceramics. Deep crustal fluid migration is hardly constrained by any observations, and so it remains unclear how fluids are channelized and distributed in an actively deforming lower crustal shear zone.

This study investigates the deformation mechanisms, fluid-rock interaction and development of porosity in a mangerite ultramylonite from Lofoten, northern Norway. The synkinematic mineral assemblage consists of plagioclase, K-feldspar, hornblende, quartz, calcite and biotite, and yields P, T conditions of deformation of 700-730° C, 0.65-0.8 GPa. Mass-balance calculations indicate (1) a volume increase of 2.3%, and (2) fluid infiltration during the protolith-ultramylonite transformation.

Microstructural observations and EBSD analysis are consistent with diffusion creep as the dominant deformation mechanism in the ultramylonite. The microstructure shows extensive evidence of synkinematic nucleation of new phases in dilatant sites resulting from the concomitant operation of grain boundary sliding and cavitation during grain-size sensitive creep. EBSD maps show the occurrence of isolated quartz grains along C' shear bands in feldspathic layers. Quartz does not show a crystallographic preferred orientation in these bands, suggesting that it precipitated in cavities. The occurrence of such quartz bands is consistent with the coalescence of individual pores originally formed at dilatant sites resulting from the operation of grain boundary sliding. Opening of pores implies local dilatancy. Positive volume change accompanied by fluid infiltration, as inferred from the mass balance calculations, is consistent with the precipitation of new phases in pores from intragranular fluids.

We used synchrotron X-ray microtomography to analyse shape and distribution of pores in two feldspathic layers. The pores (6-30 μm in diameter) are preferentially distributed along C' shear bands, lending support to our interpretation of precipitation of quartz in cavitation bands with a C' orientation.

In summary, this study presents clear evidence that synkinematic porosity can organise in shear bands as a consequence of creep cavitation during grain-size sensitive flow in lower crustal shear zones. It is likely that new phases precipitate from intragranular fluid in such cavitation bands, which may control deep crustal fluid flow.