Geophysical Research Abstracts, Vol. 9, 04956, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04956

Dynamic and static recrystallization following high stress deformation of quartz – experiment and nature

C.A. Trepmann (1), B. Stöckhert (1), D. Dorner (2), M. Küster (1), K. Röller (1)

(1) Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum, Germany, Collaborative Research Center 526.

(2) National Institute for Materials Science, Tsukuba, Japan.

Recrystallization of quartz can occur after a high stress deformation event in the middle crust, originating from stress redistribution during a major earthquake in the upper crust. This recrystallisation can be dynamic or quasi-static, depending on the relative time scales of stress relaxation and recrystallization. To investigate these processes, non-steady state deformation experiments at high stress and moderate temperature, with or without subsequent annealing at high temperature and varying stress conditions, were carried out on quartz in a modified Griggs-type deformation apparatus. Three types of experiments were performed. Type A: Deformation at a temperature of 400˚C, a confining pressure of 2 GPa, a constant strain rate of $10^{-4}s^{-1}$; Type A+B: Deformation as in type A, followed by annealing for 14-15 h at zero nominal differential stress, temperatures of 800-1000˚C and a confining pressure of 2.0-2.7 GPa; Type A+C: Deformation as in type A, followed by annealing for 15 h at 900˚C and at a residual stress, in contrast to type A+B experiments. The quartz microstructures after short-term high stress deformation (type A) demonstrate a mixed mode response with localized brittle and plastic deformation. Microfractures merge into deformation bands. Both features are flanked by zones of high dislocation density, while the microstructure beyond these zones of localized deformation appears to be unaffected when compared to the starting material. Static annealing (type A+B experiments) results in recrystallisation and is restricted to regions of localized plastic and brittle deformation. The microstructure is characterised by recrystallised grains aligned in strings, with isometric shape and without crystallographic preferred orientation or a specific orientation relation to the host crystal. This indicates nucleation and growth in the highly damaged zones developed during the preceding high stress deforma-

tion. Annealing at non-hydrostatic conditions (type A+C experiments) results in shear zones also developing from deformation bands or cracks formed during the high stress deformation. In this case, however, the recrystallised zone is several grain diameters wide, the grains are elongate, and a marked crystallographic preferred orientation indicates flow by dislocation creep with dynamic recrystallisation. Quartz microstructures with strings of isometric recrystallised grains identical to those produced in type A+B experiments are observed in cores recovered from Long Valley Exploratory Well, California, with considerable seismic activity. In accordance with the experimental results, these microstructures are therefore interpreted to reflect brittle and localized plastic deformation at high stress followed by quasi-static annealing. The experiments demonstrate the behaviour of quartz at rapid loading (type A experiments) and subsequent static annealing (type A+B samples) or creep at decaying stress (type A+C experiments) in the middle crust. The experimentally produced microfabrics allow identifying similar processes and past conditions in exhumed rocks.