Geophysical Research Abstracts, Vol. 9, 04976, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04976

Heterogeneous microstructures in deformed calcite: the relationship of recrystallised grains, core and mantle subgrains to deformation conditions

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Calcite deformed by high temperature creep develops a heterogeneous microstructure consisting of deformed and recrystallised grains. The deformed grains either contain homogeneously distributed subgrains of similar size, or heterogeneously distributed small subgrains at grain boundaries (mantle subgrains) and relatively large subgrains in the core of grains (core subgrains). This presentation shows a large experimental dataset of calcite samples, uniaxially deformed at a range of differential stress (15-85 MPa), natural strain (0.15-0.90) and temperatures (700-990°C) at a confining pressure of 300 MPa. The samples have been analysed using the electron backscattered diffraction technique (EBSD) to make automated 1000 x 1000 μm orientation maps (step size 1 μm). A size measurement technique was developed for separately measuring the size of the recrystallised grains, deformed grains, and within the latter, core and mantle subgrains. The size measurements were compared with stress, strain and temperature. In this presentation, we will focus on recrystallised grains, but compare the results with data on subgrain sizes. In many materials, including rocks, the recrystallised grain size has been found to be related to the deformation stress. It is shown here that the recrystallised grain size measured in most of our samples has been found to be related to flow stress in a similar way as in previously determined stress-recrystallised grain size relationships. The recrystallised grain size does not seem to be influenced by increasing strain in a systematic way. However, for a sample set at constant stress, we observed that the recrystallised grains have largely variable sizes at low strains (0.15-0.30), even within one sample, but approach more stable sizes at higher strains (0.45-0.90) even when the samples are not fully recrystallised. Also temperature does not influence the recrystallised grain size in a systematic manner. However, temperature has an effect on the recrystallisation mechanism itself. At high

stress (>50 MPa), an increase in temperature significantly enhances grain boundary migration an increase in the recrystallised grain size takes place. Consequently, for these particular samples deformed at high temperature (>800°C) and high stress (>50 MPa), the recrystallised grain size does not fit the stress-size relationship determined in this study, as this is based on samples with little or no grain boundary migration. Similar to the recrystallised grain size, the average subgrain size, regardless of the subgrain type, is often used to estimate the deformation stress. In the presentation differences between the subgrains and recrystallised grains in terms of their relationship with stress will be shown.