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The effect of deformation on subgrain misorientations

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The development and improvement of automatic crystal orientation mapping methods using electron backscattered diffraction in scanning electron microscopes enables the size and misorientation distributions of deformation induced subgrains in minerals to be characterized. In an associated project of the Substructure Dynamics project of the EuroMinSci programme we are investigating the effect of deformation parameters on subgrain misorientations in experimentally deformed NaCl polycrystals. The aim of the study is to test the hypothesis that average subgrain misorientations may be used as a strain guage for the amount of deformation accommodated by intragranular dislocation creep during multi-mechanism ductile deformation (Pennock et al. 2005). In this contribution we develop the theoretical background for the influence of deformation conditions on average misorientations (M-ave).

Modification of Ashby's (1970) model for plasticity of aggregates with one easy slip system suggests that the average misorientation of geometrically necessary subgrain boundaries will depend on strain and grain size with M-ave = k e d / D, where e is the strain, d the average subgrain size, k a constant and D the grain size. For large scale deformation band type subgrains, which form to accommodate grain scale heterogeneous deformation, a dependence of subgrain size on grain size can be assumed with d = D/h, where h is a constant, resulting in a dependence of average misorientation only on strain. A similar dependence is obtained if the geometrically necessary boundaries only occur in a mantle substructure along old grain boundaries. If subgrain size is stress dependent then average misorientations are predicted to be dependent on strain, stress and grain size. In this case the development of high average misorientations and hence the occurrence of recrystallization by subgrain rotation will be favoured by smaller grain size and higher stress.

Deformation experiments on [100] NaCl single crystals are in progress to test these

models for the effect of deformation on average subgrain misorientations.

References

Ashby (1970) Phil. Mag. 21, 399-424.

Pennock et al. (2005) Journal of Structural Geology 27, 2159-2170.