Geophysical Research Abstracts, Vol. 9, 08024, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-08024

1 Subgrain Rotation Recrystallization in Minerals

M.R. Drury and G.M. Pennock

Department of Earth Sciences, Utrecht University, PO Box 80.021, 3508TA Utrecht, The Netherlands (martynd@geo.uu.nl)

Subgrain rotation is a common mechanism of continuous dynamic recrystallization in minerals and some metals. This mechanism involves new grain boundary formation either by subgrain rotation or by subgrain boundary migration in regions with an orientation gradient. The aim of this presentation is to review the status of our current knowledge of rotation recrystallization and the effect of rotation recrystallization on rheology.

A key aspect of rotation recrystallization is the transformation from a crystal lattice dislocation array to a disordered grain boundary structure. Little is known about how the structure and properties of boundaries in minerals vary with misorientation angle (θ). For olivine, $(Mg_{0.9},Fe_{0.1})Si_2O_4$, recent studies imply that the structural transition from subgrain to grain boundary occurs at high angles of θ =15-25˚. In contrast to the structural transition, the onset of significant subgrain boundary mobility may occur at low angles (θ =3-5˚) in some minerals. In many cases rotation recrystallization may involve an initial stage of rotation followed by subgrain growth, producing new grains larger than the subgrain size. Models for rotation recrystallization (Shimizu 1998, de Bresser et al. 1998) predict that the grain size is stress and temperature dependent. The temperature dependence of recrystallized grain size has often been overlooked but has recently been detected in magnesium alloys and halite (NaCl) (t'Heege et al. 2005). The lack of knowledge on structure and mobility of low and medium angle subgrain boundaries is a barrier to the further development of realistic models for recovery and recrystallization of minerals.

Current theories of subgrain rotation assume that subgrain misorientations increase with increasing strain (Poirier 1974, Shimizu 1998). However, studies on analogue materials (Tungatt and Humphreys 1984, Means and Ree 1988) and NaCl (Pennock et al. 2004) show that many different types of subgrain boundary develop during deformation. The formation of high angle boundaries by subgrain rotation is only likely along geometrically necessary (GN) boundaries, formed by processes such as grain subdivision, kinking, and polygonization of GN dislocations produced by slip gradients. New models for rotation recrystallization are needed that incorporate different types of GN boundaries and link the development of misorientation to texture development. The rheological effect of rotation recrystallization is variable and uncertain and further work on this topic is needed.