Geophysical Research Abstracts, Vol. 9, 08449, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-08449

Deformation mechanisms and rheology of localized shear zones in exhumed mantle rocks

M.R. Drury, (1) L. Palasse (1), G.M. Pennock (1), H.G. Ave Lallemant (2), R.L.M Vissers (1) and H.L.M van Roermund

(1) Department of Earth Sciences, Utrecht University, PO Box 80.021, 3508TA Utrecht, the Netherlands, (2) Department of Earth Science, Rice University, Houston, Texas, USA, (martynd@geo.uu.nl)

This contribution will address some current problems in the interpretation of deformation mechanisms and rheology of localized shear zones in exhumed upper mantle peridotites.

Shear zones in peridotites usually contain fine-grained mylonites. Some form of grain size sensitive, granular flow mechanism is often indicated from the microstructure and weak to random olivine lattice preferred orientation. The details of the deformation mechanisms remain obscure and experimental studies show that several mechanisms are possible including, diffusion creep, diffusion accommodated grain boundary sliding, dislocation accommodated GBS, easy slip accommodated by GBS, and recrystallization accommodated dislocation creep. Recent studies using electron back-scattered diffraction on fine-grained olivine rocks have found a wide variety lattice preferred orientations that may be useful as indicators of different types of grain-size sensitive deformation.

Significant grain boundary sliding is often identified as an important mechanism in fine-grained peridotites, however, it is uncertain if sliding was frictional or viscous. (Bos and Spiers 2001) have shown that cohesive mylonites containing asymmetric porphyroclasts in a fine-grained matrix of elongated grains can develop during deformation by frictional sliding along phase boundaries accommodated by diffusive mass transfer. This type of behaviour could be important in sheet-silicate rich peridotite mylonites deformed at low effective pressure. Some natural serpentine-olivine and phlogopite rich mylonites could be examples of such frictional-viscous mylonites, although experiments are required on olivine-sheet silicate systems to test this idea.

Rocks in upper mantle localised zones often have a compositional banding with olivine-rich and poly-phase layers. The olivine-rich layers are derived by recrystallization and reaction of olivine porphyroclasts, while the polyphase layers are derived by reaction of large pyroxenes, and Al-rich phases (plagioclase, spinel and garnet). Polyphase layers generally have smaller grain size than the olivine-rich layers and these layers may control the strength of upper mantle shear zones if grain-size sensitive deformation is the dominant mechanism. The grain size of recrystallized grains in the olivine-rich layers can be predicted from experimentally calibrated grain-size scaling relations for grain size as a function of stress, temperature and water content. Currently there is no theoretical model and only limited experimental data on the grain size formed by dynamic reactions in the fine-grained polyphase bands. Information on the grain size produced by dynamic reactions will be important in the development of realistic models for shear zone formation in the lithosphere.