Geophysical Research Abstracts,
Vol. 11, EGU2009-5436, 2009
EGU General Assembly 2009

Does static recrystallization occur in the continental lithosphere? Insights from an experimental study

V. VIGNON (1,2), B. GIBERT (1), S. DEMOUCHY (1), and A. VAUCHEZ (1)

(1) Géosciences Montpellier, UMR 5243, Université Montpellier 2 and INSU-CNRS, Place Eugène Bataillon 34095 Montpellier Cedex, France., (2) Laboratoire de Géodynamique des Chaines Alpines, UMR 5025, Université Joseph Fourier and CNRS, Maison des géosciences 1381 rue de la piscine 38041 Grenoble cedex, France

The microstructure of a mantle rock reflects its tectonic and thermal evolution. Detailed study of the microstructure and crystallographic preferred orientation (CPO) of mantle rocks also allows a better characterization of its physical properties and thus a more accurate interpretation of geophysical observations such seismic anisotropy measurements for instance. Various processes accommodate rock deformations and thus may account for the observed microstructure and CPO. Under medium temperature conditions dislocation creep and recrystallization through subgrain-rotation dominate. Under higher temperature conditions, diffusion accommodates a larger part of the deformation and allows the olivine crystals to recrystallize through the nucleation of new grains. Diffusion also modifies both the microstructure and the CPO of olivine through annealing, which involves a decrease of the dislocation density and an increase mobility of subgrain and grain boundaries. Under static conditions, recovery and grain-boundary migration are known as efficient mechanisms that modify the microstructure and the CPO of rocks. An open question is: may olivine aggregate recrystallize through nucleation under such static conditions? Answering this question is important for interpreting the nucleation-recrystallization observed in mantle xenoliths from the lower part of the cratonic lithosphere. Nucleation-recrystallization under static conditions (i.e., due to an increase in temperature) would also have an important effect on the mechanical properties of the olivine aggregate, which would favor a destabilization of the lower part of the cratonic lithosphere.

Therefore we performed annealing experiments under static conditions (no deviatoric stress) in a high-resolution gas-medium apparatus (Paterson press). Samples selection was performed following 3 criteria: (1) a simple mineralogy (olivine), (2) a grain-size large enough to identify new grains after experiments, (3) A clear substructure with subgrain boundaries, and (4) a strong initial CPO. Annealing experiments were conducted on coarse grained dunites at confining pressure of 300 MPa and 1250°C. The annealing time varied between 2 and 16 hours, under both hydrous and anhydrous conditions (water was supplied by talc dehydration) with and without previous deformation.

Annealed specimens were studied using optical microscopy and electron back scattered diffraction method to perform mineral orientation maps. No evidence of significant nucleation-recrystallization has been observed. Annealing mainly resulted in recovery and grain boundary migration. Indeed, no significant modification of the olivine CPO occurred. Limited evidence of increased grain-boundary mobility (bulging) and few nucleus have been observed. These results suggest that under high temperature and static conditions, diffusion leads to recovery rather than to nucleation-recrystallization. Assuming these results could be extrapolated to geological conditions, they would imply that "annealing" of the lithospheric mantle under static conditions, for instance due to the temperature increase associated with a plume reaching the base of the lithosphere would not cause grain-size reduction through static recrystallization, nor significant modification of the olivine CPO. Our conclusions also suggest that mantle xenoliths showing evidence of nucleation-recrystallization have recorded a high temperature deformation episode.