On pure climb creep mechanism in the lower mantle

Philippe Carrez*[1], Francesca Boioli[1], Patrick Cordier[1], Benoit Devincre[2], Karine Gouriet[1], Pierre Hirel[1], and Antoine Kraych[1]

[1]Unité Matériaux et Transformations - UMR 8207 (UMET) – Institut National de la Recherche Agronomique, Université de Lille, Sciences et Technologies, Ecole Nationale Supérieure de Chimie de Lille (ENSCL), Centre National de la Recherche Scientifique : UMR8207 – Université Lille 1 Bâtiment C6 59655 Villeneuve dÁscq, France

[2]Laboratoire d´étude des microstructures (LEM - ONERA - CNRS) – ONERA, Centre National de la Recherche Scientifique : UMR104 – F-92322 Chatillon, France

Abstract

It is usually assumed that diffusion creep is the main deformation mechanism in the lower mantle. However, this puts quite strong constraints on grain sizes and point defect concentrations. Along this line, several experimental or theoretical studies have recently highlighted the fact that high lattice friction is opposed to dislocation glide in silicates from the deep mantle under pressure, especially in bridgmanite. In this presentation, we further investigate this aspect by providing quantitative estimates for dislocation mobilities in both glide and climb from atomic scale modelling. We show that under low stress conditions representative of the mantle, dislocation creep operates under conditions very different from those activated at laboratory strain-rates. We propose that the creep in the deep mantle can result from pure dislocation climb processes. Based on dislocation dynamics models, we show that pure climb creep is an efficient strain-producing mechanism in bridgmanite in the conditions of the lower mantle, which is grain size insensitive. Involving pure climb of dislocations with no shear, this creep mechanism is compatible with the absence of seismic anisotropy in the Earth's lower mantle.

*Speaker