Anisotropic rheology of a cubic medium and implications for geological materials

L.Pouilloux[1], Stéphane Labrosse[2] and E. Kaminski[1].
[1] Institut de physique du globe de Paris
[2] Ecole Normale Supérieure de Lyon

Dislocation creep, which is the dominant deformation mechanism in the upper mantle, results in a non-Newtonian anisotropic rheology. The implication of non-Newtonian rheology has been quite extensively studied in geodynamic models but the anisotropic aspect remains poorly investigated. In this paper, we propose to fill this gap by (1) introducing a simple mathematical description of anisotropic viscosity and (2) illustrating the link between plastic crystal deformation and bulk material rheology. The study relies on the highest symmetry of the anisotropic tensor, a cubic symmetry, for which anisotropy is characterized by one parameter only, . First-order implications of anisotropy are quantitatively explored as a function of . The effective rheology of the material is described as a function of the orientation of the crystals and of the imposed stress and the validity of the isotropic approximation is discussed. The model, applied to ringwoodite, a cubic crystal with spinel-type structure, predicts that the dynamics of the transition zone in the Earths mantle is going to be strongly affected by mechanical anisotropy.