The Influence of Dynamic Recrystallization of Olivine on the Development of Seismic Anisotropy in the Mantle

Edouard Kaminski[1] **and Neil Ribe**[1]

[1] *IPG Paris - Université Paris VII, 4, place Jussieu, 75252 Paris Cedex, France*

The interpretation of seismic anisotropy in the mantle requires a knowledge of the relationship between the lattice preferred orientation (LPO) of crystals and the convective flow field. In order to better understand this link, we present a model for the evolution of LPO in olivine aggregates that deform by both intracrystalline slip and dynamic recrystallization. Dynamic recrystallization depends on the dislocation density of the grains, which is a function of the applied local stress. Grains with a large density of dislocations lower their bulk strain energyby nucleating strain-free subgrains at a rate proportional to a dimensionless nucleation parameter λ^*. Grains with high energy are then invaded by grains with low energy by grain boundary migration, at a rate proportional to a dimensionless grain boundary mobility M^*. The value of λ^* is constrained by observed LPO patterns in experimentally deformed olivine aggregates,and M^* is constrained by the temporal evolution of the strength of the LPO. For $M^* = 75 \pm 25$ and $\lambda^* > 3$, the model predictions agree well with the experimental results. When an initially isotropic aggregate is deformed uniformly, the mean orientation of the *a*-axis first follows the long axis of the finite strain ellipsoid and then evolves by GBM toward the softest orientation. At larger strain, it rotates towards the long axis of the strain ellipsoid corresponding to infinite time (the "infinite strain ellipsoid" or ISE). The mean *a*-axis orientation will align with the flow direction only if changes of the ISE orientation along flowlines are sufficiently slow, i.e. if $\Pi \equiv |\mathrm{D}\Theta/\mathrm{D}t|/\dot{\epsilon}_o \ll 1$, where Θ is the angle between the flow direction and the long axis of the ISE. We predict that the best approach to interpret seismic anisotropy is the direct calculation of synthetic seismograms from 3D mantle flow models for which the LPO can be calculated using the present model.