Geophysical Research Abstracts, Vol. 7, 03926, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03926

1 Modeling Anisotropy Development in the Lower Mantle

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In many parts of the earth seismologists have established that seismic waves travel at different velocities in different directions. This is the case in large parts of the upper mantle, in the D" zone near the core mantle boundary and in the inner core. In the upper mantle anisotropy is best understood and can be related to preferred orientation of olivine that was attained during convection. The interpretation relies on a detailed knowledge of microscopic deformation mechanisms, the effects of these mechanisms on reorientation of crystals in a macroscopic deformation field, and on the elastic properties of single crystals at given temperature-pressure conditions. Linked micro-macro-scale simulations have been used to predict realistic seismic anisotropy in the upper mantle. Here we investigate anisotropy development as material is subducted from the upper-lower mantle boundary (650 km) to the core-mantle boundary (2800 km). A tracer records the strain evolution in the geodynamical model. Two phases are considered: orthorhombic $MgSiO_3$-perovskite and cubic magnesiowuestite (Mg,Fe)O. Diamond anvil experiments can provide data about deformation mechanisms at very high pressure. Elastic properties at mantle conditions are obtained from first principles calculations. It is assumed that deformation is accommodated by slip. In the polycrystal plasticity model perovskite develops a strong texture and, averaged over appropriate single crystal elastic properties, it shows moderate p-wave anisotropy of up to 4 % near the core-mantle boundary. MgO has weaker preferred orientation but significant single crystal anisotropy, thus contributing also to overall anisotropy. Based

on these simulations it is predicted that seismic anisotropy is weak in the upper parts of the lower mantle and more pronounced in the lower parts, consistent with seismic observations. Local heterogeneity is expected.