Geophysical Research Abstracts, Vol. 9, 02575, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02575

Linking mineral physics and geodynamic mantle models

A.S. Piazzoni (1), H.-P. Bunge (1) and G. Steinle-Neumann (2)

(1) LMUniversity Muenchen, (2) BGI Bayreuth

Geophysical studies of the deep Earth now provide considerable insight into the physical state of our planet. In particular, seismic tomography has recentely brought a wide range of spatial mantle heterogeneities scales into focus, and geodynamic models that simulate 3D spherical convection at high resolution explore an alternative route for the temperature state of the Earth's mantle. Despite this progress, many important features in mantle structure remain unexplained by geodynamics, as the chemical state and the mineralogical thermodynamics of the deep Earth are not sufficiently well understood and described in mantle convection models. In addition to mantle structure, the mantle phase transitions could interact with upwelling and downwelling thermal structures in a complex way that cannot be easily modeled by parameterized buoyancy forces, e.g. based only on the post-spinel transition in the Mg2SiO4 part of mantle mineralogy. Only Mineral Physics models that relate pressure, temperature and chemical conditions to density and elasticity account for the complexity of phase transitions and for the change of the physical properties. Recent experimental and theoretical advancements in Mineral Physics have made it possible to build self-consistent models of the (dry) phases of the Earth's mantle. The models are based exclusively on physical and thermodynamic measurements. Here we have constructed a new thermodynamic database for the mantle and have coupled the resulting density dynamically (through the buoyancy term) with mantle convection models. The database is build on a self-consistent Gibb's free energy minimisation of the system MgO-FeO-SiO2-CaO-Al2O3 that is appropriate for standard chemical models of the Earth's mantle (e.g. pyrolite) for relevant high pressure and temperature phases. We have linked the database with a high-resolution 2-D convection code (2DTERRA), dynamically coupling the thermodynamic model (density) with the conservation equations of mantle flow. The coupled model is run for different parameterisations of viscosity, initial temperature conditions, and varying the internal vs. external heating. We compare the resulting flow and temperature fields to convection cases based on the Boussinesq approximation or other standard descriptions of the equation of state in mantle dynamics to assess the influence of realistic mineralogical density on mantle convection. The same Mineral Physics model provides the conversion of the temperature field into seismic velocities that allow the predictions of mantle convection to be tested with seismic observations.