Geophysical Research Abstracts
Vol. 12, EGU2010-9644, 2010
EGU General Assembly 2010

Constraints on thermochemical structure of the mantle from seismic and gravity data.

Fabio Cammarano (1), Gaia Soldati (2), Takashi Nakagawa (1), Lapo Boschi (1), and Paul Tackley (1)
(1) Geophysisal Fluid Dynamics, ETH Zurich (fabio.cammarano@erdw.ethz.ch) , (2) INGV Rome

We present preliminary results of an iterative inversion of seismic and density data for the 3-D thermochemical structure of the upper mantle. Our approach relies on a mineral physics model based on current knowledge of material properties at high pressure (P) and temperature (T). The phase equilibria and the elastic properties are computed by using a recent thermodynamical model covering a six oxides (NCFMAS) system. Anelastic properties are implemented with a P, T and frequency dependent law based on available mineral physics knowledge. The model predicts values of physical parameters (e.g., shear velocity, density) as function of pressure (or depth), temperature and composition. Equilibrium compositions or mixtures of different compositions (e.g., MORB and Harzburgite) can be considered.
First, we interpret available seismic models for temperature, assuming given compositions. For each model, we predict density and viscosity structure. Second, we compute the geoid kernels considering the average viscosity profiles of each model and perturb the 3-D density model(s). Density variations from the starting models are assumed to be due to lateral variations in composition. Consistently with the origin of such anomalies through melting extraction, we start by assuming only variations along a compositional axis that goes from harzburgite to MORB. We iterate the procedure until convergence. The inversion is implemented using a parametrization in spherical harmonics, a global scale basis which allows a clear analysis of the results in terms of relative contribution of different harmonic degrees (or wavelengths).
Although lateral variations in viscosity are not accounted for in the inversion, we evaluate their effects with a forward approach, using the numerical code STAGYY. The synthetics geoids are computed with instantaneous flow calculations and compared with observations. We also use extreme physical laws for the most uncertain material parameters, i.e. viscosity and anelasticity, in order to assess their role on the outcome of the inversion.
In general, we found that lateral thermal variations can explain most of the data. Including gravity data helps to determine lateral variations in composition. At a global scale, the dychotomy between continental and oceanic regions clearly emerges. Also, the large temperature variations between continents and oceans down to $\sim$300km produce large viscosity variations. In turn, these play a not negligible role on the geoid anomalies at spherical harmonics between 4 and 16 degrees.
Including higher frequency seismic data, comparing the results with available petrological information and adding more complexities into the compositional parametrization (e.g., water effects) can help to better resolve the thermochemical anomalies at a regional scale.