Geophysical Research Abstracts
Vol. 13, EGU2011-3113-2, 2011
EGU General Assembly 2011

Subduction to the lower mantle: A comparison between geodynamic and tomographic models

Bernhard Steinberger (1,2,3), Trond H. Torsvik (2,3,4), and Thorsten Becker (5)

(1) Section 2.5 - Geodynamic modelling, GFZ German Research Centre for Geosciences, Potsdam, Germany (bstein@gfz-potsdam.de, +49-3312881938), (2) Physics of Geological Processes, University of Oslo, Oslo, Norway, (3) Centre for Advanced Study, Norwegain Academy of Letters and Sciences, Oslo, Norway, (4) Centre for Geodynamics, Geological Survey of Norway, Trondheim, Norway, (5) Department of Earth Sciences, University of Southern California, Los Angeles, CA, USA.

It is generally believed that subduction of lithospheric slabs is a major contribution to thermal heterogeneity in Earth's entire mantle and provides a main driving force for mantle flow. Mantle structure can on one hand be inferred from subduction history and geodynamic models of mantle flow. On the other hand, seismic tomography models provide important information on mantle heterogeneity. Yet, the two kinds of models are only similar on the largest (1000s of km) scales and are quite dissimilar in their detailed structure. Here we provide a quantitative assessment how good a fit can be currently achieved with a relatively simple (viscous flow) geodynamic model. The discrepancy between geodynamic and tomography models can indicate where a model refinement could possibly yield an improved fit.

Our geodynamical model is based on a model of 300 Myr of subduction inferred from a global plate reconstruction. Density anomalies are inserted into the upper mantle beneath subduction zones, and flow and advection of these anomalies is computed with a spherical harmonic code and for a radial viscosity structure constrained by mineral physics and surface observations. Model viscosities in the upper mantle beneath the lithosphere are $\sim 10^{20}$Pas, and viscosity increases to $\sim 10^{23}$Pas in the lower mantle above D". Comparison with a number of recent tomography models is assessed in terms of correlation, both overall and as a function of depth and spherical harmonic degree. We find that, compared to previous geodynamic and tomography models, correlation improved significantly, both because of presumably improved plate reconstructions and improved treatment of mantle flow. However, the highest correlation values are still limited to lowest spherical harmonic degrees. Further improvement – in particular at spherical harmonic degree two – is achieved, if we include a basal chemical layer in the model. Subduction shapes this layer into two rather stable hot but chemically dense "piles", corresponding to the Pacific and African Large Low Shear Velocity Provinces. With the inclusion of these, we are also able to reproduce the large-scale features of the geoid as an outcome of our geodynamic model. Furthermore, we compute the degree-two geoid as a function of time and infer "true polar wander". If we also include a stable contribution due to the compositional "piles", we are able to explain essential features of observed true polar wander over the past 120 Myr.