Geophysical Research Abstracts
Vol. 16, EGU2014-13796, 2014
EGU General Assembly 2014

Influence of anelastic corrections to the temperature derivatives of seismic velocities on 3-D wavefields in geodynamically derived seismic mantle heterogeneity

Bernhard Schuberth (1), Claudia Gräber (1), Eldar Baykiev (1,3), and Christophe Zaroli (2)

(1) Ludwig-Maximilians-Universität München, Geophysics, Dept. of Earth and Environmental Sciences, Munich, Germany (mail@bernhard-schuberth.de), (2) Institute de Physique du Globe de Strasbourg (UMR 7516 CNRS, Université de Strasbourg/EOST), 5 rue René Descartes, 67084 Strasbourg Cedex, France, (3) Dept. of Petroleum Engineering and Applied Geophysics, Norwegian University of Science and Technology 7491 Trondheim, Norway

Recently, we have developed a new joint forward modeling approach to test geodynamic hypotheses directly against seismic data: Seismic heterogeneity is predicted by converting the temperature field of a high-resolution 3-D mantle circulation model into seismic velocities using thermodynamic models of mantle mineralogy. 3-D global wave propagation in the synthetic elastic structures is then simulated using a spectral element method. Being based on forward modelling only, this approach allows us to generate synthetic wavefields and seismograms independently of seismic observations.

The statistics of observed long-period body wave traveltime variations show a markedly different behaviour for P- and S-waves: the standard deviation of P-wave delay times stays almost constant with ray turning depth, while that of the S-wave delay times increases strongly throughout the mantle. In an earlier study, we showed that synthetic traveltime variations computed for an isochemical mantle circulation model with strong core heating can reproduce these different trends. This was taken as a strong indication that seismic heterogeneity in the lower mantle is likely dominated by thermal variations on large length-scales; that is, relevant for long-period body waves.

To test the robustness of our earlier conclusion, we address now the question on the influence of anelasticity on the standard deviation of synthetic traveltime variations. Owing to the differences in seismic frequency content between laboratory measurements (MHz to GHz) and the Earth (mHz to Hz), the seismic velocities given in the mineralogical model need to be adjusted; that is, corrected for dispersion due to anelastic effects. This correction will increase the sensitivity of the seismic
velocities to temperature variations. The magnitude of this increase in sensitivity depends on absolute temperature, frequency, the frequency dependence of attenuation and the activation enthalpy of the dissipative process. Especially the latter two are poorly known for mantle minerals and our results show that variations in activation enthalpy produce the largest differences in temperature sensitivity with respect to the purely elastic case. We will present new wave propagation simulations and corresponding statistical analyses of traveltime measurements for different synthetic seismic models spanning the possible range of anelastic velocity conversions while being based on the same mantle circulation model.