Seismic constraints on Earth's small scale structure

Sebastian Rost[1]

[1]Institute of Geophysics and Tectonics, School of Earth and Environment, The University of Leeds, Leeds, LS2 9JT, United Kingdom

*s.rost@leeds.ac.uk

In recent years, seismology was extremely successful in imaging the interior of our planet. Most of these results indicate that Earth's mantle is far from being homogeneous. Strong heterogeneities have been detected on many scale lengths spanning several orders of magnitude from 1000's of kilometers to the smallest detected structures with scale lengths of a few 10's of kilometers. Smaller structures in the mantle are likely and their detection depends on increased seismic resolution. Seismic imaging uses a wide variety of seismic probes. These are, in general, sensitive to different scale lengths ranging from seismic tomography imaging structures spanning hundreds of kilometers to scattering studies resolving structures below the seismic wavelength of short-period seismic waves. Together with new developments in mineral physics, geochemistry and geodynamics these seismic images help to better understand the composition, evolution and dynamics of our planet.

The core-mantle boundary (CMB) is arguably Earth's most important internal boundary. The CMB and the surrounding area of the D"-region likely control many processes from plate tectonics to the generation of Earth's magnetic field. The seismic models of the lowermost mantle include a variety of features such as intermittent sharp horizontal discontinuities which show considerable topography, seismic anisotropy, strong seismic scattering, thin ultra-low velocity zones (ULVZ) and large low velocity provinces that are likely related to chemical heterogeneities.

Using high-quality seismic data from seismic arrays and networks it is possible to resolve the short-period band of the spectrum of these structures. We use the seismic data together with models from geodynamics and information from mineral physics and geochemistry to develop models that connect the fine scale structure of the Earth with the dominant structures imaged in tomography such as the large low velocity provinces at the CMB and the high-velocity regions surrounding them.

This lecture will present several examples of high resolution studies of the Earth's interior from the mid-mantle to the CMB. Using several seismic probes it is possible to develop a composite image of the mantle structure that allows inferences about Earth's current dynamics and structure and its evolution.