Probabilistic tomography and mineral physics : A new view on the old mantle

J.TRAMPERT

Department of Earth Sciences, Utrecht University, Netherlands

The most compelling evidence for compositional heterogeneity emerged from several observations of regions with high ratios of relative S to P velocity heterogeneity and a general anti-correlation between bulk-sound and shear wave speed in the lowermost mantle. No consensus has been reached yet, since the inferences are study dependent, most likely due to the inherent non-uniqueness of the associated inverse problem. Using a Monte Carlo technique, we identified all possible models compatible with seismic data (fundamental mode and overtone phase velocity data and normal mode splitting functions). Sambridge's Neighbourhood Algorithm does not need ad hoc damping parameters, the algorithm is easy to tune, and most importantly, it converts the solutions into probability density functions for long wavelength models (spherical harmonic degree 2, 4 and 6) of bulk-sound and shear wave speed, density and boundary topography in the mantle. Using appropriate sensitivities (which take into account our ignorance on the thermodynamic reference state and the published range of mineral physics data), we convert the results from probabilistic tomography into likelihoods of variations in temperature, perovskite and iron content throughout the lower mantle. Several robust features emerge which are shedding a new light on the nature of the lower mantle. Throughout the mantle temperature variations are much weaker than classically inferred from shear wave speed alone. Compositional variations are essential to explain the seismic data. In most places, the inferences are robust, i.e. the amplitudes of chemical variations are much larger than the uncertainties inferred from the width of the likelihoods. Below 2000 km, the correlation between relative shear wave speed variations and temperature is quite low. In particular, we find that the much debated superplumes beneath the Pacific and Africa are due to an enrichment in perovskite and iron. This makes these features denser than the surrounding mantle and hence not buoyant. We compare our results to models of thermo-chemical convection, some including a post-perovskite phase.