A Multi-Discipline Approach to Investigate Shear-wave Anomalies in the Lower Mantle

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Broad, low velocity anomalies in the lower mantle beneath Africa and the Pacific are conspicuous features in global shear-wave tomographic images. Currently it remains uncertain whether these structures are dense thermochemical piles or superplumes or clusters of relatively narrow isochemical plumes which appear blurred due to the non-ideal distribution of sources and receivers used in the tomographic process. In collaboration with Jeroen Ritsema, Carolina Lithgow-Bertelloni and Lars Stixrude, we develop a multi-discipline approach (geodynamics-tomography-mineral physics) to analyze conceptual geodynamical models that have been filtered by the resolution matrix of the tomographic model S20RTS. Using this method, which allows us to quantify the effects of heterogeneous resolution in seismic images, we aim to distinguish between thermochemical structures and thin isochemical upwelling as the cause of the seismic anomalies. Using wavespeeds derived from first-principle mineral physics, we consider both spherical thermochemical and isochemical geodynamic convection models with imposed plate history for recent geologic history. We show that although both isochemical and thermochemical structures in the geodynamic models undergo some degree of blurring during filtering, the thermochemical model is better able to recreate the anomalous structures observed in tomography. We also choose to investigate the influence which the imposed core-mantle boundary temperature has on the geometry of the anomalous structures in our filtered geodynamical models, demonstrating that the temperature at the base of the mantle is an important parameter to constrain when considering models of lower mantle structure.