AGU FALL MEETING
San Francisco | 14 – 18 December 2015

DI51A-2613: Understanding slow velocities in the European upper mantle – evidence for melting?

ABSTRACT

Friday, 18 December 2015
08:00 - 12:20
Moscone South - Poster Hall

We present a thermochemical interpretation of the S-wave speed structure beneath Europe, as obtained from full waveform seismic tomography.

The European upper mantle is characterised by seismic wave speeds that are slower than the global average. However, especially low velocities (< 4.0 km/s) are seen beneath Iceland and other parts of the mid-Atlantic ridge, as well as beneath Iberia, reaching a maximum between 120-130 km. Using experimental data from mineral physics and statistical thermodynamic modelling, we seek to reconstruct the observed Vs distributions with appropriate thermochemical models. By working with a high-resolution tomography model in which the wave speed structure is given in terms of absolute rather than relative (% anomaly) velocities, we can in turn constrain absolute properties of the thermochemical structure rather than just the amplitude of lateral variations. Using Vs alone, in the absence of any other observable (e.g. Vp, density), it is difficult to constrain the chemical composition. This is because chemistry (C) and temperature (T) have sensitivities to Vs which trade off with each other. At the same time, we find that 3-D variations in chemical composition are required by the data in order to avoid unrealistically large temperature variations and over-interpretation of the seismic structure in terms of temperature.

Even with taking into account mineral intrinsic anelasticity and allowing for the presence of fluids, it is very difficult to create sufficiently low velocities to fit the slowest regions of the tomography model, using simple variations in T or C. Doing so requires either extremely high temperatures or unfeasibly high attenuation. However, the slowest velocities can readily be modelled by including a few percent melt. Additionally the anisotropy structure in the slow regions is broadly compatible with predicted models of melt storage in the upper mantle. We discuss whether melt provides the most likely explanation for the slow regions, considering also the effect of more advanced anelasticity models such as “elastically accommodated grain boundary sliding”, recently suggested by Karato et al (2015).

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