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Global Seismic LAB measurements from full waveform tomography

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In a recent 3D radially and azimuthally anisotropic model of the upper mantle in north America [1] we showed that azimuthal anisotropy is a powerful tool to detect layering in the upper mantle. Two domains in the cratonic lithosphere are observed, separated by a sharp laterally varying boundary in the depth range 100-150 km, which seems to coincide with the mid-lithospheric boundary (MLD). In addition, azimuthal anisotropy also detects the lithosphere-asthenosphere boundary (LAB) as manifested by a change in the fast axis direction, which becomes quasi-parallel to the absolute plate motion (APM) below ~250 km depth. A zone of stronger azimuthal anisotropy is found below the LAB both in the western US (peaking at depths of 100-150km) and in the craton (at a depth of about 300 km).

Here we show preliminary attempts at expanding our approach to the global scale, with a specific goal of determining whether anisotropic LAB can also be observed in both the global continents and oceans. We started with our most recent global upper mantle radially anisotropic shear velocity model, determined using the Spectral Element Method [2,3], and augment the corresponding global surface wave and overtone dataset (period range 40 to 400 s) with deep events as well as shorter period body waves, in order to ensure optimal deeper depth (>250km) anisotropy recovery due to the paucity of shear wave splitting measurements in the oceans.

Our preliminary results, which do not yet incorporate sparse SKS splitting measurements, look promising as they not only confirm the layering found previously in North America (NA) (using a different, global dataset and starting model here), but also extend the NA observation to the major continents. We observe globally a shallow continental lithosphere whose fast axis directions seem to spatially correlate with structure trends of surface tectonic units. At depths of 150-250km a coherent anisotropy domain is found, which, albeit weak in amplitude, possesses systematic quasi APM-parallel anisotropy directions. In the Pacific, our study confirms earlier azimuthal anisotropy results in the region [4-8] that the shallow upper mantle beneath the ocean basin is strongly stratified. The boundary between the anisotropy domains clearly follows the age progressive deepening of the fast velocity in the shallow domain, suggesting an oceanic LAB that separates the Pacific lithosphere and the underlying asthenosphere.

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