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Revealing fine layering within cratonic upper mantle using H-κ-φ anisotropic stacking with crust-corrections

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Seismic imaging with converted body waves has been used to infer layering within the global lithosphere leading to observations of a globally ubiquitous boundary known as the mid-Lithosphere discontinuity (MLD). Explanatory models include partial melt/chemical stratification, anisotropy, and elastically-accommodated grain-boundary sliding; each with unique implications for the geological evolution of continents. We present a new method for investigating these hypotheses, using a parametric approach which involves stacking of three-component earthquake-source deconvolved- receiver function traces.

We conduct a statistical parameter search to determine the lithospheric discontinuity depth (H), the wave-speed ratio (κ), and order,φ , of harmonic back-azimuth variations, which can distinguish conversions from sub-crustal layers with anisotropic media. We demonstrate the procedure with a pilot study of synthetic waveforms and long-running seismic stations located in the Precambrian region of the US. We target sub-crustal depths, and distinguish between free surface reverberations, using a suite of high-resolution crustal 1D (PREM, IASP91, AK135) and 3D models (Crust1.0, LITHO1.0, and EMC-US.2016) velocity models. The results have important implications for the origin of the MLD and the approach can be used to study other cratonic regions globally.