Fine-scale structure of the bottommost mantle beneath Cocos Plate

Chunpeng Zhao
zhaochp@asu.edu
School of Earth and Space Exploration, Arizona State University, Tempe, Arizona, USA

Edward Garnero
garnero@asu.edu
School of Earth and Space Exploration, Arizona State University, Tempe, Arizona, USA

Using Transportable Array (TA) data from EarthScope’s USArray, we have constructed a data set of ~2000 high quality SH component seismograms to investigate the fine structure of the bottom 10’s kilometers of the mantle beneath the Cocos and Caribbean plates. This region has been previously identified to have higher-than-average shear velocities, and velocity discontinuities some 100’s of km above the core mantle boundary (CMB). We have developed a new ScS stacking approach that simultaneously utilizes the pre- and post-cursor wavefield to study the fine scale shear velocity structure right at the bottom of the mantle, such as ultra-low velocity zones (ULVZs), and forward and/or backward transitions across the perovskite-to-post-perovskite phase boundary. We stacked source-deconvolved ScS waveforms to extract and combine the ScS pre- and post-cursors with ScS removed – stripping ScS from recordings permits investigation of fine-scale layering near the CMB, which would otherwise be obscured by ScS. Stacking the data significantly suppresses incoherent noise while enhancing coherent features in the wavefield. Synthetic seismograms show that the time-amplitude behavior of the stacked-stripped signals are sensitive to velocity structure in the bottom 100 km of the mantle. While ULVZs are most commonly associated with low velocity, presumably warmer, provinces in the deepest mantle (owing to the partial melt hypothesis for their origin), some ULVZs have been noted in higher-than-average velocity region in deep mantle. This raises the possibility of a chemically distinct origin to some ULVZs, and we thus pursue this region with unprecedented dense sampling for boundary layer structure at the CMB. In the western portion of our study area, a previous study noted a small ULVZ, but most of the study area has not been specifically probed for ULVZ. While much of our study region appears consistent with models lacking any significant CMB heterogeneity, preliminary results show compelling evidence for both high and low
velocity layering in the bottom 10’s of km in some spots, with some suggestion of geographical correlation to large-scale shear velocity heterogeneity. We will compare these results with our recent work in the central Pacific, which shows abundant evidence for ULVZ structure.