Mapping lithospheric structure using depth phase precursors recorded by EarthScope’s USArray

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Abstract:

Precursors to teleseismic depth phases such as pP or sS have been used to detect MOHO and possible intracrustal boundaries (Schenk et al., 1989; Zandt et al., 1994; McGlashan et al., 2008a), the LAB lithosphere-asthenosphere boundary (McGlashan et al., 2008b) and various within mantle boundaries at 80 km, 210 km, 330 km, 440 km and 660 km (Zhang and Thorne, 1993; Flanagan and Shearer, 1998; Shearer and Flanagan, 1998; McGlashan et al. 2008b). However, new large scale, high density seismic arrays such as EarthScope’s provide much more powerful means of detailing such features with these phases. EarthScope’s USArray has a station spacing about 70 km and covers a large area of the continental US. From the EarthScope open dataset we have extracted recordings of intermediate to deep (150 km to 700 km) earthquakes from subduction zones around the Pacific Rim. With proper phase alignment, filtering and coherency enhancement, we use the precursors to pP from slab earthquakes beneath South America to image the underside reflections from Moho (pmP), from the LAB (plP) and from possible 410 (p410P) discontinuities. The redundancy provided by the EarthScope’s USArray allows us to enhance signal-to-noise ratios by stacking within common reflection point bins and application of multichannel coherency filters. In the Andean case, we gathered the underside reflection points in 4 km * 40 km bins for stacking, resulting in substantial improvement in the resulting image. Synthetic seismograms confirm that the observed arrivals are appropriate for reflections from the Moho and LAB. The observation of specular reflections from the underside of the LAB is particularly significant, as this boundary has been proven difficulty to image by traditional seismic techniques. Comparable results have been obtained from deep earthquakes beneath western Pacific island arcs for the adjacent oceanic lithosphere and interpretation of these reflections needs to be further considered. We suggest that this technique applied to recordings from new seismic arrays like EarthScope’s USArray can make significant new contributions to our understanding of lithospheric structure around subduction zone.