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Receiver Function Images of the Lithosphere in the Western U.S. from USArray

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We are making P- and S-wave receiver functions from USArray Transportable Array station data to examine lithospheric and upper mantle structure beneath the western US. At present the Transportable Array extends from the U.S. West Coast to as far east as ∼106°W, and thus crosses the San Andreas system, the Cascadia subduction zone, the Cascade volcanic arc and Sierra Nevada batholith, the Snake River Plain and Columbia flood basalts, the Basin and Range, part of the Southern Rocky Mountains, and about half of the Colorado Plateau. Our preliminary results are for PdS receiver functions: We have constructed common conversion point (CCP) stacked volumes for the western U.S. using both a standard reference velocity model for ray tracing, and a model based on the 3D North American S-wave model NA04 (van der Lee and Fredeiksen, 2005), and updates to it made more recently with USArray data (Bedle and van der Lee, 2007). For the 3D models we correct the travel times for PdS scattering using the linear travel time tomography corrections. The various stacks contain between 10,000 and 50,000 receiver functions from 50 to 350 earthquakes recorded at more than 400 stations.

The preliminary stacked volumes show a number of interesting lithospheric features, particularly the lithosphere-asthenosphere boundary (LAB). We identify the LAB as a negative polarity event at various depths beneath the Moho, above the zone of contamination from crustal multiples in PdS receiver functions. In northwestern Nevada near (120°-117°W, 40°-42°N), the LAB appears to shallow almost to Moho depths (∼30 km), but is otherwise at about 60km depth beneath the rest of the Basin and Range. These results are in good agreement with SdP receiver functions by Li et al., 2007.

To the north beneath the Snake River Plain and Columbia flood basalts, the LAB is deeper, broader, and centered at about $\sim$75 km depth. In a number of places two negative events appear beneath the crust, indicative of two low velocity features, which suggests two possible zones of partial melt in the uppermost mantle. The southernmost Sierra Nevada, Mojave block, and southern Basin and Range have an eastward thickening lithosphere, with the LAB increasing in depth from $\sim$50 to 70km under the southwestern edge of the Colorado Plateau. The Sierra Nevada has lower crust and upper mantle complications previously identified by Zandt et al., 2004. The Transverse Ranges also show upper mantle complications previously identified by Humphreys et al., 1984.

We note that in this and other datasets we have examined, an accurate crustal velocity model can reposition Moho depth from that obtained from a reference model by several times the formal depth error, i.e. more than 5 km. This is also presumably true for the depth to the LAB.