Imaging Lithospheric Seismic Discontinuities beneath Cascadia using S-to-P Receiver Functions

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Strong, sharp seismic discontinuities in the 60 –110 km depth range are now frequently imaged and sometimes related to the lithosphere-asthenosphere boundary. However, determining the exact relationship has proven challenging, and interpretations diverge particularly between the continents and the oceans. Here we use S-to- P receiver functions recorded by the Cascadia Ocean Bottom Array and the western most Transportable Array to image crust and upper mantle discontinuity structure beneath the Juan de Fuca and Gorda Oceanic Plates and western North America. We handpick events from epicentral distances 55 –80 degrees away, choosing 5021 waveforms of which 343 are from ocean bottom seismometers. We use an extended time multi-taper technique to deconvolve the waveforms and migrate to depth in 3-D. We image a positive phase, or velocity increase with depth, that corresponds to an oceanic Moho at 6 –7 km depth and a continental Moho at 33 –37 km depth. We also image a negative discontinuity beneath the ocean plate that thickens with age from 25 –45 km depth beneath the oceans in general agreement with expectations from half-space cooling. Waveform and geodynamic modelling indicate that these are defined by melt. This suggests that melt exists at the base of the plate, defining it, and that melt is likely transported along the base of the plate towards the mid-ocean ridge. In addition, we image a deeper discontinuity at 55 –75 km beneath the continental lithosphere also likely related to the lithosphere-asthenosphere boundary.

Keywords: lithosphere-asthenosphere, seismic, receiver function, Cascadia, melt, ocean plate

