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SS Precursor and Receiver Function Imaging of the Lithosphere Asthenosphere Boundary

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The lithosphere-asthenosphere boundary is fundamental to our understanding of plate tectonics and mantle dynamics. It is well established that a rigid lithospheric lid moves over a weaker asthenosphere. New high resolution imaging of the boundary has constrained the associated velocity gradient, showing that a mechanism in addition to a thermal gradient, such as melt or composition is required to explain the sharp nature of the boundary at least in some locations. However, a unified definition of the tectonic plates remains unknown. To fully understand this enigmatic boundary I compare the lithosphere-asthenosphere boundary using multiple methodologies such as SS precursors, S-to-P, and P-to-S receiver functions to attain the best-resolution possible given data coverage. The boundary is imaged beneath a variety of tectonic environments including continental cratons, margins and oceans. Sharp boundaries are frequently imaged at depths which could reasonably be associated with the lithosphere-asthenosphere boundary beneath continental margins and regions that have been tectonically altered in the past ∼500 My. However, beneath continental interiors sharp boundaries have been imaged at shallow depth (∼60 – 140 km) yet no sharp boundary at the base of the craton (depths > 200 -250 km) has been definitively and consistently imaged. Beneath oceans sharp boundaries have also been imaged and interpreted as the lithosphere-asthenosphere boundary. However, they have been imaged both at constant depth and also increasing in depth with age, leaving large questions regarding the dynamics of the system. Anisotropy and variations in waveform sensitivity likely reconcile apparent contradictions. Investigation of the behavior of the boundary at the transition of tectonic environments lends further insight. For instance, at the transition from continent to ocean spreading at the Ethiopian Rift System the boundary is quite sharp on the flank of the rift, defined by melting. A steep slope from flank to rift suggests that the permeability boundary that the mantle lithosphere beneath the rift has been destroyed and replaced by convecting asthenosphere. The slope implies lithospheric rigidity and a boundary defined by permeability. Overall, lithospheric structure may be complicated, but detailed investigations at a variety of tectonic environments and the transitions between environments suggest that seemingly contradictory observations may be reconciled and a better global understanding of the lithosphere-asthenosphere boundary may be near.