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P and S waveform modeling of continental sub-lithospheric detachment at the eastern edge of the Rio Grande Rift

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East of the Rio Grande Rift, tomographic images of teleseismic data have revealed a SE dipping, slab-like structure underneath the western edge of the Great Plains in the southwestern United States. However, finite difference synthetics of such a model do not reproduce the waveform distortions as observed in broadband waveform data recorded along the La Ristra Transect. In addition to travel time anomalies, Song and Helmberger (2006) demonstrated how to use S waveforms and their amplitude patterns to further constrain on the magnitude of the anomalous structure. Their preferred model suggests the slab-like structure is about 4 % fast, 120 km thick and dipping $70^{\circ} - 75^{\circ}$ to the SE to about a depth of 600 km. We adopt the preferred S wave model from Song and Helmberger (2006), and scale the P wave model using a suite of scaling factors $dlnV_s/dlnV_p$. We find the scaling factor $\sim$ 1.25 fits the P waves broadband waveforms and amplitude patterns best. Such a low SF indicates that the slab-like anomaly is probably also compositionally distinct and SF $\sim$ 1.25 corresponds to $\Delta(V_p/V_s) \sim$ -0.77 % when $\Delta V_s/V_s \sim$ 4 %. This result suggests that the slab-like anomaly is depleted and its $Mg\#$ ($Mg/(Mg + Fe) \times 100$) is nearly 3 units higher than that of the adjoining mantle athenosphere. This estimate is consistent with xenolith data on variations in $Mg\#$ between the sub-continental lithosphere and the mantle athenosphere. Temperature contrast at depths below 200 km can reach $\sim$ 310 $\pm$ 20 $^{\circ}C$ and it is probably large enough to promote the observed foundering of the continental lithosphere beneath the western Great Plains. Since the deeper part of the continental lithosphere is less depleted it can be recycled into the mantle.