Hunting for Ultra Low Velocity Zones using SKS and SKKS Differential travel time residuals

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Introduction

Ultra-low velocity zones (ULVZ’s) are characterized as localized thin (5-40 km thickness) layers at the CMB of strongly reduced seismic velocities but increased density. ULVZs influence multiple aspects of mantle dynamics and might be the source of mantle plumes, regions of core material invading the mantle, and/or geochemically distinct regions such as the remnants of a global magma ocean or currently undefined exotic material.

Results and Interpretation

Figure 5 (left). The results of the differential travel time residual calculations for the SKS/SKKS CMB entry points (top) and exit points (bottom). Points are plotted where the path indicated by the statistical analysis (2008-SKS, 2009-SKS and SKKS, 2010-SKS). The white symbols represent regions with a negative differential travel time whereas black symbols indicate positive differential travel time residuals. Negative travel time residuals indicate low velocity zones along the SKS raypath or high velocity along the SKKS raypath. Positive residuals indicate the high velocity anomalies along the SKS raypath or negative velocity anomalies along the SKKS raypath. Here the white cluste of + symbols is interpreted as an ULVZ on the entry side. The black cluste of + symbols is interpreted as a possible high-velocity anomaly on the exit side. Therefore the high velocity signal may be due to raypath multipathing within the West Pacific slab geometry. The background is Grand’s Tomography model (Grand, 2002).

Figure 6 (above). The ULVZs identified in Figure 5 are quite concordant with other previous studies as they are located near edge of the Pacific Large Low S Velocity Province. Moreover the potential ULVZs in this study occur in a region that has contain mixed results of detection and non-detection from various seismic probes (e.g. Scp, Pcp, Sks). The gray dots indicate the approximate locations of the ULVZs detected in this study whereas previous detections (red) and non-detections (blue) (Figure modified from McNamara et al, 2010).

Conclusions

• A possible ULVZ is identified near the edge of the Pacific Large Low S Velocity Province. This detection signal may additionally be influenced by fast velocities along the SKKS path (circles in Figure 5).
• A region of fast velocity in the lowermost mantle is identified near the Caspian sea. This region is coincident with a high velocity structure identified in the Grand (2002) tomographic model.
• To determine the validity of the interpretations future work employing additional phases such as Scp and Pcp as well as more detailed modeling is required.

Any Questions? Ask me via e-mail: aldwin.vazquez@upr.edu

References