Quantify chemical stratification in the mantle transition zone using USArray data

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Plate tectonic processes operating over much of the Earth’s history induce long-term mantle mixing of chemical heterogeneities, recycling of volatiles into the mantle and regulate basalt geochemistry. Fundamental questions relevant to the mantle transition zone concern the nature of phase transition, the distribution of chemical heterogeneities (e.g., harzburgite, basalt), the temperature gradient, as well as the degree and extent of hydration and melting. One particularly important question is how the slab stagnation may be influenced by hydration or/and basalt enrichment in the mantle transition zone. To help answer these questions, we aim to detail upper mantle seismic discontinuity properties, including the shear velocity contrast, the density contrast, the transition sharpness and the gradient using high-quality receiver functions using broadband data.

We collect USArray seismic data and calculate receiver functions up to 350 s after the P arrival. Stacked receiver function record sections show robust detection of forward converted waves and backward scattering of top-side reflections between 0.1 Hz and 0.5 Hz. Timings of the forward/backward scattering waves are migrated to obtain the topography of the 410 and 660. Frequency-dependent amplitudes of forward and backward scattering waves are analyzed to estimate the shear velocity and density jump, as well as the transition width and local velocity and density gradient near the 410 and 660 beneath the US continent. To examine the impact of long-term subduction on the thermochemical state of the transition zone, we will compare features of TZSDs in the tectonically active western US and stable eastern US, while contrasting them against the result previously obtained in the east Asia beneath the Chinese continent and South Korea.

Keywords: transition zone, USArray, forward and backward scattering waves, long-term subduction, chemical stratification

