Toward a comprehensive understanding of transition zone discontinuities: Inferences on the thermochemical state of the transition zone near a stagnant slab region beneath China

*Teh-Ru Alex Song[1], Xuzhang Shen[2], Lars Stixrude[1], Carolina Lithgow-Bertelloni[1]

1. Seismo Lab, Department of Earth Sciences, University College London, UK, 2. Lanzhou Institute of Seismology, China Earthquake Administration, China

Plate tectonics and subduction operating over much of the Earth’s history can induce mantle mixing, chemical heterogeneities and recycle volatiles into the mantle. Some slabs are penetrating into the deep lower mantle, but others are stagnated near the transition zone (TZ). Presumably, the thermochemical state of the TZ is a consequence of delicate balance and feedback between the short-term and long-term mixing.

TZ seismic discontinuities hold the key resolving the mystery of mass and heat transport in the Earth’s mantle as well as the composition of the Earth’s interior. But deciphering discontinuity properties are not trivial. Data were typically limited to either mantle triplications, converted waves (P-to-S or S-to-P) or mantle reflections (e.g. SS precursors, ScS reverberations). These observations place constraints on the velocity gradient near the discontinuity as well as discontinuity reflectivity, but hardly offer independent information on the density jump or/and density gradient. In few cases where multiple datasets are jointly analyzed to resolve the density jump, the region of sensitivity (or the fresnel zone) of different dataset does not necessarily coincide. Finally, the use of short period (~1 Hz) data (e.g., P’P’ precursors) or long period (~> 0.1 Hz) data (e.g., SS precursors) does not allow us to simultaneously address the transition width and the gradient near the discontinuity.

We advocate a simple and effective strategy. Specifically, we involve broadband direct converted waves (e.g., P410s, P660s) and the topside reflections (the multiples, e.g., PpP410s, PpP660s) in the context of P-wave receiver function technique. Such a tactic not only minimizes tradeoffs between velocity and density jumps, but also allows self-consistent estimates of the shear velocity jump, the density jump, the transition width and the velocity/density gradient near the boundary. We will detail our first attempt near the region of stagnant slab beneath China. These new observations, along with the thermodynamic framework, HeFESTo, allow us to test and validate hypotheses including the state of mantle mixing and equilibrium, compositional heterogeneities and the degree of hydration in the TZ.

Keywords: transition zone, receiver function, mantle mixing

