S-velocity structure of the mantle transition zone beneath the Northwestern Pacific inferred from waveform inversion and its geophysical interpretation

*Lina Yamaya[1], Anselme F. E. Borgeaud[1], Kenji Kawai[1], Maxim Ballmer[2]

1. Department of Earth and Planetary Science, School of Science, University of Tokyo, 2. ETH. Zurich Swiss Federal Institute of Technology Zurich

Studies for the mantle transition zone (MTZ) structure can contribute to the understanding of the mantle dynamics. Fukao & Obayashi (2013) show that some slabs are stagnant but the stagnant depths are different according to each region, which can be controlled by the difference of the mix of mantle components (Ballmer et al. 2015).
The MTZ structure has been inferred by travel-time tomography studies (e.g., Gorbatov & Kennett 2002; Fukao & Obayashi 2013) and forward modeling approach (e.g., Tajima et al. 2014). However, the seismic waveform data are triplicated because of the discontinuities for 440 km and 660 km depths so that travel-time tomography cannot utilize the travel-time of later phases which are sensitive to the MTZ structure. Also, forward modeling studies have contributed greatly to understanding geodynamics, but there are several inherent problems such as effects of source-side structure and lack of objectivity. We have developed new methods for quantitative and objective waveform inversion of body wave data for localized structure in the Earth’s deep interior (Kawai et al. 2014), inferred the detailed S-velocity structure in the lowermost mantle using the overlapped phases such as S and ScS (Suzuki et al. 2016; Borgeaud et al. 2017), and contributed to the understanding of dynamics of slabs subducted to the core-mantle boundary. Therefore, in order to objectively infer the detailed structure in the MTZ we apply them to dataset mainly composed of overlapped triplicated S phases for many events and many stations. First, we divide the target region into several sub-regions and infer the regionalred 1-D S-velocity structure by waveform inversion. We confirm that the structure on the continent side is different from that of the oceanic side. Second, we compare the inferred 1-D velocity profiles to synthetic velocity profiles that are calculated for simplified scenarios of thermal and compositional MTZ structure. Accordingly, we can constrain the regional enrichment of the MTZ by mafic materials (e.g. mid-ocean ridge basalt, MORB), and the thickness of any such a basaltic layer. Thereby, we test whether the stagnant slab can deliver MORB to the MTZ, or rather tends to dynamically remove any pre-existing MORB reservoir.

Keywords: Mantle transition zone, Waveform inversion

