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It has long been considered that the large ground motion from deep-focus earthquakes traveling long distances along the plate is explained by efficient guiding of seismic wave inside the high-V and high-Q plate in the subduction zone. However, the seismic wave is easily escaping into the surrounding low-V mantle from the high-V slab with a strong velocity gradient from the center to the outer part of the slab constrained by its thermal regime. The observed ground motions traveling long distances along the slab show low-frequency (f < 0.25 Hz) onset for P and S waves, followed by large, high-frequency (f > 2 Hz) coda with long tail, but such feature of the slab guided wave cannot be explained by the traditional simple high-Q and high-V model.
Now, the character of the high-frequency and lengthy seismic waves is explained by multiple forward scattering of seismic waves in the heterogeneous slab (Furumura and Kennett, 2005). The heterogeneity is well modeled by stochastic representation of velocity fluctuations using the von-Karman distribution function with horizontally elongated correlation length of about 10 km and much shorter (0.5 km) correlation length in vertical, with a standard deviation of about 2%, or more reality it grows from 0.5 to 2.5 % from the top to bottom of the slab (Kennett and Furumura, 2015). Such a quasi-lamina feature of the heterogeneities in the slab is very efficient to develop forward scattering of high-frequency wave with much shorter wavelength than heterogeneity scale, and low-frequency onset as a result of multiple diffractions. The net result of high-Q and high degree of heterogeneity in the slab is a strong frequency-dependent, which capture only high-frequency (f > 2 Hz) and escapes intermediate-frequency (f=0.1-1 Hz) signals. Very low-frequency signals (f < 0.15 Hz) with much longer wavelength than the slab thickness are not affected by the slab.
As for very deep-focus (h > 400 km) earthquakes, the waveguide effect for the intermediate frequency (f=0.2-1 Hz) signal will be changed and is captured inside the slab due to an additional low-V anomaly inside the slab. As is recognized that the phase transformation from olivine to spinel in the subducting cold slab develops wedge-shape anomaly (metastable olivine wedge; MOW) at the center of the slab at depth between 400 and 560 km. The sudden change in the waveform for very deep (> 400 km) events with much elongated P and S wave precursors than those for shallower events (< 400 km) was noticed in the F-net broadband records of the Pacific slab events beneath Sea of Japan (Furumura and Padhy, 2014). This observation should be a strong evidence for the existence of low-V anomaly at the depth to capture and guide intermediate frequency signal. The detectability of the MOW inside the slab in the waveform anomaly had been discussed based on numerical simulation (e.g., Vidale, 1991; Koper and Wiens, 2000; Yoshioka and Murakami, 2012) and analysis of observed long-period records at teleseismic distances (e.g., Kaneshima et al., 2007). This additional waveguide property of a thinner low-V MOW resembles to the previously reported oceanic-crust guided wave occurred for shallower events in the brittle oceanic crust (e.g., Fukao et al., 1983; Hori et al., 1985). The finite difference method (FDM) simulation demonstrated the preferred MOW model in

the Pacific slab is about 100 km wide at 400 km depth and wave-speed anomaly is 6% lower than the surrounding slab to explain observation. This is consistent with the previously investigated MOW model based on travel time anomaly analysis (e.g., Iidaka amd Suetsugu, 1992; Jiang et al., 2008; PanKow et al., 2012) and receiver-function studies (e.g., Kawakatsu and Yoshioka, 2011) etc.

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