Strong S-wave attenuation in the mantle wedge beneath the NE Japan and interpretations of high-frequency wave propagation path of intraslab earthquakes

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For intraslab earthquakes at intermediate-depths in NE Japan, especially at greater than about 100-km depths, it has been often recorded that high-frequency waveform higher than 8 Hz show a remarkable delay of arrival compared with S wave which predominates in a low-frequency band. The magnitude of the delay is little in the forearc region, whereas it increases up to about 40 s in the backarc region. In this study, we investigate the details in the propagation processes of the high-frequency later phase observed for the intraslab earthquakes at the intermediate-depths. To constrain the source location of the high-frequency later phase, we employ the source-scanning algorithm (SSA) [Kao and Shan, 2004] with realistic velocity and attenuation structures, assuming that the high-frequency later phase is generated by the single scattering process. Namely, we estimate a scattering point by using mean-square amplitudes which is synthesized from two horizontal components of the observed waveforms.
Results in frequency bands of 4-32 Hz show that scattering points are distributed beneath the forearc region. The scattering points can reproduce the observed delays of amplitude amplifications associating with the high-frequency later phases. Moreover, similar locations of the scattering points are imaged along the forearc region in the entire NE Japan. These results indicate that high-frequency later phase is a wave scattered at the forearc region and that short wave-length heterogeneity generally developed in the forearc region of NE Japan.
This interpretation well matches implications from previous studies [e.g., Yomogida et al., 2004; Hasemi and Horiuchi, 2010]. Additionally, the obtained distributions of scattering points which appear to surround the highly attenuating mantle wedge suggest that attenuation structure strongly controls propagation paths of seismic wave, in particular, a high-frequency wave. In other words, the identifications of high-frequency later phase may become easy because the amplitude of direct wave crossing the high-attenuation zone decreases. To confirm this consideration, we estimate *Qs* along the direct wave by using the coda-normalization method [e.g., Aki, 1980]. This estimation provides 2-3 times smaller path-averaged *Qs* in seismic records of which rays lay on the backarc and the volcanic front than that of which rays lay on the forearc region. These results support that spatial variation in *QS* produces heterogenous propagations of seismic waves emitted from intraslab earthquakes. It is thus required to take scattering and attenuation structures simultaneously into account to understand complex behaviors of high-frequency waves in a future study.

Keywords: S-wave attenuation, Intraslab earthquakes, High-frequency later phase, Scattered wave

