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Seismic attenuation in the Pacific slab beneath northeast Japan

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Seismic activity and arc-magmatism in subduction zones are considered to relate to water carried with a subducting oceanic plate (e.g., Kirby et al., 1996; Nakajima et al., 2013). It is known that the existence of hydrous minerals, aqueous fluid, and melt contribute to reducing seismic velocity and increasing seismic attenuation. Therefore, investigations of seismic velocity and attenuation structures are important to constrain fluid distribution in subduction zones.

Seismic velocity structure in the Pacific slab beneath northeast (NE) has been investigated by a lot of studies, and characteristic structures, such as the low-velocity subducting crust down to a depth of ˜100 km (e.g., Shiina et al., 2013) and a low-velocity zone along the lower plane of the double-seismic zone (e.g., Zhan et al., 2004), have been revealed. However, seismic attenuation structure in the Pacific slab is not estimated precisely, because conventional tomographic methods are difficult to resolve detailed seismic attenuation in the slab.

To investigate seismic attenuation in the Pacific slab, we calculated the spectral ratio of the direct P waves for a pair of intraslab earthquakes with similar ray paths from shallower earthquake to a common station. Then, we estimated attenuation between the two earthquakes by fitting the Brune's source model (Brune, 1970) and t^* value to the spectral ratio, assuming constant stress drops for all earthquakes. The t^* value estimated here represents a path-averaged attenuation between the two earthquakes.

The results obtained in this study are summarized as follows.

1) In the slab mantle, observed attenuation is higher in the fore arc than in the back arc.

2) Attenuation in the subducting crust is higher than that in the slab mantle.

3) Highly attenuated ray paths are obtained in the Pacific slab near the hypocenter of the 2003 off-shore Miyagi earthquake (M7.1).

These results imply spatial changes in compositions or fluid distributions in the Pacific slab, providing a crucial constraint for the understanding of the seismic properties of rocks in the Pacific slab.

Keywords: Seismic attenuation, spectral ratio, the Pacific slab, intra-slab earthquake