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Source effects of the intraslab and interplate earthquakes in Miyagi-ken-oki region based on spectral inversion

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Previous studies showed that intraslab earthquakes generate stronger high-frequency waves than interplate earthquakes. For example, Satoh (2004) estimated the high-frequency levels of acceleration source spectra for seven intraslab earthquakes and four interplate earthquakes in Miyagi-ken-oki region. Their result showed the high-frequency level of intraslab earthquake is 3 to 4 times higher than that of interplate earthquake on the average. On the other hand, Katoh et al. (1999) estimated the excitation strength of high-frequency strong motions for intermediate-depth earthquakes based on the peak ground accelerations (PGA). Their result showed the focal depth is a key parameter controlling the PGA amplitudes rather than the difference of tectonic environments, such as intraslab or interplate earthquakes. Thus, the reason for the excitation strength of high-frequency waves of slab earthquake varies among studies, and this problem requires more precise investigation.

In this study, spectral inversion of NIED K-NET strong motion data is done to evaluate source effects of the intraslab and interplate earthquakes in Miyagi-ken-oki region. Then, seismic moments and corner frequencies are estimated from the evaluated source effects, and the high-frequency levels of the earthquakes are determined.

From the comparison between the intraslab and interplate earthquakes, the high-frequency levels of the former are 2 to 3 times higher than those of the latter. On the other hand, from the viewpoint of source depth, a clear trend is found that deeper earthquakes have higher high-frequency spectral levels. Here, it should be noted that the source depths of intraslab earthquakes are systematically larger than those of interplate earthquakes. Additionally, we find no significant difference between the spectral levels of intraslab and interplate earthquakes that have almost the same source depths. This is also seen for the difference between the spectral levels of upper-plane and lower-plane intraslab earthquakes.

Based on these results, we conclude (1) the trend that intraslab earthquakes have higher- high-frequency level than interplate earthquakes is apparent due to the fact that the former have systematically deeper source depths than the latter, and (2) the high-frequency level does not depend on the difference of tectonic environments, such as intraslab or interplate earthquakes, but on the source depth, and deeper earthquakes have higher high-frequency spectral levels. Difference of 4 times is seen between the high-frequency levels of deeper (˜80 km depth) and shallower (˜30 km depth) earthquakes for the depth difference of ˜50 km.

Finally, we pick up two factors, other than source-originated ones, that may effect the evaluation of the high-frequency level: effect of the waveform difference depending on source depth and depth-dependent Q-value structure. These effects are evaluated quantitatively, and we conclude that they cannot bring such biases as can change the above-mentioned trend of the high-frequency level. Thus, we have successfully enhanced the reliability of our interpretation that deeper earthquakes have higher high-frequency spectral levels.

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Keywords: spectral inversion, high-frequency level, intraslab earthquake, interplate earthquake, focal depth