Interpretation of attenuation of high-frequency waves from the intraslab, interplate, and outer-rise earthqukakes of Northeastern Japan

*Yasumaro Kakehi[1], Yu Ogasawara[1]

1. Graduate School of Science, Kobe University

Previous studies (e.g. Tsumura et al., 2000) have shown the backarc side of Northeastern Japan has lower Q-value than the forearc side and remarkably low-Q zones exist just beneath and slightly backarc-side of the volcanic front. On the backarc side, high-frequency seismic waves attenuate due to the low-Q medium, and the contrast is seen between the high-frequency wave amplitudes on the backarc side and those of the forearc side, where such attenuation does not occur. In this study, characteristics of the spatial distribution of peak ground acceleration and the attenuation relation from 3 types of earthquakes: intraslab, interplate, and outer-rise earthquakes, are investigated using high-density strong motion data of NIED K-NET and KiK-net. The number of studied earthquakes is 15 in total. The most clear contrast between the forearc and backarc sides is seen in the intraslab earthquakes with deep focal depths, and the contrast is also clear in the outer-rise earthquakes though the contrast is not so clear as that in the intraslab earthquakes. On the other hand, the contrast is observed also in the interplate earthquakes, but it is less clear than that in the outer-rise earthquakes. The length of seismic wave path propagating in the low-Q region on the backarc side is long in the case of intraslab earthquakes with deep focal depths, and in the case of interplate and outer-rise earthquakes, both of which have shallow focal depths, the lengths of seismic wave path are shorter than the case of intraslab earthqukaes and are approximately the same. Therefore, it is reasonable that the contrast in outer-rise earthquakes is less clear than that in intraslab eartgquake. It is incomprehensible, however, that the contrast in interplate earthquakes is less clear than that in outer-rise earthquakes. To understand this mystery, we newly take the contribution of the attenuation due to the geometrical spreading factor into consideration. In case of interplate earthquakes whose epicenters are close to the land, the curvature of hypocentral distance contors in the land area (where the observation stations are located) is large. Therefore, attenuation due to the geometric spreading factor is large at the northern and southern ends of the Northeastern Japan arc, where hypocentral distances are large than those in the central part of the island arc, the amplitude difference between the forearch and backarc sides is masked. On the other hand, in case of outer-rise earthquake whose epicenter is far away from the land, the curvature of hypocentral distance contors in the land area is very small and the geometrical spreading factor hardly varies throughout the Northeastern Japan arc. Therefore, the mask effect due to the geometric spreading factor at the norther and southern ends of the Northeastern Japan arc does not work effectively. That is, due to the mask effect of the geometric spreading factor, the contrast between the forearc and backarc sides in interplate earthquakes becomes less clear than that in outer-rise earthquakes, where the mask effect does not work. Furthermore, as to the PGA attenuation relation, an apparent effect appears in the case of outer-rise earthquakes that makes the amplitude difference between the forearc and the backarc sides apparently emphasized than it is, as pointed out by Ogasawara and Kakehi (2018, SSJ Fall Meeting). Thus, the difference of the contrast of seismic shaking on the forearc side and that of the backarc side of Northeastern Japan due to the 3 types of earthquakes is interpreted unifiedly by considering the following 3 factors: (1) the length of seismic wave path propagating in the low-Q region, (2) the mask effect due to the geometrical spreading factor, and (3) the apparent effect in the case of outer-rise earthquakes whose hypocentral distances are systematically large.

Keywords: intraslab earthquake, interplate earthquake, outer-rise earthquake, attenuation of seismic waves

