Strong ground motions from the 2006 Oita-ken Seibu slab earthquake and the structure of island arc

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1. Introduction

We have been studying the effect of the underground structures peculiar to island arcs on seismic wave propagation from the earthquakes occurring beneath island arcs (Saijo and Kakehi, 2004, 2005; Kakehi and Saijo, 2006; Kakehi, 2007). In this study, we analyze the strong ground motion data from the 2006 Oita-ken Seibu earthquake (M = 6.2, depth = 145.17km), which is a slab earthquake in the Philippine Sea slab subducting beneath the Kyushu arc.

2. Characteristics of the strong ground motions from the 2006 Oita-ken Seibu earthquakes and its interpretation

Figure shows the distribution of maximum acceleration based on the NIED K-NET and KiK-net strong ground motion records. The distribution does not show a normal circular distribution with the epicenter at the center but a very singular distribution. That is, large amplitudes are observed at the forearc side of the Kyushu arc and in the Shikoku island, while remarkably small amplitudes are seen at the backarc side.

The 2001 Iwate earthquake in the Northeastern Japan arc, occurred in the situation similar to that of the 2006 Oita earthquake. The hypocenters of both earthquakes are located just beneath the volcanic front with similar depths. Additionally, the ground motion distribution is singular one, with large/small amplitudes at the forearc/backarc sides in both earthquakes. Such singular distribution can be explained by the existence of low-Q area beneath the volcanic front and in the backarc side of the island arc. But, this attenuation due to the low-Q zone is more remarkable in the Kyushu arc than in the Northeastern Japan arc. In order to evaluate the extent of the attenuation, we see the the scatter of the maximum acceleration amplitudes within the range of about 100km epicentral distance. In this case, the scatter extent of the data implies the difference between the large amplitude at the station suffering no attenuation and the small amplitude at the station suffering attenuation due to low-Q zone. Therefore, large scatter means strong attenuation. In case of the 2001 Iwate earthquake, the extent of the scatter is about 20 times. On the other hand, a very large value of 50 times is seen in case of the 2006 Oita earthquake. This result shows the attenuation is stronger in the Kyushu arc. We estimate this difference maybe comes from the different depth distribution of low-Q zone between the two island arcs. In the Northeastern Japan island arc, low-Q zone exists only in the shallow depth, from surface to the depth of about 60km. In contrast, low-Q zone is seen in the wide depth range, from the shallow depth to about 150km in the Kyushu arc (Sekine et al., 2004). Therefore, in case of the 2006 Oita earthquake, the seismic waves undergo attenuation over the long travel length of the ray path, and the high-frequency wave amplitudes become very small.

In case of the Northeastern Japan arc, the land area of the forearc side ends at the Pacific Ocean coastline. In contrast, in case of the Kyushu arc the land area extends long to the forearc side (side where the slab becomes shallower) due to the existence of Shikoku island, and the seismic waves can be observed over the long epicentral range at the forearc side. Therefore, in the Kyushu arc it becomes possible to trace the seismic ground motion distribution over such long distance range as is impossible in the Northeastern Japan arc. In case of the 2006 Oita earthquake, the large acceleration area extends beyond Bungo Channel to the Shikoku island, and the maximum acceleration is observed at the mid-western area of Shikoku. This phenomenon, i.e. the remarkable extent of large amplitude to the forearc side, can not be explained by the existence of the low-Q zone beneath the island arc. In order to explain it, another mechanism that enables seismic waves to propagate with being trapped in the slab and without being attenuated should be necessary (e.g. Furumura and Kennett (2005)).