Spatial distribution of random inhomogeneities in northern Izu-Bonin arc

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The reflection surveys in the Izu-Bonin arc, which were conducted to address the crustal evolution process, revealed the along-arc variation of crustal structure correlated well with the arc volcanism (Kodaira et al. 2007). Crustal evolution in the oceanic island arc is a process including magma evolution in the mantle wedge. In order to clarify the structural variation in the mantle wedge, OBS observation was conducted in northern Izu-Bonin arc from 05/2006 to 07/2006 (Obana et al. 2007, JPGU meeting). This study examines high-frequency S-wave envelopes to investigate the spatial distribution of random inhomogeneities in the crust and mantle wedge.

The waveform data of 427 microearthquakes recorded at 36 OBS stations are used in this study. The magnitude and focal depth ranges are 1.5˜4.9 and 35-200km, respectively. The total number of ray-paths is approximately 3500. We composed the root mean square (RMS) envelope of velocity seismograms from the horizontal components in 4-8Hz, 8-16Hz and 16-32Hz bands. We measured the peak delay time which is defined as the time lag from the S-wave onset to the maximum amplitude of S-wave envelope. This peak delay time is the best measure quantifying the accumulated scattering effect due to random inhomogeneities. From the path-dependence of RMS envelopes and their peak delay times, we found the following remarkable characteristics; (1) most of the envelopes propagating beneath the volcanic front are significantly broadened regardless of whether hypocenter is in the fore-arc or back-arc, (2) envelope broadening is especially strong for the waves propagating beneath the Quaternary volcanoes (Hachijo-jima, Aoga-shima & Sumisu-jima and Tori-shima), and weak for the ray-paths propagating between Sumisu-jima and Tori-shima.

We apply the inversion analysis of the peak delay time assuming the spatially non-uniform isotropic random media with impulsive seismic sources (Takahashi et al. 2006, JPGU meeting). The power spectral density function of random media is assumed to be a von Karman type. There are two unknown parameters representing the spectral decay in short-wavelength component and the spectral level in long wavelength component. Considering the weak spatial variation of frequency dependence of the peak delay time, we examine the following two cases for spectral decay; spatially uniform case and non-uniform case. In both cases, the results show the strong inhomogeneities beneath Hachijo-jima, Aoga-shima & Sumisu-jima and Tori-shima at the 20-60km depth. In the case of non-uniform spectral decay, the regions beneath Hachijo-jima, Aoga-shima & Sumisu-jima and Tori-shima show weak gradient. The mutual relation between the random inhomogeneities and the volcano distribution is similar to that in the northeastern Japan.