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Primary estimation of deep subsurface structures in the Tokyo metropolitan Area, by the inversion of H/V spectral ratios

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We estimated deep subsurface structures in the Tokyo metropolitan Area, using dominant periods of H/V spectral ratios of coda waves observed by MeSO-net (Metropolitan Seismic Observation network). At first, we obtained dominant periods of H/V of coda waves averaged by several different earthquakes and the dominant periods are quite stable with a small variability (Tsuno et al., 2010). The dominant periods of H/V obtained by MeSO-net are generally in good agreement with the depths of the seismic bedrock in the Tokyo metropolitan Area (Yamanaka and Yamada, 2006). Also, we compared the observed dominant periods of H/V with peak periods of ellipticities calculated by the theory of fundamental mode of Rayleigh waves using Yamanaka and Yamada's model. The dominant periods of H/V matched well for sites where the shallow basin structures are located; however, dominant periods of H/V didn't match well for sites where the deep basin structures are located. In Yamanaka and Yamada's model, which is based on phase velocities of Rayleigh waves obtained by array microtremors observations, there are still uncertainties in the data obtained from deep basin structures when phase velocities for long periods were not obtained by array microtremors observation data. Therefore, we improved the S-wave velocity structural model in the Tokyo metropolitan Area, especially for bedrock and/or a deep boundary between layers, using the inversion method of H/V of coda waves observed by MeSO-net.

We applied the Genetic Algorithm (Yamanaka and Ishida, 1996) for the inversion of H/V spectral ratio of coda waves. Deep S-wave velocity structures were inverted from H/V spectral ratio on and around the dominant periods. As the estimated structures, we adopted the best fit between observations and calculations over 3 trials of changing random numbers in the inversion. S-wave velocities of all the layers and a depth of the top surface layer from Yamanaka and Yamada's model were constrained; and therefore, the thicknesses of the second layer (Vs 1.0 km/s) and the third layer (Vs 1.5 km/s) were estimated by this inversion procedure. Peak periods from ellipticities of fundamental mode of Rayleigh waves by the estimated structures matched well with the observed dominant periods of H/V. The estimated structures are deeper than the previous model proposed by Yamanaka and Yamada (2006) for the area of the west coast of the Tokyo Bay, where the calculated dominant periods of H/V were underestimated. At some sites in this area, the interface of the seismic bedrock was estimated at a depth of about 3.5 km (In Yamanaka and Yamada's model, the depth of the interface was about 2.5 km.).

Preliminarily, we estimated the deep subsurface structures in the Tokyo metropolitan Area, using H/V spectral ratios of coda waves on and around the dominant periods. However, the amplitudes of H/V spectral ratio, which are defined by the division of the geometric mean between horizontal components by a vertical component, are composed of Rayleigh waves and Love waves; and therefore, we would need to include the amplitude of Love waves for the inversion of H/V. As a next step, we will examine the contribution of Love waves for the horizontal amplitude of H/V in the inversion process.

Keywords: Deep underground structures, Tokyo metropolitan Area, H/V spectral ratio, Coda waves, MeSO-net, Inversion