Small-aperture Microtremor Array Surveys in the Southern Part of the Kyoto Basin and Northern Part of the Nara Basin, Japan

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The Nara-Bonchi-Toen Fault Zone forms the eastern margin of the Kyoto and Nara basins. The Kyoto and Nara basins are mostly filled by the Plio-Pleistocene Osaka Group. Holocene alluvium and terrace deposits covering over the Osaka Group distributed along the Kizu and Uji rivers. The thickness of alluvium layers in the Kyoto Basin is thought to be less than 20 m based on analysis of a boring database (e.g. Kansai Geoinformatics Council, 2002). Improvement on the velocity structure model from the superficial alluvium layers to the seismic bedrock is quite important for advanced strong motion prediction for future earthquakes from nearby source faults. As a part of Comprehensive Research Project for the Nara-Bonchi-Toen Fault Zone funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan, we have carried out various kind of geophysical surveys to investigate the velocity structure in the Kyoto and Nara basins.
Miniature to small aperture microtremor array surveys are carried out at many sites in the southern part of the Kyoto prefecture to obtain information on S-wave velocity of shallow subsurface sedimentary layers (Fig.1). The number of surveyed sites is 57 as of Feb. 18, 2020, and the field work is undergoing to cover the whole area of the Nara and Kyoto basins. We carried out miniature and small equilateral triangle array observations at each measurement site except several sites where a small array observation could not be carried out. The circumradius is 0.6 m for a miniature array, and the circumradius for a small array depends on site in a range from 6 to 8 m. A portable integrated microtremor observation system HAKUSAN JU410 was installed at each apex of the equilateral triangle and the center of circumscribed circle. The microtremor was recorded continuously more than 15 minutes at a sampling rate of 200 Hz after amplified by 100 times (200V/G).
The vertical component of the observed microtremor were analyzed to obtain the spatial autocorrelation (SPAC) coefficients (Aki, 1957). The spatial autocorrelation function was calculated in the frequency domain, and the Fourier spectrum was smoothed by the technique of Konno and Ohmachi (1998). The phase velocity dispersion curve was estimated by the extended SPAC method (Ling and Okada, 1993; Okada, 2003).
The one-dimensional S-wave velocity structure model for each measurement site was estimated by assuming that the observed phase velocity dispersion curve as the fundamental mode of the Rayleigh wave using the Markov chain Monte Carlo method. The velocity structure model of deep sedimentary layers (Vs >= 550 m/s) and the upper crust was given referring to the existing three-dimensional velocity structure models J-SHISV2 (Fujiwara et al., 2012), and the velocity structure model from the lower crust to upper mantle was referred to JIVSM (Koketsu et al., 2012). The obtained S-wave velocity structure model will be discussed in terms of spatial distribution of low-velocity layers with referring to surface geology and boring data information.
H/V spectra was also estimated from three-component records of the observed microtremors. The observed peak frequency of H/V spectra is shown in Fig.1. The H/V peak frequency is 0.3–0.4 Hz in the southern part of the Kyoto Basin including the Ogura-ike reclaimed land. It is relatively high (~1 Hz) in Kyotanabe where the boundary of the Kyoto and Nara basins is geologically identified. The sites around the Narayama Hills have the H/V peak frequency of 0.4–0.5 Hz, indicating the existence of thick Osaka Group sediments.
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