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Estimation of S-wave attenuation in the sedimentary layer beneath southern Kanto by using KiK-net borehole records

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1. Introduction

Seismic wave is amplified greatly at big cities in Japan that are generally located on thick sedimentary layer. In terms of seismic hazard estimation, it is important to evaluate amplification and attenuation characteristics of S-wave in the sedimentary layer. Because nowadays borehole seismic records are available all over Japan, it is possible to estimate Qs^{-1} values at many sites on the thick sedimentary layer. In this study, we estimate Qs^{-1} values by using KiK-net borehole seismograms obtained at three stations in southern Kanto operated by National Research Institute for Earth Science and Disaster Prevention (NIED).

2. Data

Seismograms obtained at Chiba (CHBH10), Yokohama (KNGH10), and Tokorozawa (SITH04) whose depths are 2000m are used. We analyze data recorded for periods from May, 2003 to February, 2011. Epicentral distances of analyzed events are within 150km and peak ground accelerations are less than 100cm/s^2. The numbers of analyzed events at the three stations are 89, 38, and 20, respectively. We apply a band-pass filter (1-10Hz). Transverse component of velocity waveforms is analyzed.

3. Method

Fukushima et al. (1992) estimated Qs^{-1} values by using incident S waves and surface reflected S waves on seismic records at a 732m-deep borehole at Chikura, southern Kanto region. In this study, we use a method slightly modified from theirs. First, we pick a start time t1[s], an end time t2[s] of an incident phase, and a lag time between the incident and the reflected phase on each observed waveform. Because the lag time is automatically determined for given t1 and t2, we only need to search for the optimal value of t2 with t1 fixed. The optimal value is determined so that correlation of these phases and amplitude of the reflected phase become highest. Finally, we calculate system functions from the incident and the reflected phases, and estimate Qs^{-1} values from the system functions.

4. Results

We fit a power-law model to the estimated Qs^{-1} values in the 1-5 Hz band. Qs^{-1} values at Chiba and Yokohama decrease with frequency with exponents of -0.76 and -0.50 and Qs^{-1} values at 1Hz of 0.020 and 0.032, respectively. On the other hand, Qs^{-1} values at Tokorozawa hardly show frequency dependence. Qs^{-1} values estimated for the stations are smaller than that for Chikura (Fukushima et al., 1992). We speculate that this difference is due to the depth dependence of Qs^{-1} values. Since the variation of Qs^{-1} values is as large as about $\pm$1 order so far, we need to investigate the cause. We plan to conduct similar analysis at many stations in order to understand relationships between Qs^{-1} values and other factors such as geology, S-wave velocity, and depth.

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Keywords: seismic wave attenuation, sedimentary layer