Estimation of the spatial distribution of Qs values beneath the Kii Peninsula, Japan by the twofold spectral ratio method

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Evaluation of radiation energies of tremors is important to understand the generation mechanism. Previous studies estimated the radiation energy assuming a spatially uniform S-wave attenuation quality factor, Qs value, over the area of interest (e.g. Maeda and Obara, 2009). However, when we discuss a regionality of the tremor generation, the spatial changes of Qs values are important. The objective of this study is to estimate the spatial distribution of Qs values beneath the Kii Peninsula by using the twofold spectrum ratio method (e.g. Matsuzawa et al., 1989).

We use a dense seismic array (39 three-component velocity sensors, array aperture:1.5 km) installed by AIST at the Kii Peninsula. We also use seismograms recorded at a Hi-net station (N.HYSH) that is located close to the seismic array. We analyze the data for 2 years from July 2012 to July 2014, referring to the tremor catalog determined by Sagae et al. (2019 JpGU) in which 27,066 events are listed for the 2 years. For tremors recorded at the stations, we calculate velocity amplitude spectra and estimate their slopes at a frequency range of 2.0-4.0 Hz. Outliers are removed by setting a threshold of 4.4 times Median Absolute Deviation of the spectral slopes at each station. Totally, 18,330 events are selected for the following analysis.

We create horizontal blocks of 0.1×0.1˚ within a region of 136˚E to 137˚E and 34˚N to 35˚N. The twofold spectral ratio method is applied when the number of tremor events in a block is more than 100. We calculate twofold spectral ratios for two events locating in the block, when their separations are more than 5 km. Qs value is estimated by the twofold spectral ratio method. In this method, a logarithm of a twofold spectral ratio that is corrected for the geometrical spreading (log TSR) is linearly proportional to a twofold differential travel time (TDTT); The slopes is $-\pi f/Qs$, and an intercept is a term about the radiation pattern. However, the intercept is expected to be close to 0 when focal mechanisms of tremors occurring in a block are similar. At each narrow frequency band (2.0-4.0 Hz, 2.8-5.6 Hz, 4.0-8.0 Hz), we assume that Qs value of the structure along the ray paths from hypocenters to the seismic array and the Hi-net station is constant. Then, we estimate the slope ($-\pi/Qs$) and the intercept at each frequency band.

Estimated Qs values are summarized as follows; Qs values are in a range of 63-458, 58-896, and 66-2044 at 2.0-4.0 Hz, 2.8-5.6 Hz, and 4-8 Hz, respectively. Qs values estimated at the high frequency band tend to be larger. However, at the high frequency band, the number of blocks for which the Qs value is estimated to be a negative value increases. The intercepts are confirmed to be close to 0 (-0.03 ~ 0.008) in blocks for which Qs values are estimated to be a positive. This suggests that focal mechanisms of tremors occurring within the same block are similar.

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