Estimation of seismic attenuation properties in eastern Hokkaido based on a diffusion-absorption model

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It is widely accepted that seismic coda waves are scattered waves with random phases generated by medium heterogeneities. We can often assume that the distribution of coda-wave energy is homogeneous and isotropic in space at large lapse times. However, it is reported that this assumption does not always hold at northeastern Honshu, Japan, where a volcanic front stretches from the north to the south. In order to interpret the observed spatial variation of coda-wave energy in the region, a diffusion-absorption model was proposed by Yoshimoto *et al.* (2006). This model consists of two half-spaces with different absorption coefficients, and the seismic energy density of each half-space satisfies the diffusion-absorption equation. In order to examine whether such a phenomenon is observed in other areas, we perform the similar analysis around the volcanic front in eastern Hokkaido, which runs central part of Hokkaido from the east to the west. We further investigate the spatial energy distribution of S-coda waves around the region and estimate the attenuation properties across the volcanic front based on the diffusion-absorption model.
We analyze seismograms of a local intermediate-depth event whose epicenter is located in the forearc, Tokachi region in Hokkaido. The hypocentral parameters obtained by Japan Meteorological Agency are 2 February 2013 23:17, 102km depth, and M6.5. We use seismograms recorded by 40 Hi-net stations in eastern Hokkaido, which are provided by the National Research Institute for Earth Science and Disaster Prevention. We apply bandpass filters of 2-4, 4-8, 8-16, and 16-32Hz to the three component velocity seismograms. We set seven time windows with a length of 5 sec for S-coda waves, and calculate the mean amplitudes of sum of squared three component velocity seismograms. We multiply them by the average density of the crust and upper mantle 3.0[g/cm^3] to obtain S-coda wave energy density.
We find the energy density in eastern Hokkaido is uniformly distributed in the forearc, while it decreases with the horizontal distance from the volcanic front in the backarc. Such spatial variation is similar to that observed in northeastern Honshu. It is revealed that the coda-wave energy in the backarc exponentially decreases with the distance. On the other hand, the coda-wave energy in the forearc is almost equally distributed in space, decreasing with the lapse times. In the backarc, the rate of the decrease is about two or three times larger than that in northern Honshu ((1.7-4.8)×10^{-2} [km^{-1}] at 2-32Hz) while the frequency dependence is approximately the same. Based on the diffusion-absorption model, the rate of the spatial decrease in the backarc is expressed by the square root of the ratio between the absorption coefficient and the diffusivity, while the rate of the temporal decrease in the forearc is expressed by the absorption coefficient. According to these relations, the intrinsic attenuation in the backarc is estimated to be larger than that in northeastern Honshu at all frequency bands by assuming the S-wave scattering coefficient of 0.01[km^{-1}]. In the forearc, intrinsic attenuation is smaller than that in the backarc, and the frequency dependence is estimated to be $Q_i^{-1} \propto f^{-1}$. We confirm that similar results can be obtained even for two other events.

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Keywords: diffusion, attenuation, coda-wave, volcanic front

