Spatiotemporal distribution of S-coda wave energy and scattering and attenuation structure of the lithosphere in Japan

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The formulation of the spatiotemporal distribution of S-coda-wave energy was firstly proposed by Aki (1969) and Aki and Chouet (1975), and since then the studies on the earth's random heterogeneity have been progressed. In the last decade, the development of theoretical modeling of coda waves enables us to investigate the characteristics of the short-wavelength random heterogeneity of the lithosphere by measuring the scattering coefficient, the frequency dependence of coda Q, and the apparent attenuation of S waves. We here report the nonuniform spatial distribution of S-coda-wave energy observed in Japan and estimated regional variation of the intrinsic attenuation of the lithosphere.

We analyzed the spatial distribution of coda-wave energy of 18 local earthquakes occurred in Japan. The velocity seismograms recorded by the Hi-net were used in this study. We calculated the coda-wave energy in frequency bands of 2-4, 4-8, 8-16, and 16-32Hz as the squared sum of the coda-wave amplitudes on horizontal components. The coda waves at lapse times after the 1.5 times of the S-wave travel time were analyzed. To compile these estimates and to evaluate the coda-energy coefficient that characterizes the magnitude of coda energy at each station, we adopted a conventional inversion algorithm that had been used for estimating the site amplification factor. The coda-energy coefficient obtained from this inversion analysis shows clear regional variations, especially in the high-frequency range of 16-32 Hz. The magnitude of coda energy is systematically small in the area where the Quaternary volcanoes exist and high heat flux is observed (central and northern Hokkaido, western Tohoku, Hokuriku, in and around the Izu peninsula, and southwestern Kyushu). The difference in magnitude reaches up to 40 dB.

Assuming that the nonuniform spatial distribution of coda energy is caused by the regional variation of intrinsic attenuation of S waves, we applied an inversion technique to the coda energy observed by the Hi-net. To calculate spatiotemporal coda-energy distribution on the basis of an energy transport model (Yoshimoto, 2000), JMA S-wave velocity model (Ueno et al., 2002), a point source with isotropic radiation, and an isotropic scattering with scattering coefficient of 0.01kmˆ-1 were adopted in this inversion analysis. Supposing an intrinsic attenuation quality factor of 1000 for the eastern part of the Tohoku region, we obtained the intrinsic attenuation quality factor of 500-800 for the regions where the magnitude of coda energy is systematically small. This result suggests that the thermal structure of the lithosphere characterizes the regional variation of coda energy.

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