Estimation of intrinsic absorption structures by the inversion analysis of maximal amplitudes based on the Markov approximation

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High-frequency seismic waves of microearthquakes are broadened and attenuated as travel distance increases due to random inhomogeneities and intrinsic absorption in the lithosphere. We have proposed an inversion analysis of the peak delay times to estimate the spatial distribution of random inhomogeneities, where the peak delay time is defined as the time lag from the S-wave onset to the maximal amplitude arrival (Takahashi et al. submitted to G.J.I.). According to the inversion analyses of the peak delay times in Japan, the regions beneath the Quaternary volcanoes and high-seismicity area have strong inhomogeneities. In this study, we propose an inversion analysis of the maximal amplitudes of S-wave envelopes to estimate spatial distributions of the intrinsic absorption, in which the scattering attenuation are evaluated by using random inhomogeneities estimated by the peak delay time analyses.

To achieve a stable estimation of the intrinsic absorption by maximal amplitude analyses, we have to resolve a trade-off between the site amplification factors and energy excitation at seismic sources. This study uses the seismic moments for moderate sized earthquakes as known parameters in inversion analyses. Since seismic moments for moderated sized earthquakes are usually estimated by broad-band seismic networks, we can expect this approach can be applied for the ocean bottom seismograph (OBS) data without any information on site factors. In inversion analysis, we assume the omega-square model for seismic sources and power-law functions for Q-values and site amplification factors. We also assume that random inhomogeneities are characterized by the von Karman type PSDF. The scattering attenuation due to random inhomogeneities is evaluated by using the recursive formula that we had proposed in previous study (Takahashi, 2008 JPGU Mtg.). We use randomly generated initial models, and estimate an optimum solution by a method based on the genetic algorithm.

We conduct a synthetic test by using a medium that has an anomaly of strongly inhomogeneous and highly absorbing region. Seismic moments are randomly given in the range of 10^{12}(Nm) ˜10^{17}(Nm), and we assume that the seismic moment larger than 10^{15}(Nm) are known parameters in inversion. We analyzed the maximal amplitudes at 2-4Hz, 4-8Hz, 8-16Hz and 16-32Hz by adding random noise. In this synthetic test, we found that absolute values of the intrinsic absorption, source factors and site amplification factors are successfully reconstructed. This result implies that our method can be safely applied for the OBS data. A preliminary analysis of OBS data in northern Izu-Bonin arc (Obana et al. 2009, JPGU Mtg.) shows that the site amplification factors at all OBSs shows strong attenuation. We may say that these attenuations are due to sedimentary layer beneath the seafloor. Q values in the fore-arc side of the volcanic front are larger than 1000, that is agree with the result in the fore-arc side in the northeastern Japan (Saito et al. 2005).