Transdimensional imaging of scattering and intrinsic Q structures around the Japan Trench off Miyagi, northeastern Japan

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Crust at subduction zones shows various structural inhomogeneities over a broad scale range due to accumulation of deformation and fault fractures. We may consider that smaller scale structures are more important for discussing the details of medium inhomogeneities in terms of such tectonic processes. This study analyzes randomly scattered seismic waves at high frequencies (>1Hz), and estimates horizontal variations of scattering Q (Qs) and intrinsic Q (Qi) of S-wave around the Japan Trench, off Miyagi, northeastern Japan. Our imaging method is based on the Multiple Lapse Time Window Analysis (MLTWA) (e.g., Hoshiba 1993). The MLTWA gives a stable estimation of Qs and Qi, but generally assumes constant Qs and Qi in a study area. For a precise imaging of horizontal variations of Qs and Qi, we have introduced the reversible Jump Markov chain Monte Carlo (Green 1995) to the MLTWA (Takahashi 2017, EGU). Our method partitions the study areas into the 2-D Voronoi cells, and retrieves the MCMC samples near the maximal posterior with changing space-partitioning and Q values in Voronoi cells. Synthetic tests showed good reconstruction of input structures. We applied this method for seismic waveform data at Japan Trench. These data have been retrieved by ocean bottom seismographs after the 2011 Tohoku-Oki earthquake, and estimated Q structures at 4-8 Hz, 8-16 Hz and 16-32 Hz. Intrinsic Q shows weak horizontal variations at all frequency bands, meanwhile scattering Q shows clear horizontal variations. The highest 1/Qs (i.e., strong scattering) was imaged beneath the toe of the overriding plate. The petit spot areas (Hirano et al. 2008) at the Pacific plate also shows high 1/Qs values. These high 1/Qs anomalies are imaged at all frequency bands. Fault zones of large earthquakes (M>7) show that 1/Qs at 16-32 Hz tends to be higher than 1/Qs at lower frequency bands. Such anomalous frequency dependence of 1/Qs implies that these fault zones are rich in small scale inhomogeneities. We may consider that such small scale inhomogeneities may be developed by fault fractures. We also note that a large earthquake (M7.1) have occurred at one of these anomalous areas after the seismic observation. It suggests that this earthquake may have occurred at a pre-existing fractured zone.

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