Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SSS027-02 Room:105 Time:May 22 11:00-11:15

Application of auto-correlation analysis to the estimation of the seismic basement structure beneath the Noubi Plain

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Seismic interferometry is a recently established method to obtain a seismic response from auto- or cross-correlation of seismograms. Claerbout (1968) proposed that the auto-correlation of a transmitted seismogram from a source at depth and a surface receiver is equivalent to the reflected seismogram from a surface source and the receiver at the same location. Since seismic interforometry does not require artificial sources, it recently attracts attention as a new exploration method of subsurface structure. Yoshimoto et al. (2008) applied this method and obtained the basement structure beneath the Kanto Plain.

In this study, we applied the auto-correlation analysis to the strong-motion seismograms of local earthquakes observed at the seismic stations in and around the Noubi Plain in order to estimate the seismic basement structure.

The basic procedure is as follows. First, we extracted the transverse (SH-wave) component from the horizontal components of the record of each station. Then, the acceleration waveform were double-integrated to the displacement waveform after applying a high-pass filtering. At each station, the auto-correlations of the time-windowed displacement waveform were stacked to improve the S/N ratio. We investigated the frequency and the shape of the high-pass filter, the length of the time-window and the effect of normalization of auto-correlation to obtain the suitable result. In addition, we applied the deconvolution process to remove the source function of each earthquake. Two different procedures, the deconvolution before and after auto-correlation were examined.

In the synthesized seismic reflection section, we found some prominent phases with negative amplitudes. We compared the section to the 3D velocity structure model beneath the Noubi Plain which was compiled by Aichi Prefecture based on the gravity map and partially on the seismic reflection and refraction survey and borehole records. The prominent phases correspond to the reflection from the top of the seismic basement. The dip of the reflector coincides with the dip of the basement of the velocity structure model, although its depth is slightly deeper than the depth of basement of the model. The reflection section may indicate the existence of the velocity boundary in the shallow sediment unexpressed in the structure model. The auto-correlation section also agrees with the receiver function section. The auto-correlation shows higher resolution than the receiver function in the depth section. Therefore, the seismic interferometry is beneficial in exploration of the subsurface structure using natural earthquakes. In order to improve the accuracy of the subsurface structure, more dense distribution of seismic stations are needed.

We are grateful to Aichi prefecture, Nagoya city and NIED for the use of the strong-motion seismograms observed in the area of interest.

Keywords: seismic interferometry, auto-correlation analysis, Noubi Plain, basement structure, receiver function