Crustal structure in and around the focal region of the 2008 Iwate-Miyagi Nairiku earthquake by the cross-correlation analysis

Ryota Takagi[1]; Tomomi Okada[1]; Hisashi Nakahara[2]; Norihito Umino[1]; Akira Hasegawa[1]; Matsuzawa Toru Group for the aftershock observations of the Iwate-Miyagi Nairiku Earthquake in 2008
[3]

[1] RCPEV, Graduate School of Sci., Tohoku Univ.; [2] Geophysics, Science, Tohoku University; [3] -

Seismic interferometory can reproduce the Green's function between two receivers by calculating cross-correlation of records measured at their locations. By this method, subsurface structure can be obtained stably even without explosions and/or earthquakes. For examples, crustal structure can be imaged in high spatial resolution by using a dense seismic network (e.g., Abe et al., 2007), and temporal variation of structure can be detected by using ambient noise that exist at any time (e.g., Brenguier et al., 2008). In this study, as one of the applications of the seismic interferometory, we attempted to image the crustal structure in the central part of Tohoku in and around the focal region of the 2008 M7.2 Iwate-Miyagi Nairiku earthquake.

We estimated seismic velocity structure in the study area by the cross-correlation analysis of ambient noise. Data were the vertical components of ambient noise at 55 routine seismic stations (Hi-net, JMA, Tohoku Univ.) in the central part of Tohoku. We made 353 station pairs and calculated cross-correlation functions for 120s-length data in the frequency range from 0.25 to 0.5 Hz. Before calculating the cross-correlation functions, we normalized the data by disregarding completely the amplitude and by keeping only a one-bit signal. This procedure can reduce the effect of abrupt changes of amplitudes due to earthquakes or local noise signals. Finally, Green's function for each station pair is computed by stacking these cross-correlation functions for 24 hours.

Green's functions with clear peaks are obtained for 301 station pairs by using data recorded on October 1, 2008. Wave propagation can be seen from the result that the lagtime at the peak of the Green's function increases in proportion to the distance between two stations. We estimated a propagation velocity by dividing the distance between two stations by the lagtime read from the peak of the Green's function. Most of the estimated velocities were less than 3.7 km/s and consistent with the velocity of Rayleigh wave. Low velocities (0.7-2.0 km/s) were observed at Sendai Plain, Osaki Plain and Kitakami Basin, in contrast, high velocities (2.1-3.7 km/s) were observed at Kitakami massif and Ou Backbone Range. It is considered that the propagation velocities estimated in this study depends on subsurface seismic velocity structure such as low-velocity sedimentary layer in plains and basins, and high velocity basement rocks in mountain ranges.

Some Green's functions obtained in this study do not have remarkable peaks. We defined signal-to-noise ratio (S/N) for Green's function by dividing the maximum amplitude by the average of absolute amplitude. The station pairs whose propagating directions are E-W or SE-NW tend to have good S/N with greater than 4.5. In addition, the station pairs near the Pacific coast have good S/N. From these results, we infer that the sources of ambient noise seem to distribute mainly in the Pacific coast and ambient noise propagates from east to west. We also checked the relation between the distance of station pairs and S/N. As the result, S/N tends to decrease as the distance of station pairs increases. That would be due to scattering and attenuation of seismic wave.

As shown above, we could obtain the Green's functions which are dominated by Rayleigh wave from ambient noise by the cross-correlation analysis and estimate the spatial distribution of the propagation velocities. In the future, we plan to estimate more detailed seismic velocity structure and image crustal reflectors in and around the focal region of the 2008 M7.2 Iwate-Miyagi Nairiku earthquake.