Validation of seismic bedrock structure model in the Shimousa region, Chibe prefecture, Japan using seismic interferometry to strong motion

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Green’s function is estimated using autocorrelation of strong motions by seismic interferometry, and the depth to the seismic bedrock is estimated in sedimentary basins (Yoshimoto et al., 2009; Watanabe et al., 2011, Shiraishi et al., 2016). Oren and Nowack (2017) observed clear Reflected waves by applying spectral whitening to the autocorrelation of ambient noise. Chimoto and Yamanaka (2018) applied this method to the autocorrelation of strong motions and observed reflected wave from seismic bedrock by estimating the Green’s function in the sedimentary layers. We apply this method in the Shimousa region, Chiba prefecture, Japan to estimate autocorrelation using strong motions. Validation of 3D S-wave velocity structure model was attempted based on the spatial variation of reflected waves from seismic bedrock in the region.

Number of autocorrelations without the selection of strong motions enhance the clear reflected wave (Chimoto and Yamanaka, 2018). We used all the strong motions observed in the period of January 2008 to Jun 2018 observed at the strong motion stations of K-NET and KiK-net installed in the Shimousa region. After removal of offset of the strong motion, horizontal components are rotated to the transverse component. Spectral whitening is applied to the power spectrum and inverse Fourier transform provides autocorrelation function after the bandpass filtering. The range of bandpass filter is important to estimate the expected reflected waves from sedimentary layers (Chimoto and Yamanaka, 2018). We used the range of 0.5-2.0Hz to estimate the reflected wave from the seismic bedrock. Theoretical Green’s function for the validation of the model was calculated by Haskell method using 1D structure model extracted from the 3D J-SHIS deep structure model.

We observe the distinct reflected waves from the seismic bedrock in the autocorrelation functions estimated in the Shimousa region, Chiba prefecture. Two-way travel time of the reflected wave at KiK-net Narita station is 3 seconds and that is 3.5 seconds at K-NET Narita station. These values are almost consistent to those of the theoretical Green’s functions, while slight faster arrivals are observed. On the other hand, the stations located north and east to Narita exhibit several arrivals in the autocorrelations and the reflected wave from the seismic bedrock becomes weak. The travel time is faster than Narita. The reflected waves from the seismic bedrock at the stations located west to Narita appears later than 4 seconds, meaning the deeper bedrock than Narita. The southern part to Narita, central part of Chiba prefecture, shows the two-way times of later than 6 seconds, suggesting the deepest bedrock structure. This fact is consistent with the previous 3D models in the Kanto basin. We thus captured the spatial variation of the seismic bedrock from the estimation of autocorrelations of the strong motions in the Shimousa region, Chiba prefecture. The characteristics of spatial variation was similar to that of previously proposed 3D models. However, it is highly expected for the accurate modeling by tuning the slight difference between the autocorrelation function and the theoretical Green’s function.
We used the records observed at K-NET and KiK-net by National Research Institute for Earth Science and Disaster Resilience and deep structure model of Japan Seismic Hazard Information Station.

Keywords: Seismic interferometry, Autocorrelation function, Strong motion, Seismic bedrock structure model, Shimousa

