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Daily monitoring of shear wave velocity and anisotropic structure using the reflected wave extracted from BBOBS data

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Temporal variation at subsurface structure has been recently detected by using seismic interferometry. This would be achieved by extracting waves propagating between two stations, and measuring the temporal variation of the extracted wave. For example, with the extracted surface wave, Brenguier et al. (2008) found that a velocity reduction and its relaxation occurred at and after the 2004 Parkfield Earthquake. Nakata et al. (2011) detected velocity changes between two stations deployed in vertical array, which was caused by the 2011 Tohoku-oki Earthquake. Moreover, reflection profile underneath a seismic station can be obtained by auto-correlation function of seismic noise. Chujo et al. (2011) constructed the reflected P wave from auto-correlation function of seismic records observed at BBOBS, and detected a temporal velocity change due to the 2005 Miyagi-oki Earthquake. In this study, we try to extract the reflected S wave by using horizontal components of BBOBS data, and also investigate whether temporal variation of the shear wave velocity and its anisotropic structure occurs or not.

We used 2 BBOBS deployed on the accretionary prism at the Nankai trough. The time period of the observation is from 2008/8 to 2009/9. This period contains the time in which the very low frequency earthquakes (VLFs) are active.

We applied a bandpass filter of 1-3 Hz to two horizontal components. The amplitude of the records was disregarded by keeping one-bit signal. We then synthesized the waveform by rotating two horizontal components with a step of 5 degrees, and calculated auto-correlation functions (ACFs) with a time length of 600 sec. The ACFs stacked for 1 day were prepared for approximately 400 days. Note that the ACFs of the waveform for all directions allow us to extract the reflected S wave with different polarization directions.

Our results show that the S wave reflected at the bottom of the accretionary prism can be seen in the ACFs for all directions. Interestingly, the travel time of the reflected S wave is varied as a function of polarization directions, which is considered to be the effect of anisotropic structure between the station and seismic discontinuity. The velocity change between the fast and slow S wave is approximately 3-4 %. Moreover, such reflections can be constructed with 1 day stacking of noise, allowing us to daily monitor the S wave velocity and its anisotropic structure. However, no temporal variations could be found at or after the VLF activity on 2009/3. In the presentation, in addition to the above result, we will also report that the temporal variation of travel time of the reflected S wave due to the 2011 Tohoku-oki Earthquake is observed by using BBOBS data deployed in the outer-rise.

Keywords: seismic interferometry, monitoring, accretinary prism, anisotropy, shear wave velocity