Temporal change of subsurface velocity structure associated with the 2016 Kumamoto earthquakes

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We investigated temporal velocity change of subsurface structure before and after the 2016 Kumamoto earthquakes in April 2016 by applying the seismic interferometry method to ambient seismic noise. We calculated auto-correlation functions (ACFs) of continuous waveforms recorded by Hi-net vertical velocity component after bandpass filter of 1 –3 Hz is applied. Velocity change of subsurface structure was calculated by applying the stretching method (Sens-Schönfelder and Wegler, 2006) to the ACFs for lag times of 1 –5 s and 4 –15 s.

The results using the lag time of 1 –5 s showed velocity increase of 6 % at the N.MSIH station located near the fault just after the Kumamoto earthquakes. This velocity increase remained more than 6 months. The stations of N.OGNH and N.KKCH also showed velocity increase although the velocity increases completely recovered (disappeared) 6 months after the earthquakes. On the other hand, significant velocity decreases from 0.5 % to 6.0 % were obtained at N.ASVH, N.NMNH, and N.TYNH. The decrease recovered partially except for the N.ASVH. The result for the lag time of 4 –15 s showed velocity decreases from 0.5 % to 6 % at N.MSMH, N.TYNH, N.ASVH, N.HKSH, N.NMNH, N.KKEH, and N.SNIH near the after shock area and a induced seismicity area of the 2016 Kumamoto earthquakes.

The N.MSIH station which showed the velocity increase is located where negative volume change was expected by a theoretical fault model of the Kumamoto earthquakes. Actually, a large compressional strain was observed between the KiK-net sensors installed on the surface and at the borehole bottom at N.MSIH (Fukuyama and Suzuki, 2016). We, therefore, suppose that the velocity increase found only near the fault was caused by the static compressional-strain. On the other hand, the velocity decrease found at several stations in wider area would be caused by large dynamic strain-change.

Keywords: The 2016 Kumamoto Earthquakes, Temporal velocity change

