Time-lapse change of S-wave velocity and polarization anisotropy associated with the 2016 Kumamoto earthquake, Japan

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By analyzing seismograms of 8 KiK-net stations, we detected change of S-wave velocity and its polarization anisotropy in the shallow subsurface associated with the 2016 Mw7.0 Kumamoto earthquake, Japan. By rotating EW and NS components of the seismogram pairs recorded on the ground surface and at the borehole bottom (100 to 300 m depths), we obtained surface/borehole deconvolution for arbitrary polarization azimuths. Applying the stretching technique to pair of deconvolutions obtained in different periods and different polarization azimuths, we detected time-lapse change of S-wave velocity and that of polarization anisotropy. The azimuthal average of the S-wave velocity decreased by 1 % to 6 % within 1 day after the mainshock. The reduction ratio of the S-wave velocity had a strong correlation with the maximum dynamic strain (MDS) due to the ground motion by the mainshock. The S-wave velocity continued to recover proportional to logarithm of the lapse time (log (t)) after the mainshock. The proportionality factor between the S-wave velocity reduction ratio and log (t) had the values of 10^{-2}~10^{-3} for most of the used stations, and was irrespective to the MDS by the mainshock. This result is different from previous studies on rock experiment which reported a linear relationship between the proportionality factor and the MDS. We think delay of the recovery due to strong aftershocks may be one reason of this discrepancy. The amplitude of the polarization anisotropy (anisotropy coefficient) increased by up to 1 % for most of the used stations within 1 day after the mainshock. The increase of the anisotropy coefficient had almost no correlation with MDS and ΔCFF computed at each station. According to the theory of fracture mechanics, the stress intensity factor near the tip of the crack has larger values for longer cracks. Therefore, we think only the relatively longer vertical cracks oriented along the fast Vs direction would grow selectively under certain range of stress perturbation, and consequently increase of anisotropy coefficient was more frequently observed than decrease.

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