On high-frequency energy release by aftershocks of several inland large earthquakes in Japan

*Kaoru Sawazaki¹, Katsuhiko Shiomi¹

1. National Research Institute for Earth Science and Disaster Resilience

Detection of aftershocks occurring immediately after a large earthquake is generally difficult because their waveforms overlap in seismograms. Therefore, it takes usually more than one day before a reliable aftershock forecasting becomes available from a conventional catalog-based method. This method is often too late for the largest aftershock that tends to occur within one day after the mainshock. To overcome this defect, in this study, we propose another approach that detects high-frequency energy release by all the aftershocks occurring from immediately after the mainshock. In this approach, instead of detecting the aftershocks one by one, we estimate a continuous energy release by the aftershocks. By applying an inversion scheme to envelope of continuous seismograms of Hi-net, we estimate spatiotemporal distribution of energy release by the aftershocks. For saturated Hi-net records, we alternatively use KiK-net records that co-located with the Hi-net sensor, which enables us to use data of wide dynamic range from microseisms to strong ground motion. In theory, the estimated energy release is not disturbed by "missing" of the event detection. So far we apply this inversion scheme to 8 inland large earthquakes occurred in Japan, where their M_J ranges from 6.3 to 7.4. The target frequency range of the seismogram is from 4 to 20 Hz.

The estimated cumulative energy normalized by their mainshock energy distributes from 0.017 to 1.37. This normalized cumulative energy (NCE) does not show clear dependence on the mainshock energy. NCE represents relative productivity of aftershocks: the aftershock activity is closer to "swarm" type rather than "mainshock-aftershock" type when NCE is larger. Among the analyzed 8 events, the 2004 Chuetsu earthquake is the only case whose NCE exceeds 1, which means the energy released by its aftershocks exceeds the energy released by the mainshock. As expected from the Omori-Utsu law, amount of energy release is larger at earlier lapse times. By the first 1 hour after the mainshock, 9 % to 73 % of the aftershock energy released within 7 days is released. This percentage becomes 10 % to 79 % and 28 % to 96 % by the lapse times of the first 3 hours and 6 hours, respectively. For 5 of the 8 analyzed events, more than half of the 7 days' aftershock energy is released within the first 6 hours. This result strongly suggests that using energy release by aftershocks within the first several hours is essential to improve the method of aftershock forecasting.

Keywords: aftershocks, high-frequency energy release, Hi-net, realtime aftershock forecasting