Estimation for Seismic Moments of small earthquakes

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There are various kinds of earthquake magnitude. Using the maximum amplitude, we can calculate the magnitude of small earthquakes easily and stably. Hence, this magnitude is routinely estimated just after an earthquake occurs. In Japan, the Hi-net operated by National Research Institute for Earth Science and Disaster Resilience (NIED) estimates the magnitudes of earthquakes using the maximum amplitude distribution of the earthquakes and releases the earthquake magnitudes on the Hi-net web site. Another measure to characterize earthquake magnitude is seismic moment that is defined by the average slip and the earthquake fault area. The broad-band seismograph network called the F-net estimates seismic moments and moment tensor of the earthquakes based on the waveform inversion analysis for the earthquakes whose magnitude are larger than 3.5. However, it is hard to estimate them by the inversion analysis for the earthquakes less than magnitude 3.5 due to the signal to noise ratio in observed seismograms. Therefore, for small earthquakes (M < 3.5), seismic moments are not routinely estimated by the NIED. To obtain the seismic moment of small earthquakes, we estimate source spectra for the small earthquakes recorded by the Hi-net. Although the Hi-net has provided good quality continuous seismograms for more than fifteen years on their borehole basement, we need to examine the signal to noise ratio in observed seismograms. Also we cannot neglect the path and site effects. By analyzing the Hi-net seismograms carefully, this study intends to estimate the seismic moment of small earthquakes. The seismic moment was estimated for small earthquakes which occurred in the Tanzawa region. We used the S-wave displacement spectrum during the time from one second before and nineteen second after the S-arrival time. Since the Hi-net sensor is a short-period seismograph, we corrected the instrumental response to reproduce long period seismic signal. The spectrum amplitude lower than the corner frequency shows a constant value that is scaled by the seismic moment. After the corrections of the path effect using a quality factor and the frequency-dependent site amplification factor in the S-wave spectrum, we estimated the seismic moment using the spectrum amplitude in the lower-frequency limit. We carefully examined the signal to noise ratio of the low-frequency spectrum by using the spectrum before the P-arrival time as noise. We confirmed that the seismic moment was stably estimated when the magnitude was larger than 2. When an earthquake occurred near stations, we could estimate seismic moments smaller than magnitude 2. However, in general, we could not estimate the seismic moment less than magnitude 2 because the seismic amplitude in low frequency range is close to or below the background noise level.

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