

Estimation of faulting types of small earthquakes using template events east off Tohoku

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In the northeastern Japan subduction zone, there are many earthquakes with various focal mechanisms. The most reliable focal mechanisms are those evaluated using CMT solutions, but it is difficult to estimate CMT of small earthquakes. However, it is essential to know focal mechanisms of small earthquakes to discuss earthquake generation process in detail.

In this study, we have developed a new method that classifies small earthquakes into several groups of faulting types. In the method, we used template events whose focal mechanisms are known. For pairs of target and template events, we evaluated the similarities of the waveforms for several stations. If the two events are located at the same location and have the same focal mechanism, they should show very similar waveforms at the same station. Thus if the cross-correlation coefficients are large for two events, we can consider the two events have similar focal mechanisms. As a first step, we examined relationship between the focal mechanism differences and the waveform cross-correlation coefficients whose focal mechanisms are known. Here, the differences in focal mechanisms were quantified by using minimum 3D rotation angle (Kagan, 1991). The P and S waves were separately analyzed by using 10 second time windows to reduce the effect of the separation distance between the two earthquakes. Although there were many event pairs with low cross-correlation coefficients for event pairs with small differences in the focal mechanisms, we found that event pairs with large cross-correlation coefficients (CC) always had small differences in focal mechanisms and small inter-event distances. According to the evaluation of the focal mechanism-known pairs, we adopted a threshold of $CC \geq 0.6$ to select events with similar focal mechanisms.

As a second step, we calculated CC of event pairs; in each event pair, the focal mechanism of one event (template event) is known but the other (target event) is not. We classified events using the threshold of $CC \geq 0.6$. Most events were classified as thrust faulting and some events were normal faulting.

Although we need more effort to optimize the method, our method based on template events has a potential of classifying large number of earthquakes into several fault types.

Keywords: focal mechanism, template event, subduction zone