Spatial and temporal distribution of repeating earthquakes in and around the source area of 2003 Tokachi-oki earthquakes, Japan

Makoto MATSUBARA[1]; Yuji Yagi[2]; Kazushige Obara[1]

[1] NIED; [2] BRI

In the subduction zone around the northeastern Japan, seismicity of interplate earthquakes is high and there are several large events around the plate boundary. Waveforms from earthquakes occurring closely with the same focal mechanism must be similar. These earthquakes are called 'repeating earthquakes'. Igarashi et al. (2003) and Uchida et al. (2003) estimated quasi-static slip on the plate boundary off Sanriku, northeastern Japan. Repeating earthquakes are appropriate to study the slip on plate boundary around the source area of large earthquakes. In this study, we investigated existence of repeating earthquakes off Hokkaido and Tohoku, northeastern (NE) Japan, beneath the Pacific ocean including source area of 2003 Tokachi-oki earthquake.

We used waveform data during October 2000 to November 2003 recorded by National Research Institute for Earth Science and Disaster Prevention's (NIED) high-sensitivity seismograph network of Japan (Hi-net). We analyzed 3,139 events with a magnitude larger than 2.5 within the region of interest (40.75–43N, 141.5–146E, 0–200 km depth) and selected 47 Hi-net stations with low noise level (40.4–44.1N, 140–146E). The procedure used in the waveform similarity analysis is as follows: (1) Search earthquake pairs whose epicentral intervals are less than 50 km. There are 10,495 pairs. (2) Calculate cross-correlation coefficients of 1-8 Hz band-pass filtered UD-component seismograms between the paired events recorded at the same station. The length of time window is set between one second before P-wave onset and five seconds after S-wave arrival. (3) Treat the paired earthquakes as 'repeating events' if the coefficients calculated for more than two stations are greater than 0.95.

As a result of the analysis, we found 10 groups of repeating earthquakes composed of 27 events in the east side of Erimo Cape on Hidaka Collision Zone and 46 groups with 106 events in the west side of the cape. In the west side, 78 events occurred before 2003 Tokachi-oki earthquake and 28 events occurred after, however, in the east side, only one event occurred before the earthquake while the other 26 events occurred after. This suggests that slip rate on the plate boundary of the east side was extremely slower than that of the west side before the earthquake in the east side.

Repeating earthquakes surrounded the co-seismic slip area of the main shock (Yagi et al., 2004; Honda et al., 2004) and aftershock area (Ito et al., 2004) and rarely overlapped with that. They occurred at the edge of the major afterslip area following the main shock obtained by Miyazaki et al. (2004) , while the area of the inter-plate aftershocks coincide with the major afterslip area. These results suggest that the inter-plate aftershocks in the major aftershock area mostly occurred in the conditionally stable sliding area where stable slide under quasistatic loading but unstable slide if subjected to a sufficiently loading velocity jump.