Comparison of rupture processes of the 2008 and 2001 small repeating earthquakes off Kamaishi, NE Japan.

Kouhei Shimamura[1]; Toru Matsuzawa[1]; Tomomi Okada[1]; Naoki Uchida[1]; Toshio Kono[2]; Akira Hasegawa[1]

[1] RCPEV, Graduate School of Sci., Tohoku Univ.; [2] KGJ,Graduate School of Sci.,Tohoku Univ.

The cluster of repeating earthquakes of M4.8 +/- 0.1 occurring on the plate boundary off Kamaishi, NE Japan is an example supporting the hypothesis of persistent asperities. Matsuzawa et al. (1999) found that the earthquakes had occurred repeatedly in the cluster from 1957 to 1995 with the mean recurrence interval of about 5.5 years. After the 1995 event, the 2001 and 2008 events occurred within the time range of 99% probability predicted by Matsuzawa et al. (1999, 2002).

Comparing the rupture area of the 2001 event with that of the 1995 event inferred from waveform inversions, Okada et al. (2003) showed that rupture areas of the two events were almost overlapped. From this result they concluded that the two events were caused by the repeated ruptures of the same asperity.

By using the same method as Okada et al. (2003), Shimamura et al. (2008a) also showed that the 1995, 2001, and 2008 events were caused by the repeated ruptures of the same asperity. Moreover, Shimamura et al. (2008b) estimated the slip distributions of the 2001 and 2008 events in more detail. However the obtained solution was not stable in their analysis. In this study we picked up the first arrivals of P- and S-waves more accurately and as a result we successfully obtained solutions with higher accuracy and reliability.

Since the rupture time of the repeating earthquakes off Kamaishi was estimated to be about 0.3 seconds, we have to read first arrivals with errors less than 0.03 seconds for inferring rupture processes. In order to achieve such accuracy, we picked up onsets very carefully taking into consideration that a double difference (DD) of S-wave arrival times should be the product of a DD of P-wave arrivals and V_P/V_S ratio. As a result, stability of the solutions was greatly improved.

We estimated the slip distributions of the 2001 and 2008 events in the frequency range of 1.0-10.0Hz. Roughly speaking, these slip distributions almost overlapped with each other. However, slip amount of the 2001 event was greater than that of the 2008 event to the north of the epicenter while the 2008 event shows larger slip to the east and west of the epicenter.

Uchida et al. (2008) estimated the centroids, radii of the rupture areas, and stress drops of the 2008 and 2001 events and small repeating earthquakes around the two events from spectral analyses. Comparison of our result with the result of Uchida et al. (2008) shows that the areas with greater slip in the 2008 event correspond to the locations of smaller repeating earthquakes. These smaller repeating earthquakes were active just before the 2001 event, but they were inactive just before the 2008 event.

This result indicates that slip distribution of an earthquake may be controlled by the activity of nearby smaller events just before the occurrence.

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