

## On the long-term prediction of the characteristic earthquake activity off Kamaishi, Iwate prefecture, Japan

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At the 1999 SSJ fall meeting (Igarashi et al., 1999) and the 1999 AGU fall meeting (Matsuzawa et al., 1999), we reported that there was a characteristic earthquake sequence off Kamaishi, Iwate prefecture, Japan. In the sequence, earthquakes with  $M4.9 \pm 0.1$  (\*) had repeatedly occurred at a regular interval. The mean recurrence interval was estimated to be 5.35 years and the standard deviation (SD) was estimated to be 0.53 years. Assuming that the repeating interval would follow the normal distribution, we predicted that the next event would occur by January 2001 with a probability of 68% (within the range of the SD) and by November 2001 with a probability of 99% (the range of 2.57 SD). The expected event with  $M4.8$  really occurred on November 13, 2001 (Matsuzawa et al., 2002).

After the occurrence of the 2001 event, Matsuzawa et al. (2002) recalculated that the recurrence interval was 5.52 (mean)  $\pm$  0.68 (SD) years. This meant the next event would occur in May 2007  $\pm$  8 months (September 2006 - January 2008) with 68% probability and  $\pm$  21 months (August 2005 - February 2009) with 99% probability (Matsuzawa et al., 2002).

The anticipated event occurred on January 11, 2008. Precise hypocenter relocation, focal mechanism analysis and slip distribution estimation indicate that the event occurred rupturing the same asperity as that for the 1995 and 2001 events. JMA preliminary magnitude is reported to be  $M4.7$ , which seems to be a little smaller than the previous events. However, moment tensor analyses show that all the 1995, 2001 and 2008 events are as large as around  $Mw4.6-4.7$ . These results indicate that earthquakes of the same size have repeatedly occurred at the same location on the plate boundary.

These results also substantiate the asperity model: If there is an asperity (sticking patch) on a plate boundary and the asperity is isolated from other asperities of the same size or larger, the stress at the asperity will be increased with a constant rate because of the aseismic steady slip in the surrounding area. Since the seismic region is finite, the asperity will generate earthquakes of the same size periodically if the strength does not change with time. Therefore, the off-Kamaishi earthquake sequence can be interpreted from the physical view. If this interpretation is correct, the off-Kamaishi earthquake can be predictable in principle. The success in the present earthquake prediction is thus quite important because it shows that there really exist 'predictable earthquakes'.

Including the new data, the recurrence interval is re-estimated to be 5.59 (mean)  $\pm$  0.67 (SD) years. Thus, the next event is expected to occur in August 2013  $\pm$  8 months (December 2012 - April 2014) with 68 % probability and  $\pm$  21 months (November 2011 - May 2015) with 99 % probability.

(\*) Originally, the magnitude was shown as  $M4.8$  in Matsuzawa et al. (2002) etc. However, JMA magnitude scale has been changed since 2003. In this abstract, we use the new JMA magnitudes.