Experimental prediction of the 2001 Northern Hyogo Prefecture earthquake

ken'ichiro Yamashina[1]

[1] Earthq. Res. Inst., Univ. Tokyo

Based on the time sequence of seismic activity at northern Hyogo Prefecture around Jan. 2001, occurrence of major events was tried to predict. On 15th in Dec. 2000, small earthquakes including M3.1 and 3.0 were considered to be possible foreshocks. After the M5.4 main shock, range of the number of felt aftershocks and those with M3.5 or larger was predicted for 8 periods. Because of occasional large fluctuation in activity, successful predictions were 5/8 amd 7/8 in total, respectively. Cumulative energy released by aftershocks suggested predictions that "middle of M4 - M5 on 13-15th in Jan.", "the larger half of M4 during 16-19th in Jan." and "around M4 during 6-15th in Feb.", which were succeeded by M4.4 (15th in Jan.), M4.7 (20th in Jan.) and M3.9 (16th in Feb.), respectively.

Based on the time sequence of seismic activity at the northern part of Hyogo Prefecture around January 2001, occurence of major events was tried to predict. Small earthquakes started to occur in December 2000, and it culminated in M5.4 and M4.7 on 12th and 20th in January, respectively. The aftershock activity was slightly complicated, i.e. a pair of conjugate faults with an acute angle were displaced by the M5.4 and M4.7 events, respectively. According to the earthquake data preliminary determined by the Japan Meteorological Agency, predictions were tried as follows with rispect to 1) a possibility that small events in December 2000 would be foreshocks for a forthcoming larger event, 2) a plausible range of the number of felt aftershocks and those with magnitude 3.5 or larger, and 3) possible time of major aftershocks around M4 based on a pattern of cumulative energy released by aftershocks.

As discussed by the author (1981a,b), successive events with smal difference in magnitude may be a foreshock activity, especially in case that the diffarence in magnitude is equal to or less than 0.4 (when the later event is larger) or 0.2 (when the former event is larger). In the present experiment, on 15th in December 2000, a prediction was made that "M3 or larger might occur by around 2nd in January 2001, considering the occurrence of M3.1 and M3.0 on 10th and 12th in December 2000, respectively. In that time, three weeks were assumed to be a period in attention against the fact that the M5.4 main shock occurred on 10 days after the expected period. The present convenient method for prediction might be useful to stimulate further consideration on the state of strain accumulation or the previous detailed seismic activity.

Prediction of a plausible range of aftershocks were based on the author(2000)'s method applied to the 1999 taiwan earthquake. At first, the expected number of aftershocks was estimared using parameters in the modified Omori formula. Here, if the estimation was not so confident, 1/a and a times of the expected value were used. Then a plausible range was obtained from the 5-95% (or 0-90% in case that the lower threshold is zero) points of the Poisson distribution, in order to achieve the probability of successful predictions of 90%. In the present case, the range of the number of aftershocks was tried to predict for 8 periods: i.e. 15:00-24:00 on 12th, every day during 13-15th, 3 days for 16-18th, and every week during 19th in January - 8th in February. The activity, however, sometimes fluctuated beyond the expectation. That is, assuming a=1.5-1.2, the rates of successful predictions were 5/8 and 7/8 for felt afterfshocks and events with magnitude 3.5 or larger, respectively.

In order to predict major aftershocks with magnitude around 4 in the present case, cumulative energy released by aftershocks was plotted with respect to transformed time obtained from the modified Omori formula, as proposed before by the author (1995,1996). According to this method, predictions were successful or nearly successful in three times. The first prediction was "middle of M4 - M5 on 13-15th in January". The M4.4 event actually occurred on 15th. The second prediction that "the larger half of M4 during 16-19th in january" was followed by the M4.7 event on the next day (05:19 on 20th). The third prediction that "around M4 during 6-15th in February" was followed by M3.9 also on the next day (02:19 on 16th). The results suggest that the present method of prediction will be useful at least to some extent.