

Earthquake forecast based on a magnitude difference between the largest and the second largest earthquakes

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Based on a statistical study on a magnitude difference between the largest and the second largest events in each earthquake sequence, the author proposed a pair of earthquakes with similar magnitudes may be a signal of an impending larger earthquake (e.g., Yamashina, K., *J. Phys. Earth*, 29, 1981a; Maurice Ewing Ser. 4, 1981b). For example, when a magnitude difference is equal to or less than 0.4 (if the second largest event precedes the larger one) or 0.2 (if vice versa), another larger event will occur with the probability of about 20-30%. In contrast, the probability will become very small when the value of a magnitude difference is large.

Since the proposal, more than 30 years have passed, and many data of earthquake sequences were accumulated. Among them, e.g., the Off-Ibaraki-Prefecture (central Japan) earthquake of M7.0 in 2008 was preceded by events with M6.4 and M6.3 (in JMA scale), and prospectively worried about the occurrence of a larger event with a magnitude around 7.0. The Kumamoto-Prefecture (southern Japan) earthquake of M7.3 in 2016 was also preceded by events with M6.5 and 6.4 (in JMA scale). In case of the L' Aquila (central Italy) earthquake of M6.3 in 2009, the occurrence of events with M4.1 (30 March) and M3.9 (5 April; in INGV scale) might have been useful to warn a possibility of the disastrous main shock (6 April), which occurred several hours after the event with M3.9.

In a typical main-and-aftershock sequence, a magnitude of the largest aftershock is far less than that of a main shock. It will be important that a magnitude difference between the largest two events is a good indicator whether they are considered to be an ordinary main-and-aftershock sequence or not. Although a success rate of the present method of earthquake forecasts is not large, it will still help to prompt an examination of various observed data, and also to call attention to a preparatory check against unexpected disasters. Recently, a detailed statistical analysis for a magnitude difference between the largest two earthquakes is carrying out by Dr. Shunichi Nomura and others. The author appreciates the progress of the present subject.

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