

Seismicity in a source region of a large interplate earthquake and the characteristic earthquake model

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The occurrence rate of characteristic earthquake is compared with seismicity in nine source regions of interplate earthquake, i.e. regions off Shikotan Island, off Nemuro, off Tokachi, off Northern Sanriku, off Miyagi, and far off Miyagi, Tonankai, Nankai, and Taisho-Kanto regions, by combining instrumental data and the data on the characteristic earthquakes evaluated by the Headquarters for Earthquake Research Promotion (HERP) in Japan. We used a unified catalog of earthquakes obtained by the Japan Meteorological Agency (JMA) on the basis of recently improved seismic network, together with the old JMA catalog. As a result, seismicity of all the interplate source region shows that the observed number of events are much less than the expected number of events estimated from the Gutenberg-Richter (G-R) relationship and the occurrence rate of the characteristic earthquake. In all regions except the region far off Miyagi, the characteristic earthquake(s) occurred during the interval of the earthquake catalog. Thus our dataset includes the highest seismicity period during an earthquake cycle. In the region off Tokachi where the 1952 and the 2003 Tokachi-Oki earthquakes occurred, the magnitude frequency distribution (MFD) has a magnitude gap of 0.8-1.0 between the characteristic earthquakes and the other events. Thus our results favor the characteristic earthquake model.

Secondly we estimated from the seismicity data of small earthquakes, an average recurrence interval of the characteristic earthquake in each region based on the assumption that the G-R relationship holds. The estimated recurrence intervals are remarkably longer than the evaluation given by HERP. For example, the estimated interval for the Nankai region (HERP estimation is 90.1 years) is 508-675 years. In this study, we did not distinguish between interplate and intraplate earthquakes. Nonetheless, the observed number of earthquakes are less than that expected from the G-R relationship. These results are unchanged regardless of the uncertainty in off-shore hypocenter determination.

The characteristic earthquake model was proposed by Schwartz and Coppersmith in 1984. Wesnousky (1994) examined the shape of MFD from instrumental and geological data in California, which was followed by Stirling et al. (1996)'s study in California, New Zealand and Southwest Japan. They concluded that seismicity around late Quaternary faults did not obey the G-R relationship and are consistent with the characteristic earthquake model. We showed that MFD of seismicity around the Japanese active faults follows the characteristic earthquake model by using geological data examined and compiled by HERP and the JMA unified catalog. We also showed that the larger an average slip-rate is, or the shorter an average recurrence interval is, the larger is the magnitude gap. In this study, we study large interplate earthquakes in stead of active faults. In comparison with an average recurrence interval of 1,000 to 10,000 years for a large earthquake on an active fault, a large interplate earthquake repeats in several tens to several hundreds of years. Hence, we can study a complete seismic cycle or the most part of one earthquake cycle.