

Active foreshocks of $M > 7.5$ earthquakes in the northern Japan to Kuril Trenches

HARADA, Tomoya^{1*} ; YOKOI, Sayoko¹ ; SATAKE, Kenji¹

¹Earthquake Research Institute, Univ. of Tokyo

Along the northern Japan to Kuril Trenches, active foreshock sequences preceded some $M > 7.5$ earthquakes, providing a good opportunity to understand the characteristics of foreshocks for large interplate events. Active foreshocks are identified in the M-T diagrams and cumulative frequency curve of earthquakes before and after the mainshocks. The earthquakes preceded by active foreshocks are: the 2006 (Mw8.3) and 2007 (Mw8.1) offshore Simushir earthquakes, the 1963 (Mw8.6), 1991 (Mw7.6), 1995 (Mw7.9) offshore Urup events, the 1978 (Mw7.8) offshore Iturup event, the 1969 (Mw8.2) offshore Shikotan event, the 1989 (Mw7.4) offshore northern Sanriku event. In contrast, $M > 7.5$ interplate earthquakes offshore Hokkaido to northern Sanriku in 1952 (Mw8.1), 1968 (Mw8.3), 1973 (Mw7.8), 1994 (Mw7.8), 2003 (Mw8.1), and intraslab earthquakes in 1958 (Mw8.4), 1978 (Mw7.8), 1993 (Mw7.7), 1994 (Mw8.3) had few or no foreshocks.

Some results from our examination of the foreshock sequences are as follows. Fitting the ETAS model (Ogata, 1988, 1992) to foreshock sequences show that the active foreshocks were composed of large foreshocks and their aftershocks. Foreshocks of the 2007 Kuril outer-rise earthquake were interpreted as aftershocks of the 2006 interplate earthquake. Relocated foreshocks show that they migrate in various, not unique, directions. Distributions of foreshock do not overlap with the large coseismic slips (asperities) of the mainshocks of interplate earthquakes.

Relocation of foreshocks and mainshocks were made by the modified JHD method and time-difference grid-search method (Hurukawa & Harada, 2014). The coseismic slip distributions were estimated by the teleseismic body-wave inversion (Kikuchi & Kanamori, 2003).

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