

Short recurrence intervals of repeating earthquakes in the Tonga subduction zone

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The Tonga subduction zone is characterized by high seismicity and fast convergence rates exceeding 20 cm/year with a wide variation along the trench. We searched repeating earthquakes in this region and identified several sequences.

We selected 1399 $M > 5$ events with the depth shallower than 60 km occurred from 1991 to 2011 in the ANSS global earthquake catalog. For all events, broadband seismograms at about 27 stations were downloaded from IRIS DMC, and bandpass filtered in 0.02 - 4Hz. For each pair of two events, we computed a cross-correlation function between vertical seismograms recorded at the station CTAO, Australia, for 800 s time windows around the theoretical S arrival times. We consider two events are repeating when the maximum of the cross-correlation function is larger than 0.9. Through this procedure and manual inspection of recurrence intervals, we identified 45 repeating earthquakes in 11 sequences. Almost all events have a low-angle thrust mechanism and for most sequences, the difference of relative S arrival times between stations are less than 0.5 s, suggesting the proximity of source regions.

The recurrence intervals of these events are very short despite their large size. For example, five M6 earthquakes occurred in 1993-2011, with the average recurrence interval of about 4.3 years. After the normalization of recurrence intervals using the scaling law of Nadeau and Johnson (1998), we found that the recurrence intervals are yet short, compared with those estimated in other regions such as northeastern Japan subduction zone and Parkfield, California. This difference can be explained by the different convergence rates.

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