Long-term tectonic tremor activity around the afterslip area of the 2003 Tokachi-oki earthquake.

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A study on behavior of slow earthquake activity after large megathrust earthquakes is important to understand interaction between those earthquakes. However, there are few cases of observing slow earthquakes immediately after the occurrence of a large earthquake, because of long recurrence interval and rarity of large earthquakes. The Japan and Kuril trench-trench junction region is suitable for the study because high slow earthquake activity zone neighbors on the source area of the 2003 Tokachi-oki earthquake (Mw 8.0), and several long-term observations using ocean bottom seismometers (OBSs) have been conducted. This study aimed to reveal the effect of the occurrence of a large earthquake on tremor activity.

We analyzed two datasets of the aftershock OBS observation of the 2003 Tokachi-oki earthquake (2003/10/1–2003/11/20) and long-term OBS observation (2006/10/25–2007/6/5), respectively. To detect and locate tremors, we firstly applied an envelope cross-correlation method (Ide, 2010) to continuous OBS records. Next, we discriminated tremors by visually confirming the waveform and running spectrum (RS) of tremor candidates which satisfied three conditions (duration ≧ 20 s, epicentral error ≦ 5 km, time residual ≦ 3 s). As a result, we detected 960 and 363 tremors from the long-term and the aftershock observations, respectively.

Detected tremors in 2006–2007 show comparably high activity in November 2006, March 2007, and May 2007. The first activity distributes in the southern part of the tremor activity zone by Nishikawa et al. (2019), but it is likely that tremors at the northern side could not detect because only thesouthern half of the stations were in operation at that time. The second activity showed bilateral epicenter migration with a speed of 10–25 km/day. Tremors in the third activity occurred intensively in one day and ceased within a few days. On the other hand, tremors detected during the aftershock observation period occurred sporadically during the first half of the period but burst and intermittently for three weeks in the second half period. Each burst ceased within a few hours to a day with repeating intervals of a few days.

We found that obtained tremor catalogs have some notable similarities in tremor activities against the catalog revealed by S-net data in 2016–2018 (Nishikawa et al., 2019): a good consistency in starting location of sequence, migration direction, and speed of the tremor sequence during large-scale activities, the existence of medium-scale minor activities. In addition, although the northern limit of the first activity in 2006 could not be clarified due to the lack of the northern half of the OBS network, the distribution of incident VLFEs implies an expansion of tremor occasions towards the north of the network. Whereas, the occurrence interval of large activities is 4 months (2 months including the medium activity) in 2006–2007 and is quite shorter than 8–11 months (3–7 months) in 2016–2018. Furthermore, the duration of burst tremor activities are significantly different; activities after 2016 cease only a few days, which is much shorter than the three weeks observed in 2003.

We consider that observed differences, lengthening in the interval and shortening in duration of activities since 2003, relate to the process of the afterslip of the 2003 Tokachi-oki earthquake. The afterslip in the tremor activity zone, immediately after the mainshock, has progressed with a high slip rate and gradually decayed as time passes (Itoh et al., 2019). Assuming that the afterslip almost converged by 2016,

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behaviors of tremor activities in 2003 and 2006–2007 may reflect a faster interplate slip rate in those days than now. In consequence, we suggest that occurrences of large earthquakes would have a significant effect on tremor activity near source areas and that behaviors of tremor activities would return to a steady-state following the afterslip decay.

Keywords: Tectonic tremor, Ocean bottom seismometer observation, Envelope correlation method, The 2003 Tokachi-oki earthquake

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