Trial detection of deep low frequency tremor using analog seismograms of Kanto-Tokai Observation Network in 1988-1990

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Slow earthquakes (i.e. low frequency tremor (LFT), very low frequency earthquakes and slow slip events (SSEs)) have been vigorously studied since the discovery of deep low frequency tremor (LFT) in the Nankai region (Obara, 2002). However, the past activity of LFT is not clear, as these events were not well known in 20th century and continuous seismic data in this period is rare due to the cost of data storage. Therefore, only analog seismograms are available source to reveal the LFT activity in such period. In terms of the crustal deformation, Kobayashi et al. (2006) revealed the activity of short-term SSEs in the Tokai region since 1984, using a strain meter of JMA. On the other hand, as the data volume of seismic data is much larger than that in geodetic observations, it is not easy to keep the recordings for a long time. Fortunately, NIED has stored the paper recordings of seismograms of the Kanto-Tokai Observation Network, which started since late 1970s. In our previous study, we have reported the tentative result of LFT detection in the Tokai region from 1980 to 1987, using this data (Matsuzawa and Takeda, 2019). In this study, we report the tentative result from 1988 to 1990, in which occurrence of a long-term SSE is reported (Kobayashi and Yoshida, 2004).

We visually examined waveforms at Shimoyama (SMY) seismograph in the Kanto-Tokai Observation Network by NIED, to detect active episodes of LFT, as in our previous study. The waveforms are identified as tremor-like signal lasts for several minutes and is repeatedly found within several days, even if a single station is used. When the number of low frequency signal is small within several hours, we discard the event, as it is not clear whether the signal is caused by a regular earthquake or a small LFT episode. This feature was also confirmed using simulated analog seismogram and current LFT catalog (Matsuzawa and Takeda, 2019). After visual inspection of the waveforms from 1988 to 1990, we found possible LFT episodes, for example, in Apr. 1988, Oct. 1988, Feb. 1989, Oct. 1989, Jun. 1990, and Sept. 1990. In addition, possible triggered tremor by a far field earthquake is found, for example, after an M7.7 earthquake in Philippines on Jul. 16, 1990.

In our studied period, six tremor episodes are detected, while short-term SSEs are reported in Apr. 1988, Oct. 1988, and Oct. 1989, which correspond to our detected episodes. In our previous study, we reported four tremor episodes in 1980-1985, and three episodes in 1986-1987. Combining our new result, our results suggests that tremor was active in 1986-1990. Tremor episode were active in 2003-2004 during a long-term SSE in 2000-2005. The activation of tremor in late 1980s is similar to the activation during a long-term SSE in 2000-2005. However, the active period of tremor precedes the period of the long-term SSE in this case. Therefore, the long-term SSE in late 1980s may start close to the deep LFT region and propagated to shallower part. Further study, including location of tremor episodes, might reveal the details and variety of slip process in long-term SSE events.

Keywords: Low Frequency Tremor, Analog Seismogram, Slow Earthquakes

