

## Classification criterion between regular earthquakes and tectonic tremors in shallow subduction zone, based on near-field seismic observation

\*Akiko Toh<sup>1</sup>, Satoshi Ide<sup>1</sup>, Wu-Cheng Chi<sup>2</sup>

1. EPS, Tokyo Univ., 2. IES, Academia Sinica

In the eastern Nankai Trough, both regular earthquakes and tectonic tremors have been recorded very close from their sources by ocean bottom seismometers. The classification between the two types of seismic events have been based on their waveform features. So far, the tremors are reported show (1) longer signal duration (2) depletion in high frequency component above  $\sim 10$  Hz (3) unclear P and S wave arrivals compared to regular earthquakes (e.g. Obana & Kodaira, 2009). Especially, the criteria (1) of long signal duration has been adopted to distinguish tremors from regular earthquakes, in many tremor related studies of this region.

Here, we report that, based on visual inspection of DONET records, we identified tremors with short signal duration. More specifically, their signal duration is as short as ( $\sim 1$  s) that of regular earthquakes when recorded very close ( $< 6$  km) at the station located just above the source. The duration becomes long ( $> 7$  s) and the amplitude of signal decreases drastically at other stations located farther away (but only  $\sim 10$  km) from the tremor source. The feature is not due to site effects, as confirmed by comparing waveforms with those of regular earthquakes located close from the same station and from the tremor sources. More interestingly, even when their duration is short, tremor signals lack energy above 10 Hz. The short duration tremors are different from so-called low frequency earthquakes (LFE; Shelly et al., 2007) observed at deeper subductions zone. One of the major differences is that signal duration of LFEs does not change so drastically among stations.

The observation suggests that the source duration of tremors is not necessarily long, and can be short. The clearest classification between tremor and regular earthquakes can be made by their spectrum (i.e. depletion above 10 Hz for tremor), rather than the signal duration. Furthermore, the drastic change of waveforms between the nearby station and other farther stations, suggests that tremor source is surround by an attenuative and scatterous structure. It has been shown that a series of slow earthquakes (e.g. tremors, VLFs and SSEs) occur along the same fault zone (Araki et al., 2018). Thus, the anomalous structure found to surround the tremor sources could be one of the controlling factors of the slow earthquake phenomenon.

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