Interplay between long-term SSE and ETS facilitated by different underground environment

*Kazushige Obara[1]

1. Earthquake Research Institute, The University of Tokyo

Slow earthquakes consist of fault slip phenomena with various characteristic times. Geodetically detected slow earthquakes are mainly classified into two types; short-term and long-term slow slip events (SSEs) with duration from days to weeks and from months to years, respectively. In southwest Japan, at the deeper part from the seismogenic zone along the subducting plate interface, long-term and short-term SSEs are adjacently distributed and they indicate interaction. Because the short-term SSE usually occurs as an Episodic Tremor and Slip (ETS) associated with low-frequency tremor and very-low-frequency earthquake, the interaction is usually observed clearly in ETS tremor seismicity.
In Bungo channel, the long-term SSE is well known to occur at interval of 6-7 years. After the deployment of dense high-sensitivity seismograph network, major long-term SSEs in 2003 and 2010 were accompanied by activation of tremor seismicity. The activated tremor region is limited within a narrow width of 10 km from the updip edge of ETS zone and the tremor activity of the rest downdip part is constant irrespective to the occurrence of the long-term SSE.
In this region, two small long-term SSEs were detected by GNSS in 2014 and 2016; however, the interaction to ETS tremor were different from cases in 2003 and 2010. In 2014, activated tremor was smaller than that in 2010 according to the difference in the magnitude of SSE. On the other hand, there was no tremor activity associated with 2016 SSE. This is because the slip region of SSE was located southward apart from the tremor zone. By the way, a long-term SSE from the end of 2018 continues associated with activation of tremor lasting for several months. This SSE might be expected as a major SSE since 2010.
The main difference between long-term and short-term SSEs is slip rate. The difference in the slip rate may affect to the tremor rate. During the long-term SSE in 2003 and 2010, the temporal change in cumulative number of tremor increased smoothly similar to the GNSS displacement. However, the gradual increase of tremor number was actually composed of superposition of small bursts corresponding to the faster speed slip compared to the long-term SSE. This suggests that the ETS region has a characteristic slip and frictional property different from the long-term SSE region.
A recent receiver function study conducted along a linear seismic array installed at the west of Shikoku besides from Bungo channel has revealed a low velocity oceanic crust and a continental Moho discontinuity just above ETS activity. This indicates that the ETS occur at the boundary between the subducting oceanic plate and the overlying mantle wedge, whereas that long-term SSE occurs at the boundary between oceanic plate and the continental lower crust. The difference of slow earthquake behavior controlled by the structure in the hanging wall is very similar to the Tokai region (Kato et al., 2010). Therefore, the different environment at the plate interface facilitates these SSEs with different characteristic times.

Keywords: slow earthquake, low frequency tremor, slow slip event, subduction zone

