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Phenomenology of Episodic Tremor and Slip
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小原 一成 [1*]
OBARA, Kazushige[1*]

[1]Earthquake Research Institute, UTokyo
[1]Earthquake Research Institute, UTokyo

Episodic Tremor and Slip (ETS) is a coupling phenomenon composed of continuous weak seismic events and geodetic short-term slow slip event (SSE) in the transition zone between the brittle seismogenic zone and stable sliding regime recognized in southwest Japan and Cascadia. This paper reviews characteristics of ETS and related phenomena to contribute to discussion for subduction process.

ETS is interpreted as a stick slip on the plate interface accompanied by seismic swarm at small patches surrounded by the SSE plane because of coincidence of their sources and linear relationship between the duration of tremor episode and the moment of SSE estimated geodetically for each episode. ETS is distributed in a narrow belt-like zone along the strike of the subducting plate. ETS zone is divided into several segments in which episodes recur at each regular recurrence interval. However ETS is not ”characteristic earthquake” because the rupture area and recurrence interval are fluctuated. Sometimes we observe rupture propagation through a couple of segments. The segment is usually bounded by gap which is considered as not a barrier but an easily sliding portion because of the existence of multi-segment migration.

ETS activity has depth dependent property. At the deeper part of the ETS zone minor episode frequently occurs, on the other hand major episode occurs infrequently at the shallower part. Large ETS usually initiates from the deeper part and migrates upward then activates at the shallower part. This might be caused by gradual change in frictional property with increasing the depth. At the downdip edge of the ETS zone tremor episode easily occur due to weak strength and stress concentration from stable sliding zone. Each small episode transfers the stress to the updip side. Finally a small episode can propagate to the updip edge then develop as a large ETS episode.

The activity style of ETS in southwest Japan and Cascadia is very similar; however there are some differences. One is the existence of deep very low frequency earthquake (VLF). In Japan the VLF earthquake is usually associated with ETS but has not been detected in Cascadia. It might depend on the detection capability or difference in inhomogeneity of the plate interface because the distribution of VLF earthquake in southwest Japan is more localized compared to that of tremor.

The other difference is the existence of long-term SSE. It is detected at the updip side of ETS zone in the Bungo Channel and Tokai in southwest Japan but not detected in Cascadia. The long-term SSE with duration from several months to years activates tremor at the adjacent limited region in the ETS zone. On the other hand, the tremor activity at the downdip part is not affected. Similar long-term SSE has been detected in Alaska and Mexico, where tremor activity was recently detected at the downdip side of the source fault of the long-term SSE. The tremor is seems to be activated during the SSE period like as in southwest Japan. The long-term SSE in Tokai is located above the anomalously high Vp/Vs region in the slab. In Mexico, a ultra slow speed layer was found in the long-term SSE source region. Therefore, the anomalous structure might be a cause of the long-term SSE. ETS and long-term SSE are quite different in the slip velocity. It might reflect the difference in the frictional property. In Tokai, the source region of the long-term SSE and ETS is bounded by the inland Moho discontinuity. Therefore, ETS occurs at the interface between the subducting plate and overlying mantle wedge.

ETS has not been recognized besides in southwest Japan and Cascadia; however ambient tremor has been detected in some regions. We expect that the ambient tremor is triggered by small SSE which is not detected by the current observation. Understanding detail relationship between tremor and SSE based on improvement detection capability is important to reveal the mechanism of ETS.

Keywords: slow earthquake, non-volcanic tremor, slow slip event, subduction zone, plate interface