Segmentation of the transition zone on the subducting plate boundary derived from deep slow earthquakes activities

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Non-volcanic deep low-frequency tremor has been detected at the transition zone of deeper plate interface along the strike of the subducting Philippine Sea plate (PHS), southwest Japan [Obara, 2002]. The tremor activity is clustered spatially and temporally within the belt-like zone. Peak of tremor activity recurs with a characteristic time interval of six months accompanying to short-term slow slip event lasting for a several days in some regions [Obara, et al., 2004]. During the active stage, the source of tremor and slow slip migrate with a propagation velocity of around 10km/day. Recently, we succeeded to detect the other type of low-frequency seismic phenomena, which is called deep very low-frequency (VLF) earthquake [Ito et al., 2007]. These three slow earthquakes, short-term slow slip, deep VLF earthquake, and non-volcanic low-frequency tremor reflect the stress relaxation process at the transition zone of deeper plate interface.

The belt-like tremor zone is divided into some segments considering with the space-time distribution of activities. Western Shikoku, northern Kii and Tokai segments are characterized by the recurrence interval of six months. In these areas, the short-term slow slip event can be detected by some tiltmeters and the fault models are estimated. On the other hand, eastern and central parts of Shikoku and central Kii segments have a recurrence interval of three months and there is no major tilt change during the active tremor episode.

Some segments are bounded by the inhomogeneity of the slab geometry. Beneath the Ise Bay and Kii Channel, significant ridge structure of the slab geometry corresponds to the inactivity of tremor based on the receiver function analysis (Shiomi et al, 2006). In the northern Kii segment, the tremor usually begins from the Ise Bay and migrates to southwest. The slab geometry might affect the nucleation of the slow slip activity. However, episodic tremor and slip in January 2006 started at the south edge of the northern Kii segment and migrated to north, finally across the Ise Bay reached to Tokai area. This episode suggests that the smoothness of the ridge geometry enable to propagate the remarkable slip event.

There are many minor tremor activities without tilt change, however major tremor episodes are always accompanied by the slow slip event and migrate unilaterally or bilaterally. Comparison between the tilting record and tremor activity indicates that the beginning of the detectable slow slip coincides with activation of tremor. This supports an idea that the slow slip event occurs first and induces the tremor. The front of the migrating tremor activity is very sharp and behind of the front the tremor activity keeps for a while. The migration of tremor is induced by the rupture propagation of the slip event and the tremor behind the migration front keeps highly activity by the slipping.

The VLF earthquake with predominant period of 20 seconds has been detected during the episode of tremor and slip. Based on the centroid moment tensor analysis, the VLF earthquake is located at the same position of the tremor source area and the focal mechanism is the reverse fault type coincident with the slow slip event and the plate interface geometry. During the episode 2006 in Kii and Tokai regions, many VLF earthquakes migrating with the tremor and slow slip event were identified. There exists a spectrum gap between the VLF earthquake and tremor. Therefore these seismic phenomena are basically generated by different source processes with strong relationship reflecting the inhomogeneous structure on the plate interface at the transition zone. One possible idea is that the source of the VLF earthquake is a relatively strong patch surrounded by the short-term slow slip source fault. When the stress accumulation in the patch exceeds the failure strength according to the progress of slow slip, the VLF earthquake may occur at the patch interface saturated by fluid.