Deep low-frequency tremor and slow slip detected in southwest Japan - Monitoring for subducting plate motion -

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The deep low-frequency tremor in southwest Japan (Obara, 2002) is distributed along the strike of the subducting Philippine Sea plate. Therefore, the tremor may reflect the subduction process with the existence of fluid. If the dehydration process takes place at a limited depth range in the subducting plate, the distribution of the fluid is parallel to the depth contour of the subducting plate. In this case, the tremor seems not to be related the plate motion directly. However, very recently some slow slip events have been detected associated with the active stage of tremors. This indicates that the tremor is expected to be one of the important geophysical phenomena for monitoring of the plate motion at the mega-thrust zone.

Slow slip events accompanied by active tremors often occur in the western part of Shikoku and the Bungo channel area (Obara et al., 2004). For four years from 2001, ten slow slip events were detected by tiltmeters installed at the Hi-net observation well. Nine events are accompanied by active migrating tremor and the duration time of each event is shorter than 1 week. The short-term slow slip events had a constant recurrence interval of 6 months for 2 years of 2001 and 2002; however, the recurrence rate was shortened from the occurrence of the long-term slow slip event, which continued for three months from August 2003. The long-term slow slip can be detected by GPS and tiltmeter; however the GPS is not available to detect the short-term slow slip event. Such tilt changes accompanied by active tremor are detected in not only western Shikoku but also eastern Shikoku and northern part of Kii peninsula. This indicates that the short-term slow slip occurs in these areas. Moreover, the tremor and slow slip have been detected in the Cascadia margin on the northwest part of the North America (Rogers and Dragert, 2003). The episodic tremor and slip (ETS) have a recurrence interval of 14 – 16 months and the source of the ETS migrates along the strike of the subducting oceanic plate.　The time duration of each active stage is a few weeks. There are many common features in ETS in southwest Japan and Cascadia, periodicity, migration, short-term duration, waveform patterns of tremor, and so on. Therefore, the ETS might be controlled subducting young and warm oceanic plates, which characterize both regions.

At present, the physical process of the tremor is not resolved.　However, we are probably safe in thinking the slow slip event taking place at the plate interface. The estimated fault geometry of slow slip events is located at the deeper extension of the locked zone on the subducting plate boundary. At the depth, the temperature is higher and the frictional strength is lower than those on the locked zone. Fluid liberated from the oceanic plate might be important to reduce the frictional strength. Therefore, a slip event easily takes place even in a small stress. On the other hand, the strain keeps accumulating at the locked zone. The accumulated strain should be comparable to the released strain at the slow slip zone.　The accurate detection of the slow slip event might be useful for estimation of strain accumulation at the locked zone. If these are the different phenomenon with different location, the slip takes place at first when the accumulated stress exceeds a threshold, then the stress redistribution due to the slip and fluid flow with change in the pore pressure might trigger the occurrence of tremors.　If these are the identical phenomena with the same source location, there might be many undetectable slow slips with small activity of tremors without any tilt change. In any cases, we have to clarify the relationship between the slow slip and tremor. Considering with the observation technique, the tremor is easily to detect compared with the slow slip, therefore, the observation of tremors is very important for monitoring of the plate motion and the stress accumulation at the plate interface.