Tidal modulation of slow slip events in the Nankai subduction zone detected by borehole strainmeter

*Junji Kikuchi[1], Satoshi Ide[1], Norio Matsumoto[2]

1. Department of Earth and Planetary Scinence, The University of Tokyo, 2. Tectono-Hydrology Research Group, Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (AIST)

Slow slip events (SSEs) often occur in the Nankai subduction zone, Japan. SSEs are believed as shear slip on the plate interface, where the frictional property changes from velocity weakening to strengthening in the dip direction. SSEs are also suggested that they alter the stress condition of the adjacent area, where megathrust earthquakes occur. Therefore, the dynamics of SSEs may give some hints to understand the depth dependent friction and plate subduction process. The tidal modulation of SSEs has been identified by statistical analysis using strain data of Plate Boundary Observatory, in the Cascadia subduction zone. We perform similar statistical analyses in western Japan using strain data recorded at borehole stations maintained by National Institute of Advanced Industrial Science and Technology. Target SSEs are detected using tremor catalog. The correlation between the oscillation in SSEs and tidal stress is confirmed statistically. However, the tidal components which modulate SSEs are diurnal tides, and different from a semidiurnal tide in the previous study in the Cascadia subduction zone. This result shows that the responsiveness of SSEs is not so simple that SSEs depend on any of tidal components and suggest that total tidal stress should be considered. Hence, we try to directly compare the slip rate and total tidal stress on the plate interface. Simulated strain from tremor activity is qualitatively similar to observed strain from SSEs. Thus we assume that tremor hypocenters represent the slipping region of SSEs, and calculate the temporal change of slipping region of SSEs. Quantitatively estimating the effect of the relative location between the station and the slipping region, we compare the slip rate on the plate interface inferred from strain data with total tidal stress. The slip rate and tidal shear stress are positively correlated. This result suggests that the frictional law acting on SSEs occurring region is of velocity strengthening type. This is the first evidence of the velocity strengthening friction law in the transition zone derived using geodetic data. If this method is applied to the other SSEs occurring region, we may comprehensively understand the frictional property of the plate subduction zone.

Keywords: Slow Slip Event (SSE), strainmeter, tidal stress, slip rate, velocity strengthening friction law

