Seismic activity in the Tokai region and a numerical simulation for the stress field around the locked zone on the plate interface

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Since 1854 Ansei-Tonankai earthquake, strain accumulation in the Tokai region have been continued for 150 years. The possibility of forthcoming large interplate earthquake was pointed out (Ishibashi, 1976; Proc. Fall Meet. Seismol. Soc. Jpn.). Dense observation networks have been established around this region.

The National Research Institute for Earth Science and Disaster Prevention (NIED) began construction of a micro-earthquake observation network in 1979 as well. Since then active seismicity around the plate interface has been observed for 25 years. It is thought that seismicity indicates a level of the stress increase (Dieterich, 1994). In term of this, seismicity around the plate interface can reflect the stress increase due to the interplate coupling. And then, it can be possible to determine the distribution of the locked patches on the plate interface and to monitor inhomogeneous strain accumulation process before the forthcoming large thrust event.

Recently, seismicity in the Tokai region comes to change (e.g., Matsumura, 2003; Bull. Earthq. Res. Inst.). Slow crustal deformation beneath the region around Lake Hamana which have been continued since the latter 1990s is interpreted by an aseismic slow slip event on the plate interface (Ozawa et al., 2002; Science). These two changes (in seismicity and in crustal movement) may have a relation to the locked state on the plate interface and this relationship has been attracting the attentions of geoscientists.

In order to know the relationship between the seismicity and the locked state, we need to investigate the influence (perturbation) on the stress field caused by the interplate coupling or its temporal change. In this study, we simulate the stress field caused by the locking on the plate interface using a finite element method. We compare various patterns of locked patches on the plate interface to discuss on the characteristics of the stress field.

Through our numerical simulation, we find the following characteristics for the stress field around the locked zone;
(0) stress increase around the locked zone on the plate interface,
(1) increase of compression in the trenchward side of the foot wall and in the landward side of the hanging wall,
(2) increase of tension in the trenchward side of the hanging wall and in the landward side of the foot wall,
(3) stress concentration to the upper and lower edges of the locked zone,
(4) more remarkable stress concentration to smaller locked area,
(5) changes of stress axes around the locked zone.

Then, we try to compare these characteristics of the stress field with the seismicity observed by NIED in the Tokai region. Actually, in the Tokai region, active seismicity can be seen in the landward side of the overriding plate and in the trenchward side of the subducting slab, while seismicity in the trenchward side of the overriding plate is inactive. These features are consistent with the characteristics (1) and (2) from the simulation result. Based on this relationship, we can determine the locked zone on the plate interface to be around 15 – 25 km depth.

In the presentation, we will also compare the directions of the stress axes with focal mechanisms of earthquakes around the plate interface.