An estimation of stress changes based on earthquake swarm seismicity accompanied by Boso slow slip events

*Tomoki Ukawa[1], Hitoshi Hirose[2,1]

1. Department of Planetology, Graduate School of Science, 2. Research Center for Urban Safety and Security, Kobe University

In off the coast of Boso peninsula, the occurrence of slow slip events (SSEs) are reported (e.g., Ozawa et al., 2003). SSE does not cause seismic motion and tsunami in itself, but in the northern part of the SSE area, earthquake swarm activity arises concurrently with SSE. A previous study stated that earthquake swarm were triggered by SSE (Hirose et al., 2014), so it is expected that an SSE affects a stress field in the area of earthquake swarm, but the quantitative relationship is poorly known. In this study, we estimate a stress change before and after each of the Boso SSEs by using the method of Dieterich et al. (2000) based on seismicity rate of the earthquake swarm.

We used JMA unified Hypocenter catalog from 1997/10/01 to 2015/12/31. And analysis domain in this study was approximately 60 km×60 km square and depth of 10 km˜35 km. This domain contains almost entire areas of the earthquake swarm areas accompanied by the Boso SSEs. Because there was a possibility that detection ability of earthquakes have changed during the analysis periods, we assessed a completeness magnitude, and we selected earthquakes larger than or equal to M1.5.

To calculate the time series of stress changes, we applied seismicity rates to the equation (3) in Dieterich et al. (2000). The values of parameters required to the calculation are set as follows ;

A, a dimensionless fault constitutive parameter, is 0.005, that is the value used in Dieterich et al., 2000; normal stress is 340 MPa, that equals to the overburden pressure less hydrostatic pore-fluid pressure in a depth of 20 km; reference stressing rate is 0.05 MPa/yr . That was calculated under the assumption that the amount of one SSE’ s stress drop (Hirose et al., 2012) was recovered in an average SSE’ s recurrence interval. r , steady-state seismicity rate at the reference stressing rate, is 0.123 /day, we assume the seismicity is in steady-state from 2003/1/1 to 2006/12/31.

Consequently, stress changes in the SSEs, 2002SSE, 2007SSE, 2011SSE, and 2014SSE were +0.1 MPa, +0.5MPa, +0.5MPa, -0.7MPa, respectively. Their interval were changed 77mo.→58mo(2002SSE), 58mo.→50mo. (2007SSE), 50mo.→26mo.(2011SSE), and 26mo.→54mo. (2014SSE). That is the recurrence interval was shorten in cases with a positive stress change, and prolonged in negative stress change’ s case. In the cases of 2002SSE and 2014SSE that the amount of stress increase was small or negative, the duration of the SSEs are about twice as long as other cases (Fukuda, 2018). This suggests that the duration and the complexity of a source process of an SSE may contribute to the stress change.

Keywords: recurrence interval, Coulomb stress, Dieterich

