

The b-value of the earthquake swarm activities accompanied by the Boso slow slip events

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Slow slip events (SSEs) which are accompanying earthquake swarms repeatedly occur at intervals of about 2 to 7 years off Boso Peninsula (e.g., Sagiya, 2004; Hirose et al., 2012, 2014; Fukuda, 2018). These SSEs and swarms are thought to occur on the upper boundary of the subducting Philippine Sea plate.

As a statistical property of earthquakes, Gutenberg-Richter's law is well-known, that is, the relationship between the magnitude and the logarithm of occurrence frequency of earthquakes is expressed well with a straight line $a-bM$ (Gutenberg and Richter, 1944). Although the b-value (slope of the line) often takes values around 1, there are many reports about the temporal changes of the b-value. For example, a decade-scale b-value decrease prior to the 2011 Tohoku Earthquake is reported (Nanjo et al., 2012). Although the relationship between the temporal change of b-value and aseismic slip is suggested, but the lack of near field geodetic observations prevents the direct evidence for the relationship. Here we examine the b-value of the earthquake swarms accompanied by the Boso SSEs, of which the aseismic slip is revealed by geodetic observations.

In this study, we estimate the b-value of the earthquake swarms in 2002, 2007, 2011 and 2014. We use the JMA unified earthquake catalog. As a preliminary analysis, we investigated the earthquakes with focal depths of 5 km to 40 km occurring at 35.05° to 35.56°N in latitude and 140.15° to 140.73°E in longitude. Eventually, "event period" estimated in the previous studies of the crustal deformation by geodetic observation does not necessarily agree with the period of the swarms occurring at the same time. Therefore, in this research, "event period" was redefined from seismic activity and used. In other words, we extracted swarms including a SSE period from crustal deformation studies and the time when the seismicity rate (the number of earthquakes per unit time) is significantly higher than the other time is defined as "event period". In addition, the period other than the event period is defined as "inter-swarm period".

We find that the b-values in the event periods tend to be lower than that during inter-swarm period. In more detail, different trends that seem to correspond to the difference in slip zone and location of earthquake activity of each SSE (Hirose et al. 2014) are seen in the b-values for the event periods. A seismic activity near the southern coast of the Boso Peninsula was hardly observed in the 2007 event period, whereas an active seismic activity was seen there in the 2011 event period. In order to clarify the dependence of the b-value on the difference in the location of the earthquakes, we divided the survey area into two areas, that is, the northern area (area A) and the southern area (area B). The seismic activity is observed in all event periods in the area A, whereas an active seismic activity is observed only in the event periods of 2002 and 2011 in the area B. Then a b-value is estimated in each period in the same way. As a result, for the earthquakes occurred in the northern region (area A), there is a tendency that the b-value in each of the event periods is lower by about 0.2-0.4 than that during inter-swarm. On the other hand, such a tendency is not observed in the southern area (area B). Such differences in the northern and southern regions may suggest that the effects of stress changes caused by SSEs vary from region to region.

Keywords: Gutenberg-Richter's law