2010-2014年に琉球弧南西部で発生したSSEの地殻変動解析

Analysis on Crustal Deformation of Slow Slip Events Occurred in the Southwestern Ryukyu Arc in 2010-2014

*小池 俊貴、西村 卓也[2]、宮崎 真一[1]
*toshiki koike, Takuya NISHIMURA[2], SHINICHI MIYAZAKI[1]

1.京都大学理学研究科、2.京都大学防災研究所
1.Graduate school of Science , Kyoto Univercity, 2.Disaster Prevention Research Institute, Kyoto Univercity

In the last 20 years, various types of slow earthquakes have been reported mainly on the plate boundary. For example, Slow Slip Events (SSEs) are one of the slow earthquakes. They don't radiate seismic wave and last for a few days to years. Discovery of slow earthquakes encourage us to examine about strain accumulation and release on plate boundaries.

In the southwestern ryukyu arc, SSEs were reported by Heki and Kataoka (2008). They estimated a simple rectangular fault model from displacement data at 8 GNSS stations. And they reported that SSEs are repeatedly occurred beneath Iriomotejima island. Though, we think faults which cause SSE are probably more complicated, and there is a difference on slip distribution between SSEs.

In this study, we estimate slip distribution of each SSE by using 13 GNSS stations including new stations (one station in Miyakojima island and four stations in and around Iriomotejima island). We adopt a station in Irabujima island as a reference. Then, we analyze GNSS daily coordinates from Apr. 1, 2010 to Jan. 31, 2015, and estimate crustal deformation by fitting a function to the time-series data. We estimate displacement of SSE and earthquake, linear velocity, and initial offset by least square method, and estimate SSE occurrence time and time constant for duration of SSE by grid search method. We assume temporal evolution of SSE is expressed by an exponential decay function proposed by Heki and Kataoka (2008). Then, we obtain horizontal and vertical displacement for eight SSEs.

We estimate slip distribution of SSE by inversion analysis from displacement data. We estimate dislocation on each patch in an elastic half-space (Okada, 1985). We decide fault patches as follows. First, we divide a slip area to small patches, whose size is 10 km square. Then, we set rectangular fault lying on the plate interface on each patch. We adopt constraints on smoothness of slip distribution and non-negative slip. Slip azimuth and weight between data and smoothness are determined by minimizing ABIC. The geometry of the plate interface is based on the Slab 1.0 model (Hayes et al., 2012).

As a result, average moment magnitude, recurrence time, and slip azimuth are estimated to 6.90, 7 month, and 155 degree, which is clockwise angle from north, respectively. Heki and Kataoka (2008) successfully estimated characteristics of SSEs in the southwestern ryukyu arc. However, we found more complicated slip distribution which is varied among SSEs. We introduce obtained results. The slip region is biased to the west on the SSE occurred on Aug. 9, 2010. In case of the SSE occurred on Apr. 30, 2012, slip is also estimated in the region south off Yonagunijima island, besides the slip region on the SSE occurred on Aug. 9, 2010. And south off the Yaeyama islands at a depth of 15~20 km is commonly suggested as a slip area from some SSEs. The depth of the slip area around Iriomotejima island and Yonagunijima island are estimated to be 35~50 km, which is deeper than that in the previous study, mainly because of the adopted geometry.

We also estimate coupling distribution from average velocity data during inter-SSE period. The result suggests strong coupling region. This region is almost the same as slip region of SSE. In this region, coupling rate is calculated to be 75 %. Because back slip rate is almost equal to the

average slip rate of SSEs in this region, most strain is released by the SSEs. Furthermore, we estimate weak coupling south off Taramajima island, although this region has poor resolution. We propose the hypothesis that strain may be accumulated over a long time in this region, and that this region has a potential of a future megathrust earthquake. To examine this hypothesis, we must continue geodetic observation for a long time, and set new stations including ocean bottom pressure gauges.

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