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Detailed hypocentral distribution associated with the 2011 Boso Slow Slip Event

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The slow slip events (SSEs) recur every 5-7 years off the Boso Peninsula. The latest event occurred from October to November in 2011, with the shortest recurrence interval in the last 29 years. In association with this event, significant crustal deformations caused by the SSE were clearly observed by high-sensitivity accelerometer (tilt meter) operated by the NIED. The Boso SSE has a significant feature that it accompanies seismic swarms. During the 2011 SSE, numerous swarms also occurred and clear migration was observed. Its spatio-temporal distribution agrees well with slip migration estimated from crustal tilt data for each characteristic period. Focal mechanisms from the NIED Hi-net and AQUA catalogue for major earthquakes are thrust type with slip vectors consistent with the relative motion between the Japanese island arc and the Philippine Sea plate. Repeating earthquakes also occurred during the period of significant crustal deformation. Since repeating earthquakes at the plate subduction zone reflect interplate quasi-static slips (Kimura et al., 2006), these repeating earthquakes associated with the Boso SSE also can be regarded as interplate earthquakes triggered by the SSE slip. In this study, we determined high-precision hypocentral distribution to investigate the SSE activity in detail.

The Kanto plain is covered with thick sedimentary basin and this is a critical issue in the hypocenter determination. In other words, seismic wave velocities of the sediments are approximately Vp˜1.9km/s and Vs˜0.7km/s, and affect arrival time of seismic wave greatly, and surface ground noise is very large due to human activity. To avoid these issues, the NIED have constructed deep borehole stations. At the Boso peninsula, seven 1000m-class borehole stations have been constructed. In these stations, seismographs are installed at the bottom of the boreholes, where effect of low velocity sediments is small. We relocated hypocenters by using five 1000m-class or deeper borehole stations. When arrival time data is available for four or more stations, we determined hypocenter by using hypomh (Hirata and Matsu'ura, 1987). By using these results as initial hypocenters, we determined high-precision hypocenters by Double Difference (DD) method. For comparison, we also determined high-precision hypocenters by DD method by using the NIED Hi-net hypocenter.

Compared to the latter results, hypocentral depths in the former results are 2.0 km shallower on average below the eastern coast of the Boso peninsula and 2.1km deeper below the southeastern coast. As a result, the former results exhibit clear planar distribution gently dipping northward. Earthquakes along this plane have thrust type focal mechanisms. Repeating earthquakes are also distributed along this plane. These results indicate that this plane corresponds to the interface of the interplate shearing. In the 2007 SSE, more seismic swarms occurred off the eastern coast of the Boso peninsula and more swarms occurred below the southwestern coast in the 2011 SSE. The above results indicate that such difference of the swarm activity corresponds to difference of the SSE slip.

Keywords: Slow slip event, Boso Peninsula, high-precision hypocenter distribution, repeating earthquake