Periodic change in the interplate locking state off Kyushu Island, Southwest Japan, inferred from spatial gradient of displacement rate field and small repeating earthquakes

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Abstract

Recently, Uchida et al. [2016, Science] revealed the periodic changes in the interplate locking in the northeast Japan subduction zone based primarily on the activity of small repeating earthquakes. They found that slow slip on the plate interface has occurred repeatedly at intervals of from 2 to 6 years, depending on the location. They also used the change in the spatial gradient of horizontal displacement rates in the 1-year time-window to estimate the recurrence interval and concluded that the recurrence intervals based on the seismic and geodetic data analyses are mutually corresponding.

In the meantime, in the southwest Japan subduction zone, large earthquakes such as Tokai, Tonankai, and Nankai earthquakes repeatedly occur that rupture the plate interface fault between the Philippine Sea plate and the continental plate (Eurasia or Amurian plate), because the Philippine Sea plate is subducting from the Suruga-Nankai Trough in southwestern Japanese Islands, namely from the Tokai to the Kyushu districts. Many studies have been carried out to estimate the distribution of interplate locking using the surface displacement rate fields [e.g., Ito *et al.*, 1999; Mazzotti *et al.*, 2000; Loveless and Meade, 2010; Yokota *et al.*, 2016], and revealed that the interplate locking at the rupture areas of these large earthquakes are strong during the inter-seismic periods. However, temporal change in the degree of interplate locking in and around the source region of Tonankai and Nankai earthquakes has not been considered in previous studies. Long-term slow slip events (SSEs) with duration of several months to several years have yet to be detected in these regions.

In this study, we investigated the spatio-temporal change in the interplate coupling along the plate boundary in SE Japan based both on the seismic and geodetic data. The activities of small repeating earthquakes that occur off Kyushu Island were utilized to estimate the average cumulative slip within several sub-areas assuming the underlying slow slip is similar in each area. We also applied the monitoring method for spatial and temporal variation of the degree of the interplate locking proposed by Iinuma [2018] to the southwest Japan. The spatial gradient of the surface displacement rate field in each belt-like region that is configured along the direction normal to the Nankai Trough for time windows such as 0.5, one,

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two, three, and five years being shifted by one week. The gradient of the horizontal displacement rate is negative and has a large magnitude when the degree of interplate locking at the shallow and intermediate part is strong, while the sign of the spatial gradient of vertical displacement rates becomes negative and positive when the deep plate interface beneath the observation network is locked and unlocked, respectively. Therefore, temporal change in the degree of interplate locking must be detected based both on the small repeating earthquakes and spatial gradients of surface displacement rate field. The preliminary results show that temporal changes in the spatial gradients of surface displacement rates and in the cumulative slip estimated from the small repeating earthquakes mostly coincide. And the results indicate that the temporal variations are quasi-periodic. We will also present the results of the analysis about the spatial distribution of the recurrence period of the quasi-periodic change in the degree of interplate locking at the conference.