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Comparison between the Locked Zones Estimated from the GPS-Derived Velocities and Those Inferred from Seismicity

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/ Introduction /

It is important to know the state of the locking on the plate interface, to understand the strain accumulation and release process in the earthquake occurrence cycle. Strain accumulation due to the locking appears as long-term crustal deformation in the surrounding areas. And stress increase (or decrease) due to the locking can be consistent with the changes in seismicity around the locked portions. Then, what is the difference between them: strain and stress? We expect they are very consistent with each other in terms of the locked portions they suggest. In this study, for the Tokai and Tonankai subduction zones along the Nankai and Suruga troughs, we estimate the locked zones through the GPS-derived velocity field, and we also infer the locked portions based on the seismicity pattern around the plate interface. And then we compare them in terms of the locking on the plate interface to discuss their characteristics.

/ Locked Zone from GPS /

GPS velocity field is obtained through the same procedure shown by Nishimura et al. (2004). We obtain the velocity component from the gradient of linear trend of the GPS time series. We use the GPS time series during the period from Mar. 21, 1996 to Mar. 20, 2000. We applied the backslip model to the velocity field in the past (Nishimura, 2005: Geod. Soc. Jpn. Fall meeting). Of course, the backslip model has a sufficient importance as a first order approximation. However, in the Tokai region, the locked zone estimated by the backslip analysis (Sagiya, 1998) locates seaward in comparison with the locked zone inferred from seismicity pattern (Matsumura, 1999). The unlocked material in the shallower updip side of the hanging wall can be dragged to move with the locked parts because it is not constrained by the other parts. Therefore, it is pointed out that the deformation field cannot fully explained by the backslip model (Matsumura and Okada, 2005). We must consider visco-elastic behavior of the upper mantle (Ito and Hashimoto, 2004) which cannot be realized only by an elastic response of semi-infinite homogeneous media to a dislocation (Maruyama, 1964; Okada, 1992). Moreover, inversion analysis cannot resolve phenomena in the offshore region where the observation networks do not cover (e.g., Nishimura et al., 2005: PEPI). Therefore, in this study, we try to apply a forward modeling of the locked portions to the actual velocity field. For this calculation, we use three-dimensional finite element method (e.g., Yoshioka and Hashimoto, 1989). We calculated stress field due to the locking on the plate interface so far (e.g., Nishimura and Matsumura, 2004). Now we construct a new framework with curved configuration of the plate interface. Referring to Ishida (1992) or Ishida and Sakanashi (2003: Chikyu Monthly), we assume that the sub-crustal seismicity layer is in the upper part pf the slab. With this assumption, we determine the model configuration of the plate interface based on the seismicity pattern and focal mechanisms.

/ Locked Zone from Seismicity /

We also infer the locked portions based on the seismicity pattern and focal mechanisms in the Tokai region. We use hypocenter and focal mechanism catalog by the NIED Kanto-Tokai observation network. The relationship between the seismicity and stress field due to the interplate coupling has been shown in the previous works.