An influence of a slow-slip event on the inter-plate great earthquake

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Although slow slip phenomena have been reported in various areas, there have been the cases with incorrect recognition on the difference in generating condition and the physical meaning. Here, we focus on the relationship of slow slip events with the inter-plate great earthquakes by referring to the cases of Tokai and Boso slow-slips.

Expression by displacement is used for the analysis of a slow slip in many cases. Since 'displacement' expresses the movements of the observing point with respect to a reference point, it is anticipated that the displacements are influenced by a parallel translation to a fixed point. On the other hand, since 'strain' is the relative change among observing points, it is suitable for analyzing a regional field. Moreover, since it can become a physical measure to show a quantitative relation with a destructive phenomenon like 'stress', the interpretation depending on strain becomes important.

As a slow slip means a slow speed phenomenon literally, an inelastic slip or a creep phenomenon is intuitively assumed, differently with a rapid slippage phenomenon like an earthquake. However, though it is an inelasticity-phenomenon, unless the slippage reaches the surface of the earth, we have to think that strain accumulates around the slippage. So, if a dislocation occurs in the lower part of a plate boundary, strain and stress concentration will take place in the upper end of a sliding part inevitably even if they are reduced to some extent by relaxation effect.

Slow slip events have been observed by GPS in the southeast coast of Boso Peninsula in 1996 and 2002 (Sagiya, 1997; the Geographical Survey Institute, 2002) and according to record of a tiltmeter, slow slip events seemed to have repeated at least also in 1983 and 1990 (NIED, 2003). If such events can be supposed to have repeated, it is possible that strain accumulated in the surrounding area, but since the depth of the sliding plane is expected to be shallow or reaching to the surface, remarkable stress concentration seemed not arise at least in 1996 and 2002 (Yoshikawa, 2003). On the other hand, since the slow slip in the Tokai area has been occurring as deep as 30 to 40 km under Hamanako- lake, it does not lead to the strain release in the shallow coupling portion of the plate boundary, but it promotes strain accumulation having been caused by regular plate motion (Yoshikawa, 2004). Thus, resultant strain works in a reverse direction depending on the generating depth, release or accumulation, and is expected to affect the possibility of occurrence of an earthquake.

By the way, although the amount of released moments by slow slips is usually considered as an index of possibility of occurrence of an earthquake, since it is directly connected with interpretation that the slip event completes when the moment reaches a stationary value, cautious treatment is required. There were the cases where the slow slip events occurred repeatedly in the past in the Tokai area according to Kimata and Yamauchi (1998), and Yamamoto et. al. (2003). And in the numerical simulation executed by Kuroki et al. (2004), the slow slip events can be reproduced several times before a main shock and the occurrence of a singe slip event does not always lead to the main shock. However, since the slow slips do not necessarily mean release of the accumulated strain in the coupling portion of the plate boundary, we should consider the possibility that the stored strain energy is maintained high and a great earthquake would occur ultimately.