3-D simulation of the occurrence of a slow event in the Tokai region with a rate- and state-dependent friction law

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A slow event has been progressing on the plate interface around Lake Hamana, near the western boundary of the estimated focal region of the Tokai earthquake since October, 2000 (Ozawa et al., 2002). The event was revealed by the analysis of GPS data installed by GSI.

We have so far reported short-, intermediate- and long-term changes of crustal movement, stress field and Coulomn stress function before the hypothetical Tokai earthquake using results of three-dimensional simulation of the plate subduction that is based on a rate- and state-dependent firction law (Kuroki et al., 2001,2002). In the model, the time evolution of a dislocation field in an elastic half-space is governed by a quasi-static interaction induced by the dislocation field itself as well as by a rate- and state-dependent friction law acting on the plate interface. We take a model of plate interface obtained by the hypocentral distribution of micro-earthquakes in the slab determined by JMA (Harada et al., 1998). The relative velocity is 4cm/year at each element (Seno et al., 1993). The direction of the plate subduction is that of the backslip analyzed by Hirahara (1999). We make use of the overshooting method employed in Tse and Rice (1986) is describing the moment during the earthquake.

Kato (2002) showed that the regions with negative a-b (velocity weakening) or a large characteristic distance L behave as barriers or asperities in 2-D planar fault model. Also, Yoshida and Kato (2002) showed that an episodic slow slip occurs in a two-block model.

However, Kuroki et al. (2002) failed to reproduce occurrence of a slow event because the friction parameter does not contain effects of imhomogeneity on the plate interface.

We focus mainly on reproduction of slow events by changing the depth dependence of the friction parameter. Also we extend the simulation region to the west so as to include Lake Hamana. The width of the model region is 160km, and to avoid singularity, buffer zones of 20km in width are attached to the both sides.

In a homogenous model (case1), we adopted the friction parameter of Kato and Hirasawa (1996). In an imhomogenous model (case2), the parameter L is 5cm except 22km to 27km in depth and is taken 15cm there. In the seismic zone with negative a-b value, we gave imhomogeneity in parameter L so that the a slow event happens. That is expected because imhomogeneity in the direction of depth is considered to play a role of barrier.

It turns out that earthquakes occur approximately periodically (about 190 years in the case1 and about 375 years in the case2). The period in the case2 is larger than that in the case1 because slow events occur in the seismic zone. In the case2, slow events occur several times before the earthquake. The moment release rate increases at the time when slow events occur. The moment release rate at the time of a slow event is much smaller than that at the ordinary earthquake. It is interesting to note that a slow event occurs repeatedly around Lake Hamana although parameter L has only a depth dependence.

We will try to reproduce slow events by varying defferent parameter in the future.

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