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Possible effects of frictional healing on slow slip events occurrences -Quest for a fundamental effect of dehydrated fluid-

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In recent years, some kind of slow slip events in southwest Japan have been revealed as interplate slip events in deep regions next to seismogenic zones (*Shelly et al. [2006,2007]*, *Ide et al. [2007]*). Moreover, based on a fact that the hypocenters of them and low velocity zones of S-wave overlap, it has been suggested that these events correlate with slab dehydration (*Kodaira et al. [2004]*, *Shelly et al. [2006]*).

On the basis of the suggestion, in order to consider the relation between the dehydrated-fluid and the occurrence of the slow slip events mechanically, we have to introduce a numerical model. Particularly, a friction model for interplate earthquake cycles enables us to discuss them and normal interplate earthquakes from the unified viewpoint. In this light, many numerical model studies have performed. They have revealed that we can duplicate the observed slow slip events at some level by parameter adjustments (e.g., *Shibazaki and Shimamoto [2007]*).

Now, returning to origin, we would like to think how the existence of the dehydrated fluid causes to occur the slow events. In the previous studies of the seismic velocity structure (*Kodaira et al. [2004]*, *Shelly et al. [2006]*), they proposed that the dehydrated fluid increases pore fluid pressure on the plate interface to cause the slow events. However, our numerical study using the friction model (*Mitsui and Hirahara [2008]*) showed that the increase of the pore pressure under a steady state condition does not lead to the occurrence of the slow events. It is because critical stiffness, which controls frictional instability, is proportional to effective normal stress generally. If we intend to cause the slow events with the pore pressure increase under a steady state assumption, we have to change other parameters in parallel to increase the critical stiffness as some previous studies (*Shibazaki and Shimamoto [2007]*, *Liu and Rice [2007]*). This fact clearly shows that the steady pore pressure increasing due to the slab dehydration is **not** a determining factor for the occurrence of the slow events.

Therefore, we try to constrain how the dehydrated fluid affects quasi-static friction evolutions without being restrained by the high-pore pressure concept, from the viewpoint of the numerical modeling. Now, particularly, we focus on 'logarithmic time healing with cut-off time'. The 'logarithmic time healing with cut-off time' has been confirmed by lots of laboratory-experiments (e.g., *Dieterich [1972]*). Moreover, it can be interpreted as an increasing process of real contact area on a friction surface (e.g., *Brechet and Estrin [1994]*). We suggest that rate increase of the time healing and prolongation of the cut-off time are fundamental effects of the dehydrated fluid.

In this presentation, we show the increase of a proportionality factor **b** for the logarithmic frictional healing and the cut-off time $\mathbf{t}_c$ lead to the occurrence of the slow slip events, by specific model calculations. This hypothesis can resolve one discrepancy that the spontaneous slip events, even slow slip, occur around high temperature regions in which all of previous rock experiments reveal velocity strengthening behaviors. However, if we clarify these are fundamental effects of the dehydrated fluid on the slow events, we should go further to an elementary process of friction. In the *Brechet and Estrin*'s model, both **b** and $\mathbf{t}_c$ are inversely proportional to material hardness on the real contact area. Following this model, for example, a process that the massive and fresh dehydrated fluid filling with the interplate surface causes chemical reactions for decreasing the material hardness would lead to the occurrence of the slow slip events.