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A primary model of earthquake cycle almost controlled by pore pressure evolution

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In a recent Ph.D thesis by the first author (and related papers), certain effects of pore pressure evolution are introduced to simple numerical models for earthquake cycles. One is the pore pressure increase by shear heating, and the others are the pore pressure alteration by porosity changes. Since evolution of pore pressure within fault zones directly affect friction as well as frictional coefficient, earth cycles in fluid-saturated fault zones are related to pore pressure evolution by necessity. This introduction of the pore pressure evolution was an essential step toward constructing realistic mechanical models for natural faults.

On that basis, here, we make a model of earthquake cycle, almost controlled by continuous evolution of pore pressure. It would be an alternative model to that just controlled by evolution of frictional coefficient. By unifying our previous models of one-degree-of-freedom (*Mitsui and Hirahara* [2009, JGR], *Mitsui and Hirahara* [2009, GRL], *Mitsui and Cocco* [2010, GRL]), we can implement the continuous effects of pore pressure evolution by shear heating (including heat diffusion), porosity changes (pore dilatancy and compaction) and fluid diffusion in a traditional model for earthquake cycles only controlled by a rate- and state-dependent friction law.

Since the shear heating and porosity changes are assumed to occur homogeneously within a certain thickness in our simplified model, the fault behavior strongly depends on the value of the fault thickness. This fault thickness almost represents the thickness of fault gouge. We show examples that the fault behavior changes from stick-slip behavior, recurrence of moderate (slow) slip and completely aseismic slip, depending on the thickness value. Although the assumptions in our present model are too rough to represent the structures of natural faults, this is another fundamental step for realistic fault models.

Keywords: Earthquake cycle, pore pressure fluctuation, thermal pressurization, porosity change, fluid diffusion, fault thickness