2D earthquake cycle simulation on the dipping fault with R. S. friction in the viscoelastic heterogeneous structure

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Many numerical simulation studies of earthquake cycles with the rate- and state-dependent friction law assume the homogeneous elastic half-space model. For an infinitely long strike slip fault existing an elastic layer overlying a Maxwellian viscoelastic half-space, Kato(2002) confirmed that simulated cycles in the viscoelastic Earth model are nearly the same as those in a uniform elastic half-space model. However, it is important to evaluate the effect of viscoelasticity on earthquake cycles on faults in a more complex sub-surface structure such as the subduction zones.

In this study, we simulate quasi-static earthquake cycles in viscoelastic heterogeneous materials by GeoFEM-based simulation code. In our simulation code, quasi-static equilibrium state is directly evaluated by solving the equilibrium equation in each time-step, and calculated stresses on FE grids are used to evolve the fault slip or other variables on the fault plane obeying the rate- and state-dependent friction law. Updated fault slips are used as the boundary condition of the fault in the next time-step.

The advantage of our program is that we do not have to prepare the slip response functions under the viscoelastic heterogeneous structure before the execution of numerical simulations. While, its disadvantage is requirement of a lot of computational time due to the evaluation of the equilibrium equation at the every time-step, and fine FE mesh discretization is needed for the accurate estimation of stress field near the fault. Hence, in this study, we treat the viscoelastic heterogeneity perpendicular to the trench axis as the plane strain problem.

As a tentative result, in case of a dipping fault existing in a viscoelastic layered structure, the simulated cycles in the viscoelastic model are not so different to those in a uniform elastic model similar to Kato (2002). In the presentation, we will show the results of more complex viscoelastic structures or several asperities case.