Simulation of the 3-D Kato-Hirasawa model in viscoelastic media

Hidekuni Kuroki[1], Hidemi Ito[2], Akio Yoshida[3]

[1] Seismological and Volcanological Dep.,J.M.A., [2] Seismology and Volcanology Research Dep., M.R.I., [3] MRI

To get a clearer picture of the coming Tokai earthquake, we have investigated the subduction processes based on the Kato-Hirasawa model, focusing our attention on cyclicity as well as precursory crustal changes before large earthquakes. The effect of the curved shape of the Philippine Sea plate was a subject of our latest discussion. In the present talk, we will discuss a simplest case composed of uniform and isotropic Maxwellian viscoelastic media filling a half space. In the above analysis, we used the rate- and state- dependent friction law by Kato and Hirasawa(1996,1997) and Kuroki(1998)

To get a clearer picture of the coming Tokai earthquake, we have investigated the subduction processes based on the Kato-Hirasawa model, focusing our attention on cyclicity as well as precursory crustal changes before large earthquakes. The effect of the curved shape of the Philippine Sea plate was a subject of our latest discussion (Kuroki et al. 1999). Throughout the previous discussion, we have assumed that the media are uniform, isotropic and elastic.

To carry out more realistic simulation, it is necessary to take into account the viscoelasticity of the mantle. In quasi-static approximation, the effect caused by a slip of a block upon the other blocks on the plate surface can be expressed by a time-delayed term in the equation of motion of the blocks. The time-delayed term can be obtained beforehand either numerically by the finite element method in general or analytically if the Green's function is available.

In the present talk, we will discuss a simplest case composed of uniform and isotropic Maxwellian viscoelastic media filling a half space. Viscoelasticity is taken up to the 1st order in the Prony series. The time-delayed term is obtained by a standard method (see e.g. Mura 1987). We solve an elastic problem (of stress field generated by a dislocation in an elastic medium) in the Laplace transformed space. Then we convert the result to the time domain by the inverse Laplace transformation.

We numerically integrated the equation of motion including the above mentioned time-delayed term. The preliminary results so far obtained for a flat plate case are as follows. Size of the blocks is about 10km times 10km.

1. Large earthquakes occur in a quasi-periodic manner similarly to the elastic case. But the fluctuation tends to be larger.

2. Average recurrence interval is larger than that in the elastic case, while the size of the seismic regions, amount of slip as well as stress drops are smaller than those in the elastic case. More quantitatively, the amount of change is 10 to 20 1.068855e-305n the amount of total relaxation in the shear modulus is 20 and when it relaxation time is 5 years (several percents of the average recurrence interval).

In the above analysis, we used the rate- and state- dependent friction law by Kato and Hirasawa (1996,1997) and Kuroki (1998), and employed the overshooting method by Tse and Rice (1986) in treating large earthquakes.