Geophysical Research Abstracts, Vol. 9, 03087, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03087

The effect of geometrical nonlinearity in visco-elastic deformation

E.W. Postek (1), G.A. Houseman (1) and P.K. Jimack (2)

(1) Institute of Geophysics and Tectonics, School of Earth and Environment, University of Leeds (earewp,eargah@earth.leeds.ac.uk 44(0)113 3435259), (2) School of Computing, University of Leeds (pkj@comp.leeds.ac.uk, 44 (0)113 3435468)

The lithospheric layers characterize visco-elastic behaviour with high values of viscosity. The geometrical nonlinearity is included by taking into account the nonlinear part of the elastic strain tensor. This can predict the deformation more accurately, in particular, close to irregularities of fault boundaries where stress concentrations appear. The quasi-static FEM equation and the shear relaxation function are of the form

$$(\mathbf{K}^{ev} + \mathbf{K}^{ct} + \mathbf{K}^{g})\Delta\mathbf{q} = \mathbf{Q} - \mathbf{F}, \qquad G(t) = G_{\mathrm{o}} + \sum_{i=1}^{n} G_i \exp\left(\frac{-t}{\lambda_i}\right)$$

where $\mathbf{K}^{ev}$ is the elasto-viscous stiffness, $\mathbf{K}^{ct}$ is the contact stiffness and $\mathbf{K}^{g}$ is the "geometric" stiffness which includes the effect of the (linearized) nonlinear part of the strain tensor, $\Delta\mathbf{q}$ is the displacement increment, $\mathbf{Q}$ is the external loading vector and $\mathbf{F}$ is the internal forces vector. The visco-elastic model belongs to the family of generalized Maxwell models (λ_i are the relaxation times). Conclusions concerning the triggering of the earthquake under stress-weakening contact stiffness relation can be drawn. The examples concern the displacements applied along the fault and observations of the vertical displacements on the surface. The problem is described in the UL frame and the FE equation is solved using Newton-Raphson technique. The calculations are performed using the newly developed visco-elastic version of the program "Oregano". We examine a conceptual 3D model in which a surface traction applied to a vertical fault causes vertical displacement of the upper surface of a crustal block. We demonstrate the effect of geometrical non-linearity in this problem.

Acknowledgement: The Engineering and Physical Sciences Research Council provides the funding for the research project under the contract EP/D03728X/1.