Event size distribution in simple multi-fault systems

Langer, S.[(1)], Olsen-Kettle, L. M.[(1)] and Weatherley, D. K.[(1)]

(1) The University of Queensland, Brisbane, Australia
ph. +61 7 334 64096 ; fax +61 7 334 64134 ; email s.langer@uq.edu.au

It has been shown (Burridge and Knopoff, 1967; Rice, 1993; Duan and Oglesby, 2005) that faults have a memory and past ruptures influence future ones. Triggering of earthquakes occurs as a result of the redistribution of stress induced by an earthquake (Freed, 2005). This spatio-temporal interaction of faults in a fault system consequently leads to a different frequency-magnitude distribution of earthquakes than along isolated faults. The conditions for realistic fault system modelling with a Gutenberg-Richter distribution have been an object of interest (Rice and Ben-Zion,1996; Shaw, 2004).

The literature describes two distinct models for event size distributions: In the first model the distribution of fault lengths governs the distribution of event sizes (Wesnousky, 1994; Stirling and Wesnousky 1996). In the second model each fault produces a Gutenberg-Richter event size distribution (Carlson and Langer, 1989). A combination of both models has also been proposed based on the observation that isolated faults can have either more characteristic or more Gutenberg-Richter distributed event sizes (Dahmen et al., 1998).

We have constructed a numerical model employing the Finite Element Method to simulate cycles of earthquakes within a simplified fault system. The model consists of a dynamic rupture phase during which we solve the wave equation and an interseismic tectonic loading phase during which the quasi-static elastic deformation equation is solved. We use a homogeneous medium, constant friction along the fault and an initially homogeneous stress distribution along the fault and elsewhere in the model region.

Using this model, we will examine how the event size distribution of a single fault is influenced by the existence of faults in its vicinity. The shift from characteristic to Gutenberg-Richter size distributions for multi-fault systems appears to depend on varying fault lengths, relative fault orientations and stress artefacts from previous ruptures. We are examining variations in the Coulomb Failure Criterion along the fault and study how they affect earthquake size distributions.