Geophysical Research Abstracts, Vol. 7, 06018, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06018

Investigation of Grain Fracture Mechanisms in Numerical Simulations of Granular Fault Gouge in 3D

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The dynamic behaviour of a fault is strongly influenced by its geometry, which includes the size and shape distribution of the grains within the fault gouge. In order to understand the evolution of the behaviour of a fault over time it is therefore necessary to understand the processes determining the evolution of the fault gouge. One of those processes is the fracturing of gouge grains during shear of the fault.

Particle based simulation methods such as the Discrete Element Method (DEM) and the Lattice Solid Model (LSM) have been used successfully to investigate the dynamics of fault gouge. Recent advances in the computer technology, in particular the availability of large parallel computer system have made it possible to simulate larger and more realistic models of faults with gouge. In particular it has become possible to extend the simulations to three dimensions and to use aggregate grains composed of many particles each, therefore enabling the grains to fracture. In the simulations presented here a parallel implementation of the Lattice Solid Model is used. The model setup consists initially of a number of large, roughly spherical aggregate grains between two blocks of solid material. The aggregate grains and the solid boundary blocks consist of a large number of randomly sized spherical particles linked together by elastic/brittle bonds and arranged in dense packing. The model is then sheared while a constant normal force is applied in the direction perpendicular to the shear movement.

With increasing strain the grain size distribution within the gouge is evolving towards a fractal distribution with a dimension between 2.3 and 2.9 which is consistent with grain size distributions observed in real fault gouge and predicted by the constrained comminution model. Analysis of the fragments formed by the fracture of grains in the simulated gouge shows that different fracture mechanisms are operating. One "com-

minution" type mechanism is resulting in several large fragments produced whereas a second, "abrasion" type mechanism is resulting in one or more very small fragments broken of a larger grain.