Geophysical Research Abstracts
Vol. 15, EGU2013-4026, 2013
EGU General Assembly 2013

Numerical modelling of granular subglacial deformation using the discrete element method

Anders Damsgaard (1), David L. Egholm (1), Jan A. Piotrowski (1), Slawek Tulaczyk (2), and Nicolaj K. Larsen (1)

(1) Aarhus University, Dept. of Geoscience, Aarhus C, Denmark (anders.damsgaard@geo.au.dk), (2) University of California, Dept. of Earth and Planetary Sciences, Santa Cruz, California, USA

We apply the Discrete Element Method (DEM) to explore the highly nonlinear dynamics of a granular bed when exposed to stress conditions comparable to warm-based subglacial environments.

As a method of validation of the simulated macromechanical behavior, and as a calibration benchmark, we compare results from successive laboratory ring-shear experiments on simple granular materials to results from similar numerical experiments. Overall, there is good agreement between the geotechnical behavior of the materials in the analogue and numerical experiments, and materials deform by an elasto-plastic rheology under the applied effective normal stress and shear velocity.

By using the numerical approach it is possible to make a detailed analysis of the material dynamics and shear zone development during progressive shear strain. By visualizing the particles according to the sum of contact forces exerted onto them, the geometry of the heterogeneous stress network is visible in the form of force-carrying grain bridges and adjacent, volumetrically dominant, inactive zones. We demonstrate how the shear zone thickness and dilation is dependent on the effective deviatoric normal stress, where higher stresses mobilize material to greater depths.

The data-parallel nature of the basic DEM formulation makes the problem ideal for utilizing the high arithmetic potential of modern general-purpose GPU's. Using the Nvidia Cuda C toolkit, the algorithm is formulated for spherical particles in three dimensions with a linear-elastic soft-body contact model.