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DEM Simulation of shear induced mixing in layered Sand-Clay Sequences

S. Abe (1), J. Schmatz (1) and J. Urai (1)
(1) Geologie-Endogene Dynamik, RWTH Aachen (s.abe@ged.rwth-aachen.de)

An important sealing mechanism in fault zones of sand-clay sequences is mechanical mixing of sand and clay. For the case of perfect mixing, a 1 mm thick clay gouge is transformed into a 3 mm thick sand-clay gouge with the same low permeability and a better sealing capacity. The process of mixing has been discussed in the literature and was identified in laboratory experiments, but its rate as a function of sand and clay properties is poorly understood.

In this project, a Discrete Element (DEM) simulation is used to investigate the micro-mechanics of the mixing between sand and clay during shear of a layered sequence. Initial work is performed using a 2D model but the approach can easily be extended to full 3D simulations. Due to the difference in scale between the sand and the clay particles, the model only attempts to reproduce the micro-mechanical processes at the scale of the sand grains whereas for the clay only the bulk properties are matched.

The simulation model consist of 2D box sequence of alternating layers of sand and clay which are represented by DEM particles with different size and frictional properties. In order to obtain a sufficiently large contrast in the frictional properties between the sand and the clay a range of different grain shapes are used in the model of the sand layers. These grain shapes are realized by constructing aggregate grains from the spherical DEM particles. The clay layers are modelled using single spherical DEM particles. On the boundaries orthogonal to the layering a constant normal stress is applied whereas on the boundaries parallel to the layers periodic boundary conditions have been implemented. The model is then sheared perpendicular to the orientation of the layers by moving the edges of the model with a constant velocity. Due to the

periodic boundary conditions the model enables arbitrarily large displacements, only limited by the computational cost. Initial results show the development of structures in the mixing zone between sand and clay layers which are comparable to those observed in laboratory experiments. In particular, a thickening of the mixed layer with increasing strain is observed.