Geophysical Research Abstracts,
Vol. 11, EGU2009-4652, 2009
EGU General Assembly 2009

SDEM modelling of fault-propagation folding: a dynamic-kinematic analysis

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Understanding the dynamics and kinematics of fault-propagation-folding is important for evaluating the associated hydrocarbon play, for accomplishing reliable section balancing (structural reconstruction), and for assessing seismic hazards. Accordingly, the deformation style of fault-propagation-folding has already been the topic of a large number of empirical studies as well as physical and computational model experiments.
However, with the newly developed Stress-based Discrete Element Method (SDEM), we have, for the first time, explored computationally the link between self-emerging fault patterns and variations in Mohr-Coulomb parameters including internal friction.

Using SDEM modelling, we have mapped the propagation of the tip-line of the fault, as well as the evolution of the fold geometry across sedimentary layers of contrasting rheological parameters, as a function of the increased offset on the master fault. The SDEM modelling enables us to evaluate quantitatively the rate of strain . A high strain rate and a step gradient indicate the presence of an active fault, whereas a low strain-rate and low gradient indicates no or very low deformation intensity. The strain-rate evolution thus gives a precise indication of when faults develop and hence also the sequential evolution of secondary faults.
Here we focus on the generation of a fault -propagated fold with a reverse sense of motion at the master fault, and varying only the dip of the master fault and the mechanical behaviour of the deformed layers overlying the master fault. The results show that the Mohr-Coulomb parameters of the succession overlying the master fault control the overall deformation of the succession, and that the geometry of the faults, and the frequency of secondary structures, depend on the internal friction of the layers and the dip of the masterfault. The modelled results are furthermore related to observations on seismics.