Geophysical Research Abstracts,
Vol. 11, EGU2009-8445, 2009
EGU General Assembly 2009

Application of Distinct Element Modeling to the Critical-Taper Wedge with Heterogeneity

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The mechanics of accretionary wedges, and its relation to the strengths of the wedge and basal detachment have been concerned and developed with various equations under different boundary conditions. Many geological data have been applied to verify the theory, but some internal properties of the wedge cannot be directly known, especially the deeply basal detachment. As a result, the theory is geologically less constrained due to the lack of proper data. Here we apply Distinct Element Modeling (DEM) to simulate the deformation behavior of accretionary wedges under various shortening rates and dips of the detachment in a global scale. DEM can simulate the behavior of macroscopic wedge in terms of large amounts of microscopic particles. The simulation with well deriving microscopic model parameters can be well followed the theoretical predictions and also imitate the results of sandbox experiments but in a real scale. The simulated wedge with a large deformation upon a detachment layer can be considered as the evolution of an accretionary wedge process. With various converging rates from the back wall, the results show a power law dependency between the surface slope and the shortening rate. Thus we adapt the lower shortening rate, when approaching a constant resulting surface slope that can be considered as quasi-static state, for further experiments. The taper angle with different detachment dips can reveal a simple linear relation to the strength of fault and wedge. Besides, the test of numerical rock properties can also be performed to obtain the physical properties within the wedge. However, in considering the models with bonded element mode, broken bonding between elements in specific areas may raise the issue of heterogeneity that has to be more careful when comparing results with the simplified wedge theory. Hence we also address the mechanics of heterogeneous wedges in the context of the spatial variations in surface slope and detachment dip corresponded to the heterogeneity. Consequently, we illustrate the application of DEM to various strengths of wedge and basal detachment under different detachment dips. The numerical heterogeneous wedge might be a proxy to the natural accretionary wedges and its results can provide insights into understanding to the mechanics of heterogeneous wedges.