Numerical modelling of an orogenic wedge: Exploring new possibilities with distinct element code

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Orogenic belts are relatively narrow zones on earth's crust that preserve evidences for major parts of crustal deformation, and the dynamic evolution of orogenic wedge has broadly been explained by Critical taper theory (e.g. Chapple, 1978; Davis et al., 1983; Dahlen, 1990). Analog experiments such as sandbox experiments (e.g. Davis et al., 1983; Marshak and Wilkerson, 1992; Mandal et al., 1997) have further advanced our understanding of the mechanism of large-scale evolution of orogenic belts. However, these analog experiments could not provide stress field that is vital for mechanical interpretations during evolution of wedge.

We have used distinct element method (DEM; Itasca, 1999) for the simulation of sandbox (i.e. numerical sandbox) for exploring a possibility that this method may be used for the studies of fold-thrust belts in terms of kinematics and mechanics. DEM is a method for solving mechanical problems of discontinuum and the method consists of particulate data structures and boundary-condition elements. Stored energy in elastically compressed particles with Hookean or Hertzian force-displacement relation is a driving force for motions of particles.

The biggest advantage of a numerical sandbox over a physical sandbox is that *forces are seen*, instead of guessed, in a numerical sandbox. The observed forces can be combined with kinematic observations for the 'full' interpretation of structural development and evolution. We have focused on two aspects of fold-thrust belts; (1)formation of critically tapered wedge and (2) structural development during and after incipient faulting.

From the experiments related to critically tapered wedges, it is found that the sum of topographic slope and decollement dip remains constant while decollement dip varies from 0 to 10 degrees. This is the similar results as predicted by Mohr-Coulomb wedge model of Davis et al. (1983). However, a slight rate-dependence of the summed angle is observed as we change the velocity of

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backstop, and we are currently investigating the reasons. From the experiments related to structural development, we found that incipient faulting occurs in the region of thrust toe (figure 1), which is also commonly observed in many orogenic belts (e.g. Sevier fold-thrust belt of western US). We are currently studying imbrication-related pattern formation as well as structural evolution related to faulting at thrust toe.

We believe that the 'fully-mechanical' findings from the numerical sandbox experiments will be exciting as did the findings from physical sandbox experiments that are later recognized to be directly applicable for the interpretation of fold-thrust belts.

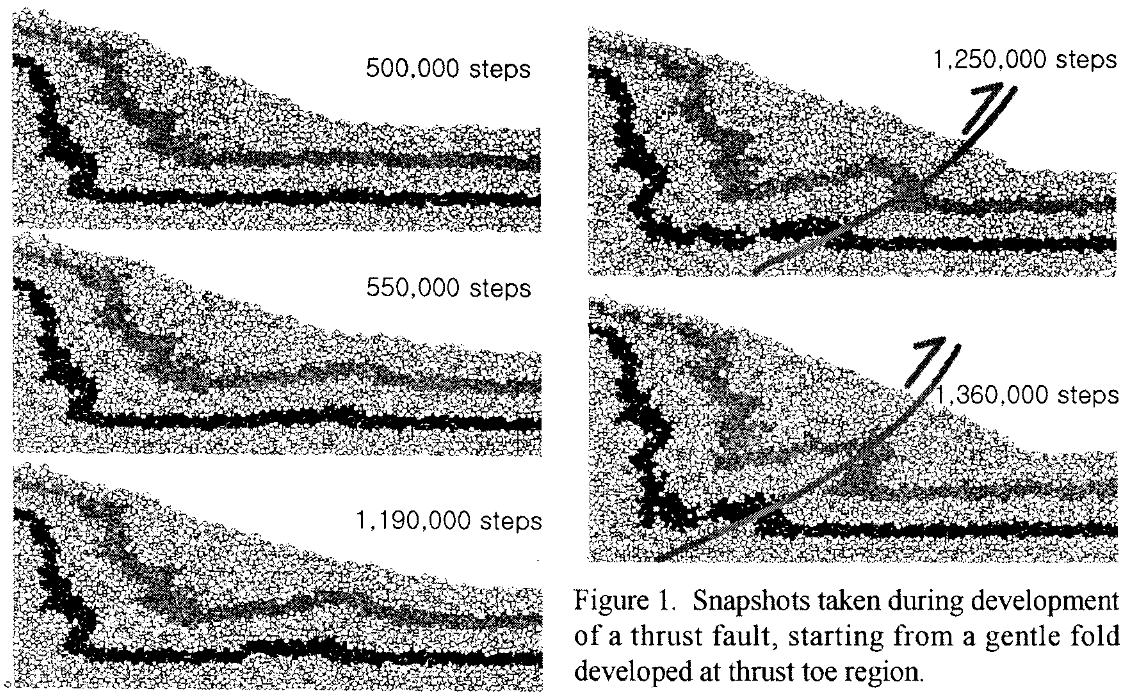

Figure 1. Snapshots taken during development of a thrust fault, starting from a gentle fold developed at thrust toe region.

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