Geophysical Research Abstracts
Vol. 17, EGU2015-10845-1, 2015
EGU General Assembly 2015

Transition between folding and thrusting: numerical simulations and applications to the Swiss Jura Mountains and the Canadian Foothills

Florian Humair, Arthur Bauville, Jean-Luc Epard, and Stefan Schmalholz
University of Lausanne, Institute of Earth Sciences, Lausanne, Switzerland (florian.humair@unil.ch)

Asymmetric thrust related anticlines which are displaying steep to overturned forelimbs are common structural features of foreland fold-and-thrust belts. Natural examples from the Jura Mountains and the Foothills of the Canadian Rockies (data provided by the Alberta Geological Survey) fold-and-thrust belts also display in addition a curved and steep backlimb along with the presence of back-thrusts (hinterland-verging). These two belts are classically interpreted as thin-skinned belts where folds develop over weak detachment horizons. Existing geometric fault-related models (fault-propagation, fault bend, break-thrust, detachment folds or a combination of the latter) account for the development of folds in response to faulting. However, the mechanics of thrusts (or ramps) formed as a consequence of detachment folding is incompletely understood.
In order to address this, we use two dimensional numerical simulations to investigate the transition between two end-member styles of deformation: (1) detachment folding and (2) thrust ramps with related anticlines. Model results were then compared with natural examples of fault-related anticlines. The model configuration consists of two plastic materials: a thin (10-100m) weak basal layer (friction angle: 10°) overlaid by several kilometers (1-3 km) of stronger sediments (friction angle: 30°). The weak layer is thicker on one side of the model than on the other and folding is initiated at the center where the thickness jump occurs. We investigated the control of (1) the ratio of detachment layer thickness on each side of the jump and (2) the friction angle of the detachment horizon on the style of deformation in the overlying sediments.
Preliminary results suggest that the development of thrusts at the base of anticlines is subsequent to an initial stage of low-amplitude symmetric buckling. In turn, folding of the strong layer further amplified in response to the propagation of the previously formed thrusts. Back-thrusts are initiated during the first increments of deformation and then progressively stop accommodating deformation in favor of foreland-vergent thrust where the detachment layer is thinner. The foreland vergent thrust can then passively transport the anticline.
Low thickness ratio of the detachment layer favors symmetric folding while high ratio favors the development of ramps. The absolute strength of the detachment layer had only a minor control on the deformation style. First order geometry and kinematics of modeled folds and thrusts agree with field observations and cross-sections from the Jura and the Foothills of the Canadian Rockies (from literature and constructed). In a second step we compared strain ellipses and principal stress orientation from the models with fracture distribution from natural examples. Finally we mapped the distribution of fracturing in the model through time to constrain the evolution and distribution of deformation mechanism.