Geophysical Research Abstracts
Vol. 21, EGU2019-16496, 2019
EGU General Assembly 2019

Mechanical analysis of the propagation of compressive deformation beyond a décollement topography: application to the Jura Mountains

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Numerous fold-and-thrust belts (FTB) worldwide develop above a non-planar décollement. The décollement can be offset, notably by normal basement faults inherited from former extensive tectonic episodes. Normal faults that offset the décollement generate basement topography and create steps in the décollement surface. Two types of steps can be distinguished: downward and upward steps, depending on the dip of the basement faults and/or basement topography relative to the direction of transport. Such discontinuities in the décollement are believed to localize and concentrate deformation. Structures would grow, and once a critical stage is reached, deformation can propagate torwards the foreland and beyond the décollement discontinuity.

The Jura Mountains are a good example of a thin-skinned fold-and-thrust belt that develops above a mechanically more rigid basement. The fault-related folds initiated in Mio-Pliocene times are all connected to the main décollement in middle Triassic evaporitic levels. Inherited structures in the basement are related to permo-carboniferous graben formation and may also be linked (newly formed or re-activated) to an extensional episode during Oligocene times and associated with the development of the Bresse and the Rhine grabens. The frontal Jura FTB overthrusts the Bresse graben and the northern Jura FTB propagates over the transfer zone between the 2 grabens systems.

We use the Limit Analysis Theory and the software Optum G2 to investigate the mechanical parameters that control the propagation of compressive deformation beyond an upward step of the décollement. We initiated a parametric study using simple prototypes. The goal is to quantify the general conditions in which an upward step of the décollement can influence significantly the propagation of deformation. We explore the impact of the position of an upward step below a hinterland wedge, the slope of the wedge and the décollement friction. Preliminary results confirm that an upward step in the décollement localizes deformation. The propagation of deformation beyond the step depends on the position of the step with respect to a pre-existing topography, and on the friction along the décollement. Depending on the friction of the décollement, the structures propagate along the upward step or cross cut the step and the basement. Others parameters such as a second décollement or preexisting structures will be tested to complete the parametric study. The results will be compared to cross sections in the eastern part of the Jura FTB to discuss the structural style in this area.