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The role of thin, mechanical discontinuities on the propagation of reverse faults: insights from analogue models

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Fault-related folding kinematic models are widely used to explain accommodation of crustal shortening. These models, however, include simplifications, such as the assumption of constant growth rate of faults. This value sometimes is not constant in isotropic materials, and even more variable if one considers naturally anisotropic geological systems. , This means that these simplifications could lead to incorrect interpretations of the reality. In this study, we use analogue models to evaluate how thin, mechanical discontinuities, such as beddings or thin weak layers, influence the propagation of reverse faults and related folds. The experiments are performed with two different settings to simulate initially-blind master faults dipping at 30° and 45°. The 30° dip represents one of the Andersonian conjugate fault, and 45° dip is very frequent in positive reactivation of normal faults. The experimental apparatus consists of a clay layer placed above two plates: one plate, the footwall, is fixed; the other one, the hanging wall, is mobile. Motor-controlled sliding of the hanging wall plate along an inclined plane reproduces the reverse fault movement. We run thirty-six experiments: eighteen with dip of 30° and eighteen with dip of 45°. For each dip-angle setting, we initially run isotropic experiments that serve as a reference. Then, we run the other experiments with one or two discontinuities (horizontal precuts performed into the clay layer). We monitored the experiments collecting side photographs every 1.0 mm of displacement of the master fault. These images have been analyzed through PIVlab software, a tool based on the Digital Image Correlation method. With the "displacement field analysis" (one of the PIVlab tools) we evaluated, the variation of the trishear zone shape and how the master-fault tip and newly-formed faults propagate into the clay medium. With the "strain distribution analysis", we observed the amount of the on-fault and off-fault deformation with respect to the faulting pattern and evolution. Secondly, using MOVE software, we extracted the positions of fault tips and folds every 5 mm of displacement on the master fault. Analyzing these positions in all of the experiments, we found that the growth rate of the faults and the related fold shape vary depending on the number of discontinuities in the clay medium. Other results can be summarized as follows: 1) the fault growth rate is not constant, but varies especially while the new faults interacts with precuts; 2) the new faults tend to crosscut the discontinuities when the angle between them is approximately 90°; 3) the trishear zone change its shape during the experiments especially when the main fault interacts with the discontinuities.