198-2 - Booth No. 181: INFLUENCE OF VISCOSITY AND FAULT ANGLE ON THE KINEMATICS AND GEOMETRY OF FAULT-PROPAGATION FOLDS: A NUMERICAL-MECHANICAL APPROACH

Tuesday, September 24, 2024

8:00 AM - 5:30 PM

Hall D (Anaheim Convention Center)

Booth No. 181

Abstract

The kinematic trishear model is used to explain the kinematics and geometry of fault-propagation folds. This model proposes a triangular deformation zone from the main fault termination. The apical angle is crucial for accurate reconstructions, as it defines where deformation concentrates in the frontal limb. However, studies show that this angle can vary significantly, influenced by rheology.

This study evaluates how the viscosity of rock layers affects the kinematics of fault-propagation folds and how these deviates from the trishear model's vector field. Fault-propagation fold models with a single ramp were developed using particle-in-cell finite element software, Underworld2. The geometry and kinematic field were analyzed and compared to the theoretical model, quantifying variations based on upper layer viscosity (from $1x10^{20}$ Pa·s to $1x10^{22}$ Pa·s), which covers values typical of the upper crust. The angle of the reverse fault was varied from 15° to 45°.

Results indicate that viscosity impacts the deformation style and velocity field. Higher viscosity results in a smaller apical angle, concentrating deformation in a narrower sector. Less viscous materials produce a wider deformation sector. Lower viscosity simulations show a localized high velocity in the frontal area, interpreted as material flowing from the hinge zone to the hanging wall, similar to fault-bend folds. Conversely, simulations with highest viscosity ($1x10^{22}$ Pa·s) exhibit a kinematic field more consistent with the trishear model.

Regarding the influence of fault angles, a low viscosity zone (LVZ) was detected in models with low-angle thrusts. This zone acts as the main fault, governing the kinematic field evolution more than the imposed fault ramp. To analyze this, triaxial tests simulations were conducted, varying the confining pressure (from 5 to 17.5 km) to simulate different burial depths. Fault angles were measured, and the stress tensor was calculated, obtaining normal and shear stress for each faulting cylinder. The intact basement rock envelope approximated the Mohr-Coulomb criterion. The behavior of low cohesion rocks, similar to areas with pre-existing faults, was examined. Results showed that when the ramp angle is less than 23°, the pre-existing weakness zone does not reactivate. Instead, a new fault forms at an angle of 34°, coinciding with the location of the LVZ (33° in simulations).

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Author

P

Berenice Plotek

Department of Earth, Geographic, and Climate Sciences, University of Massachusetts, Amherst

Instituto de Estudios Andinos Don Pablo Groeber

Authors

L

Jeremías Likerman

Instituto de Estudios Andinos Don Pablo Groeber, Universidad de Buenos Aires

Instituto de Estudios Andinos Don Pablo Groeber

C

Ernesto Osvaldo Cristallini

Instituto de Estudios Andinos Don Pablo Groeber, Universidad de Buenos Aires

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