Geophysical Research Abstracts
Vol. 21, EGU2019-6119, 2019
EGU General Assembly 2019

Importance of convergence angles on the evolution of fault patterns in transpression zones inferred from analogue modeling

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Transpression is an important geological process, which controlls deformation at almost any convergent plate boundary on Earth, generating complex fault patterns in the upper crust. It is defined as simultaneous horizontal simple shear and transverse shortening that leads to vertical extrusion of material in a defined deformation zone. In order to quantitatively assess the variability of patterns resulting from transpression, a series of scaled analogue experiments was performed using the MultiBox. We characterize fault patterns developed from variable ratios of shearing and shortening velocities.

The MultiBox consists of two halves, each of which contains a piston, whereby one halve is mobile and moves relative to the fixed one parallel to the box midline, thereby inducing a velocity discontinuity. Our experiments entail viscous and brittle analogue materials that are scaled to the thicknesses of undeformed lower and upper crust. In our two-layer-models, a 3 cm thick layer of a silicone-corundum mixture of 0.94:1 simulates the ductile lower crust, and a 2 cm thick layer of quartz sand with Mohr-Coulomb rheology represents the brittle upper crust. The deformation of the surface during the experiments was recorded using two high-resolution cameras and then analyzed by means of 3D digital image correlation.

The velocity ratio between shearing and shortening in our series of analogue experiments is systematically altered to generate different convergence angles from 0° (simple shear) to 90° (pure shear), resulting in different fault patterns. We find that the convergence angle influences profoundly the fault patterns: Strike-slip faults occur preferably under small convergence angles, whereas thrust faults in experiments with large convergence angles occur close to the pistons. In experiments with a convergence angle $< 45°$, a strike-slip zone with a positive flower structure develops along the midline of the MultiBox. Experiments with a convergence angle $> 45°$ develop preferably thrust faults in front of the pistons at the margin of the experimental area. Our analogue modelling results promise to furnish important information on the influence of convergence angles on the evolution of upper-crustal fault patterns in transpressive deformation systems.