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Extrapolating surface structures to depth in transpressional systems: the role of rheology and convergence angle deduced from analogue experiments

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The internal structure of major strike-slip faults is still poorly understood, particularly how the deep structure could be inferred from its surface expression (Molnar and Dayem, 2011 and references therein). Previous analogue experiments suggest that the convergence angle is the most influential factor (Leever et al., 2011). Further analogue modeling may allow a better understanding how to extrapolate surface structures to the subsurface geometry of strike-slip faults. Various scenarios of analogue experiments were designed to represent strike-slip faults in nature from different geological settings. As such key parameters, which are investigated in this study include: (a) the angle of convergence, (b) the thickness of brittle layer, (c) the influence of a rheological weak layer within the crust, and (d) influence of a thick and rheologically weak layer at the base of the crust. The latter aimed to simulate the effect of a hot metamorphic core complex or an alignment of uprising plutons bordered by a transtensional/transpressional strike-slip fault. The experiments are aimed to explain first order structures along major transcurrent strike-slip faults such as the Altyn, Kunlun, San Andrea and Greendale (Darfield earthquake 2010) faults.

The preliminary results show that convergence angle significantly influences the overall geometry of the transpressive system with greater convergence angles resulting in wider fault zones and higher elevation. Different positions, densities and viscosities of weak rheological layers have not only different surface expressions but also affect the fault geometry in the subsurface. For instance, rheological weak material in the bottom layer results in stretching when experiment reaches a certain displacement and a buildup of a less segmented, wide positive flower structure. At the surface, a wide fault valley in the middle of the fault zone is the reflection of stretching along the velocity discontinuity at depth. In models with a thin and rheologically weaker layer in the middle of the brittle layer, deformation is distributed over more faults and the geometry of the fault zone below and above the weak zone shows significant differences, suggesting that the correlation of structures across a weak layer has to be supported by geophysical data, which help constraining the geometry of the deep part. This latter experiment has significantly similar phenomena in reality, such as few pressure ridges along Altyn fault. The experimental results underline the need to understand the role of the convergence angle and the influence of rheology on fault evolution, in order to connect between surface deformation and subsurface geometry.

References

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