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Extrapolating subsurface geometry by surface expressions in transpressional strike slip fault, deduced from analogue experiments with settings of rheology and convergence angle

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The internal structure of major strike-slip faults is still poorly understood, particularly how to extrapolate subsurface structures by surface expressions. Series of brittle analogue experiments by Leever et al., 2011 resulted the convergence angle is the most influential factor for surface structures. Further analogue models with different ductile settings allow a better understanding in extrapolating surface structures to the subsurface geometry of strike-slip faults.

Fifteen analogue experiments were constructed to represent strike-slip faults in nature in different geological settings. As key parameters 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 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 transpressional 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.