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Fold axis rotation during transpressional folding: Insights from analog and numerical models

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Transpression is a combination of strike-slip deformation and shortening orthogonal to the deformation zone. Transpressional structures generally form in response to obliquely convergent relative plate motions or crustal deformation zones at various scales. Whereas transpression in the upper crust is dominantly accommodated by faulting, viscous parts of the lithosphere accommodate transpression dominantly by folding. In some cases, transpressional strain is geographically partitioned between a strike-slip domain lacking major shortening structures and a neighboring pure-shear domain (e.g., fold-and-thrust belt) lacking major strike-slip structures.

Numerical models (Frehner, in press) have investigated growth and rotation of folds during transpression as a function of the convergence angle. In particular, this numerical study suggests that fold axes are always parallel to the major horizontal principal strain axis (λ_{max}), and that sequential folds appearing later form parallel to already existing folds and rotate with the major horizontal principal strain axis with increasing strain. This suggests that fold axes are not passive material lines and that fold hinge migration occurs during transpression.

Transpressional folding is inherently 3D and analog modeling represents a good tool to investigate the growth and rotation behavior of transpressional folds. Previous analog models used a rubber sheet at the base (Tikoff and Peterson, 1998) and thereby introduced significant boundary effects. Here we apply a distributed basal simple shear combined with a horizontal shortening to study transpressional folds. Similar to the numerical study, we investigate the influence of the convergence angle on the resulting structures forming in viscous layers, particularly in regard to fold growth and fold rotation; we also vary the viscosity ratio of the layers. Ultimately, we compare the analog and the numerical results to gain an unbiased and robust insight into transpressional fold growth and rotation.

We find that there is a unique triangular relationship between the convergence angle, the amount of strain, and the fold axis orientation. If two of these values are known, the third can be determined. Importantly, this relationship is independent of the viscosities and viscosity ratios involved in the folded layers. This triangular relationship is applied to the Zagros fold-and-thrust-belt to estimate the degree of strain partitioning between the Simply Folded Belt and the bordering strike-slip fault-system.

References

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