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Transpression / transtension: a model for micro- to macro-scale deformation

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Transpression and transtension were terms introduces by Harland (1971) to define deformation that involves both transcurrent (strike-slip) movement along a zone and compression or extension across it. Sanderson & Marchini (1984) produced a strain model for transpression, and the concept has subsequently been applied in a variety of tectonic settings over a wide range of scales.

Transpression is modelled by the simultaneous application of a transcurrent shear and horizontal shortening orthogonal to a block, with no lateral stretch. Sanderson & Marchini originally used two parameters α (the vertical elongation) and γ (the shear strain on the zone boundary) to define the deformation within the block. For constant volume deformation, the shortening across the zone is simply $\beta = \alpha^{-1}$, but volume change (Δ) is easily incorporated in the models, where $\alpha \quad \beta$ = (1+Δ). One may also specify transpression in terms of the strain rates $(\partial \varepsilon sg \gamma)$ and the direction (A) and amount (S) of convergence/divergence, where tan $A = \partial \gamma$ / $\partial \varepsilon$.

The transpressional model has a number of important implications, which include:

1. It generally leads to triaxial deformation, hence is intrinsically 3-dimensional, e.g. flattening strains characterise transpressional zones, whereas constrictional strains result from transtension.
2. It represents a spectrum of strain states, providing a useful way of classifying deformational styles between generalised compressional, strike-slip and extensional regimes. The vorticity axis will be normal to the shear direction (vertical) and does not need to be parallel to the intermediate principle stain axis.
3. At a convergence angle of $A \approx 70.5^{O}$ the incremental and finite strain axes may be differently oriented and this may produce situations where structures may appear to develop in unusual orientations with respect to the finite strain fabrics
4. Both the compressional and shear components contribute to the stretch S_n normal to the zone, where S_n = $(\alpha^2 + \gamma^2)^{-1/2}$. Thus the shortening (stretch) measured across a transpression zone (including simple shear zones), by methods such as balancing sections, should not be confused with the parameter β, which measures the convergence of the zone boundaries.
5. It may be applied to zones of deformation on a variety of scales.
6. It has been generalised to include several other components of deformation, including lateral extrusion, vertical shear both parallel and normal to the zone and oblique shear, inclined shear, etc.

The controlling parameters may vary spatially within a zone (spatial partitioning) or with time during its evolution (temporal partitioning). In many settings involving oblique convergence, the strike-slip component may be taken up mainly on faults within the zone, whilst the compression is more broadly distributed. Spatial partitioning can allow continuity across the zone boundary (e.g. Robin & Cruden 1994).