The localization of shear strain within a contractual fault-propagation fold system: a case study from the Stillwell anticline, west Texas

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Research questions:
1) How is strain distributed across the fold?
2) What mechanisms accommodate that strain?
3) What do the distribution and types of strain imply for similar systems?
Regional Laramide-age structural framework

Modified from Muehlberger and Dickerson (1989)
The Stillwell anticline system

- NW-trending, NE-vergent system
- 10 km long, less than 500 m wide
- Mapping and previous research indicate a left-stepping, en echelon system
Variations in fold geometry
(no subsurface interpretations shown)

Cross-sectional exposure at B – B’

No vertical exaggeration
Fault-propagation fold evolution

Modified from Erslev, 1991

Trishear kinematic modeling results
(FaultForward, e.g., Allmendinger, 1998; 2000; 2012)
Outcrop-scale strain accommodation: ramp-flat fault geometries
Outcrop-scale strain accommodation: inter-layer slip

NE-dipping beds in forelimb
Outcrop-scale strain accommodation: intense fracturing, brecciation, and cataclasis
Intra-layer strain accommodation

Slice-and-scan model building:
1) high-res. optical scan
2) mark visible fractures
3) export 2D fracture network
4) “slice” and repeat
5) build 3D model in ImageJ
3D intra-bed fracture network
Implications for similar fold systems

- Kinematic models, outcrop observations, and intra-bed observations support localized strain within forelimbs of bedded carbonate systems
- Strain in such systems accommodated by a combination of ramp-flat faults, inter-layer slip, fracturing, and brecciation across a range of scales
- Localization of strain in forelimb might enhance permeability and anisotropic flow parallel to fold axis
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