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Three-dimensional geometries of relay zones in normal faults

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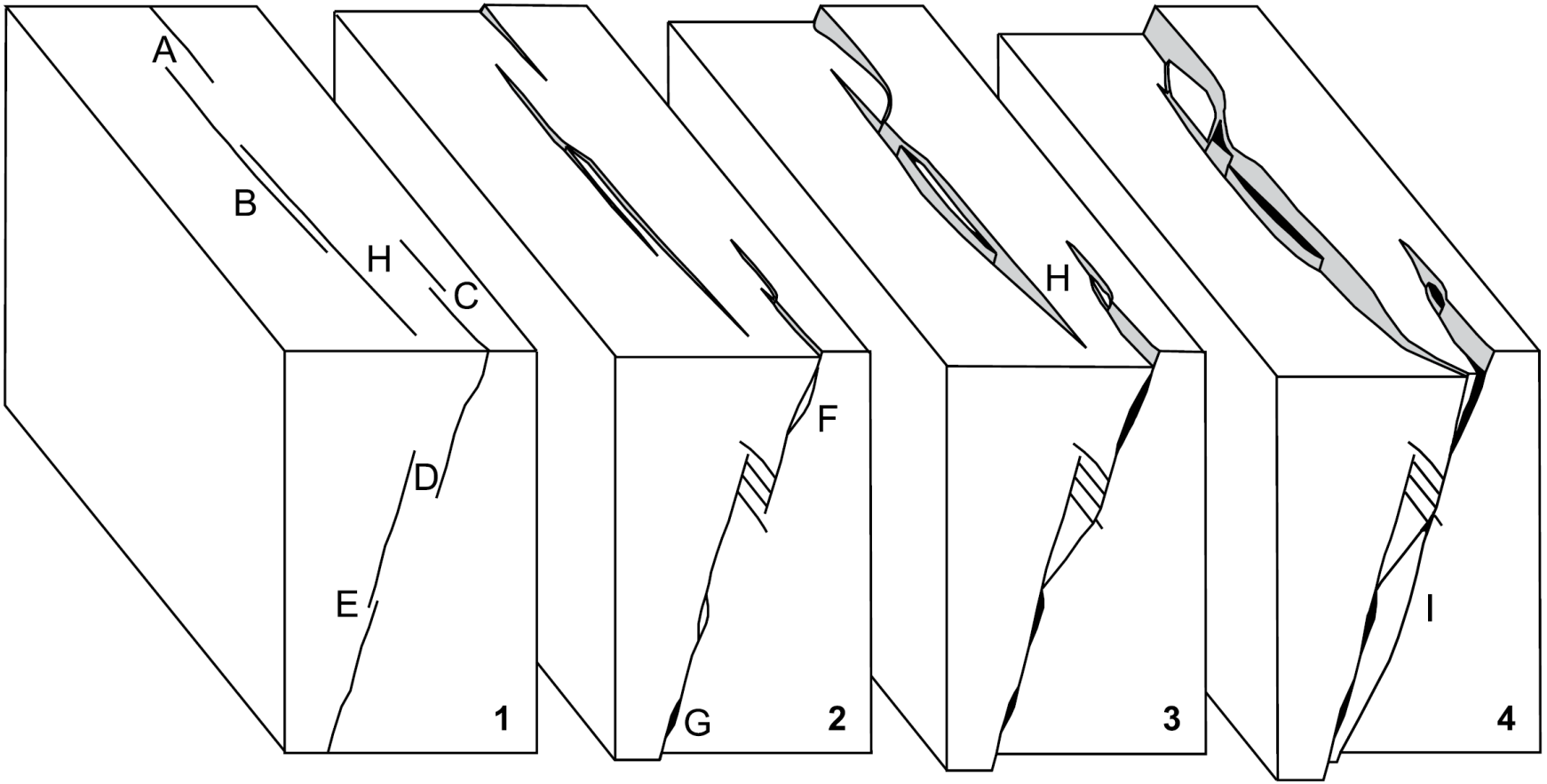
Reference: Camanni et al., 2019, *The three-dimensional geometry of relay zones within segmented normal faults,* Journal of Structural Geology, vol. 129, https://doi.org/10.1016/j.jsg.2019.103895

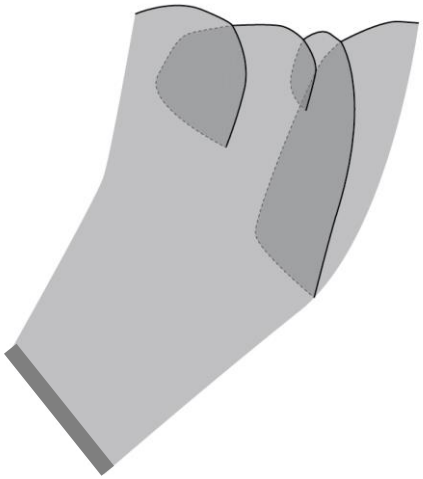
Initial fault segmentation and relay zones breaching during displacement accumulation are the main controls on determining fault zone structure

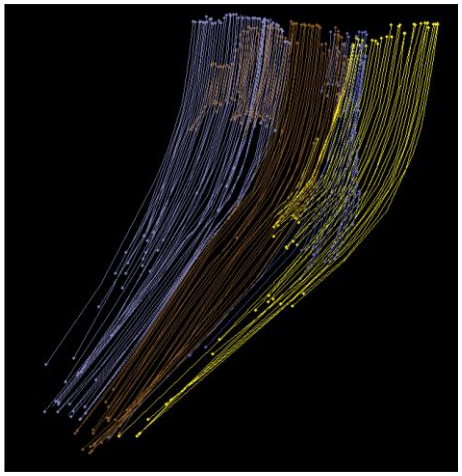


Childs et al. (2009), Journal of Structural Geology

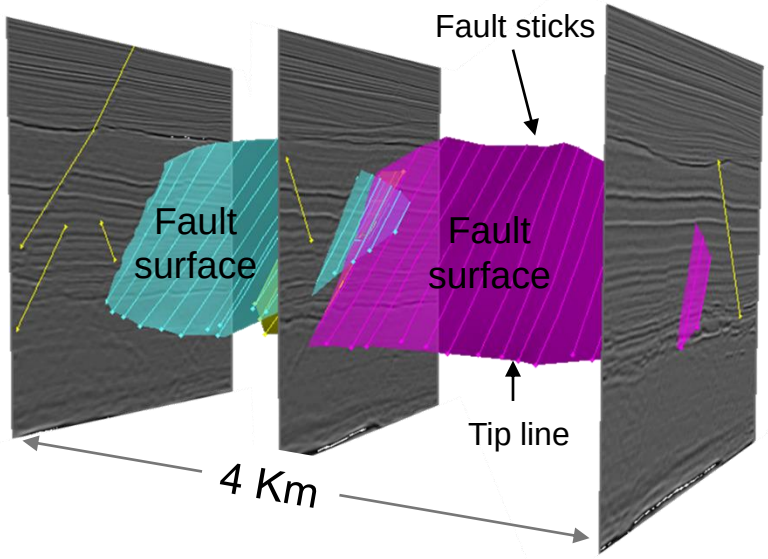
This “display” investigates the fundamental characteristics of the 3D geometry of relay zones between adjacent fault segments

We mapped relay zones (**n=532**) in normal faults (**n=67**) using high quality 3D seismic reflection datasets from 8 different geological settings..

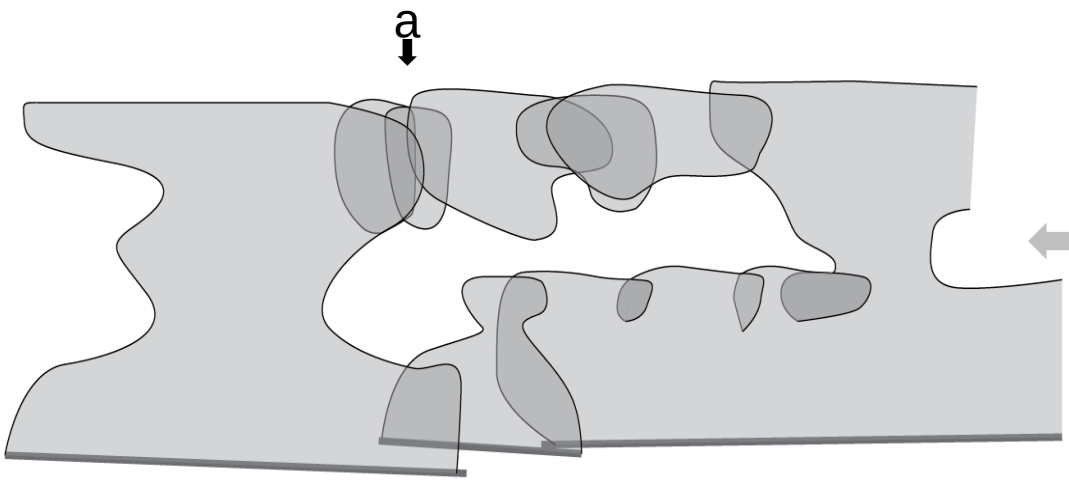




Relays in the Taranaki Basin

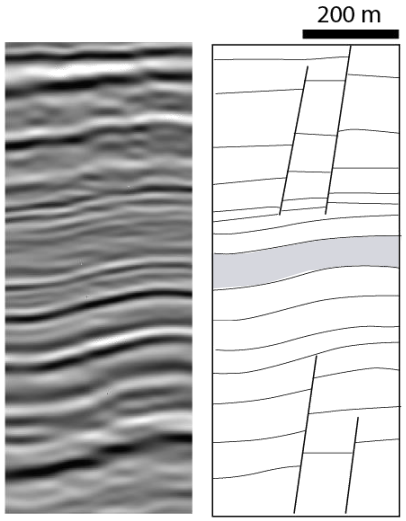


Relay in the Porcupine Basin



Relays in the Molasse Basin

Opa.

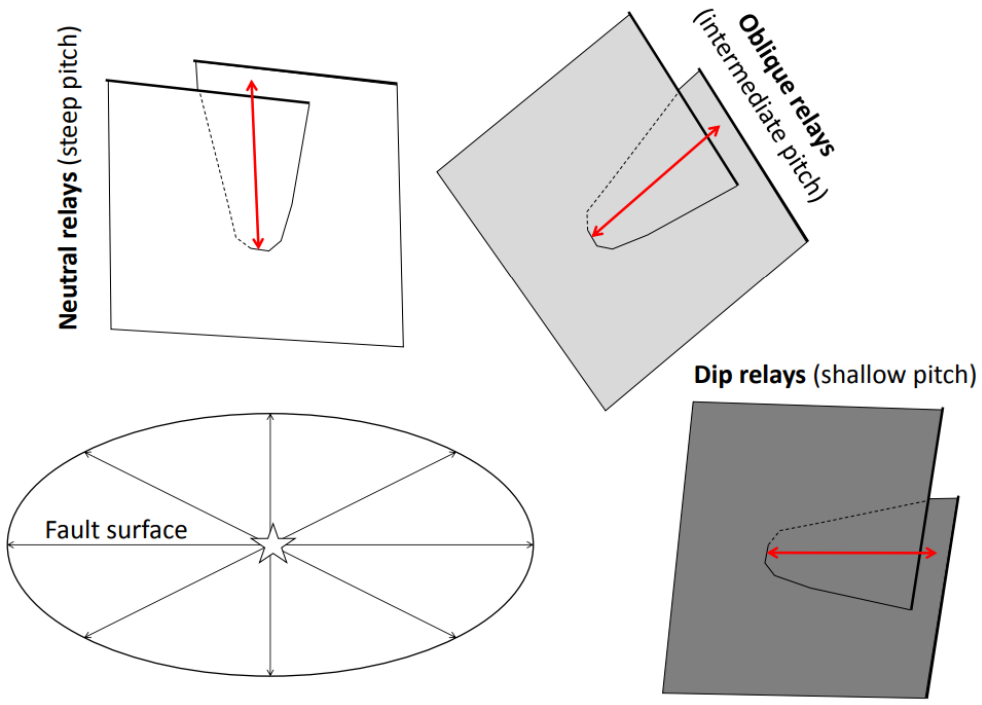


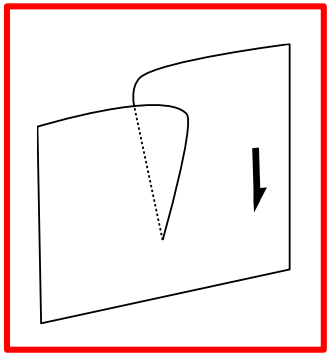
Roche et al. (2019), Journal of the Geological Society

We identified 2 major ‘forms’ of relay zone geometry in 3D

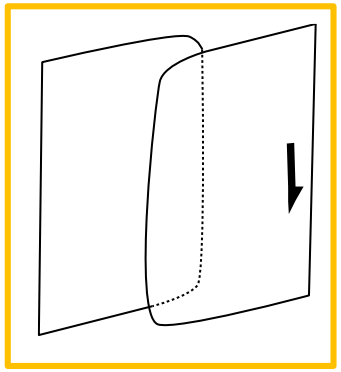
- **Bifurcating relay zone**: two bounding faults merge together into a single fault surface
- **Cylindrical relay zone**: two bounding faults do not merge but remain parallel to one another

Relay orientation based on the pitch of the relay axis





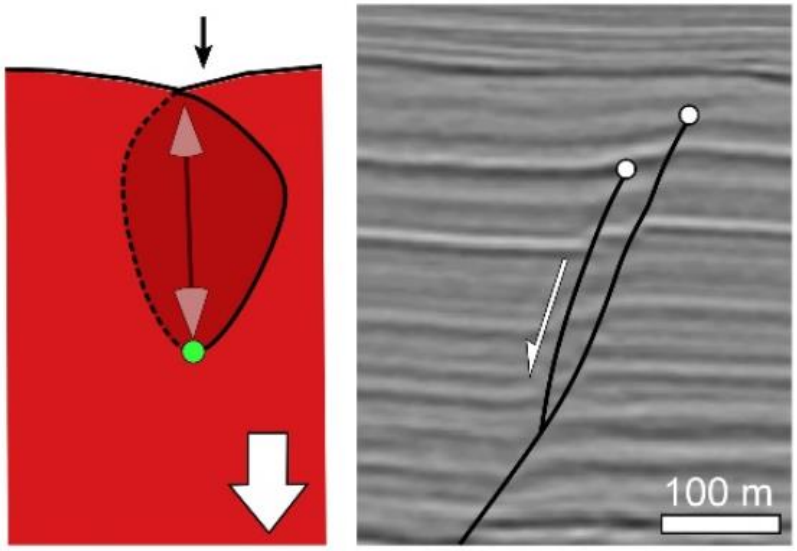
Bifurcating relay zone



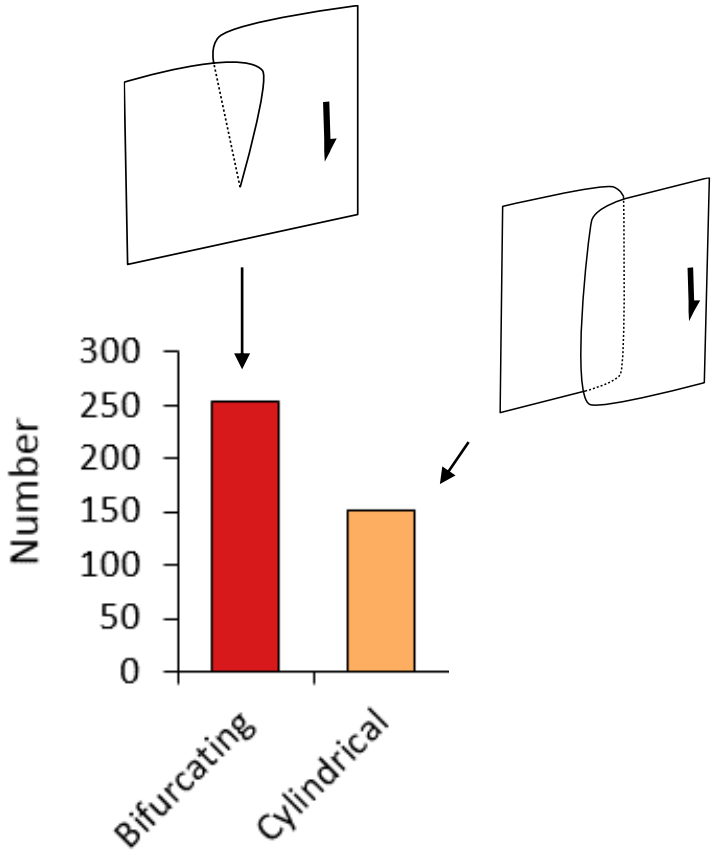
Cylindrical relay zone

We found that..

Relay zones ‘form’ in 3D



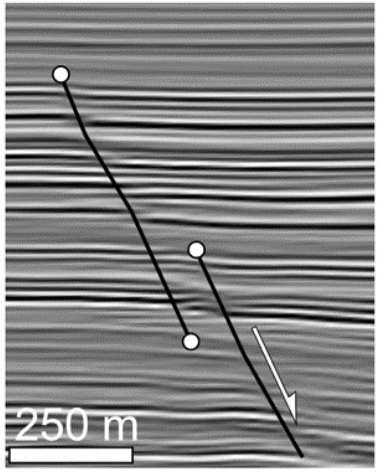
A bifurcating neutral relay in the Porcupine Basin

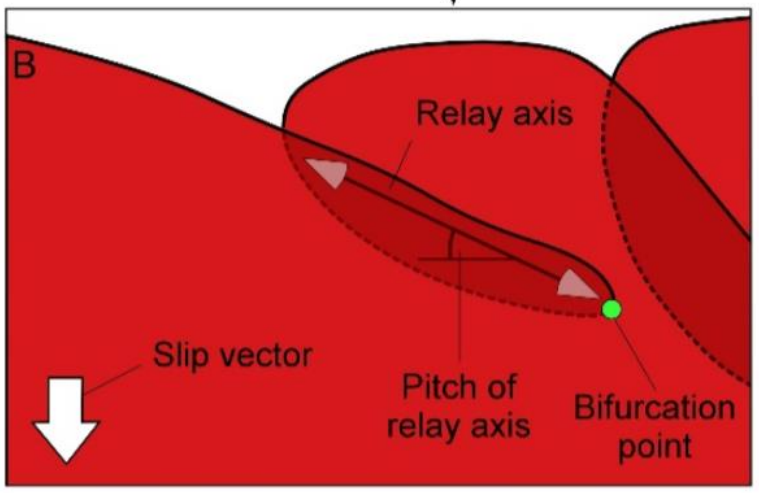


Bifurcating and cylindrical relays represent most of 3D segmentation, with the bifurcating “form” being predominant

We found that..

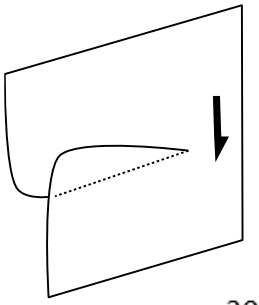
Relay zones orientation in 3D



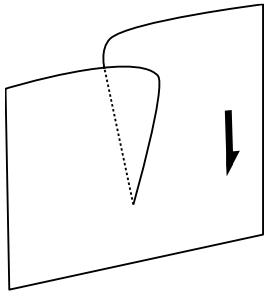


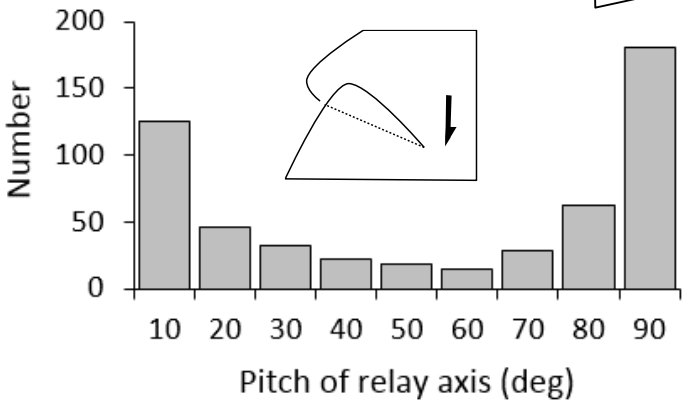
A bifurcating oblique relay in the Bonaparte Basin

Dip relay



Neutral relay

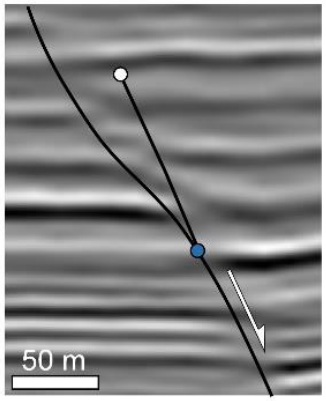


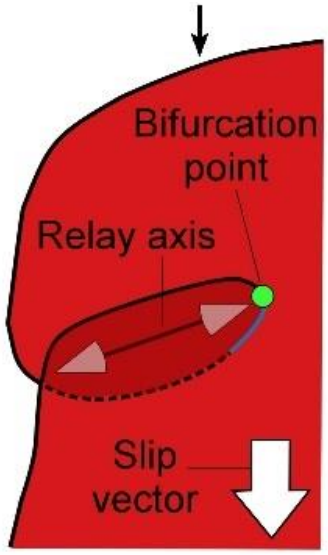


Relays are mostly oriented either parallel to fault slip direction or parallel to bedding

We found that..

Relay zone sense of stepping

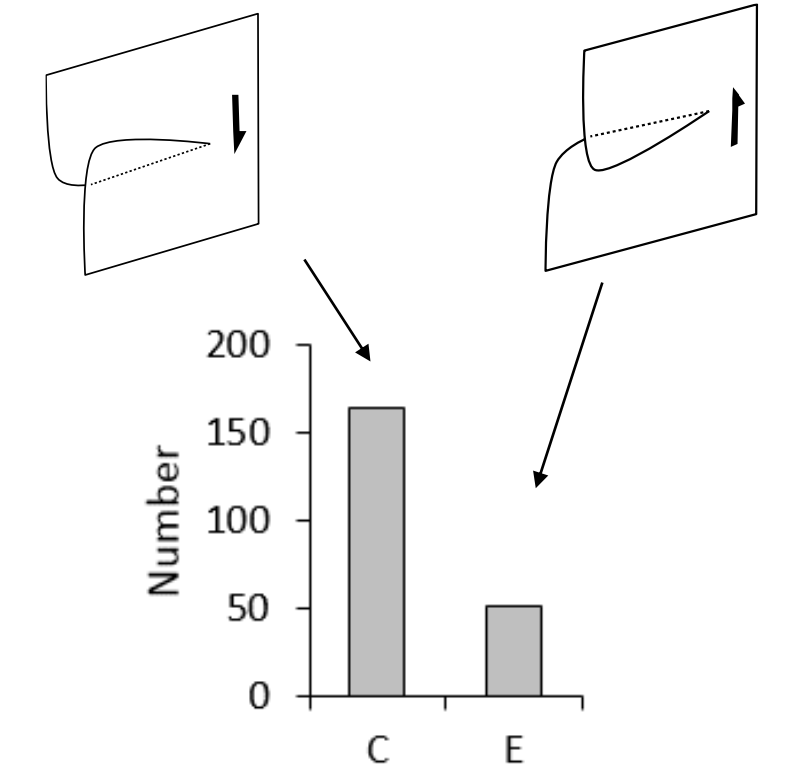




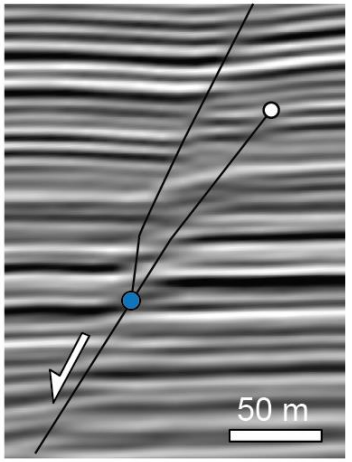
A bifurcating contractional dip relay

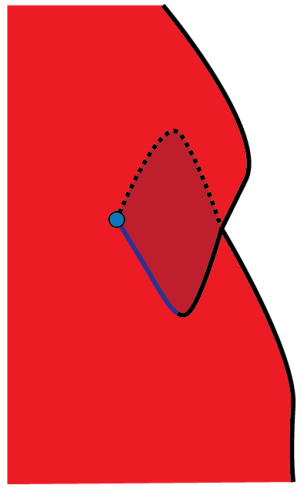
Contractional relay

Extensional relay



Contractional relay zones are more common than extensional ones





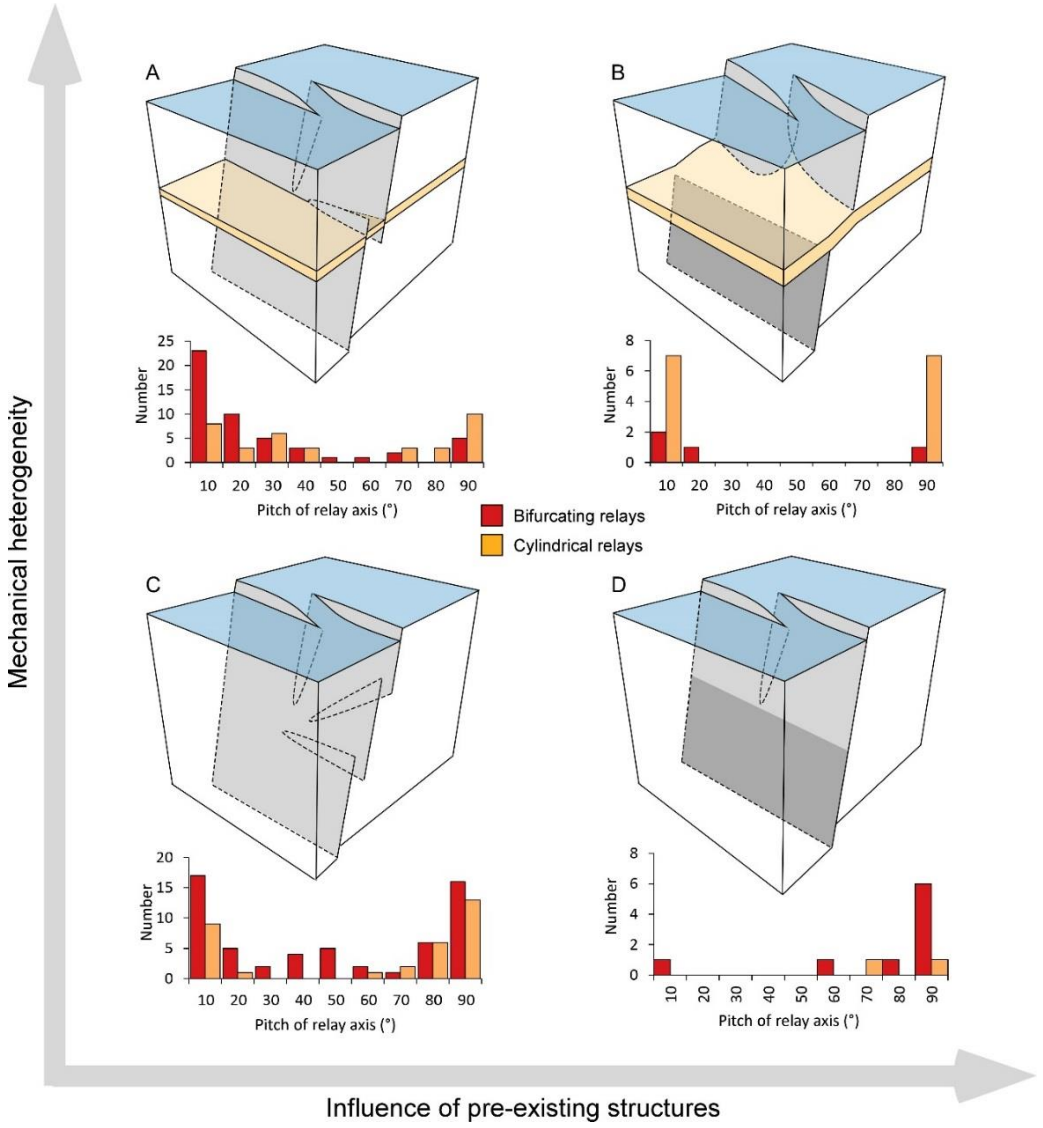
A bifurcating extensional dip relay

We found that..

Geological controls on 3D relay zones

- The character of the mechanical sequence and the degree of influence exerted by basement structures are key controls

- Different combinations of these two controls can account for variation in fault zone structure



Conclusions

1. Most relay zones (48%) are bifurcating structures in which relay zone bounding segments merge to form a single planar fault surface at one end of the relay axis. Cylindrical relay zones, defined by segments that do not merge along the relay axis, are less common (28%) and double bifurcating relay zones are relatively rare (4%). Other relay zones (20%) cannot be attributed to any of the above relay zone form categories;

2. Oblique relay zones are rare compared to neutral and dip relay zones so that assumptions at outcrop that relay zones seen in map view are likely to be neutral and those seen in cross-section are likely to be dip relay zones will generally be correct;

3. Relay zones are most commonly contractional (>75%), a feature attributed to localisation processes within both mechanically anisotropic and isotropic rock masses;

4. Populations of relay zone pitches and 3D geometries can be related to the presence of less competent units within the faulted sequence and whether or not basement structure influenced fault growth.