Push and Twist: The Story of Diligencia Basin's Asymmetrical Syncline and Scissoring Monocline

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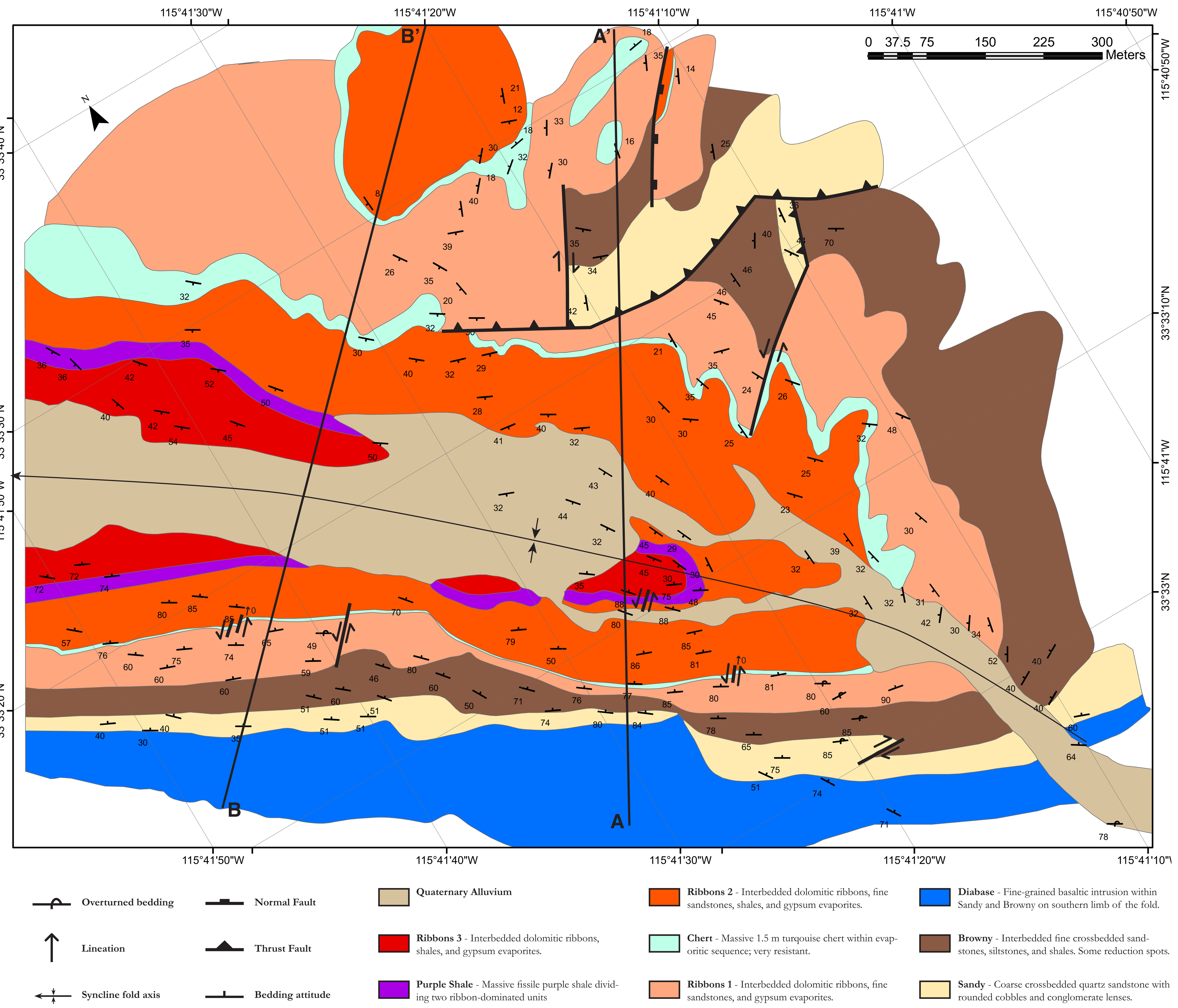
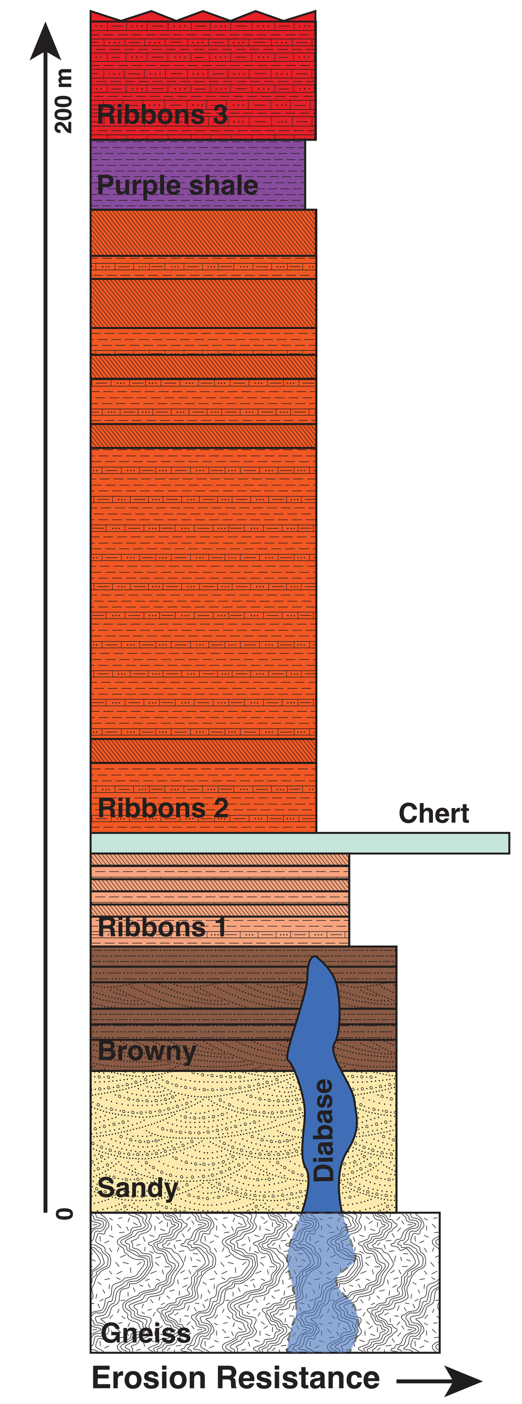




Ribbons 3 - Finely interbedded (<10 cm) orange dolomitic ribbons and white evaporites. The top contact of this unit was not defined.

Purple shale - Massive purple fissile shale that defines the transition between Ribbons 2 and Ribbons 3.

Ribbons 2 - Interbedded orange dolomitic ribbons, fine sandstones, shales, and evaporites; very similar to Ribbons 1 but with more shales.

Chert - Massive 1.5 m thick, turquoise, chert weathering in some places to red brown. This marker bed is highly resistant and defines the transition from Ribbons 1 to Ribbons 2. The chert is surrounded by evaporites. However, given how the thicknesses of Ribbons 1 and Ribbons 2 appear to vary throughout the basin (see cross sections), the chert may not be as stratigraphically significant as we initially thought.

Ribbons 1 - Thinly interbedded (<10 cm) dolomitic ribbons and fine sandstones with increasing evaporitic gypsum and anhydrite (up to 10 cm thick) towards the top. Orange-to-yellow weathering.

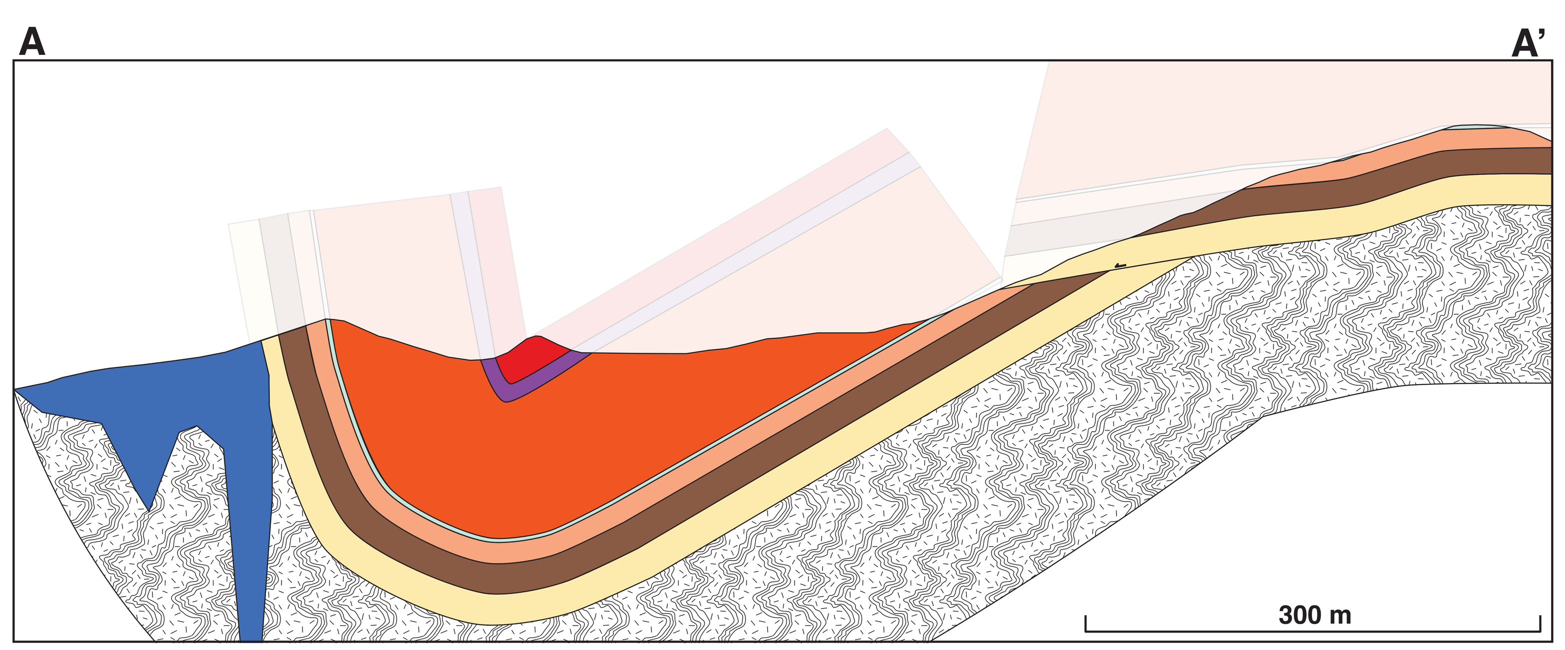
Browny - Fine trough crossbedded sandstone interbedded with siltstones, mustones, and some carbonate micrites. Darker than Sandy; brown, green, and purple. Some beds contain reduction spots.

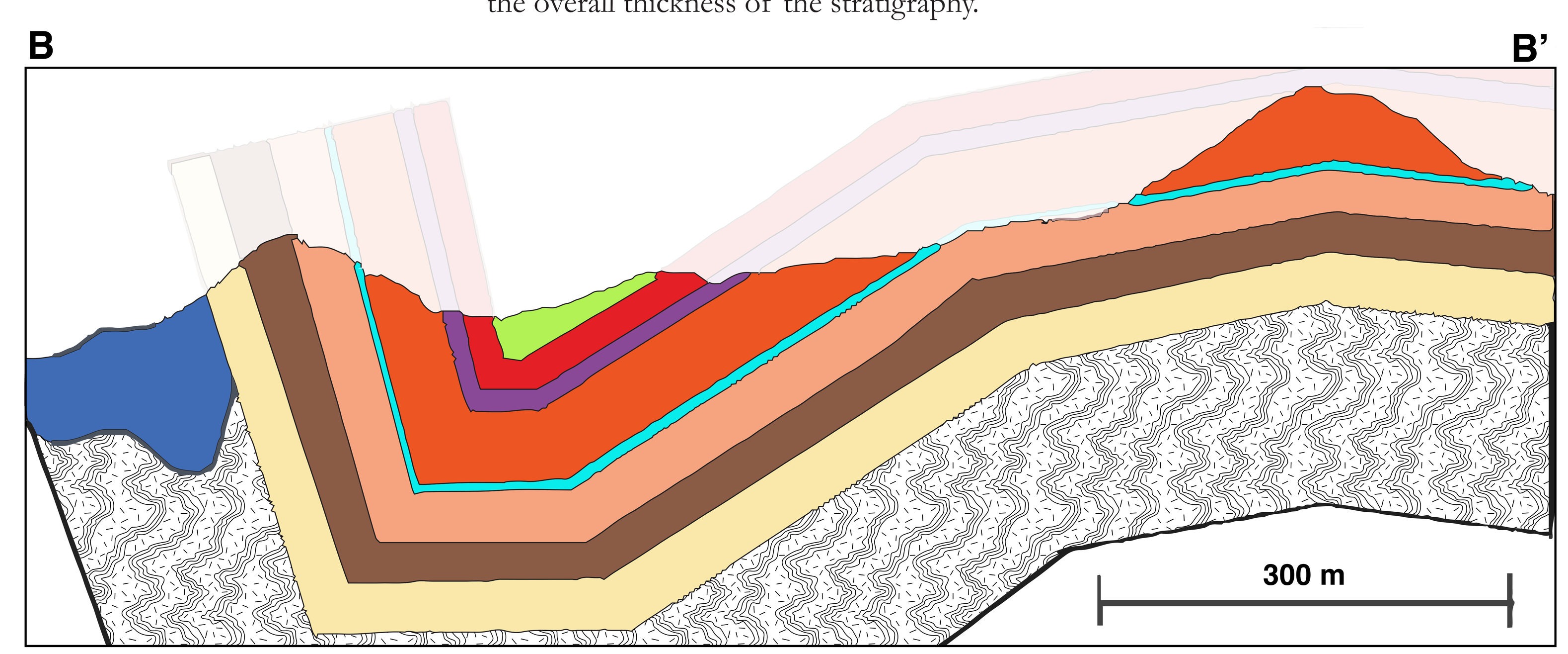
Sandy - Medium to coarse crossbedded quartz sandstone with smoothed quartitic and granitic pebbles. Graded conglomerate lenses with erosional bottoms; probably channels.

Gneiss - Granitic gneiss that appears to form the basement in Diligencia Basin. Parts of the gneiss seem to be incorporated in Sandy, which immediately overlies it.

Cross Section A - NE-SW cross-section across both limbs of the syncline showing the asymmetry of the syncline as well as the scissoring of the monocline in the east due to the clockwise rotation of the shear zone.

Cross Section B - NE-SW cross-section across both limbs of the syncline showing just the asymmetrical syncline to monocline transition without the scissoring displacement fault. Here, Ribbons 1 & 2 seem to have changed substantially in thickness without hanging the overall thickness of the stratigraphy.





Kinematic Analysis

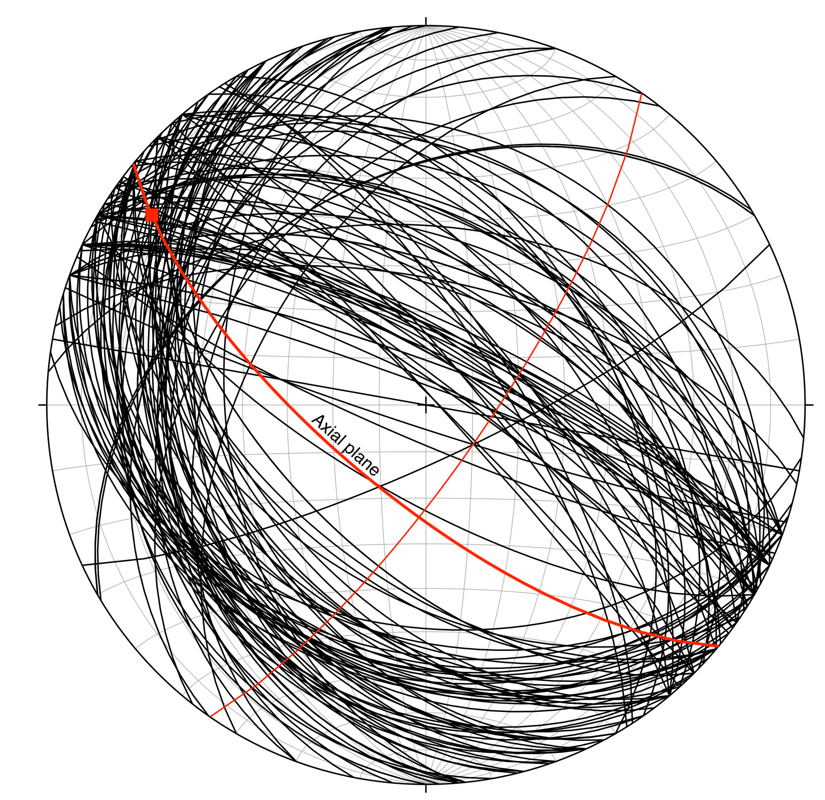
The dominant structure in our area was an asymmetric northwest-plunging syncline with an axial plane trace striking approximately NW/SE. The eastern limb of the fold became a monocline, which was broken by low-angle scissoring detachment fault with west-ward displacement increasing southwards. Smaller scale folding occurred in the weak ribbons and evaporites, often producing overturned beds. Other than the right-lateral fault in the clockwise scissoring monocline and another dextral fault in the SE, we found exclusively left-lateral faults throughout the syncline.

Dynamic Analysis

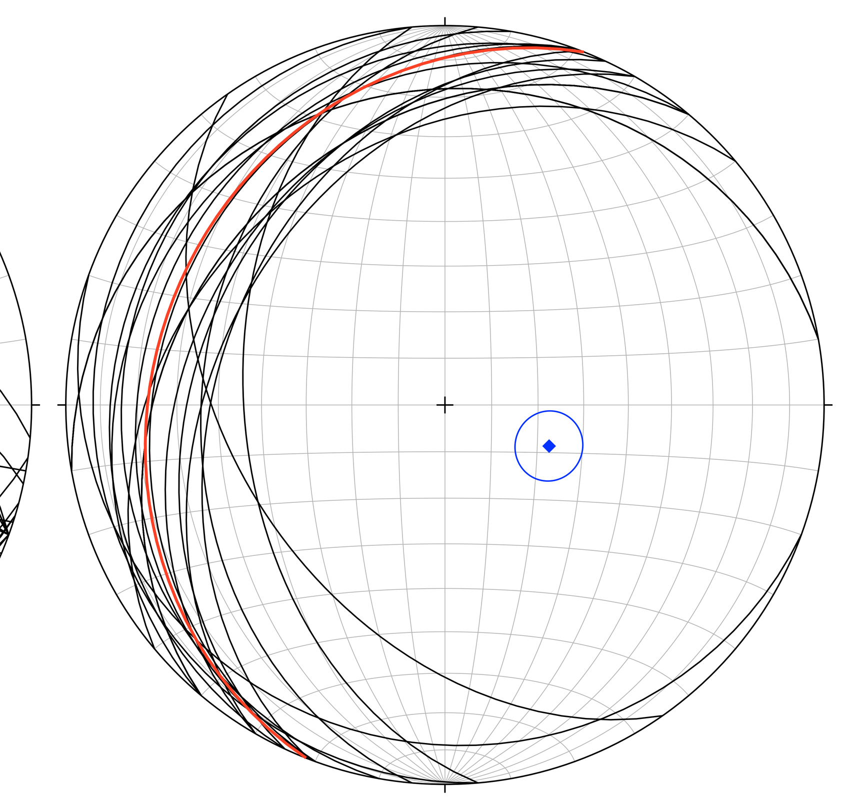
To get the large-scale syncline, with axial plane trace NW/SE, σ_1 needed to have been NE/SW and σ_3 needed to have been vertical. The small scale folding within the finely bedded ribbons and evaporites resulted from the overall weakness of these beds. A second stress regime, with σ_1 oriented NW/SE, is required to have caused the plunge present in the syncline. The scissoring fault in the monocline demonstates a clockwise rotational component of strain that resulted from the interaction of the above two stress fields, through rotation producing both the dextral and sinistral faults.

Tectonic analysis

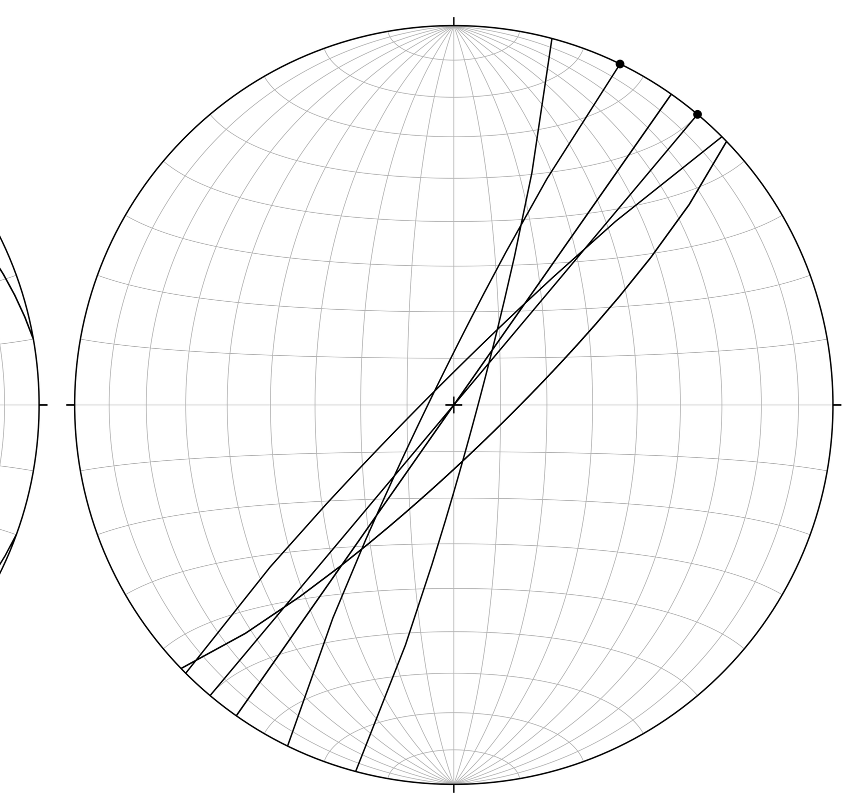
The San Andreas Fault (SAF) is, in general, a NW/SE trending, dextral strike-slip fault, made up on a smaller scale of a network of smaller faults with various attitudes and displacements. In the late Miocene, maximum compressive stress ran NE-SW, providing the stress field necessary to explain the syncline[1]. Additionally, our region is between a zone of 316º-striking faults to the west and the 330º-striking Sheep Hole Fault to the east[2]. Since the faults are subparallel, their motion drives also creates NE/SW-compression in the south where they come together. The motion along these faults also produces rotation that causes sinistral strike-slip faults within rotating blocks and transpressional stress in the NW and SE[2]. We attribute the NW plunge of the fold to this transpressional stress. The scissoring fault running through the monocline is a direct result of the clockwise rotation through the Neogene[1].



Fold Axis - Plunging fold axis computed from cylindrical best fit of a plane to the poles of strike/dip measurements along the syncline. The fold axis has an attitude of 304-14 (red square).



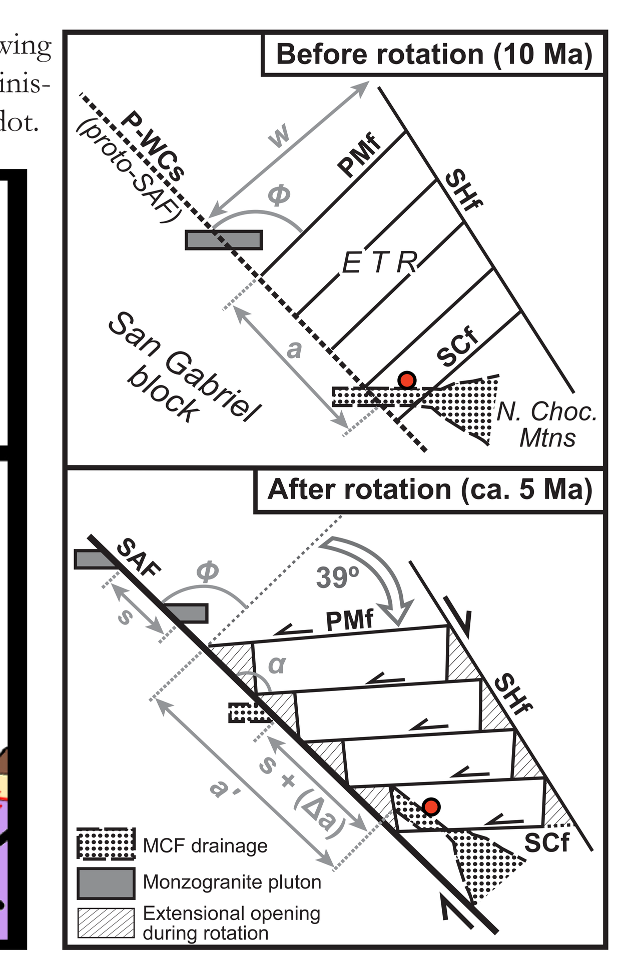
Monocline - Bedding planes along scissoring monocline with an average attitude of 202/24 (red line). The dip direction of 292 is close to the plunge of the syncline at 304.

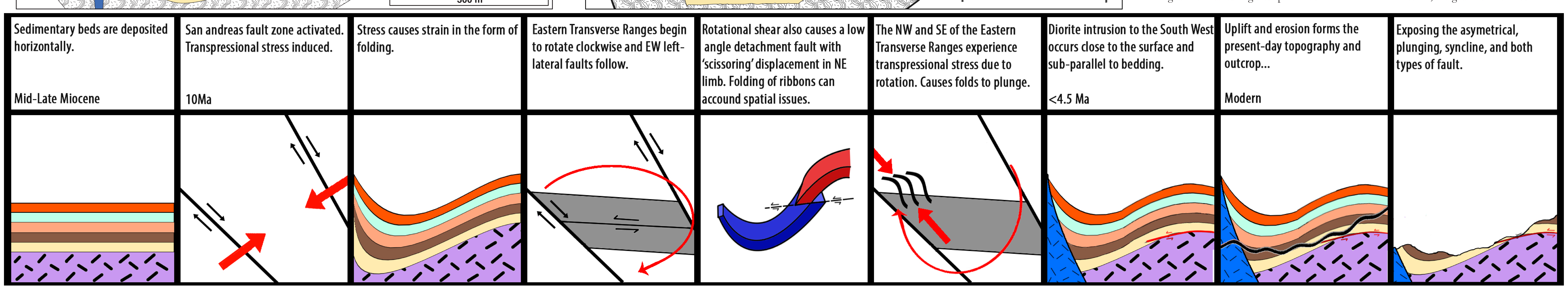


Faults - Fault planes all nearly vertical with sinistral (NE-trending) displacement.

Cartoon - Diagrammatic representation of the tectonically driven stress and the strain response within Diligencia Basin through the past 10Ma. Not to scale.

Tectonic Rotation - Schematic showing how clockwise rotation can produce sinistral shear[3]; Diligencia Basin is the red dot.





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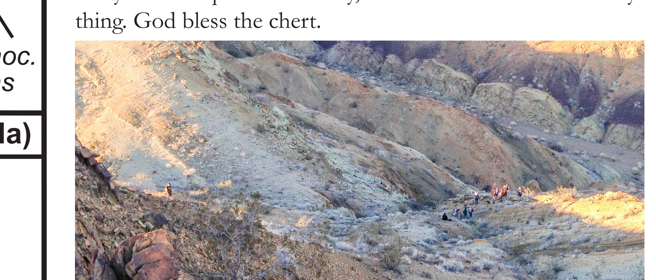

References

[1] Carter, J. N., Luyendyk, B. P., & Terres, R. R., 1987. Neogene clockwise tectonic rotation of the eastern Transverse Ranges, California, suggested by paleomagnetic vectors, Geological Society of America Bulletin, **98**, 199-206.
[2] Dickinson, W. R., 1996, Kinematics of Transrotational Tectonism in the California Transverse Ranges and Its Contribution to Cumulative Slip Along the San Andreas Transform Fault System: Boulder, Colorado, Geological Society of America Special Paper 305.
[3] Darin, M. H., Dorsey, R. J., 2013. Reconciling disparate estimates of total offset on the southern San Andreas fault, Geology, **41**, 975-978.