Geophysical Research Abstracts
Vol. 20, EGU2018-17524, 2018
EGU General Assembly 2018

Fracture attributes from Swift Anticline, NW Montana: mechanical stratigraphy and inferred structural development.

Adam J. Cawood (1), Clare E. Bond (1), Hannah Watkins (1), Mark Cooper (1,2), and Marian J. Warren (3)

(1) Department of Geology and Petroleum Geology, School of Geosciences, University of Aberdeen, UK (adam.cawood@abdn.ac.uk), (2) Sherwood GeoConsulting, Calgary, Canada, (3) Jenner GeoConsulting, Calgary, Canada

Swift Anticline is an asymmetric, thrust-related fold that exposes fractured bedding surfaces of the Mississippian Madison Group carbonates at the front of the Sawtooth Range, Montana. Excellent exposure of bedding surfaces makes the structure a suitable analogue for folded and fractured subsurface reservoirs, particularly to those of the laterally-equivalent fractured carbonate plays of the Front Ranges, Alberta. Frontal anticlines of the Sawtooths have been much-studied, and were key outcrops in early work on predicting fracture orientations in folded strata (e.g. Stearns, 1964). Observed fracture patterns at Swift, however, are complex and vary significantly in 3D. Further, they do not appear to conform to existing models of fracture orientations in contractional settings.

A digital data approach is adopted in this study, by reconstructing Swift Anticline in detail with virtual outcrops derived from UAV digital imagery. This allows us to digitally map fractures at a range of scales, and assign these fractures to stratigraphic units across the full extent of the outcrop. We assess the causes of this variation and compare measured fracture attributes (orientation, intensity and length distributions) at different along-strike, structural and stratigraphic positions. Results show that fracture attributes at Swift Reservoir vary significantly according to stratigraphic interval: shear fractures are dominant in some units but subordinate to mode I fractures in others. Along-strike and structural positions further impact measured data: fracture sets record rotation, changes in length distributions and intensity, based on measurement locations. Finally, observation scale highlights length-scale heterogeneities in fracture populations.

Spatial variation and complexity of fracture attributes at Swift Anticline record multiple influences. Changes in fracture orientations vertically are attributed to contrasting mechanical properties and thus mechanisms of deformation through the stratigraphy. Length-scale heterogeneities may reflect phasing of fracture sets and the coalescence of small, brittle fractures into shear fractures. Differing along-strike and structural positions record strain gradients through the structure. This further influences mechanisms of deformation and recorded fracture attributes. Detailed digital mapping of fractures at multiple scales, stratigraphic levels and structural positions thus highlights complex and variable fracture patterns in 3D which do not wholly conform to existing models of fracture development. Based on this study, we suggest that future examination of the link between folding and fracturing should take into account scale variations, mechanical stratigraphy and changes in strain gradients.

References

Stearns, D.W., 1964. Macrofracture patterns on Teton anticline, northwest Montana. American Geophysical Union Transactions, 45, pp.107-108.