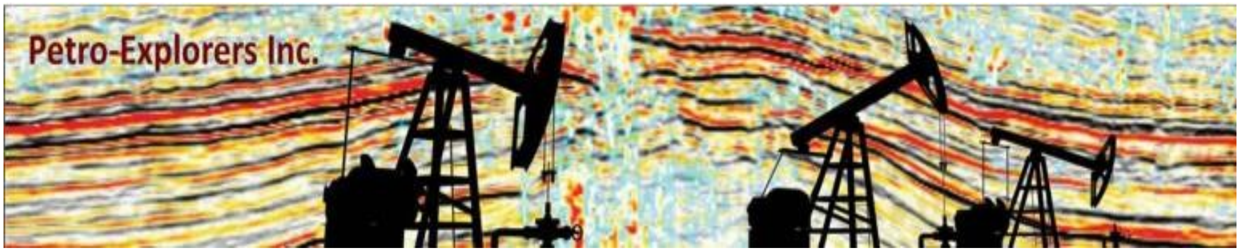


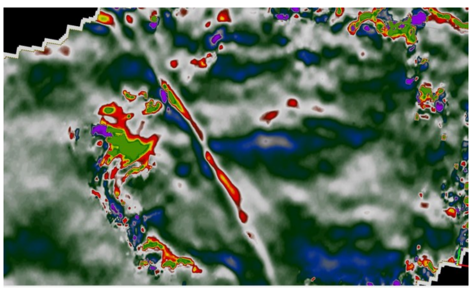
Post Stack Faults and Fracture Analyses

Post Stack Faults and Fracture Analyses are workflows to delineate structural and geotectonic framework of block or permit using available seismic data

Filtering input data is often a good start to optimize fault detection. The Dip-Steered Median Filter is edge-preserving noise reduction filter. It is applied along with pre-calculated dip-azimuth to the seismic data.

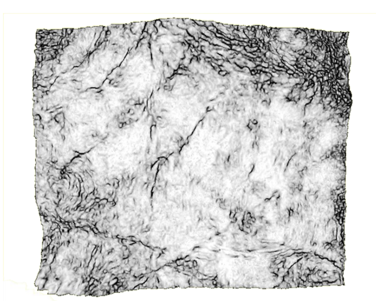
Dip Steering Attributes

Using Dip Steering algorithm, various dip and azimuth volumes are generated. Aperture of dip steering analysis and its direction brings up various hidden fractures to surface. Dip attribute (*below*) shows small scale structural variation.



Similarity

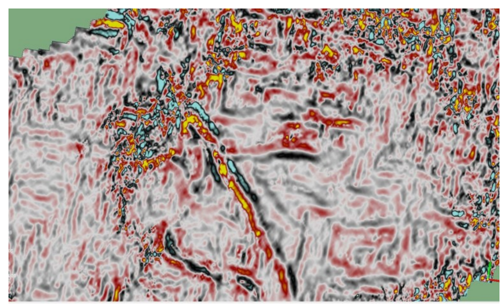
Similarity is a coherency-type attribute which is supported by OpendTect Base version. With dip-steering plugin installed the trace segments that go into the attribute calculation process can be extracted along the same seismic event, which improves the accuracy of dipping environments. Similarity is an ideal attribute for fast delineation of large-scale faults.

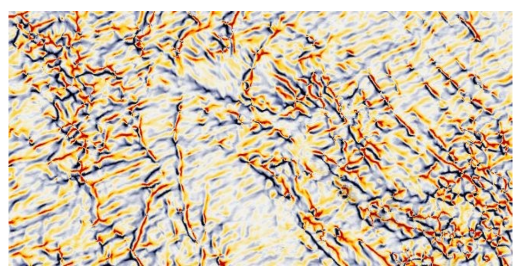


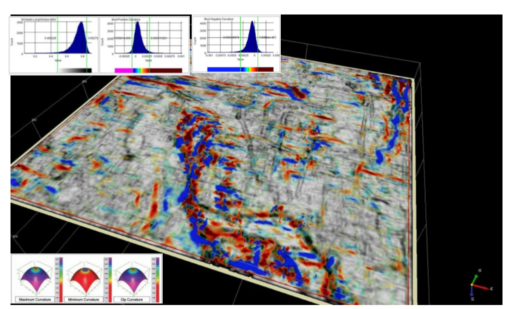
Similarity uses structural oriented dip-steering algorithm to allow improved similarity volumes.

Volume Curvature Analysis

For more detailed fault and fracture detection we often apply various curvature attributes, such as most positive and most negative, mean curvature, and max and min curvature, contour etc.). These attributes are various measures of curvedness of mapped surface. To calculate curvature at every sample position we automatically construct a local virtual horizon at each evaluation point from pre-calculated local dip- azimuth information (the steering cube). See below example of *most positive curvature and contour curvature*.







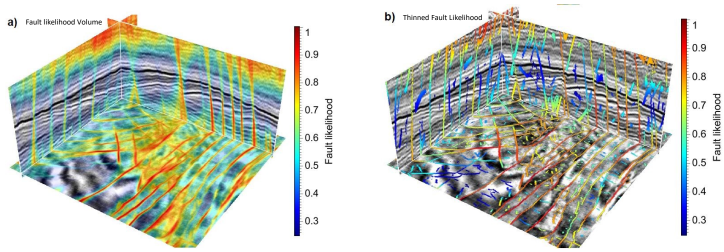
Co-visualization of multiple curvature attributes allows better definition of production zones within carbonates/ tight sands/shale.

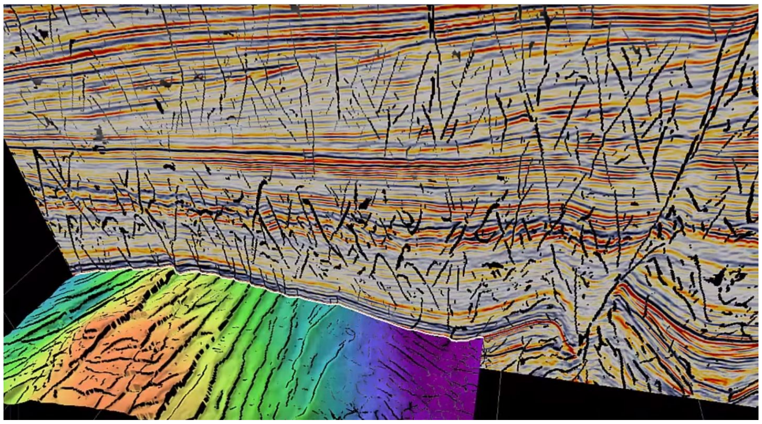
POST-STACK FAULTS AND FRACTURE ANALYSES

Thinned Fault Likelihood

Thinned Fault Likelihood is revolutionary new algorithm originating from Colorado School of Mines in 2014. This algorithm produces superior fault imaging and filtering results. In addition it allows automatically extract fault planes, to un-fault data and to compute fracture-specific attributes such as fracture density and fracture proximity.

Thinned Fault Likelihood attribute provides razor-sharp fault images on horizontal slices as well as on vertical sections (*below*). This attribute (and/or volume curvature type of attributes) can be used as a feeder to calculate fracture density and fracture proximity.





Thinned Fault Likelihood (TFL) algorithm also comes with a new, edge-preserving smoothing filter. This smoothing algorithm uses TFL attribute as input to generate seismic volumes with razor-sharp edges that are very well suited for structural interpretation.

References

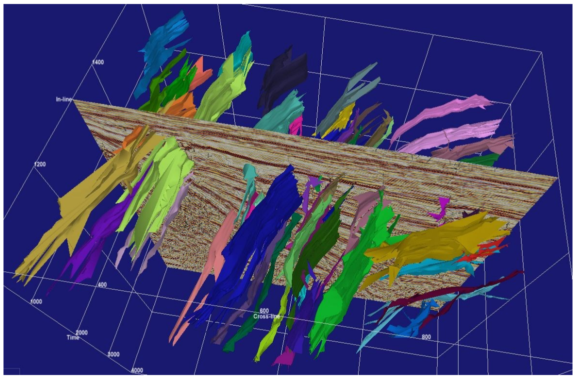
Hale, D., 2009, Structure-oriented smoothing and semblance: CWP Report 635.

Hale, D., 2013a, Dynamic warping of seismic images: Geophysics, 78, S105-S115.

Hale, D., 2013b, Methods to compute fault images, extract fault surfaces, and estimate fault throws from 3D seismic images: Geophysics, 78, O33-O43.

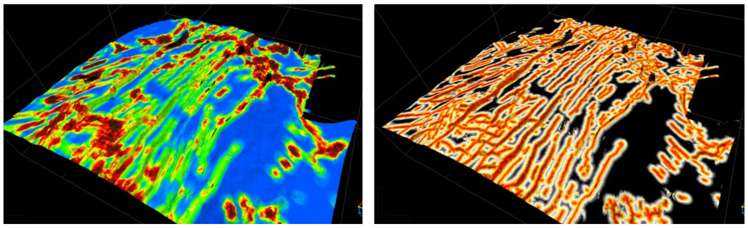
Wu, X., S. Luo, and D. Hale, 2015, Moving faults while unfaulting 3D seismic images: CWP Report 839.

Automatic Fault Detection



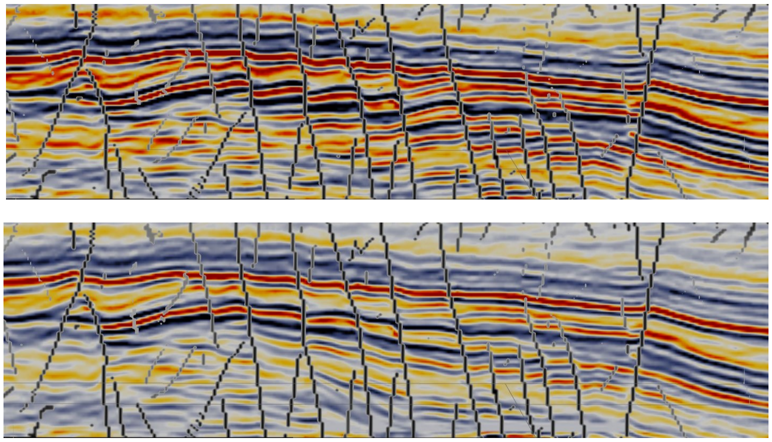
Using the newest algorithm of fault extraction we can automatically covert Thinned Fault Volume into picked faults.

Fracture Density and Proximity



Fracture density (right) and fracture proximity (left) attributes computes from Thinned Fault Likelihood (TFL).

Unfaulting



By using unfaulting feature we can unravel real stratigraphy masked by a complex array of faults.

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