Structural Interpretation

A Borehole Image (BHI) interpretation with special focus on detailed structural analysis provides a comprehensive understanding of brittle and ductile deformation in the vicinity of the wellbore.

Especially in complex geological environments, the profound understanding of structural features is indispensable for successful hydrocarbon exploration and development.

The following are a few examples of activities which can benefit from the outcome of this highly sophisticated analysis:

- New drill trajectory planning
- Well completion
- Well stimulation
- DFN modeling
- Production optimization

Standard deliverables from a structural analysis include:

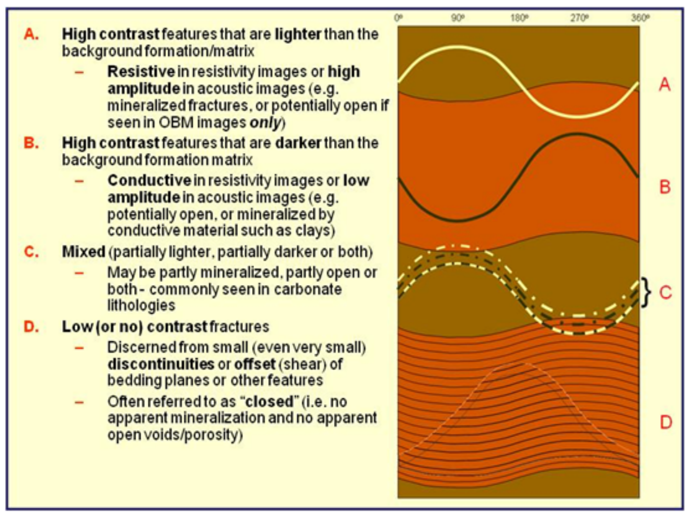
- High resolution, hand classified dip picking of bedding, fractures and faults
- Definition of the structural dip for sequence bounded stratigraphic units and distinct structural domains
- Identification of present day stress field from the orientation of borehole breakout and drilling induced fractures
- Unique classification of fractures and interpretation of fracture attitude
- Analysis of fault/fracture, fracture/fracture and fracture/bedding relationships
- Image fracture facies analysis
- Fracture frequency distribution analysis
- Borehole corrected fracture density (P32)
- Detailed report which document the study outcome and incorporate the results in the regional geologic context

Fracture Classification

All fractures will be interactively hand-picked - no automatic dip processing will be applied. In the process the true dip angle and strike will be calculated (corrected for the wellbore deviation). Task Fronterra Geosciences' in-house fracture classification scheme is fully descriptive based on image log response of fractures compared to the surrounding background formation or matrix (see figure below).

In addition, fracture-fracture, fracture-bedding and fracture-matrix interactions are carefully recorded and reported. Truncation hierarchy and cross-cutting relationships provide an excellent insight in the relative timing of different deformation phases and fracture length controlling attributes.

The fracture's property is interpreted after picking. Additional information from various sources (mud logs, cores, production data etc.) are integrated to get the best possible result.



Task Fronterra fracture classification scheme (Patent Issued)

Image Fracture Facies

The structural interpretation of the image log data is assisted by a discrete fracture facies scheme (see table on following page). It provides a qualitative estimate of tectonic deformation in addition to conventional tadpole plots and fracture density curves. In heavily fractured and/or brecciated intervals, single fractures become difficult to resolve and the resulting fracture density might not be fully representative. However, these heavily deformed zones can be accentuated with an image fracture facies.

High and moderate bedding quality is marked by green color codes, while highly fractured or brecciated sections are marked by red color codes.
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Facies Symbol	***Description***
	Well Developed Bedding Very Low Fracture Density
	Moderately Bedded Rock, Low to Moderate Fracture Density
	Massive or Homogeneous Poorly Fractured and Tight
	Disrupted Bedding by Frequent Fracturing; Increased Fracture
	Brecciated Rock, No Recognizable Bedding; Limited Recognition of
	Instrument stick and pull Bad Image Quality

Image Fracture Facies Scheme used to support the fracture distribution analysis

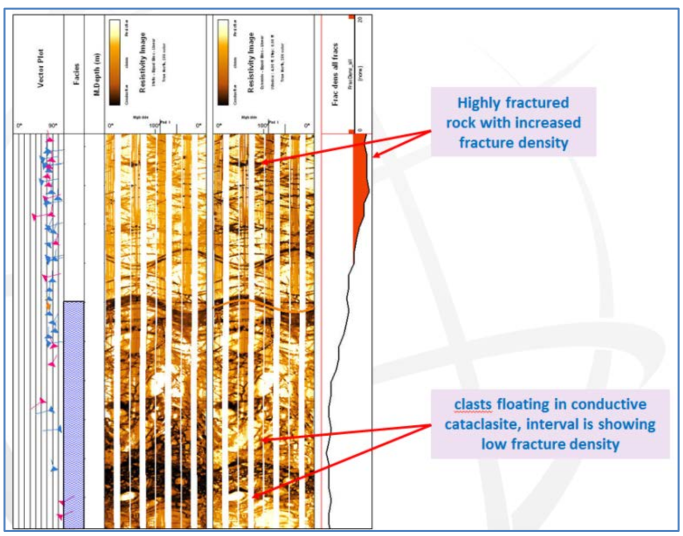
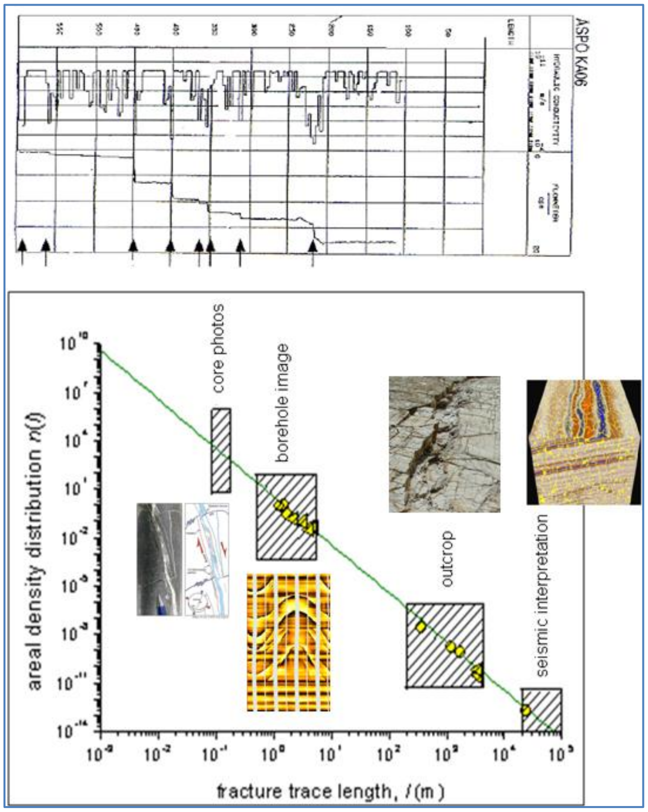


Image fracture facies supporting fracture density measurements and interpretation

Integrated Fracture Characterization

Task Fronterra considers all available data (e.g. seismic lines/cubes, outcrop studies, BHI, core, openhole logs, geomechanical analysis, production logs and well tests) for a comprehensive fracture characterization. The following aspects will be analyzed to resolve the fractures' relationships with special focus on the dynamic performance:

- Cumulative Fracture Intensity analysis to discover the domains for each fracture set. Multivariable regression is used to identify fracture density drivers (e.g. seismic attributes, facies model, matrix properties, in-situ stress field, stress/strain attributes and mechanical properties) which might allow to extend the Discrete Fracture Network (DFN) away from the borehole;
- Comparison of fracture intensity, orientation and size distribution between BHI, core, outcrop and seismic (faults). The description and interpretation of different input data need to be consistent and scale effects calibrated;
- Production logs are useful input data to validate the elaborated fracture network. In addition, pressure tests and production logs may complement the dynamic validation for areas away from the wellbore;
- The detection of faults and highly deformed rocks is of particular interest for the estimate of reservoir capacity, fluid flow behavior and planning of wellbore completions. Fault cataclasites and fault zones can considerably contribute to the total porosity/permeability of the reservoir rock;
- Elaboration of spatial distribution of highly fractured zones and brecciated intervals by direct (interactive fracture identification) and indirect (qualitative fracture image facies) methods;
- Identification of fracture swarms (interval with increased fracture density) and fracture clusters (interval with elevated fracture density and predominant strike seen). The specified zones indicate the presence of possible faults in seismic and/or sub-seismic scale.



A multi-scale fracture characterization is validated with production logs

Since the correct classification of different dip types is critical for the outcome of a structural borehole image log analysis and a subsequent static and dynamic reservoir model, dip calculation and classification is always done by an experienced structural geologist with a minimum of a Master degree in subjects associated to the topic under study.

The Task Fronterra Difference

- The unique Task Fronterra fracture classification scheme is applied to determine the fractures according to their appearance in the image and to provide an unbiased identification of the features;
- All features are manually picked by an experienced structural geologist with a minimum of a Master degree in subjects associated to the topic under study. No auto-picking system is applied;
- The Image Fracture Facies assists in the structural interpretation of the image log data as it provides a qualitative measurement of the fracture intensity including intervals where the conventional fracture classification could not resolve the single fractures anymore;

Task Fronterra considers all available data (e.g. seismic lines/cubes, outcrop studies, BHI, core, openhole logs, geomechanical analysis, production logs and well tests) for a comprehensive fracture characterization.

Task Fronterra Geoscience is a global independent provider of industry leading, integrated geoscience solutions, from single well analysis to complete reservoir studies.