

Integrated Wellbore Stability

A Paradigm Geoscience Data Service

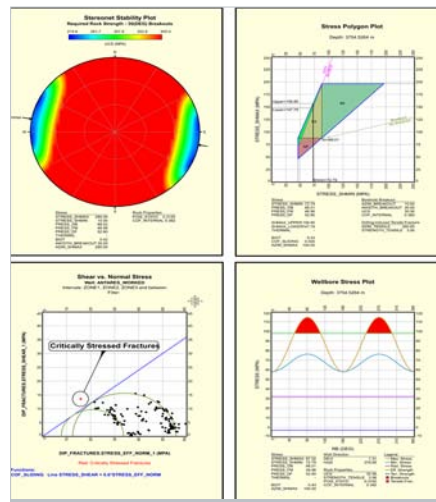
The proper assessment of wellbore stability draws on shared expertise across multiple geoscience and geological engineering disciplines. It requires an integrated approach in which team members collaborate towards completing a well, in what may be abnormal drilling conditions. The Paradigm Integrated Wellbore Stability workflow consists of a series of operations for the prediction of geopressures, stress regimes, and safe mud weights. One of the most important challenges is to perform these operations seamlessly, leading to results with the lowest possible uncertainty and attendant risk. Another challenge is to properly assess wellbore stability with only limited information.

The Paradigm Integrated Wellbore Stability workflow begins with an initial petrophysical analysis to identify minerals and fluid volumes, including fluid types and rock permeability. This is followed by an analysis of geopressures that may include shaly bed analysis, and results in a series of overburden, fracture, hydrostatic and formation pressures. Borehole images are analyzed to determine bed dip/azimuth and orientation of visible fractures, and sonic waveforms are processed for fast/slow waveforms and levels of anisotropy.

Engineering methods in Geomechanics are used to calculate isotropic/anisotropic elastic properties, rock strength, minimum and maximum stresses, safe mud weight window, and measures of wellbore stability, including critically stressed fractures. Electrofacies classification using Geolog[®] Facimage is based on criteria for rock strength and the potential for rock failure. Predictions in planned wells are performed using Geolog Geosteer[®], which incorporates a 3D geologic model for selected surfaces. This workflow uses available information, including but not limited to, interval velocities from seismic, well formation testing, drilling information for leak-off tests and mud weights. The workflow implicitly relies on the integration and support of available core analysis and drilling reports for validation at every step.

Paradigm Integrated Wellbore Stability Solutions

- An innovative and comprehensive approach to the assessment of wellbore stability using core photos, NMR, image logs, interval



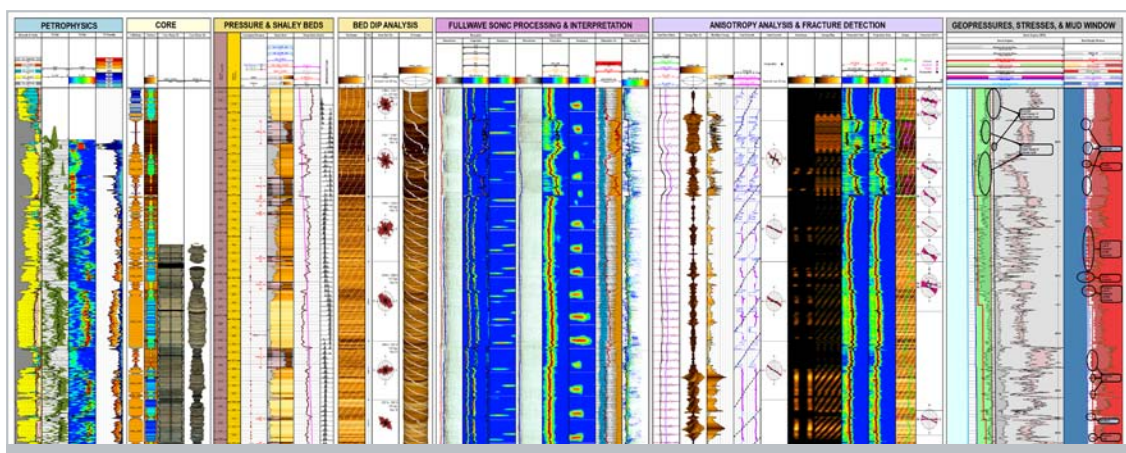
▲ Selected wellbore stability crossplots

velocity from seismic, sonic waveform, and isotropic/anisotropic rock elastic properties in the Geolog[®] Formation Evaluation system.

- Facimage to create lithofacies rock classifications based on potential wellbore failures.
- Geosteer with a 3D geologic surface model for accurate predictions in planned wells depicting variable depositional environments.

Advantages of Paradigm Integrated Wellbore Stability Services

The Paradigm Geoscience Data Services team delivers a comprehensive analysis at the wellbore that is immediately integrated into seismic and 3D reservoir models. This adds extra dimensions that reduce pore pressure uncertainty in planned wells, and allows targeting the most productive reservoirs.



▲ Wellbore stability workflow log plot