Drilling integrity services

Geomechanical analysis that reduces nonproductive time and increases drilling efficiency

Applications

Drilling challenges require measurements coupled with predictive, geomechanical modeling to address operational issues such as wellbore instability, stuck pipe, and drilling losses. These issues cause nonproductive time (NPT), costing operators millions every year.

To fulfill energy demands, operators must undertake adverse drilling operations such as high-angle drainhole drilling to increase the reservoir contact drilling in HPHT environments. Wellbore stability profile changes a lot with the deviation and azimuth. Drilling in overpressure intervals increases the risk of catastrophic events like blowouts.

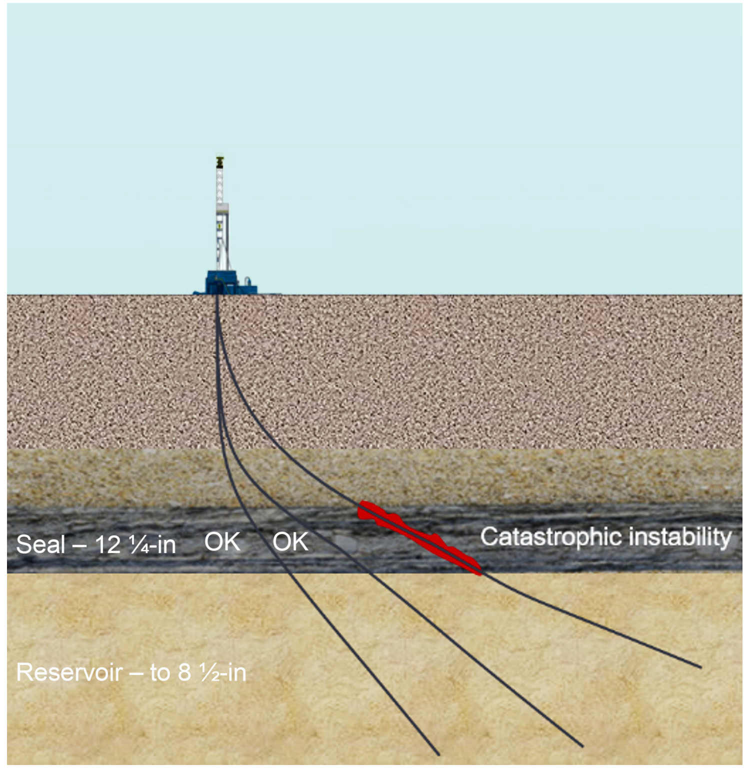
Drilling challenges include

- wellbore instability that causes NPT
- casing point decisions with optimized mud weight for minimizing drilling losses
- safer drilling in high-risk HPHT environments
- wellbore stability event mitigation for trajectory design
- drilling parameters with changing deviation and azimuth and for layered shales with bedding plane failure
- fluid sensitivity to shales.

A geomechanical analysis that incorporates drill planning offers an established alternative to identify and mitigate potential drilling hazards. As a result, a geomechanical analysis minimizes NPT.

How it improves performance

- Interacts with leftover mud in channels to reduce fluid mobility and limit channel permeability
- Saves time and reduces cost with optimized drilling parameters
- Increases efficiency for directional drilling by optimizing safer trajectories across different tectonic stress regimes
- Optimizes mud chemistry for interactions with shale for stability
- Predicts optimal mud weight for weak layered shales that have bedding plane failure
- Minimizes losses for depleted reservoirs
- Improves readout port when rock strength and stress information are used as input for bit selection
- Mitigates geological risks through predictive geomechanical models calibrated with offset drilling events
- Constructs a calibrated geomechanical earth model
- Provides detailed wellbore stability analysis
- Produces a trajectory sensitivity analysis



Wellbore stability showing varying drilling trajectories.

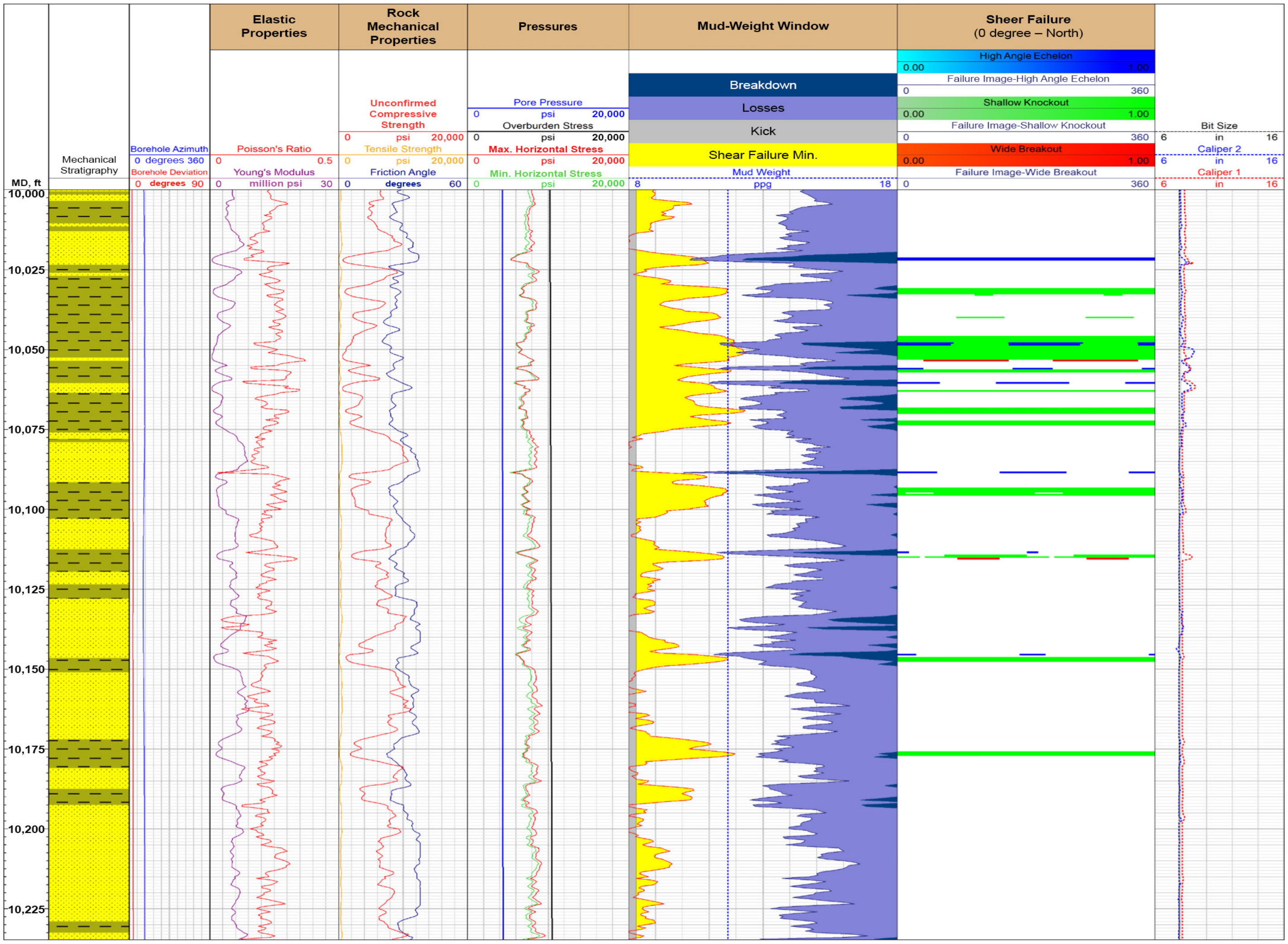
How it works

Geomechanical analysis incorporates the processing results of borehole images, acoustics data, and pressure tests. A 1D mechanical earth model is constructed to determine different rock mechanical strength properties, (anisotropic) elastic properties, and in situ stresses. The estimated stress is further calibrated using either stress testing or inverted stress magnitudes from radial profiles.

Wellbore stability analysis is done using the calibrated mechanical earth model. As drilling starts on the planned well, new data and calibration information can be acquired that further improves the original prediction and reduces model uncertainty. The ability to estimate accurate pore pressure and fracture gradient is critical. Safer drilling mud-weight window and casing placement depths are predicted along with a synthetic borehole failure image. Conducting a trajectory sensitivity analysis with model inputs ensures a safer trajectory for successful directional drilling.

Additionally, drilling fluid optimization is conducted to evaluate the potential time-dependent shale chemical stability and wellbore stability mechanisms. Mineralogical composition, pore size distribution, porosity, and pore water composition of shales are investigated in detail along with drilling reports that provide important behavioral shale characteristics. This information enables the insight and mitigation of potential drilling problems.

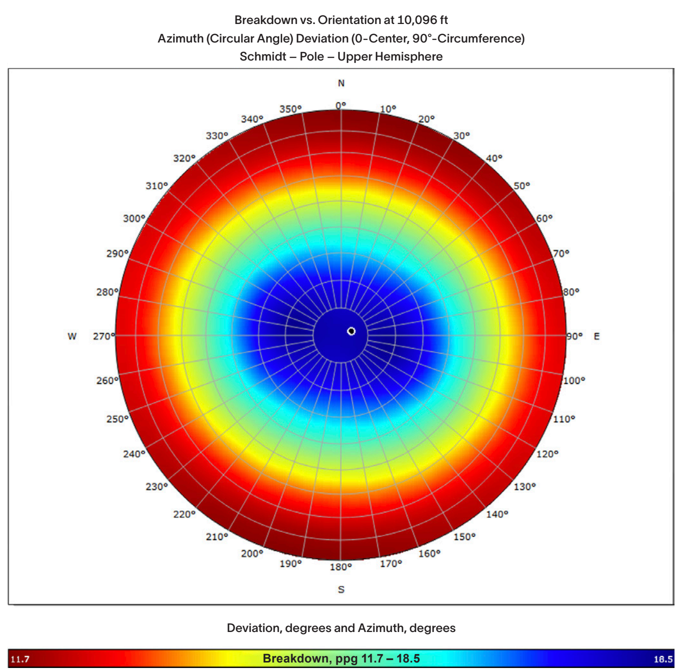
Drilling integrity services



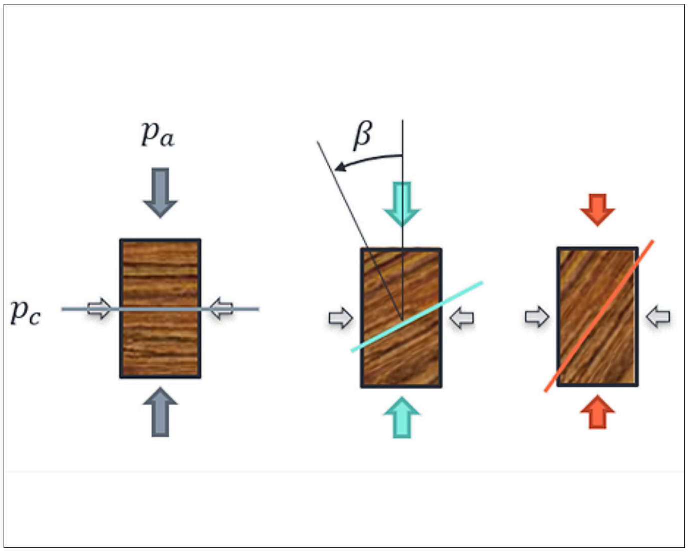
Mechanical earth model showing wellbore stability analysis for single trajectory.

Inputs

- → Conventional openhole logs (gamma ray, density, and porosity)
- → Lithology analysis results
- → Acoustics anisotropy, radial profiling results, and transverse isotropy properties
- → Wellbore images for failure analysis
- → Well mechanical diagram and trajectory
- → Mud-weight profiles and mud logging reports
- → Stratigraphic column and formation tops
- → Rock strength and elastic properties (unconfined compressive strength, Young's modus of elasticity, and Poisson's ratio) laboratory core test results
- → Shale-fluid interactions in laboratory core test results
- → Well test and pressure buildup interpretations
- → Daily drilling reports
- → Structural maps



Breakout mud weight vs. orientation.



Plane of weakness failure analysis with rock strength measurements at various angles to the bedding planes.

Takeaways

- Calibrated geomechanical earth model consisting of rock mechanical strength and anisotropic elastic properties
- Present data stress states: magnitude and orientation with continuous formation pressure
- Available data integration from cores, caliper, acoustics, petrophysics, wellbore images, pressure, and stress testing
- Stable mud-weight window with mud-weight and casing policy recommendations
- Wellbore pressure profile limits for kick, breakouts and collapse, losses, and breakdown
- Trajectory sensitivity plots at each formation
- Postwellbore stability review of drilling events
- Plane of weakness failure analysis
- DrillMAP™ drilling engineering and operations plan plot for the planned well

Learn more

Kumar, R., et al.: "Wellbore Stability and Hole Cleaning Management for Successful Well Design Optimization in Deep Tight Gas Fields," SPE/IADC Middle East Drilling Technology Conference and Exhibition, Abu Dhabi, UAE (January 2018) SPE-189357-MS https://doi.org/10.2118/189357-MS

Roy, S., et al.: "Integrating Wireline Measurements to Provide Geomechanical Solutions: A Case Study for Optimizing Drilling by Improving Wellbore Stability in a Complex and Tectonically Active Region," IPTC, Bangkok, Thailand (November 2016) IPTC-18908-MS https://doi.org/10.2118/202933-MS

Xi, G., et al.: "Geomechanics Characterization of Nahr Umr and Laffan Shales through Anisotropic Geomechanics and Shale Stability Analysis for Drilling Optimization," ADIPEC, Abu Dhabi, UAE (November 2020) SPE-202933-MS https://doi.org/10.2118/202933-MS

slb.com/SonicScanner