While every drilling team faces unique challenges specifically related to their offshore or onshore environment, the constant challenges that all operators must overcome include delivering safe, compliant and efficient drilling programs that maximize drilling performance, keep non-productive time at a minimum, and optimize wellbore contact with the reservoir. Landmark’s leading-edge Drillworks® geomechanics software provides operations personnel with unmatched tools for subsurface pressure analysis, monitoring, and review for optimal refinement of fluid, casing and fracture design. No matter what environment the drilling challenge is in, Drillworks software enables engineers and geoscientists with essential tools to improve drilling efficiency, completions design and operational safety.

**Benefits**

- Helps improve human and environmental safety by analyzing subsurface pressure prior to and during drilling operations to help prevent blowouts, wellbore collapse, and fluid imbalances.
- Delivers real-time analysis while drilling, which can prevent costly non-productive time from wellbore pressure problems by enabling immediate changes to fluid and casing programs.
• Improves fracturing effectiveness in unconventional assets by analyzing rock stresses to orient well plans in the optimal direction across the entire field.

• Model and update subsurface pressures while drilling to improve drilling performance and safety by adjusting casing and fluid plans in real time.

FEATURES

Pore Pressure Analysis

Pre-drill Analysis
Drillworks software helps users model the subsurface environment to reduce drilling uncertainty and optimize wellbore design. Greater accuracy in casing and fluid system design improves wellbore feasibility and cost forecasting as well as safety and performance.

The industry’s most dependable prediction of pore pressures is calculated using an operator-endorsed process established by the Drilling Engineering Association’s Joint Industry Project DEA 119. This process is supported by specialized features that use industry-standard or user-defined methods to calculate:

• Overburden stress from seismic velocity, density or sonic data
• Effective stress from resistivity logs, sonic logs and seismic velocity
• Pore pressure from effective stress

Real-time Analysis
Real-time analysis using Measurement While Drilling (MWD)/ Logging While Drilling (LWD) data acquired via WITS or WITSML standards allows foot-by-foot computations of wellbore stresses and collapse strengths. These computations are developed in concert with specialty software available within the Drillworks software suite, as well as third-party data.

The WITSML data standard eliminates dependency on proprietary data protocols, allowing Drillworks software users to work with any combination of well data (including MWD/LWD, and drilling data) from any WITSML-compliant service company.

Post-drill Analysis
Drillworks software is a robust tool for post-drill analysis that improves future drilling performance. Well data from a wide range of sources is easily accessed and displayed in customizable views. Engineers and geoscientists can perform and compare analyses using the latest industry methods as well as proprietary, user-defined methods and programs.
**Basin/Regional Dynamic Pore Pressure Model Building**

![Image of pore pressure model](image)

*Identify abnormal pressures before commencing exploratory drilling in complex environments using Drillworks software’s basin-scale analysis tools.*

**Exploration Workflows**

Drillworks software enables operators to leverage the investment in oil and gas fields by building integrated pore pressure models of targeted assets that can be used for exploration, well planning and real-time analysis.

Easily model complex pressure compartments and look for traps during exploration with Drillworks software. Also, with Drillworks software, operators can visualize pressures in the region and analyze prospect locations. This includes performing a fast, independent analysis to determine seal integrity and potential hydrocarbon accumulations.

**Multi-well Planning and Drilling**

Drillworks advanced modeling software is designed specifically for multi-well pore pressure analysis, enabling more accurate calculations and pore pressure predictions, especially in regions where standard compaction approaches do not work.

Users will be able to improve and refine conventional log- and seismic-based analysis by incorporating stratigraphy, geology, geophysics and permeability analysis. The software also supports advanced geopressure mechanisms beyond undercompaction, including hydrocarbon generation and thermal expansion. New technology enables subsalt geopressure analysis to improve the accuracy of pore pressure prediction in challenging wells drilled near and below salt structures.

Operators can predict geologic pressures at the basin scale and look ahead of the bit using Drillworks software.
Using Drillworks software, data collected and analyzed from each drilling well contributes to model refinements that increase accuracy and drilling performance of actively drilling and future planned wells. The model is easily calibrated and used to predict pore pressures at new locations. On-screen graphics promote intuitive visualization and understanding of conditions and trends.

**Real-time Analysis**

During drilling operations, Drillworks software quickly and easily updates the model to provide a powerful ability to predict pore pressure ahead of the bit. Studies have consistently shown that real-time updates of the model yield pore pressure forecasts within 0.5 pounds per gallon up to 1,000 feet ahead of the bit. As a result, decision makers have the time and the information to make better-informed choices.

Models are easily updated in real time from LWD and surface logging data transmitted via the WITS or WITSML industry standards used by major service companies. Real-time updating is done at the wellsite or remotely using Internet protocols.

**Visualization**

**3D Visualization and Analysis**

Drillworks software provides a dynamic three-dimensional visualization and analysis tool, which is designed to help geoscientists and engineers fully utilize geopressure data for improved pore pressure analysis and wellbore planning. The Drillworks 3D visualization tool, gives users the ability to easily view well paths, as well as cubes, sections and surfaces of any geopressure related data including pore pressure, fracture strength, effective stress and seal capacity. The user is able to apply pore pressure prediction analysis to 3D volume data and make extractions from their volume at proposed target locations for detailed analysis and geopressure predictions.
Data Browser with Customizable Views and Mapping

Drillworks software includes a comprehensive browser and visualizer designed to help users quickly and easily find, select and manage geopressure-related data and create Drillworks projects.

The application allows querying to find, select and use data in the Drillworks family of applications. Information stored in local Pressbase™ or corporate Pressworks™ databases can be browsed through the Drillworks software map or Windows® Explorer-type interfaces. Using the Advanced Well Selection query interface, users can search for raw data and analyze wells by location and/or user-defined parameters (text based or value based). Users can also perform high-level or complex queries to find wells/well attributes, wellbores, datasets, Leak-off Tests (LOTs), wellbore stability analyses, marker and other information.

Geostress & Wellbore Stability

Geostress

With Drillworks software, users can quickly identify wellbore stability problems prior to drilling and perform real-time wellbore stability analysis while drilling. Geostress capabilities help operators maintain borehole integrity to prevent more issues during drilling, logging and casing. Many stability-related problems and sources of non-productive time (NPT) can be avoided or reduced, including:

- Tight holes
- Excessive reaming and caving
- Pack-offs
- Casing-setting problems
- Stuck pipe
- Lost circulation
- Sidetracks
- Wellbore collapse

The calculation of stress conditions allows fine-tuning of mud weights and casing depths—even for the most complex deviated well. The optimal mud weight window is easily viewed with a special graphical interface.
stress Polygon analysis

Drillworks software contains the Stress Polygon Analysis Component to easily calculate and visualize the stress polygon, a plot of the maximum horizontal stress versus the minimum horizontal stress at a single depth. This can be used to constrain the magnitude of the maximum horizontal stress based on friction faulting theory.

breakout analysis

Driven from caliper logs, Drillworks software can aid in determining the operational window and indicate horizontal stress orientation.

Subsurface Geoscience Integrated Workflows

Seismic Velocities

Drillworks software allows the user to quickly and easily correct seismic bias of interval velocity performed by 2D or 3D seismic processing for improved geopressure analysis.

Seismic data features include:

• Automated and manual velocity picking
• Ability to adjust seismic velocities for time lag including seismic time origin and offset bias
• Ability to correct seismic velocities for heterogeneity including the DIX approximation
• Apply anisotropy correction to prepare seismic velocity data for geopressure analysis
• Compare results before and after corrections are applied
• Predict depths

Borehole Image Integration from OpenWorks® Database

Borehole images can be imported from Landmark’s OpenWorks® database to support wellbore breakout identification, as well as support calibration during wellbore stability analysis.
**Uncertainty Analysis**

The Drillworks Uncertainty Analysis feature enables operators to perform uncertainty analysis on geopressure predictions and wellbore stability calculations. Users can discover the sources of uncertainty, minimize them and improve accuracy. An understanding of uncertainty facilitates improved decision making in pre-drill studies and real-time pore pressure estimation.

With the Drillworks Uncertainty Analysis feature, users can:

- Perform uncertainty analysis for pore pressure predictions.
- Perform uncertainty analysis to understand the uncertainty in wellbore stability calculations.
- See a range of expected pressures/gradients for the given data including P10, P50, and P90 results.
- Run simulations to vary one or multiple input datasets such as normal compaction trends, overburden gradient and more.
- Use a variety of built in probability distributions for simulations.
- Discover the sources of the uncertainty and minimize them.
- Enhance decision making for critical well planning, mud and casing programs.

**Top Seal Integrity & Compartment Pressure Analysis for Exploration, Drilling & Production Mud Weight and Casing Design**

**Exploration & Drilling Top Seal Workflows**

The Drillworks software provides exploration and drilling teams the ability to analyze target locations, test for commercial accumulations of hydrocarbons and improve exploration and well construction success.

During exploration, the possibility of a top-seal breach can be assessed using seismic and geologic information.

In the drilling phase, mud weights and casing points are more precisely planned and safety is improved by a better understanding of sealing mechanisms and attendant pore pressures.

**Evaluating Seal Integrity of Sands and Shales**

Drillworks software estimates minimum stress and compartment fluid pressure to determine the sealing structure’s pressure capacity. The resulting calculation is used to assess whether the top seal has the strength to contain the pressure compartment, or may have breached and allowed the hydrocarbons to escape.

To evaluate seal integrity, a centroid location is established as the reference point for pore pressure calculations. This point assumes that pore pressures in sands and shales are equal because only the clay pressures can be calculated prior to drilling.
Because pore pressures in sands and shales can be very different, careful establishment of centroid points provides critical knowledge for anticipating and reducing kicks and lost circulation. This knowledge can help engineers locate a well such that it can be effectively and economically drilled and optimally produced.

**Leak-Off Test Analysis**

Drillworks software ensures that valuable leak-off test data is included in the pore pressure and geomechanics workflow. The application offers full pressure/volume/time plots from a leak-off test to be solved for minimum stress and applied to pore pressure and wellbore stability models. An intuitive graphical interface ensures fast, easy analysis.

**Scalable Data Management Enterprise/Local**

**Local Database**

Drillworks software uses a personal Pressbase relational database that empowers users to store and manage their Drillworks projects and geopressure-related data. Individual Drillworks software databases can integrate with a corporate Pressworks database to provide operators a central geopressure data store for team collaboration and data management that can help improve future exploration and drilling operations.

**Enterprise Relational Database**

A Pressworks database can additionally be deployed as an enterprise, corporate-wide database, so organizations can comprehensively store, manage and share a broad range of geopressure data, including all relevant well logs, geopressure data and project analysis from pore pressure and geomechanics project files.

**Tight Integration with Petrotechnical EDM™ and OpenWorks® Datastores**

Retrieve well data from the EDM™ database to source trajectory and casing data. Conversely, users can populate the EDM database with pore pressure and fracture gradient information for optimal casing and mud weight design.

Direct well data access from the OpenWorks data model, including well log and well header information. For mapping workflows, Drillworks software pushes pore pressure and fracture gradient data to OpenWorks database to reduce the time spent transmitting critical data and results between systems.