Accurate Pore Pressure Prediction in HPHT Well Reduces Risk, Saves Rig Time

Predrill 3D pore pressure analysis helps Gulf of Mexico operator avoid costly NPT

**CHALLENGE**
Drill 20,500-ft [6,250-m] well in an HPHT environment, preventing lost-time incidents.

**SOLUTION**
Create pore pressure and wellbore stability models and perform dipping-sand pressure analysis to pinpoint cause of drilling problems and find a safer mud weight window.

**RESULTS**
Drilled well with no NPT; eliminated cost overruns caused by NPT incidents.

**Drilling risk in a high-cost environment**
As oil and gas exploration moves to HPHT environments, it is a challenge to drill wells without the risk of NPT caused by unplanned events. The cost of these NPT incidents has been further increased by higher rig-day rates. For a GOM operator, offset wells near its exploration well had experienced up to 10 days of NPT from stuck pipe, kicks, lost returns, and the need to sidetrack, and current rig rates approaching USD 100,000 per day could cause cost overruns from hundreds of thousands to millions of dollars.

There were three main drilling challenges. It was important to find the optimal depth for the 13\(\frac{5}{8}\)-in casing; drilling into the anticipated overpressured zone without experiencing losses and wellbore instability problems would be difficult if the casing was set too shallow.

Optimizing the mud weight program and planned equivalent circulating density (ECD) was important to minimize wellbore instability in the 9\(\frac{5}{8}\)-in and 8\(\frac{1}{2}\)-in hole sections, which had a narrow ~1.0 lbm/gal safe mud weight window. Finally, insufficient offset data were available to calibrate the predrill model in the 8\(\frac{1}{2}\)-in hole section, where temperature exceeded 300 degF [149 degC] and pressure reached approximately 18,500 psi [128 MPa].

To mitigate these risks, the operator worked with the Schlumberger petrotechnical services for geomechanics team to provide a prejob plan and real-time updates during drilling operations.
CASE STUDY: Predrill 3D pore pressure analysis eliminates costly NPT, Gulf of Mexico

### Predrill modeling to real-time monitoring and updating

During the planning stage, the geomechanics team used high-quality 3D prestack time migration seismic velocity to determine the pore pressure and fracture gradient in a 50-mi² area. A locally calibrated overburden stress field was derived from density logs, and a velocity-to-effective-stress transformation was established using detailed analysis of the offset well data. The team then performed a dipping-sand analysis to calculate pressures in three sands at the location of interest.

The team identified the root cause of drilling problems in the area and provided guidelines for the safer mud weight window using Schlumberger DrillMAP* drilling planning and management tool.

Schlumberger then acquired real-time measurements for advanced drilling optimization. The acquisition of new data enabled the PERFORM* performance through risk management process engineer to monitor the model on the rig in real time and the geomechanics engineers to make daily updates for an improved prediction ahead of the bit.

### Drilling success with no NPT

Using the results from the predrill model and the application of real-time monitoring and updating, the 13¾-in casing depth was successfully extended from 11,200 ft to 11,821 ft [3,414 m to 3,603 m], enabling the operator to eliminate the 10½-in × 12¼-in expandable liner in the lower part of the well. The mud weight and casing programs were optimized to avoid well-control and wellbore-instability issues, allowing successful drilling to a TD of 20,500 ft [6,248 m] with no NPT.

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