CHALLENGE
Improve drilling performance of deep vertical exploration wells in a complex lithological and high-pressure environment.

SOLUTION
- Use i-Power® integrated motor-bit modeling service to simulate power section performance in this highly abrasive environment, and use simulations to design and operate a custom mud motor.
- Drill using the DynaForce DTX® thin-wall motor to increase power output, control high-torque loads, maximize ROP, and reduce motor-stall risk for drilling efficiency.

RESULTS
- Accurately predicted motor performance.
- Increased the maximum operating differential pressure by 57%.
- Improved the ROP by 62%, as compared with offset wells.
- Reduced the drilling time for the entire 16-in section by 5 days.

Drill complex lithological environment while avoiding downhole tool failures
Kuwait Oil Company (KOC) was looking for a significant improvement in drilling performance of deep vertical exploration wells on the Shaham Field in Northern Kuwait. Earlier drilling campaigns were plagued with tough conditions given the complex lithology, causing low ROP and downhole tool failures. The Zubair Formation—starting at 10,365 ft [3,159 m] with an average thickness of 1,380 ft [420 m]—posed a significant challenge while drilling the 16-in section of the subject well, with high compressive strength and consisting of highly abrasive fine-grained sandstone interbedded with shale. The sharp contrast in lithology resulted in low penetration rates and produced high torque loads on the drillstring, which resulted in motor and bit failures in previous drilling campaigns.

Design a high-power motor that also controls torque output
Schlumberger used the i-Power modeling service to understand and predict the power output of different power section configurations and determine how those configurations operate in varying temperature and differential pressure. The findings provided by the i-Power service were used to design the DynaForce DTX motor.

Compared with conventional motors used in offset wells, the DynaForce DTX motor increased the ROP by at least 62%.

The DynaForce DTX motor saved a total of 5 drilling days, with 2 days saved in the Zubair Formation and 3 days saved in the carbonate formations.
The DynaForce DTX motor was used to drill the 16-in section of the well, starting in the sandstone Zubair Formation and proceeding through the Ratawi, Minagish, and Makul carbonate formations to reach 14,605-ft [4,456-m] TVD. The harsh drilling environment of the Zubair Formation required a higher-power motor and high differential pressure to avoid motor stalling and control high torque loads.

**Increased differential pressure and ROP for improved drilling performance**

Enabled by the i-Power service simulations, the DynaForce motor outperformed conventional motors. The i-Power service used the geometry of the power section profile; elastomer, dynamometer, and fatigue life testing; and downhole conditions to adjust drilling parameters to achieve the desired performance.

Compared with the previously drilled offset wells that used conventional motors, the thin-wall design of the DynaForce DTX motor generated a high power output—on average 20%–30% more than conventional motors—to consistently deliver optimal torque and fully engage the PDC bit through the highly interbedded and abrasive sandstone and carbonate strata.

The high power output enabled the DynaForce DTX motor to perform at higher differential pressures, sustaining 350 psi [2,413 kPa] on average and reaching up to 470 psi [3,241 kPa]—an increase in maximum differential pressure by 57%—and improving ROP by 62% as compared with the benchmark. Based on the i-Power service simulations, the expected run life of the power section at 350 psi of differential pressure was 135 drilling hours, which closely aligned with the 132.5 hours of the actual run. The combination of increased differential pressure and improved ROP resulted in reduced drilling time for the entire 16-in section from 14 days to 9 days, with 3 days saved in the carbonate formations (Ratawi, Minagish, and Makul combined) and two days saved in the Zubair Formation.

For more details, see SPE-188937-MS.