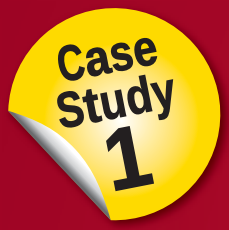
Directional Drilling

Provided by Halliburton



Operator's challenge

The operator of a North West Shelf oil field required a solution to reduce destructive vibration and improve rates of penetration (ROP) while drilling a troublesome hard limestone and chert formation.

Halliburton's solution

Sperry Drilling Services deployed the Geo-Pilot® GXT 9600 series rotary steerable system to deliver increased horsepower and revolutions per minute (RPM) directly to the bit for improved cutting efficiency in the challenging formation while reducing the occurrence of stick-slip.

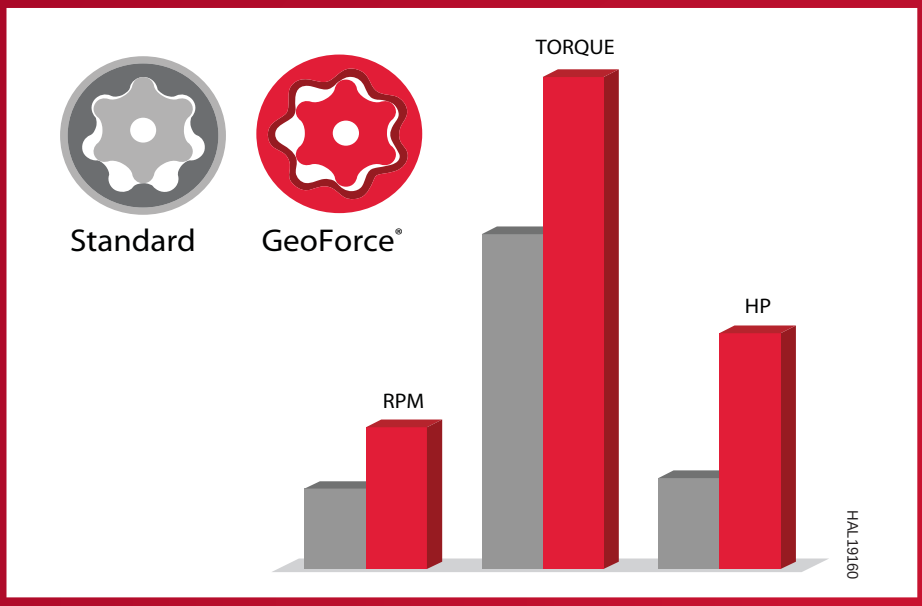
Economic value created

The Geo-Pilot GXT system improved ROP by approximately 30% over two previous 12¼" sections drilled in this formation. Drilling efficiency improved as vibration-related damage was reduced by minimising stick-slip and by decoupling the logging-while-drilling (LWD) tools from damaging shocks and torsional vibration.

Too many failures

The 12¼" hole sections of the appraisal wells had proven particularly challenging as the section drills through the hard limestones of the Walcott Formation. Previous wells had encountered low ROP, high stick-slip and multiple vibration-related LWD and rotary steerable system failures, resulting in high non-productive time (NPT).

The operator challenged Sperry to implement a solution that improved ROP while mitigating the destructive vibration mechanisms.



The GeoForce® power section in the Geo-Pilot® GXT system produces significantly higher speed, torque, and horsepower than conventional power sections for faster drilling and longer life.

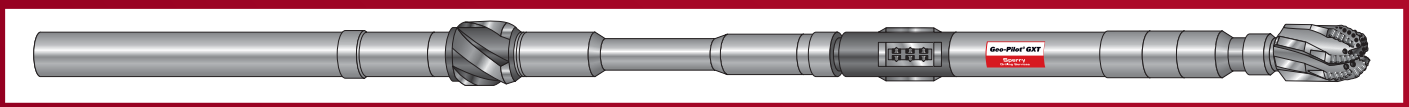
Taking drilling performance to the next level

The Geo-Pilot GXT system integrates a GeoForce® enhanced performance motor power section between the rotary steerable system and the LWD system. GeoForce motors have an optimised stator design that delivers more than double the power of a conventional motor with less vibration, resulting in faster ROP and increased reliability. The intense delivery of power directly to the bit dramatically reduces the occurrence of stick-slip and other types of undesirable bit dynamics. This power is combined with the high-precision steering and on-the-fly control of the proven Geo-Pilot point-the-bit rotary steerable system. The Geo-Pilot GXT system demonstrates the ability to achieve higher penetration rates while minimising casing wear by decoupling the bit speed from the drill string speed.

Two bit runs were planned for the section so the upper formations could be drilled with a less aggressive bit to minimise stick-slip, and the lower formations could use a more aggressive bit to increase ROP. As per the drilling program, the 12¼" section was kicked-off from vertical and built to 47° inclination in two bit runs, delivering faster ROP than offset wells. Max3Di™ drilling optimisation software was used to monitor the Geo-Pilot GXT motor's differential pressure and keep it within the optimum range. Max3Di software brings all of the critical information about the drilling process together in one user-friendly interface to help the directional driller make the right decisions, ensuring the highest ROP and longest downhole tool life. The result: increased drilling efficiency and reduced drilling costs.

Results

The Geo-Pilot GXT system delivered the section in only five days, with an improved ROP of approximately 30% over the two previous 12¼" sections drilled in the Walcott Formation. Increased RPM improved hole quality and decreased requirements for back-reaming, while vibration-related damage was reduced by minimising stick-slip and by decoupling the LWD tool from damaging shocks and torsional vibration. As the two previous sections in offset wells took 10 and 11 days respectively, due to low ROPs and trips for failure, the five-day run clearly demonstrates a significant performance improvement. ■



Case Studies

Operator's Challenge

Oil Search wanted increased rates of penetration to save time while drilling an unstable reservoir in Papua New Guinea.

Halliburton's solution

Sperry Drilling Services deployed the Geo-Pilot® 9600 series rotary steerable system and Geo-Pilot bit from Halliburton Drill Bits and Services, delivering a 1,000 m (3,281 f) 12¼" hole section with average ROP of 24.72 m (81 f) per hour, saving three days of rig time.

Wellbores at risk of collapse

Oil Search, the largest operator in Papua New Guinea, has long aspired to achieve a stretch goal of 25 m (82 f) per hour rate of penetration (ROP) on bottom while drilling the 12¼" sections of the Kutubu field. The formations, mainly shale and interbedded sands, are tectonically stressed, as the area is in an active geological province with a lot of thrust faulting. The borehole relieves the stresses in the formation and tends to collapse, either over time or more quickly if the restraining force of the mud is not high enough. Additionally, the shales react to the mud and again, over time, tend to weaken and collapse into the wellbore. Oil Search had come to recognise its goal of faster ROP to address the critical time issues it was facing would only be achieved by using a rotary steerable system.

Geo-Pilot® 9600 series rotary steerable system for increased ROP

Sperry Drilling Services deployed the Geo-Pilot 9600 series rotary steerable system with a Geo-Pilot bit from Drill Bits & Services and a measurement/logging-while-drilling (M/LWD) suite.

The Geo-Pilot system can be modified to help eliminate problems often associated with soft formation drilling, such as lower than expected build rates, stronger walk tendencies and excessive housing roll. Oil Search had utilised the modified soft formation Geo-Pilot system on two previous wells, which proved to be successful in the geologically unstable reservoir. The system has a set of specially designed extended reach anti-rotation pads, which completely eliminate excessive housing roll. It also uses stabilised lower housing that helps enhance build rates in soft formations.

A conventional rotary BHA was used to drill out the 13⅜" casing shoe and 21 m (69 f) of new formation before picking up the Geo-Pilot system. The Geo-Pilot system then drilled 270 m (886 f) below the shoe to the kick-off point, maintaining the existing hole inclination while walking the azimuth around to the kick-off direction. The angle was then built to 40.8° at a dogleg severity of 3°/30 m (98 f). This took approximately 400 m (1,312 f), with deflection averaging 70%. Inclination was then held at 41° using the 'cruise control' feature of the tool. After 890 m (2,920 f), the BHA was tripped to replace a pulser. The second BHA used the same Geo-Pilot tool and drilled a further 110 m (361 f) to section target depth of 2,237 m (7,339 f).

Control of the Geo-Pilot tool from the surface was achieved on-the-fly using the Geo-Span® downlink service. Negative pulse commands are sent via the Geo-Span service and confirmed within 90 s (on average) while on bottom drilling, and are simultaneous with LWD data transmission. The cruise control feature, three-dimensional software that allows the Geo-Pilot tool to automatically maintain the desired well trajectory and correct any walk tendencies or abrupt formation changes, was used extensively to maintain the desired hole inclination and azimuth.

Results

The Geo-Pilot system delivered the 1,000 m (3,281 f) section with an average ROP of 24.72 m (81 f) per hour, beating the planned ROP of 15 m (49 f) per hour. In addition, superior hole quality helped save even more time, allowing the 9⅝" casing to be run in only 17¾ hours, a significant reduction from the drilling program's planned 33 hours.

Although fractionally short of its ROP goal, Oil Search was extremely pleased with the result and time saved. By delivering optimised borehole quality and increased ROP, the soft formation Geo-Pilot system helped Oil Search reduce rig time by three days. ■