Originally appeared in World Oil® MARCH 2021 issue. Posted with permission.

Solid-state GWD system provides step-change in wellbore placement accuracy, collision risk mitigation

A first-of-its-kind innovation in wellbore surveying—a true solid-state GWD system—is achieving optimized reservoir placement and wellbore collision risk mitigation in several regions globally.

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Wellbore placement accuracy is one of the most important considerations in the energy industry today. As efficiencies have driven down drilling and completion costs, and commodity prices have temporarily stabilized, the need now is to get more out of each well. Gyro surveys have historically been a way of ensuring an accurately placed wellbore, and with the advent of gyro-while-drilling (GWD) systems some years ago, operators were able to obtain real-time positional data while drilling.

Recognizing the strengths and limitations of existing spinning-mass GWD technology, Gyrodata developed and commercialized a first-of-its-kind innovation in wellbore surveying—a true solid-state GWD system designed for the modern oil field. With optimized reservoir placement and wellbore collision risk mitigation as prime objectives, the Quest GWD system is now being run by operators around the world. This article examines case studies from three applications.

TECHNOLOGY

Quest GWD is designed to reduce wellbore surveying time and the ellipse of uncertainty while being more reliable and efficient than comparable conventional GWD systems. The system incorporates Gyrodata's new solid-state sensors, which are based on Coriolis vibratory gyroscope technology. The sensing element is driven to oscillate at a precise frequency and amplitude, and when rotated about its input axis, a secondary motion perpendicular to the primary motion is created. The amplitude of the secondary motion is proportional to the rotation rate seen by the sensor.

The solid-state sensor probes measure the earth's rotational rate precisely and accurately at any latitude and can handle harsher downhole environments more effectively than conventional gyroscopes. The system is not affected by mass unbalance errors, which eliminates post-run calibrations, and it allows in-collar load out, simplifying operations and tool deployment. The system's sensor package and electronics are significantly shorter than previous offerings, enabling greater flexibility related to sensor positioning in different BHA designs and configurations.

CASE STUDIES

North Sea. An operator in the North Sea historically used GWD to mitigate wellbore collision risk during the drilling of tophole and horizontal reservoir

Fig. 1. As shown here, the Quest GWD system returned a more accurate wellbore survey.

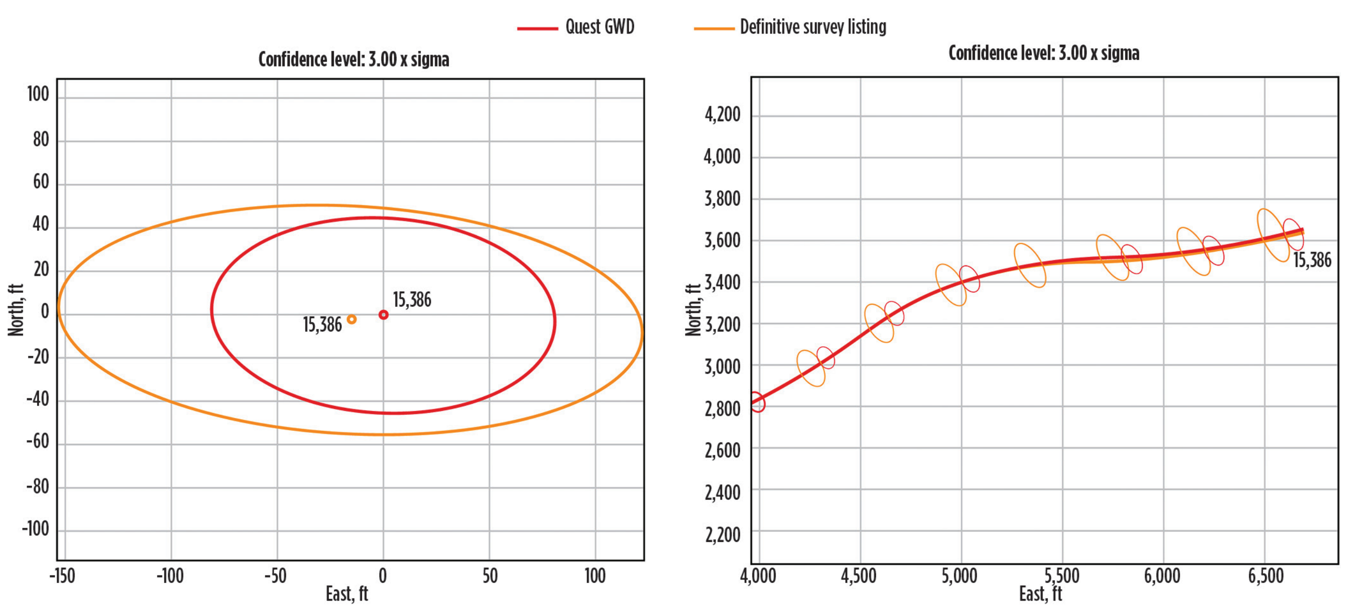
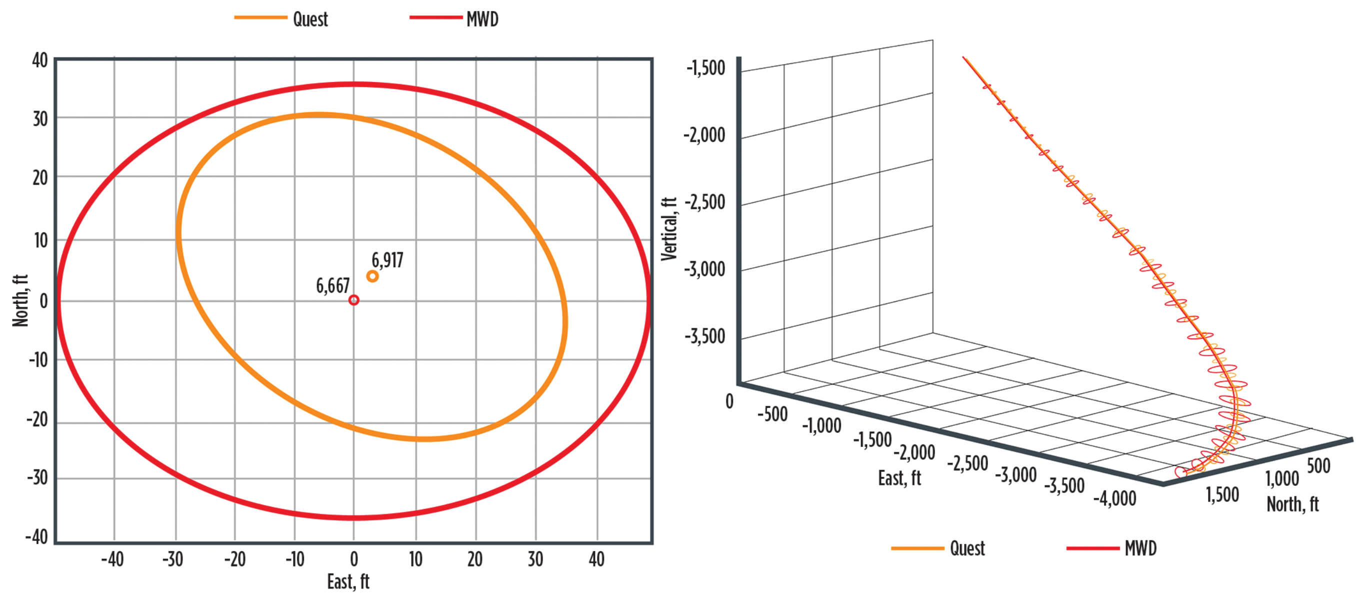


Fig. 2. The Quest GWD system successfully reduced the ellipse of uncertainty on the extended horizontal section.



sections. Conventional GWD solutions, though useful in achieving those objectives, required the operator to mobilize extra personnel to the rig, demanded additional BHA handling, and increased the time necessary to take surveys. Using the Quest GWD solid-state system, however, eliminated the challenges associated with those conventional GWD runs.

The project involved a series of offshore wells being drilled from a jackup rig. On the first well, the operator decided to pilot the Quest GWD system to validate its performance for implementation on subsequent wells. The 16-in. section of the first well was deemed low-risk, due to lack of magnetic interference, which would allow it to be drilled with accurate MWD data. The necessary BHA configuration provided an opportunity to run the Quest GWD system in the BHA without affecting rig time, and the well's broad inclination range of 30° to 58° meant that Gyrodata could validate drilling against MWD and outrun mode against previous gyro surveys.

The Quest GWD system also was used to re-survey the previously drilled 17½- × 20-in. section cased off by 17-in. liner, allowing the GWD surveys to be cross-checked versus both the corrected MWD surveys from the 16-in. section and spinning-mass gyro surveys. By implementing partially unmanned operations, only one survey specialist was mobilized to the rig—primarily to act as a safety net on this early Quest GWD deployment—with additional support from an onshore specialist in a real-time remote operating center. In the future, fully remote solid-state GWD operations are expected to yield operational/rig time savings of $60,000 per well on average, with some variance based on the well profile, scope of work, and project complexity.

The Quest GWD system successfully acquired surveys in 1 min. and 20 sec, which was approximately twice as fast as a comparable MEMS GWD system; over the whole well, this saved approximately 5 hr of rig time. The extended battery life allowed the system to be loaded out live from shore, deployed in the operation, and backloaded in stand-by mode, back to shore, while only using 40% of its battery. The system design also allowed seamless integration with the third-party RSS BHA and enabled more flexibility in configuration, due to its compact design. The Quest GWD system had no disruption to BHA functionality, and the survey results were more accurate than both alternatives—previous GWD solutions and the corrected MWD surveys.

On the second well, the Quest GWD system was deployed in the 9½-in. section with an RSS BHA assembly. The system was precongifured onshore for use in a compact collar. The operator needed to use solid-state GWD to obtain definitive, high-accuracy surveys throughout a challenging interval, which ran from 10,241 to 15,386 ft, and intended to compare the real-time gyro survey data versus the MWD data while drilling. The system was set to use five passes of data per survey with a 30-sec delay; even with this additional time, surveys were still 40 sec faster than those with conventional GWD systems. A downlink to outrun memory mode at TD allowed the operator to pull out of the hole while backreaming from 15,386 ft back to surface, which required no additional rig time.

Of all recorded surveys, 97% passed QC the first time, with only one marginal survey having excessive noise and requiring a retake. Post-well testing confirmed that all downhole data were performing according to the error model, validating the results and ensuring survey accuracy and precise wellbore placement, **Fig. 1.** The downlink to trigger outrun memory mode was successful and confirmed the first time, and incoming system test parameters were all within specification. The system was sent to shore for final downloading, and no changes to calibration terms were evident. The operator plans to continue using the Quest GWD system on subsequent wells as part of their ongoing campaign and well placement objectives.

Alaska. An operator on Alaska's North Slope needed to drill several wells through areas of magnetic interference while taking high-accuracy surveys to improve wellbore placement. The operator had previously used gyro single-shots on e-line or spinning-mass GWD systems. However, wanting to reduce spending in the current cost-constrained environment, the operator was looking for an option that would allow it to achieve its surveying and directional objectives while significantly reducing rig time.

On the first well, the operator drilled the entire 12¼-in. surface hole section from 0 to 6,973 ft, MD, using the Quest GWD system, which was placed closer to the bit for definitive surveys because of its immunity to magnetic interference, which was expected for about 900 ft. A total of 113 survey stations was presented while drilling this section, with no additional rig time or NPT. When compared to conventional gyro solutions on electric line, survey times were reduced by 20 min. to 30 min. per run, which saved 6 total hours of rig time. The system also was able to successfully withstand backreaming out of hole with no RPM limits, versus 60 RPM with legacy GWD tools. In line with the operator's objective to improve reservoir placement after drilling the extended horizontal tangent, the Quest GWD system successfully reduced the ellipse of uncertainty while drilling an extended tangent almost due west at approximately 273° azimuth, **Fig. 2.**

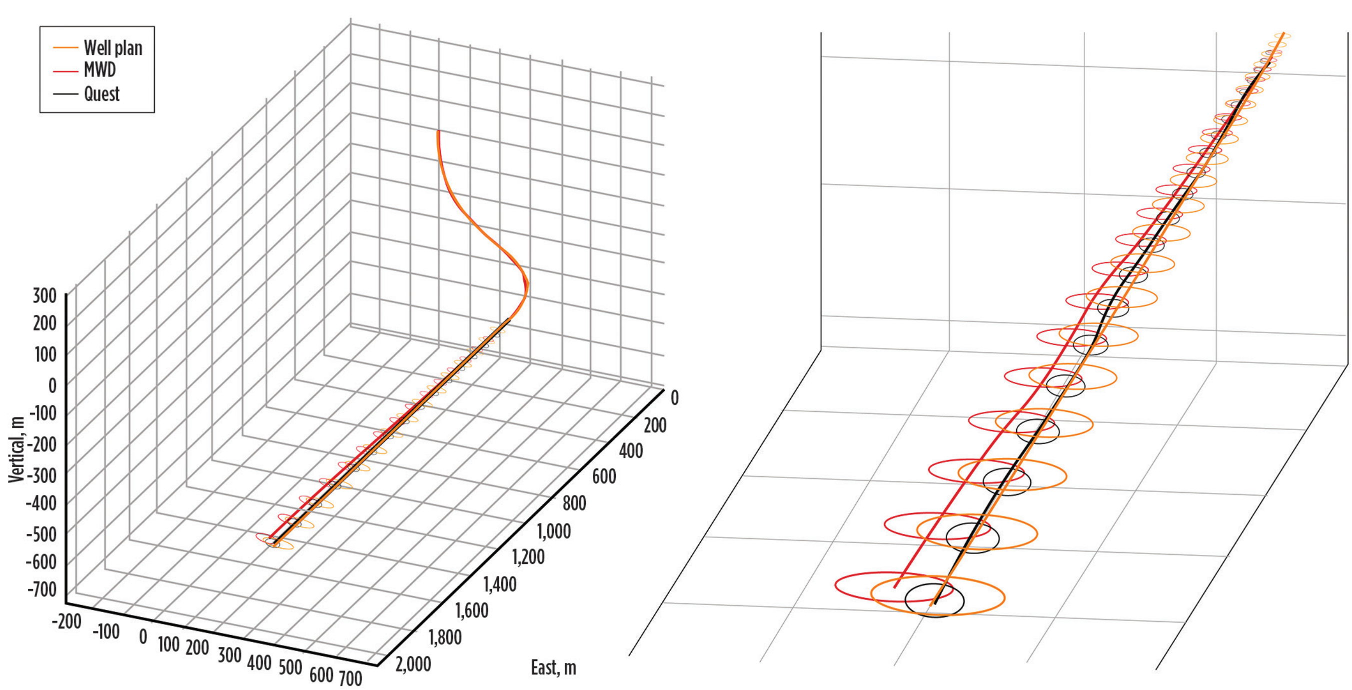
On the second well, the operator kicked off at 225° azimuth, with a long tangent at 270° before turning and landing at 5.5°. The operator drilled the entire 12¼-in. surface hole section from 0 to 8,336 ft, MD, using the Quest GWD system, which was placed closer to the bit for definitive surveys, as in the previous BHA configuration. Magnetic interference was expected for approximately 660 ft. Through a total of 88 survey stations in the surface hole section, the operator incurred no additional rig time or NPT. Time savings on surveys, due to shorter surveying times, were equivalent to those achieved on the first well, yielding a reduction in rig time of 5 hr versus gyro surveys on electric line.

Canada. An operator in Canada was drilling a series of four infill wells from a pad. As these wells were within close proximity of those drilled from existing pads in the area, wellbore collision was a serious risk. The operator also wanted to improve efficiency, reduce the risk of getting stuck, and drill the lateral sections with a narrower ellipse of uncertainty to improve wellbore placement, achieve an optimized separation factor, and increase reservoir access. After successfully trialing the Quest GWD system in mid-2020, the operator decided to return and use the system on this project.

On the first well, the operator deployed the Quest GWD system to provide real-time collision management while drilling the lateral section at 90° azimuth. The shorter BHA length improved BHA handling, and survey times using the system were reduced from 2 min. 30 sec to 1 min. 20 sec—a 47% decrease—when compared to the conventional GWD system used on previous wells. The solid-state system also reduced the risk of getting stuck by decreasing the time required for the BHA to be stationary while surveying. Using EM telemetry, the Quest GWD system experienced no missed surveys, no NPT, and no disruption of BHA functionality. The tighter ellipse of uncertainty (**Fig. 3**) confirmed an improved ellipse of uncertainty, which will allow the operator to optimize spacing between future wells.

On the next well, the operator was drilling a record-length 8½-in. lateral, as well as one of the deepest wells drilled in that area, at 90° azimuth. Similar to the first well, the operator noted several

Fig. 3. At the same depth, the Quest GWD system reduced the ellipse of uncertainty versus the corrected MWD surveys while highlighting an error in the MWD data's well placement.



distinct advantages of running the Quest GWD system, primarily related to reducing survey times and mitigating wellbore collision risk, as the horizontal sections were planned with extremely tight lateral spacing. The shorter sensor package, loaded into a compact collar, provided greater steerability, helping the operator achieve its directional targets. EM telemetry was once again used for optimal survey times. In addition to the time-related reductions of using the Quest GWD system, using solid-state GWD also allowed the operator to continue drilling the long lateral section with a 6¾-in. agitator, without switching to heavyweight drillpipe. The last two wells of the project were similar, and both were drilled with no NPT.

A changing industry demands that innovation accelerate accordingly. While many products and technologies have brought incremental change to the oil field over the past decade, dramatic changes in wellbore surveying have been few and far between. With a pioneering new system that improves wellbore placement and provides quantifiable efficiency gains while drilling, Gyrodata is rising to the challenge of helping operators achieve greater profitability, even as the industry remains challenged. Additional development on the solid-state sensors powering the Quest GWD system will see them being incorporated not only in Gyrodata's products, but also integrated into the gyro surveying systems of third-party oilfield service companies. WO

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