OVERVIEW

An operator in Ecuador wanted to find a geosteering solution that would fully exploit production in the development of a new unconventional field. Uncertainty associated with the thickness of a nonproductive sandstone formation overlying the productive zone introduced risk in the landing section, while the stratigraphic lateral changes presented concern of reservoir exits in the horizontal section. Closely collaborating with the operator, Sperry Drilling ultimately met, and exceeded, the project’s objectives by extending the length of the horizontal section in the target zone, increasing well productivity, and maximizing the value of the customer’s asset.

LANDING AND GEOSTEERING IN A CRITICAL SWEET SPOT

The operator intended to geosteer and accurately place the well within the reservoir sweet spot approximately 4–5 feet (1.2–1.5 meters) below the target reservoir top to maximize production, making it critical to precisely land the well. The determination of this landing point was complicated due to the variable thickness of the nonproductive zone, which exhibited petrophysical responses similar to the productive zone, as shown by the gamma ray, resistivity and neutron porosity measurements from available offset wells.

The following objectives were key to the project plan’s success:

» Achieve maximum reservoir contact in the lateral section by correctly interpreting the top of the productive zone to ensure an optimal landing
» Attain high productivity with easy-to-run completions and less tortuosity via lower-magnitude navigational changes while drilling to 620 feet (189 meters) in the lateral section
» Minimize risks by effectively managing unexpected, or sudden, lateral formation changes to avoid higher doglegs and unplanned reservoir exits

OPTIMIZING THE LANDING POSITION

The experienced Drilling Engineering Solutions (DES) team from Sperry Drilling collaborated with the operator to enhance understanding of the reservoir and its formation. This led to the development of an engineered solution that included StrataSteer® 3D software models that dynamically integrated data from the Geo-Pilot® rotary steerable system (RSS) and multiple logging-while-drilling (LWD) sensors, in conjunction with data from two offset wells, to accurately guide the positioning of the trajectory into the optimal part of the reservoir. On previous projects, gamma ray responses would have been used to land the well; however, the formation layers had little variation in this petrophysical response, and it would be difficult to determine when the bottomhole assembly (BHA) entered the sweet spot.
Engineered solution

The multi-sensor approach comprised the following directional drilling tools:

- **ABG™ at-bit gamma sensor** – combined with the Geo-Pilot RSS to enable real-time geosteering
- **ALD™ azimuthal lithodensity sensor** – took high-quality measurements of the formation density and photoelectric (Pe) factor for reliable reservoir evaluation
- **ADR™ azimuthal deep resistivity sensor** – provided high-resolution directional images (up to 18 feet/5.5 meters into the formation) for early warning of approaching bed boundaries, with over 2,000 unique measurements for precise wellbore placement and more accurate petrophysical analysis
- **DGR™ dual gamma ray sensor** – provided natural gamma ray logs, including gamma ray, resistivity, neutron porosity, spectral density, dipole sonic, formation tester and caliper measurements
- **CTN™ compensated thermal neutron sensor** – provided porosity, fluid type and lithology information
- **PWD™ pressure-while-drilling sensor** – measured downhole annular and bore pressure via high-accuracy quartz pressure gauges
Project highlights

After performing quality control checks and analyzing the offset well data, the DES team concluded that the target formation had a higher density contrast and, therefore, decided to place the ALD sensor closer to the bit. This positioning helped to determine and confirm the entry into the main reservoir sooner in order to optimize the landing position.

The well trajectory was planned to hold an 85.5° tangent inclination to precisely land the well. The DES team determined that this inclination was necessary to optimally geosteer the well 4–5 feet (1.2–1.5 meters) below the targeted formation top. Particularly in the lateral section, measurements from the ADR sensor were a major factor in proactively geosteering and avoiding unplanned exits.

The targeted reservoir formation for landing the well was detected by the ABG sensor and confirmed by the density response from the ALD sensor. The combination of ALD sensor placement in the BHA and the quality of the ALD-derived information was crucial to landing the well without incurring any extra nonproductive time (NPT) or sidetracking.

SUCCESSFUL OUTCOME AND POSITIVE FORECAST

The Sperry Drilling “drill-to-produce” solution enabled the operator to accurately place the well in the sweet spot and extend the lateral section for maximum reservoir contact. A lateral section totaling 675 feet (206 meters) measured depth (MD) was drilled, geosteering 100 percent within the reservoir’s sweet spot and exceeding the original plan of 620 feet (189 meters) MD by 55 feet (17 meters). Near the end of the horizontal drilling operation, the presence of coal was encountered, leading the operator to reach total depth (TD).

After further analysis, the petrophysical properties of this development area, including higher resistivity, were found to be superior to the offset wells, suggesting that well productivity in the new field should be excellent, achieving great reservoir contact. The project’s successful outcome and positive forecast helped the operator to maximize asset value and to seek more advice from Sperry Drilling experts on future projects.