Deep directional electromagnetic measurements enable industry first.

Schlumberger is showcasing the industry’s first reservoir mapping-while-drilling service at OTC 2015. Using deep directional electromagnetic (EM) measurements, the company’s new GeoSphere reservoir mapping-while-drilling service reveals details of subsurface bedding and fluid contacts more than 30 m (100 ft) from the wellbore, which is about six times farther than existing bed boundary mapping technologies. This reservoir-scale view provides an unprecedented depth of investigation, helping operators to land wells more precisely, perform reservoir steering more proactively and optimize their field development plans with greater confidence.

The reservoir mapping-while-drilling service was officially commercialized in May 2014. The service underwent several years of field testing, and it has already been run successfully in more than 220 wells in the North Sea, Europe, Africa, Russia, North America, South America, Australia and the Middle East. Key benefits include increasing potential production and ultimate recovery, unlocking access to new or marginal reserves, minimizing water production, avoiding drilling hazards, improving the accuracy of reserve estimates, eliminating geological sidetracks and refining seismic interpretations.

The technology uses a transmitter placed close to the drillbit on the bottomhole assembly (BHA) to send multifrequency EM signals into the formation at frequencies as much as 50 times lower than legacy technologies. Two receiver subs, with more directional antennas than previous tools, are placed on the BHA behind the transmitter at distances up to 30 m, depending on the thickness of the reservoir and the operator’s specific drilling objectives. Increasing the spacing increases the tool’s depth of investigation (DOI).

Each antenna receives deep EM signals from the formation, providing a unique set of azimuthal resistivity measurements at multiple depths of investigation while drilling. Readings are sent to the surface in real time through the MWD tool and fed into an advanced stochastic inversion algorithm. This novel proprietary technique automatically compares the measurements with hundreds of thousands of mathematical models. When it finds a match, the inversion generates an interpretation, incrementally displaying a color-coded resistivity map that allows detection of multiple layers in and around the reservoir along the well trajectory in real time.

The reservoir mapping-while-drilling service enables drilling engineers and geoscientists to land wells more accurately in the target interval. It also can help them to anticipate changes in the structure ahead of the bit and adjust the well path to stay in the sweet spot and maximize net pay. The service’s large DOI means wells can be steered proactively rather than reacting to formation changes already drilled. The resulting well path is typically less tortuous than would otherwise have been possible, making completions easier to install and potentially more effective. After drilling, enhanced subsurface characterization data help oil and gas operators to further refine their seismic interpretations, geological reservoir models and future field development plans.

Danish oil company DONG E&P used the GeoSphere service in its North Sea Nini East Field. The company’s main objective was to improve the accuracy of landing and steering of two horizontal wells in a sandstone injectite target ranging in thickness from 2 m to 15 m (6 ft to 49 ft). These thin injectite sand reservoirs frequently have erratic boundaries with adjacent formations, and their thicknesses often fall below the resolution of conventional seismic data. As a result, determining the stratigraphic location of reservoir boundaries and fluid contacts is almost always subject to uncertainty. Under such conditions, traditional methods of optimizing well placement suffer from critical limitations. DONG had encountered significant challenges targeting the same type of remobilized sand reservoir in a nearby field using traditional image-based geosteering techniques.

The GeoSphere service helped DONG to improve the previous net pay ratio of its wells in the area from less than 50% to an average 97%—essentially doubling reservoir exposure and production in each well. There were no sidetracks or delays, and both of the new wells were completed within budget. Deep directional resistivity inversions significantly improved the operator’s understanding of the structure and heterogeneity of this complex, sand injectite reservoir. Detailed information obtained while drilling helped refine the existing reservoir model, reduce uncertainties and improve long-term field management. Based on this technical and commercial success, DONG plans to deploy the same technology for its next North Sea drilling campaign.

Because the deep-reservoir mapping-while-drilling service is capable of interpreting multiple surfaces up to 30 m away, it also can eliminate or reduce the number of pilot holes required to plan horizontal well campaigns. During the past year, for example, another operator in the North Sea used the GeoSphere service to map the top and bottom of a target reservoir and gently guide the bit into the ideal landing position without ever drilling a pilot hole. Normally it took about five days to drill pilot holes at rig spread rates around $1 million per day.

GeoSphere reservoir mapping-while-drilling service is a 2015 Spotlight on New Technology award winner. To learn more the GeoSphere service, visit Schlumberger at booth 4541.