Logging while drilling (LWD) was conceptualized as early as 1920, but it was not until decades later, in the 1980s, that the first commercial services were introduced.

“Well placement has always been a challenge in drilling operations,” Seydoux says. “Even back in the 1980s, physicists were experimenting with technology that could help them visualize reservoir structures, including the use of gamma rays. Emphasis on well placement really started in the 1980s, with the first generation of measuring while drilling (MWD) and (LWD) tools. In the 1990s, imagers were used to get a better idea of the structure around the borehole. The first real breakthrough is considered to have been (Schlumberger’s) PeriScope bed boundary mapping service, which allowed drillers to identify formation markers away from the borehole without crossing.

“The new GeoSphere service is the next logical step and also a step change in capability, by allowing drillers to probe five to ten times deeper into a reservoir,” Seydoux continues. “The breakthroughs that led to this technology’s development, allowing a depth of investigation (DOI) in excess of 30m, were the development of distributed multi-tool architecture in a bottom hole assembly (BHA), along with more powerful transmitters, a directional sensor (PeriScope), full azimuthal capability, powerful computational capabilities and the unwavering dedication of a range of experts.

“The development of this technology took over 15 years, from first idea to commercial reality, and
involved more than 20 researchers from different fields,” Seydoux adds. “The physics was the catalyst of the design of the measurements, signal processing, and antenna structure. The hardware was also vital for standard tool development, along with mathematical computation and inversion (the other half of the technology). Important questions needed to be answered, such as how to make sense of the measurements and how to evaluate and diminish geological uncertainties.”

With a deep range of investigation drilling teams can use LWD technology/the GeoSphere service to reduce drilling risks and accurately land wells. In addition, the real-time reservoir mapping-while-drilling service enables accurate positioning of wells within target reservoirs, away from fluid boundaries, leading to increased reservoir exposure, as well as allowing geoscientists to refine their seismic interpretation and geological and structural models.

GeoSphere
Using deep, directional electromagnetic measurements, GeoSphere reveals subsurface-bedding and fluid-contact details at in excess of 100ft (30m) from the wellbore. GeoSphere can map a reservoir top, allowing a clear, real-time view of the reservoir. With this data, operators can land wells in choice locations and avoid the loss of lateral exposure or creating sumps. Exposing more of the lateral section ultimately shows much more detail of the area surrounding a reservoir, greatly increasing the level of information available to drilling teams in real-time, aiding operational decision making processes by resolving the reservoir and its boundaries.

By combining the reservoir mapping data with seismic interpretation, GeoSphere can be used to update seismic models for increased understanding of reservoir geology and accurate predictions about formations ahead of the bit.

There are three main applications for the GeoSphere service, but there can be as many applications as there are geologists and fields,” Seydoux says. The three main applications are: landing a well can be optimized to reduce the number of pilot wells and improve the planning of horizontal wells; geosteering, with respect to the main reservoir features and fluids contact; and increased reservoir structure understanding.

The three main components of GeoSphere are: a BHA that is tailored to the application; real time connection and data transfer from rig to a client’s office (otherwise well placement is not possible); and a well placement team in client’s office to provide mapping of formation structure in real-time using powerful computational clusters around the world. To make best use of the service, it is important to have a fully engaged client team (geology and geophysics and drilling), Seydoux says.

“The mapping-while-drilling service has many advantages over logging-while-drilling as LWD tools provide formation evaluation (FE) information in a very shallow DOI around the borehole (cm or m),” Seydoux says. “This new technology (RMWD), provides a structure with resistivity around the borehole up to 30m. It is a much larger area and provides additional information not previously available. It is still complementary with LWD, with integration of information as a key aspect. Another important advantage is the link to seismic. Because the technology DOI is greater than the seismic resolution, seismic data can be refined and better understood, especially while looking at some of the features on a seismic scale, Seydoux says.

By increasing the confidence in the knowledge of the environment drilled, the mapping while drilling helps increase rate of penetration (ROP), improve wellbore stability and hole quality, and optimize well placement. Seydoux pointed out that “the key is knowing earlier and making the right decisions. RMWD also helps the overall drilling operation to allow for a smoother borehole. It provides better dogleg control and decreases unwanted corrections in trajectory (going from reactive to proactive mode). By detecting and avoiding potential problematic formations (shale or other), it helps avoid side tracking and offers better entry angle control. This is a reservoir mapping technology that benefits both drillers and geologists and geophysicists.”

There were many challenges to overcome in developing the MWD service for commercial use, as it involved proving the viability and efficiency of different technologies. In order to attain well placement optimization it was necessary to have a more extensive understanding of reservoir characteristics.
“Four major advances make this new tool an effective technology for reservoir imaging. First, the tool modularity enables simultaneous radial depths of investigation in excess of 30m. Second, a broad range of measurement frequencies accommodate a wide range of formation resistivity. Third, the antenna design offers a full directional access to the resistivity tensor acquired at each spacing and frequency. Finally, a powerful real-time inversion method exploits the richness of the measurements and their deep depth of investigation, providing unparalleled support for the interpretation of complex reservoir structures,” Seydoux says.

The individual transmitters and receivers provide flexibility in the ways that the new system can be incorporated into the BHA. The multiple spacing between transmitters and receivers, along with multiple frequencies, provide the best approach to address well placement in complex formations. This helps to correctly establish the location of oil water contact (OWC), while at the same time unveiling the geometry of the reservoir, including estimating reservoir thickness, and characterizing geological block structures. The capability to produce deep directional resistivity measurements is vital for drilling wells in complex reservoirs and leads to a tighter integration with other reservoir measurements such as petrophysics and seismic imaging.

“This is a first to the market technology and it was very important to have it right from day one. The system has been through extensive testing with more than 150 jobs completed until commercialization. We have a range of applications that are very much extended and new, harder challenges can be addressed. It is important to understand how challenges can be solved by this robust product,” Seydoux says.

“Mapping-while-drilling technology has been used in deepwater offshore Brazil since late 2008. We began with offshore post salt runs in the main basins (Santos, Campos and Espirito Santo), including carbonate formations. We also undertook an extensive one-and-a-half year campaign for one client with more than 30 applications of landing and navigation,” Seydoux says.

Seydoux sees many future uses for the mapping-while-drilling service in Brazil. “The position of GeoSphere’s RMWD service in Brazil is strong, and it has become the standard technology to use for Brazil. Having an enhanced reservoir structure and model in 3D around the borehole opens the horizon for a better integration with seismic and petrophysic measurements, which is the key to decipher the reservoir and its properties. Pre-salt applications are also under investigation.”

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