REAL-TIME 3D IMAGING OF COMPLEX TURBIDITIC RESERVOIR ARCHITECTURE

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Abstract:

Siliciclastic turbidite lobes and channels are known to exhibit varying degrees of architectural complexity. Understanding the elements that contribute to this complexity is the key to optimizing drilling targets, completions designs and long-term production. Several methods for 3D reservoir modelling based on seismic and electromagnetic (EM) data are available that are often complemented with outcrop, core and well log data studies. This paper explores an ultra-deep 3D EM inversion process during real-time drilling and how it can enhance the reservoir understanding beyond the existing approaches.

The new generation of ultra-deep triaxial EM logging tools provide full-tensor, multi-component data with large depths of detection, allowing a range of geophysical inversion processing techniques to be implemented. A Gauss-Newton-based 3D inversion using semi-structured meshing was adapted to support real-time inversion of ultra-deep EM data while drilling. This 3D processing methodology provides more accurate imaging of the 3D architectural elements of the reservoir compared to earlier independent up-down, right-left imaging using 1D and 2D processing methods. This technology was trialed in multiple wells in the Heimdal Formation, a siliciclastic Palaeocene reservoir in the North Sea. The Heimdal Fm. sandstones are generally considered to be of excellent reservoir quality, deposited through many turbiditic pulses of variable energy. The presence of thin intra-reservoir shales, fine-grained sands, heterolithic zones and calcite-cemented intervals add architectural complexity to the reservoir and subsequently impacts the fluid flow within the sands. These features are responsible for heterogeneities that create tortuosity in the reservoir. When combined with more than a decade of production, they have caused significant localized movement of oil-water and gas-oil contacts.

Ultra-deep 3D EM measurements have sensitivity to both rock and fluid properties within the EM field volume. They can, therefore, be applied to mapping both the internal reservoir structure and the oil-water contacts in the field. The enhanced imaging provided by the 3D inversion technology has allowed the interpretation of what appears to be laterally stacked turbidite channel fill deposits within a cross-axial amalgamated reservoir section. Accurate imaging of these elements has provided strong evidence of this depositional mechanism for the first time and added structural control in an area with little or no seismic signal.

Bio:

Supriya Sinha is Geosteering lead at Halliburton, based in Norway. Sinha joined the oil and gas industry in 2006 as a mudlogging geologist, then moving on to data engineer and log analyst. She began her career with Halliburton in 2010 as a drilling optimization engineer (ADT) in India and Malaysia, then in 2012 progressed into a geomechanics consultant role for Scandinavia. From mid-2017, Sinha began working as a geosteering geologist specializing in applications of ultra-deep resistivity and is currently leading the geosteering team in Norway. Sinha holds a master’s degree in geology. She is a member of SPE and SPWLA.