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Geoscience evolution: new approaches to real time geosteering

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Summary

Performance improvement and cost reduction are the key drivers of technology and innovation in the industry today. This applies to the entire cycle of hydrocarbon exploration and development.

Geosteering has always been a technology-intensive discipline that combines geology, geophysics and well drilling. This paper discusses modern geosteering technologies and approaches that the industry has adopted in recent years. These new technologies became game changers in some conventional and unconventional plays, enabling operators to drill more cost-effective wells while increasing EUR.

Introduction

Horizontal wells demonstrate better production performance in tight, thin-layered, unconventional plays. Furthermore, fields developed with horizontal wells use less surface footprint and have more efficient surface facilities.

In the past, horizontal well drilling was very limited due to the general lack of expertise outside the big service companies, the high cost of equipment, and the absence of experienced within operators. This resulted in horizontal wells being drilled only where they were absolutely essential – offshore, heavy oil, and oil rim development.

The North American oil shale boom, followed by the industry downturn, created a demand for low-cost but highly efficient horizontal wells. This was achieved by making improvements throughout the entire well-drilling cycle, as a result of which more than 80% of the wells drilled in the US today are drilled horizontally.

Theory and/or Method

This paper discusses the improvements that have been made in horizontal well geosteering over the last few years.

The main purpose of geosteering is to keep the well trajectory in the desired reservoir zone or target. The target is usually defined as a balance between production/completion efficiency and drilling performance.

As previously mentioned, geosteering approaches have improved considerably in recent years. The main innovations fall into four categories:

1. MWD/LWD tool string simplification combined with data integration. These days, most horizontal wells are drilled with a GR log only. Sometimes, this would not be sufficient to confidently geosteer the well. However, the lack of additional log data is compensated for by extensive real time data integration. All the data – logs, mudlogs, drilling parameters, seismic data, geological models, structural models – is compared on the fly with the geosteering model, making sure it is consistent with all the additional data available to the geologist.
2. Multi-well geosteering. The operator usually drills a horizontal well next to or close to an existing one. In some cases, oil or gas fields are developed as a stacked play with multiple layers of horizontal wells on top of each other. Every horizontal well that has been drilled and geosteered provides a high-resolution structural model of the area that is much finer in resolution than seismic data or maps plotted based on formation tops. The geosteering results of previous wells can be used to geosteer other wells nearby. This process is called multi-well geosteering. It is widely used on heavily drilled plays like Montney, Duvernay, Bakken, and Eagle Ford.
3. Cycle time reduction. High Rate of Penetration (ROP) is currently one of the industry's major challenges. Some horizontal wells, which used to take 20 days to drill, are now drilled in 2 to 3 days. This requires a significant improvement in cycle time, i.e., the time from the acquisition of the log or drilling data to the time when the decision to change the trajectory is made. WITSML real time data transfer protocol partially addresses this issue, but most importantly Operations, Asset, Well Site geologists and Drilling Engineers have to work in a single cloud-based environment to share the data and results of their interpretation on the fly.
4. Close the loop and use geosteering interpretation products. Geosteering data represents a continuous structural model along the well, and it can be used to update structural and property models across the field. In addition, geosteering data can be used as an input to the completion design to ensure frac stages are placed in the best zones. Multi Variate Analysis (MVA) – predicting well performance from geology, drilling and completion parameters – also uses geosteering as an input.

Conclusions

Geosteering approaches have evolved considerably over the last few years. Utilization of all the new concepts (real-time data integration, multi-well geosteering, cycle time reduction, and closing the geoscience loop with geosteering data) allows more cost-efficient wells to be drilled while increasing EUR.

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