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Integrate real-time drilling data within the geological model

With the increased demand for greater efficiencies in drilling operations, oil and gas companies are searching for new means of using all available data while drilling.

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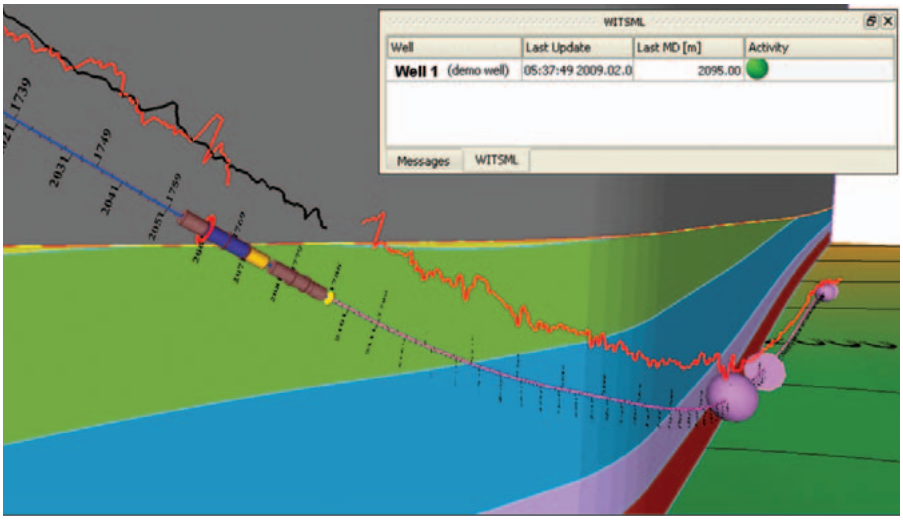


The figure above is an example of monitoring the drilling in real-time using WITSML. Bit position and logging measurement points behind it are visualized within the 3-D geological model with the red disk on the well representing the position of the survey tool. The planned ahead trajectory with a return to target option is constantly updated based on the current bit position. (Images courtesy of Roxar)

The integration of real-time drilling information with data from offset wells and the reservoir model is considered essential to effective well planning, accurate wellbore placement, and reduced uncertainty.

Another key enabler has been the growth of the standard for transmitting data — WITSML (wellsite information transfer standard markup language). WITSML has improved the ability to transfer drilling data in real-time between service and oil companies. In addition, its standard format and public domain status has enabled software companies to develop real-time applications independently of drilling companies.

Challenges still remain, particularly in regard to delays between the analysis and integration of real-time drilling data and the updating of geological models. Improvements are needed to better visualize real-time drilling data with the geological model. Using Roxar's geosteering methodology as an example, measurement-while-drilling (MWD) and logging-while-drilling (LWD) data can be used to update the model.

Visualizing real-time drilling data

Three-D visualization tools are an integral part of the drilling operation process, allowing a better communication and understanding within the asset team.

Real-time data is integrated within the earth model and can be visualized in real-time operation centers. MWD/LWD are then used to evaluate the position of the well, assess the physical properties of the rocks and fluids drilled, and analyze the behavior of the drillstring in real-time.

To fully integrate the real-time drilling information into the geological model, it is essential to co-visualize these data with seismic, horizons, faults, grid properties, and other wells.

How is this achieved? Monitoring should consist of gathering different types of real-time information, such as survey data, LWD data, drilling information and bottomhole assembly (BHA) information for the different drilling phases. All data can be displayed into multiple views in combination with elements of the geological model.

The BHA data is particularly important. Each of the physical properties measured by the MWD/LWD tools can be defined onto the BHA by its distance from the bit.

The BHA specifications can be automatically subscribed via the WITSML receiver and the information used to position each of the logging tools behind the bit. Each physical property recorded by the MWD/LWD tools can be characterized by a measurement point defined as an offset from bottom.

The bit, MWD/LWD tools, and the

measurement sensors are co-visualized with the 3-D geological model. For the geologist, this provides an understanding of how far behind the bit the logs are recorded and within the geological model. Combined with the knowledge of the BHA program, logging tools can be visualized and combined with other well data.

In addition to calculating the bit positions from the last survey points, the planned trajectory ahead of the current bit position is also used to predict future trends and can help the decision-making process.

Local updating of the model

There are a number of specific functionalities to constrain the update of the model locally around the well trajectory. These include well pick editing, synthetic vertical wells along the section, and isochore thicknesses and/or structural dip preservation.

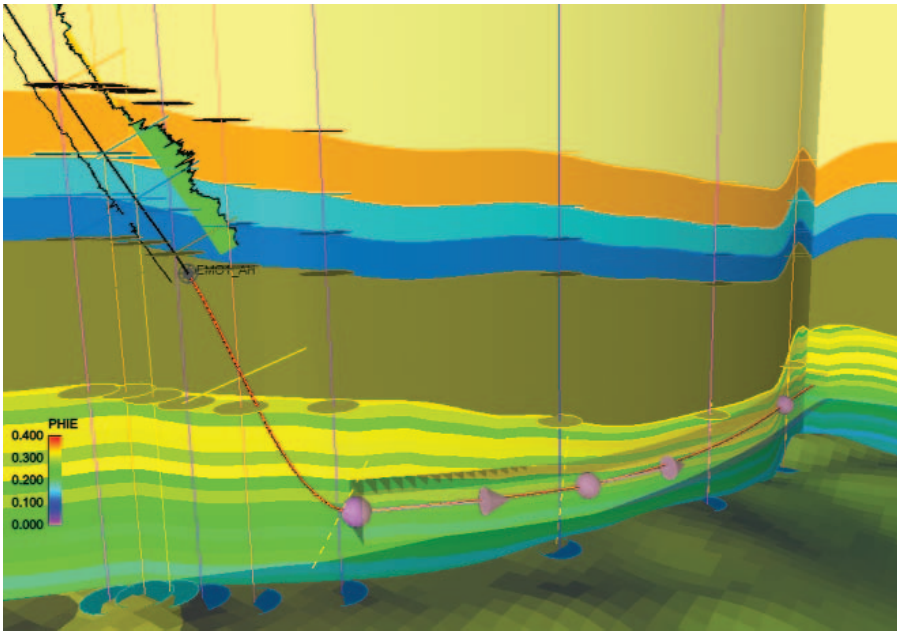
Log forward modeling can also be used to understand the stratigraphic position within the model, quantify the editing process, and validate the model.

A workflow-based approach here is vital. It allows for the local updating of the structure, the 3-D grid, and log and property modeling and ensures the repeatability and automation of the whole process with a reproducing and standardizing of the different steps.

A real-time integrated geosteering software tool

Roxar's geosteering methodology can be used to optimize horizontal wellbore placement in the reservoir and is also a means of integrating real-time data into the geological model.

The geosteering diagnosis is designed to automatically quantify the position of the well under monitoring within the geological model, achieved through the automatic and real-time updating and extrapolation of well paths from current positions and targets.



This figure illustrates a workflow-based approach from model updating while drilling. Drilled and planned ahead sections of the well are displayed with the real-time logs. Well picks are calculated and displayed along both sections of the well. The 3-D geological model in this example is composed of the effective porosity grid and the horizons.

The proximity between the bit, or sensors behind the bit, and objects in the model are also constantly monitored. Objects in the model can include horizons, contacts, faults, targets, well trajectories, grids and volume properties, and log properties.

Scanning methods can consist of distance calculations performed in a number of specific directions, such as up/down distance, left/right distance, north/south distance, or east/west distance.

As mentioned, an alarm methodology — based on the distances between objects and on the differences between property values — has been developed to help the geologist's decision-making.

As part of the rules, there are two thresholds to separate the three warnings of green, yellow, and red with the threshold definition based on object uncertainty. These are automatically applied after an update of the real-time data or an update of the model.

Warnings are activated when the monitored object (the well) crosses the vicinity of the targeted object, when the monitored object leaves the vicinity of the targeted object, and when the monitored object does not stay above or does not stay below the targeted object.

Real-time drilling in the geological model

Understanding the position of each of the LWD tool's sensors behind the bit within the geological model; the ability to monitor in real-time the proximity between the well and objects in the model; and a workflow-based approach to update the model while drilling are key elements to incorporating real-time drilling into the geological model.

The result is a robust, real-time, integrated geosteering software tool that allows the operator to make timely and informed decisions, reducing time, costs, and uncertainties in well planning and drilling.

Proper use of real-time monitoring will ultimately achieve improved wellbore stability and hole quality, and optimized well placement for increased production. E&P