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Stopping a Well to Develop a Field - A Geostopping Case Study from the Andaman Sea*

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Search and Discovery Article #20404 (2017)**
Posted October 2, 2017

*Adapted from extended abstract prepared in conjunction with oral presentation given at 2017 Third AAPG/EAGE/MGS Oil and Gas Conference, Yangon, Myanmar, February 22-24, 2017

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Abstract

Ongoing development of a producing field by conducting infill drilling to target zones or fault blocks that were bypassed by the original wells is often necessary in order to maintain production at a certain level once long-term reservoirs become depleted. The use of existing facilities as a starting point for these wells is the most cost effective way to carry out these campaigns, but that can present drilling and geological challenges, as extended lateral sections may be required to access remote fault blocks and safely cross highly depleted zones, while the lack of previous wells in the new target areas gives rise to uncertainty over the exact depth of these layers. In such cases, stopping a hole section at a certain bed boundary may be crucial to the safe and efficient drilling of a well. Drilling into under- or over-pressured zones without casing off intervals above them and making changes to the drilling fluid often leads to well stability, or well control issues, resulting in, at best, days of remedial action, through to far more serious consequences. This becomes more challenging when seismic uncertainty can only place the boundary within a window of plus or minus tens of metres True Vertical Depth (TVD). Traditionally, well to well correlation and stopping to circulate at drilling breaks have been employed to try and identify the correct point in a timely manner, however, the use of real-time data from Logging While Drilling (LWD) tools in order to reduce this uncertainty and make a decision to

stop within tight constraints is now an accepted, and in many cases, preferred method. This process is referred to as Geostopping.

Introduction

This article describes a scenario where, as part of an infill drilling campaign to further develop a gas field in the Andaman Sea, offshore Myanmar, a highly deviated well from an existing platform was required to target a certain fault block containing previously unexploited sand layers. The well plan called for an extended section to be drilled through an unstable shale that overlay a heavily depleted sand zone, with the target sands located below this (Figure 1). The mud weight necessary for efficient drilling of the shale was too high for the depleted sand, and it was feared total losses would ensue should it be penetrated too far. However, uncertainty on the surface seismic led to doubts regarding the dip and actual top of the sand.

Discussion

The challenges faced in identifying the sand were fed into a decision making process in order to ascertain the best method to do so as soon as possible; including well to well correlation, Borehole Seismic, Azimuthal Resistivity and Bit Resistivity. Each method was evaluated and, if necessary, modeled in joint consultation between the service provider and operator's sub surface team. Based on that process, it was agreed that adding a short Bit Resistivity sub satisfied the requirement for timely detection, while adding very little complexity to the BHA, and with no extra surface equipment required. Following the choice of method, a pre-job strategy was developed that best satisfied the requirements and tolerances for the geostopping and incorporated into an end-of-section decision tree.

Bit Resistivity tools are usually placed just above the directional steering tool in the BHA, and project a current down the drill-string, which exits via the bit. Current strength is monitored as it flows through the tool, and reflects the resistivity of the formation the bit is in, or is entering (Lindsay, 2008). The resistivity value given by the tool is an apparent one, largely dependent on mud resistivity, and pre-well modelling is required to give the predicted response at the boundary in question. During job execution, the Bit Resistivity signal is compared to the model, while other LWD information, including Gamma Ray and Propagation Resistivity data, may be correlated with multiple wells in order to ascertain the position of the bit in the stratigraphic section. Once a trend in the data is seen that matches the modeled boundary response, drilling will stop and a sample circulated to confirm the formation change.

Results

By following the procedures and model laid out pre-well, 10,471 ft of overlying formation was drilled in a single run, building angle from 47 deg to 79 deg inclination. Real-time correlation to a number of offset wells was utilised to get an idea of the well's position relative to seismic, before Bit Resistivity data was used to stop the run 16 ft TVD higher than expected, with minimal sand penetration (Figure 2). A hard, resistive stringer was encountered immediately above the top of the sand, however was recognised as such, and drilled through before the true top was identified. The overlying shale was cased off and the depleted zone safely drilled and cased before the well was successfully drilled a further 1843 ft to its planned sand reservoir targets, with no hole issues or down time.

Conclusions

Stopping a well or hole section at a specific location can be crucial to the safe and efficient drilling of that well. Each case is a unique combination of factors, including geology, well trajectory, level of BHA complexity, and absolute stopping tolerance. All possible methods should be discussed and evaluated in a two- way process involving the operator and service provider in order to determine that which provides the most efficient method of detecting and stopping at the desired location in a timely manner. Any modelling necessary for making this decision should be undertaken and evaluated for compliance with the aim of the geostopping and any limitations put upon it, including complexity and timeliness of detection. Once this method has been agreed upon, a clear decision tree and strategy should be drawn up and followed throughout the real-time drilling phase. This case study shows that even a highly challenging well trajectory with a tight stopping tolerance may be successfully delivered by following the process outlined here.

Reference Cited

Lindsay, G., 2008, An Analysis of the At-Bit Resistivity Decision Making Process: International Petroleum Technology Conference, 3-5 December, 2008, Kuala Lumpur, Malaysia, https://doi.org/10.2523/IPTC-12513-MS

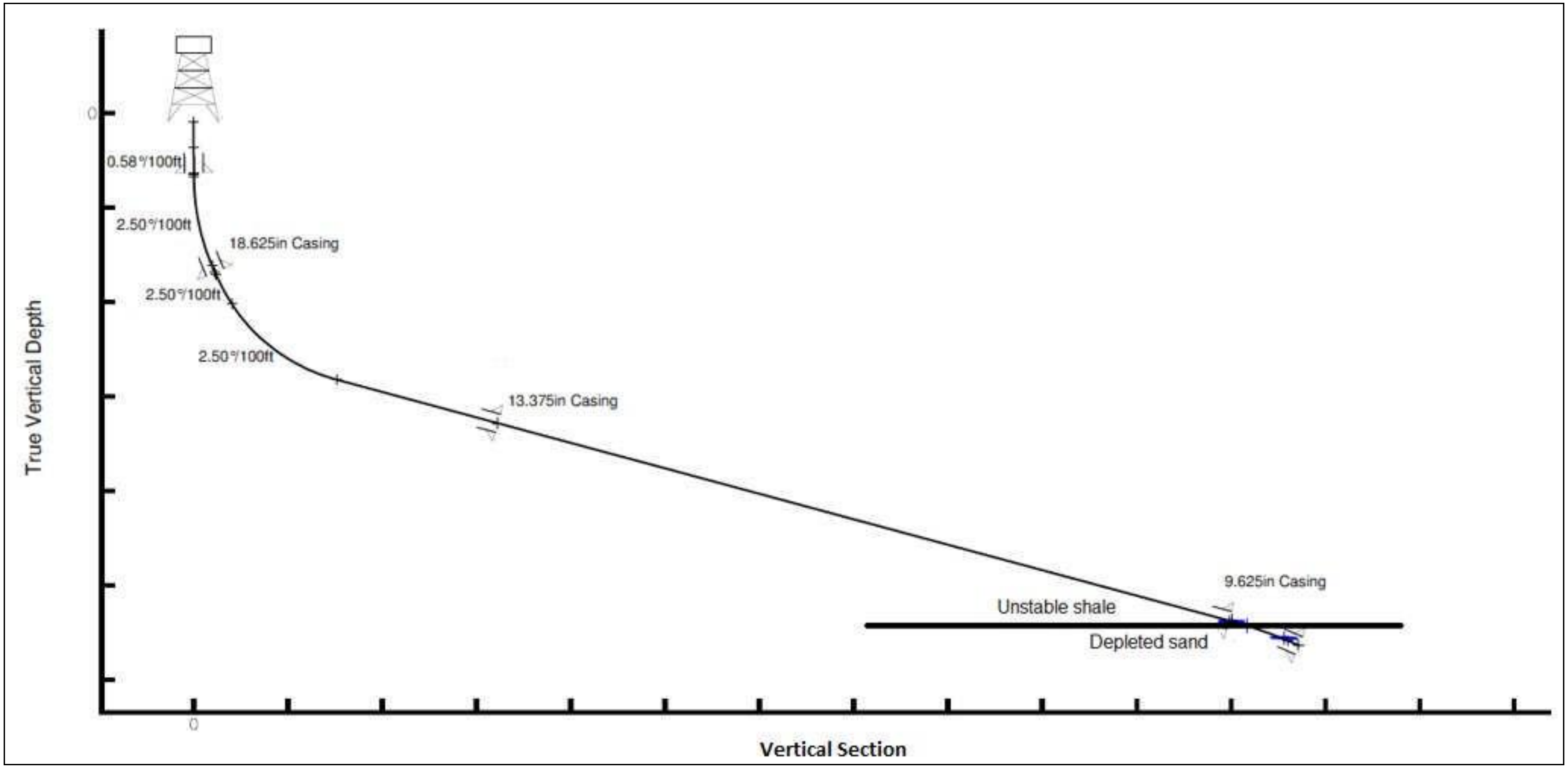

Figure 1. Schematic of pre-well plan and position of depleted sand layer.

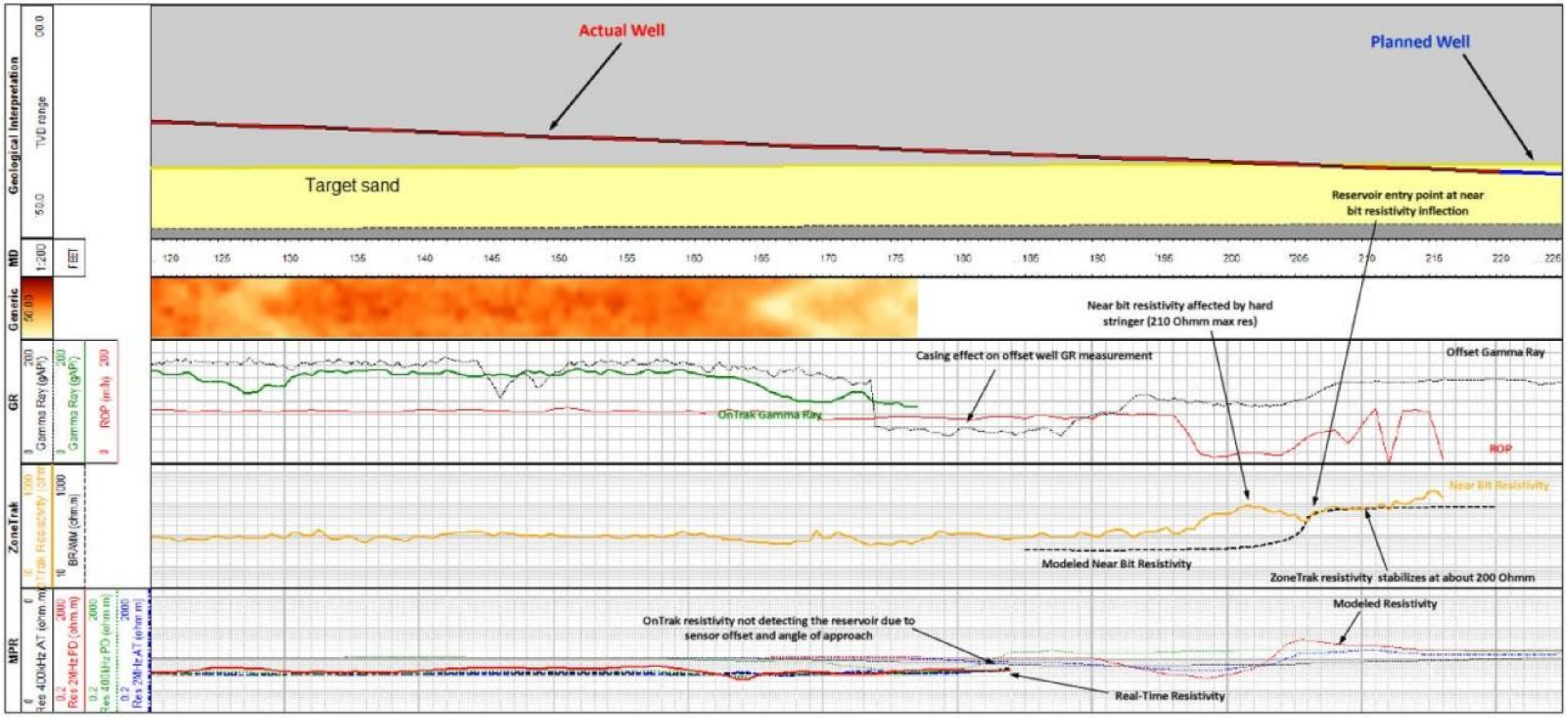

Figure 2. Section of real-time navigation screen showing correlation with currently selected offset well and LWD sensor response, including Bit Resistivity and Gamma Ray image.