

Oil Review

Oil · Gas · Petrochemicals

Middle East

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What lies ahead for the OIL MARKET?

- Drilling automation solutions
- The evolving oil and gas job market
- Complete lifetime efficiency for offshore terminals
- Advanced surface logging for well placement
- The latest in gas detection
- Bolted joint integrity

22
Years

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Advanced surface logging for well placement

Michael Macdonald and Rabie Ali, GEOLOG, discuss the benefits of advanced surface logging and its applications in well placement.

THE MEASUREMENT AND monitoring of mud gas data and the collection of drill cuttings while drilling is a standard practice in mud logging during the drilling of both exploration and development wells. Continuous gas monitoring enables operators, in general, to indicate the presence of hydrocarbon bearing intervals in addition to safety purposes. The collection of cuttings allows for a basic geological study to be completed on-site while preserving the cuttings for additional potential analysis in the future.

A suite of services which extend beyond conventional mud logging to more advanced analysis, inclusive of: gas while drilling (GWD), cuttings while drilling (CWD), real-time isotopic analysis, flow monitoring and drilling optimisation, is available. These services are enabled by recent technological innovations in surface acquisition technology and have already demonstrated huge potential in improving the characterisation of reservoirs while providing operators with direct cost savings. The results, validated by correlation and comparison with other data such as downhole logs, well tests, PVTs, etc., have allowed for a new set of applications, such as:

- Well placement and geo-steering
- Gas/oil and hydrocarbon/water contact identification
- Vertical and horizontal heterogeneity in organic tight rock formations
- Reservoir zonation, fluid characterisation and maturity
- Vertical changes in fluid over a thick mono-layer pay zone

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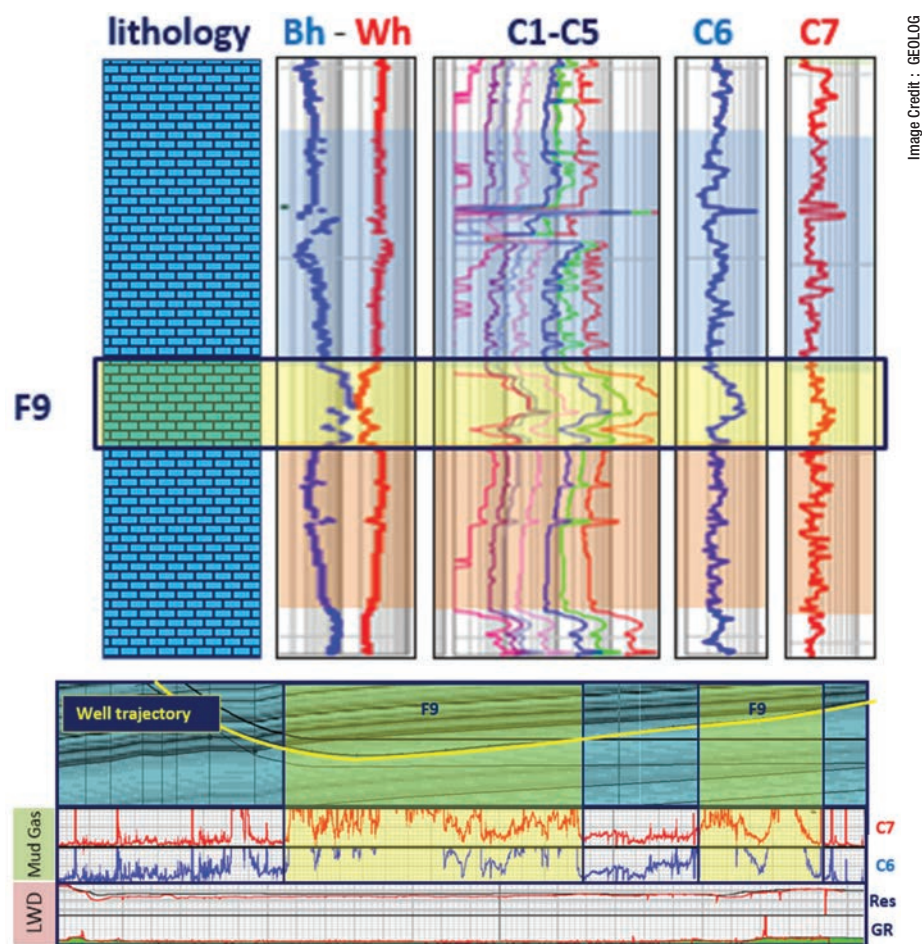


Figure 1. Geosteering, using the mud gas data, along with LWD GR and Resistivity. Advanced Gas Detection System from GEOLOG, the G8.™

- Drilling optimisation (ILT), risk mitigation (NPT) and optimising well delivery.

Well placement traditionally refers to the real-time positioning of wellbores using measurements acquired mainly downhole. The term is often used in reference to directional or horizontal wells that are oriented to maximise contact with the most productive parts of reservoirs. Due to the economic advantages of maximising

reservoir contact, horizontal and multi-lateral development programmes have quickly become the new norm in the Middle East and globally.

GEOLOG contributes to the challenge of well placement by providing near real-time analysis of either advanced mud gas data or the elemental and mineralogical signatures of the cuttings which return to surface (chemostratigraphy).

Image Credit : GEOLOG

In both cases, either through pre-drill analysis of offset wells or by analysing the data from a pilot hole, the mud gas and/or mineralogical/elemental signature of the target reservoir(s) are identified. These signatures can then be monitored from surface to ensure the well remains within the target zone. GEOLOG has deployed both of these methods in the Middle East and has been able to clearly demonstrate added value by reducing the number of downhole measurements and, in some cases, by providing the sole dataset used to place the well after downhole failures. These surface datasets have proved to be key components of the integrated data model used in optimal well placements in both conventional and unconventional reservoirs.

Figure 1 shows an example of one of the potential benefits of utilising mud gas data in well placement. While drilling a lateral well in Kuwait Oil Company's Middle Marrat carbonate reservoir, GEOLOG's G8™ service was utilised to complement the LWD resistivity and gamma ray readings. While drilling the pilot hole, the target reservoir was initially identified (F9). Once the lateral section commences, utilising the mud gas data, it is quite clear when the reservoir has been left. This is seen by the sharp drop in the C6 and C7 components of the hydrocarbons in the mud gas (between the highlighted zones in Figure 1). However, looking at the LWD resistivity and gamma ray in this case, there is very little movement. This is due to the increased cementation once the carbonate reservoir has been exited. In a case such as this, the mud gas data becomes invaluable in geosteering the well back into the zone of interest.

Gas ratio analysis has been used effectively for real-time gas evaluation. These ratios generally compare the relative quantities of the heavier components with the lighter

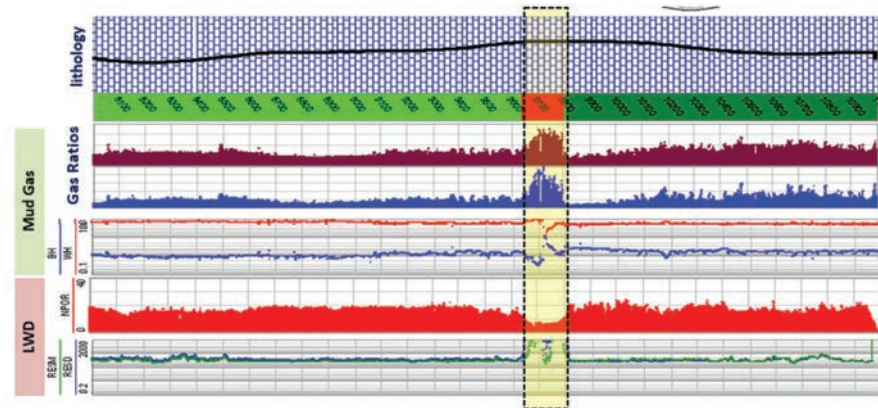


Figure 2. Geosteering, using the mud gas data, along with LWD Porosity and Resistivity. Advanced Gas Detection System from GEOLOG, the G8.™

“Versatile services and advanced technologies utilised in well placement have demonstrated substantial value to operators worldwide.”

fractions, with different ratios corresponding to different reservoir and fluid types. Analysis of the different combinations of gas fractions can lead to fluid type identification and yield other significant information. Ratios bring out these indications by enhancing the aspects that are not easily picked up by visual examination of raw data. Figure 2 shows an example from a well drilled by Chevron in the South Fuwaris field located in the partitioned zone between Saudi Arabia and Kuwait. This lateral section was drilled through a sub-layer of the Rawati

Oolite. Again, LWD is on the bottom and the GEOLOG G8™ mud gas can be seen on top. While in the previous example (Figure 1), the LWD resistivity did not provide a good indication that the reservoir had been exited, that is not the case here. When the tight upper ceiling is penetrated, the spike in resistivity is clear. This is matched by an equally large change in the mud gas ratios. In this case, the mud gas data provides an independent validation of the LWD data. Seeing this leaves no doubt of a potential tool failure and ensures that corrective action can be taken immediately.

Chemostratigraphy service provides detailed chemical and mineralogy rock characterisation on drill cuttings and core chips. A combination of X-Ray Fluorescence (XRF) analysis and X-Ray Diffractometry (XRD) measurements are obtained in near real-time at the well site. All key chemical, mineralogy, and geomechanical information are delivered within one to two hours of drilling through a formation, providing an extremely valuable and much needed alternative to the conventional long wait times for lab results and the costs associated with them.

Through a thorough pre-drill analysis of the Burgan formation in Kuwait, the elemental signatures of faulted zones were determined. As seen in Figure 3, tracking these signatures then supported the geosteering of the well through a relatively homogeneous sandstone sequence. The presence of faults dislocated the target, and the identification of specific chemical markers (in this case, zirconium, potassium, aluminum and titanium) with the GeoROX™ service helped not only to identify the faulted zones but also to isolate them in the production string to optimise overall production.

Versatile services and advanced technologies utilised in well placement have demonstrated substantial value to operators worldwide. In the Middle East, where more and more of the wells are drilled deviated, horizontal or extended reach (ERD), the need for integrated data will always be an added value to the operators. ■

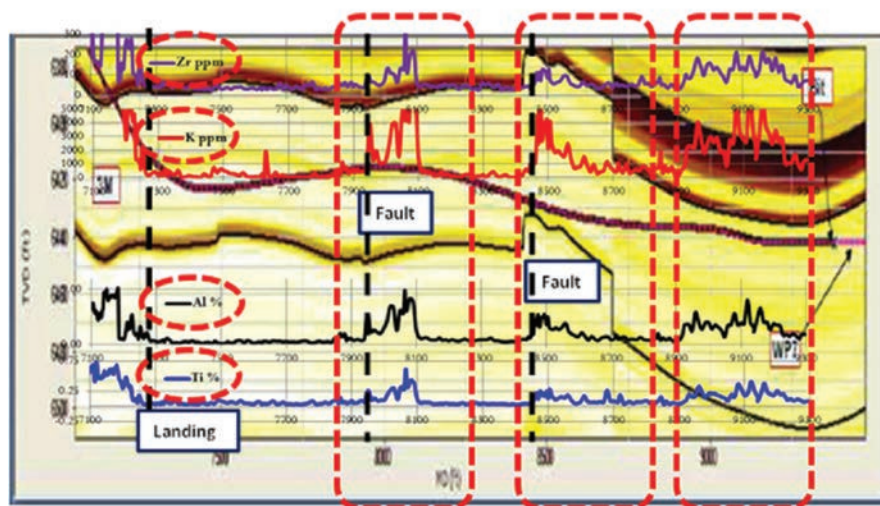


Figure 3. GeoROX™ Service provides the elemental signatures used to identify the fault zones in the horizontal well.