

Case Study: Integrated formation evaluation for Geosteering

Fluid characterization and formation evaluation through surface logging enhances carbonate reservoir development

Client

Kuwait Oil Company
Onshore Development, Kuwait

Challenge

The Mauddud “E” & “D” zones are difficult to differentiate as they are adjacent, clean carbonates. Differentiating the clean sandstone of the Mauddud “H” from the clean carbonate in the Mauddud “G” is also difficult using basic LWD tools. These challenges result in geosteering accurately being both difficult and costly. Limited sampling has resulted in little being known about the hydrocarbon content in the Mauddud “H”. Impermeable barriers are known to exist within the Mauddud but are not readily identified.

Very little information exists in terms of:

- Connectivity of fluid in the reservoir sublayers
- Fluid maturity
- Fluid charging (single or multiple charge-events)
- Fluid quality changes in the reservoir sublayers

Solution

GEOLOG provided an integrated suite of real-time services that included geochemical analysis of drill cuttings and core chips combined with compositional and isotopic analysis of mud gas.

Results

The integrated services have demonstrated the ability to identify and differentiate the Mauddud D & E sub-layers and identify the Mauddud H sandstone layer.

The hydrocarbon fluid content and maturity has been identified through the entire Mauddud formation, confirming the common thermogenic origin throughout. This suggests that variations in hydrocarbon content are not related to different origins. These observations, delivered in real-time allowed geosteering to position the well in the optimal zones.

Value

This integrated approach enabled the asset team to build an accurate geological model in near real time at a far lower cost than using more complex LWD tools. The results were applied to the geosteering model to allow effective well placement and completion.

Services used

GEOROX Mineral & elemental analysis

G9+ C9-C27 Hydrocarbon analysis

GEOIsotopes Carbon isotope analysis (C1-C3)

The integrated fluid and rock properties analysis provides an accurate reservoir fluid characterization as illustrated in figure 1. The Mauddud “D”, primarily a clean carbonate with light hydrocarbons in the upper section and heavier components near its base is one of the main targets in the Mauddud reservoir. The top of the Mauddud “E” displays a decrease in hydrocarbon content with an increase in argillaceous limestone which is possibly acting as an impermeable barrier. The Mauddud “F” displays a lack of hydrocarbons, which correlates to the appearance of argillaceous content. In the Mauddud “H” the sediment environment changes to sandstone with ankerite cementation. The hydrocarbon content reaches a maximum level in Mauddud “H” reservoir, comprising lighter components when compared to upper sublayers. The phytane to pristane ratio demonstrates significant changes in the horizontal section, suggesting changes in the nature of the fluids analyzed.

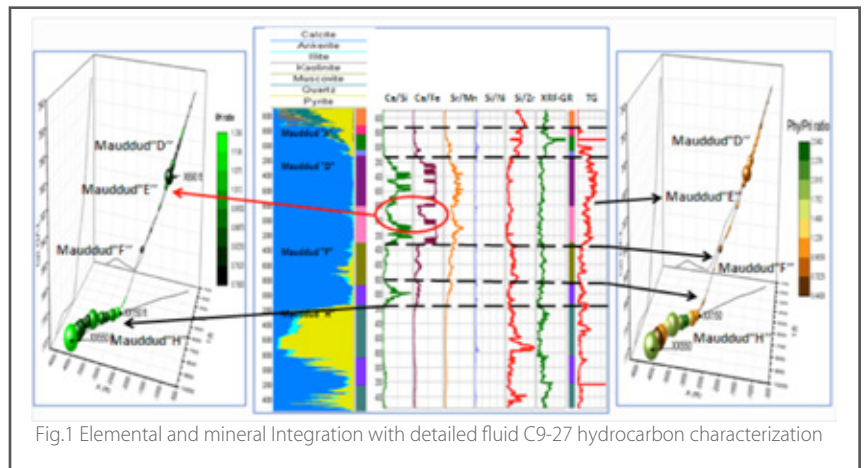


Fig.1 Elemental and mineral Integration with detailed fluid C9-27 hydrocarbon characterization

Figure 2 illustrates the carbon isotope ratios of methane, ethane and propane follow a common trend throughout the Mauddud formation, indicating the same fluid origin. This suggests that the fluid composition changes in the horizontal section are not related to the origin of the fluid. The result is revealing the “wet thermogenic origin” of the methane in the entire section. The consistency of the data and the fact that no drifts or trends are visible indicate that no mixing with biogenic gas has occurred.

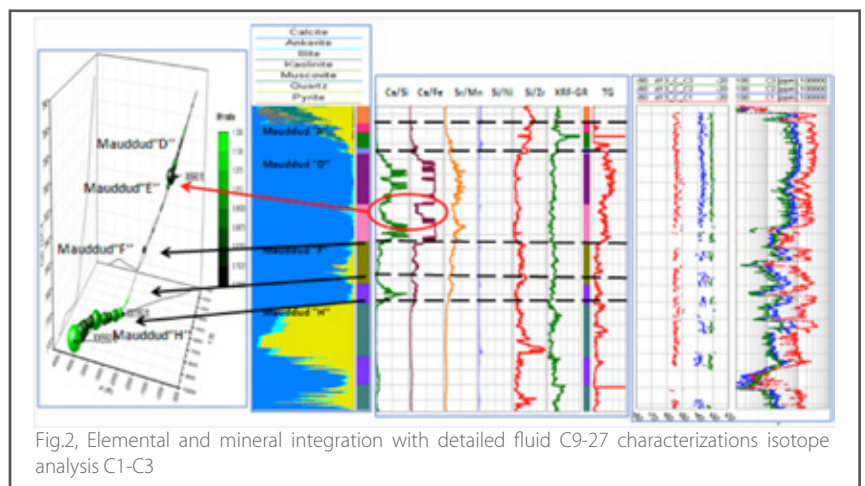


Fig.2, Elemental and mineral integration with detailed fluid C9-27 characterizations isotope analysis C1-C3

Technical Paper References



Innovative Well-Site Surface Logging Solutions to enhance Mauddud Reservoir in Sabiriyah- EAGE 44499