Case study: Abidjan, Cote D'Ivoire

MagTrak service confirmed gas zones in sand-shale sequences without density-neutron crossover

Gas identification and determination of gas-oil contact (GOC) in reservoirs can be a major challenge in laminated sand-shale sequences where the presence of shales drastically affects the response of gamma ray, resistivity, density, and neutron logs. Due to the resolution of these measurements, it becomes increasingly difficult to identify and quantify the gas reservoirs.

Using a conventional penta-combo borehole assembly (BHA), a customer in West Africa with an offshore development well in a Cretaceous formation obtained basic formation evaluation (FE) measurements. In order to improve the confidence in interpretation of the reservoir fluids, the customer contacted Baker Hughes to supply additional services such as nuclear magnetic resonance (NMR) and formation pressure tester logging while drilling (LWD) services.

The Baker Hughes **MagTrak™ LWD magnetic resonance service** offers industry-standard, transverse relaxation time (T2) -based, real-time magnetic resonance data that locates and identifies producible fluids even under the most difficult drilling conditions, such as high inclination and high-risk wells.

In the customer's well, though the size of the density-neutron crossover showed a reduction in the oil zone as compared to the gas zone to a certain degree, the actual position of the gas/oil contact and the reservoir fluid saturation were not certain. Using the traditional NMR porosity under-call in the gas zones as well as the dual wait time (DTW) T2 distribution analysis, the MagTrak service confirmed the gas zone and the saturation of each of the fluids in the reservoir was accurately determined.

The MagTrak tool was programmed to acquire data in DTW mode. The magnetic resonance DTW approach takes advantage of longitudinal relaxation time (T1) contrast to solve for hydrocarbon saturation. Due to the low hydrogen index of gas, the short wait time will only polarize a fraction of the porosity in the gas zone while achieving a near full polarization in the liquid (oil or water) zone.

The same hydrogen index effect was evident in the total porosity computation from the NMR measurement. Significantly lower porosity was observed in the gas zone as compared to the oil zone. This was the first indication of GOC. Further analysis of the dual wait time T2 distribution gave a proper estimate of the saturation of the fluids in the reservoir.

In this operation, the MagTrak service was unaffected by the laminated sand shale sequence. The tool was able to accurately determine the fluid type in the presence of shale and gas.

Challenges

Identify and quantify gas reservoirs in laminated sand-shale formation

Results

- Confirmed presence of gas in the absence of a density-neutron crossover, and position of the contacts via a pressure gradient plot
- Observed no casing pressure or fluid flow in isolated casing strings during the frac jobs or sustained casing while producing the well
- Experienced no health, safety and environmental (HSE) issues or nonproductive time (NPT)

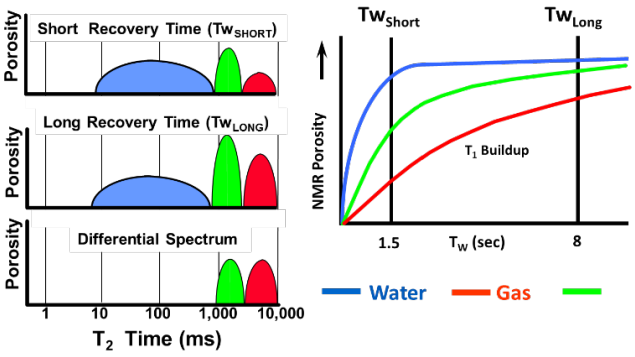

Figure 1: Dual wait time methodology

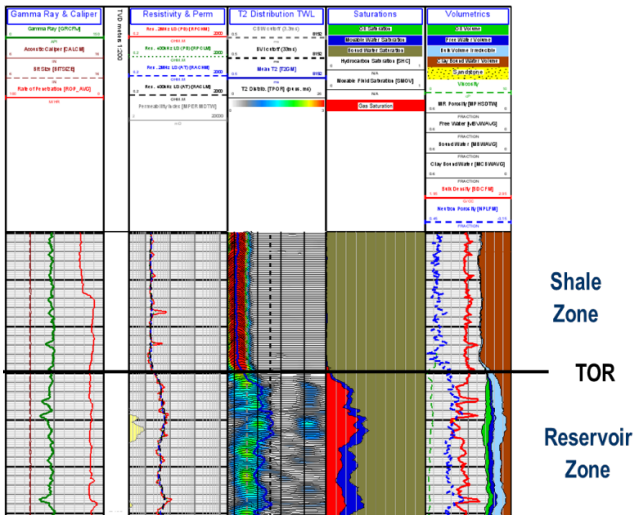

Figure 2: Top of reservoir (TOR)

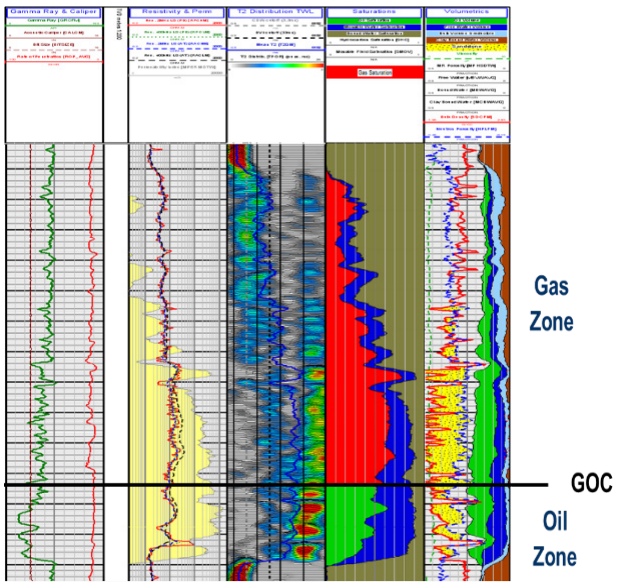

Figure 3: Gas-oil contact (GOC)

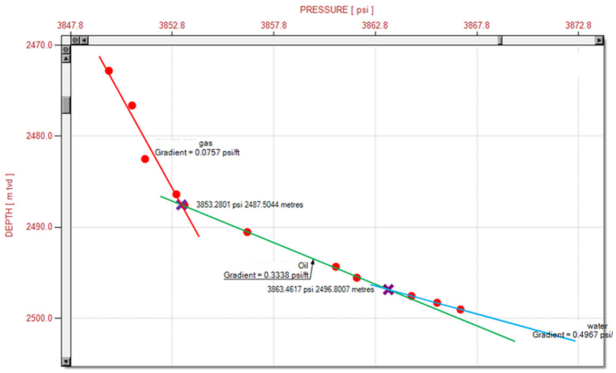

Figure 4: Pressure gradient plot

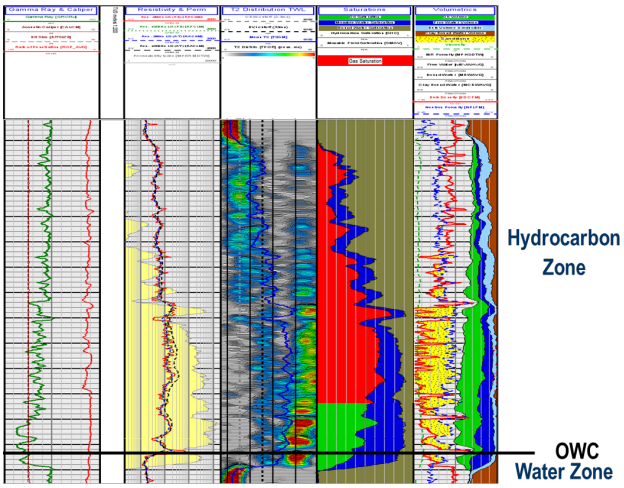

Figure 5: Oil-water contact (OWC)

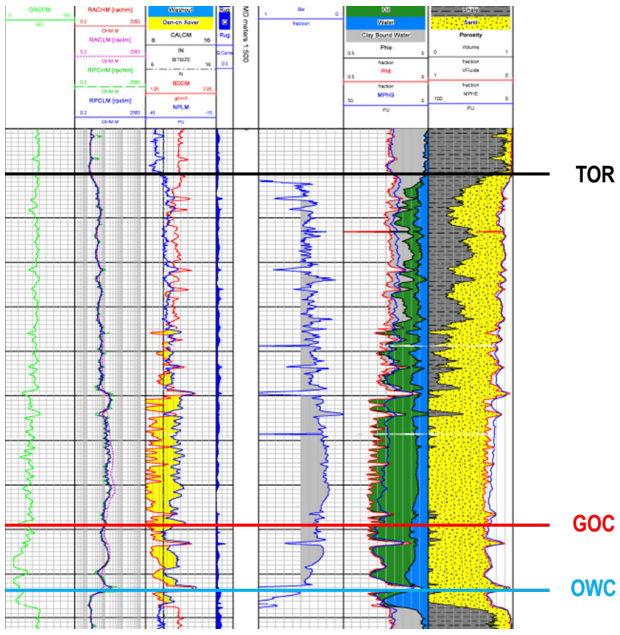

Figure 6: Comparison between total porosities of stochastic analysis (Phit) and magnetic resonance (MPHS)

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