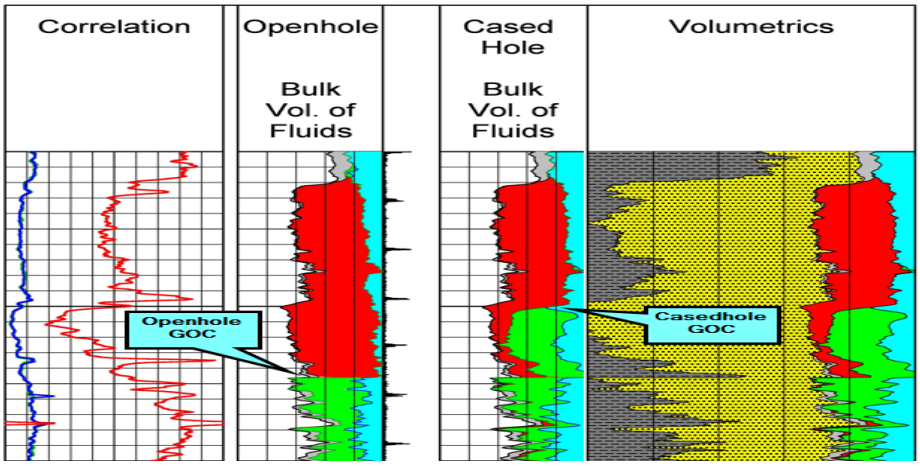
Case study: Nigeria

OmniView Service Determines Three-Phase Formation Fluid Saturations and Reduces Ambiguities in Reservoir Monitoring



OmniView service identified Gas-Oil-Contact (GOC), which has moved up as compared to Openhole logs. The gas cap underwent contraction due to water injection and re-pressurization of the reservoir.

The Understanding formation saturation changes and movements in fluid contacts is crucial for optimizing field development and maximizing production from the reservoir. This is particularly important for reservoirs that have gone through several phase changes, with gas cap expansion due to production followed by contraction due to water injection and re-pressurization of the reservoir. Historically, pulsed neutron instrument based services like Sigma and / or Carbon-Oxygen (C/O) have been used for through-casing reservoir monitoring. But, a three-phase reservoir adds another degree of complexity to the overall measurement.

Background and Challenges

One of the key operators in Nigeria have been facing challenges in quantifying the formation fluid saturation in the Niger delta field, which was discovered between 1968 and 1980. These fields underwent primary depletion and with the drop in reservoir pressure, gas caps started to expand. Eventually, water injection was initiated to increase formation pressure, causing the gas cap to recede. As the Gas-Oil-Contact (GOC) moves up and down in the reservoir, there appears to be a residual gas saturation left in its wake, as observed by openhole logs in more recent wells. Understanding the current gas, oil and water saturations in the reservoir was critical for appropriate development of these fields. Three-phase reservoir and low water salinity made through-casing formation fluid saturation even more challenging.

Challenges

- Simultaneous presence of three-phase formation fluid
- Low water salinity reservoir
- Reservoir had gone through multiple phase changes with gas-cap expansion due to production and compaction due to water injection

Results

- Confirmed gas cap contraction due to re-pressurization by water injection
- Identified three-phase formation fluid saturation, reducing ambiguities in reservoir monitoring

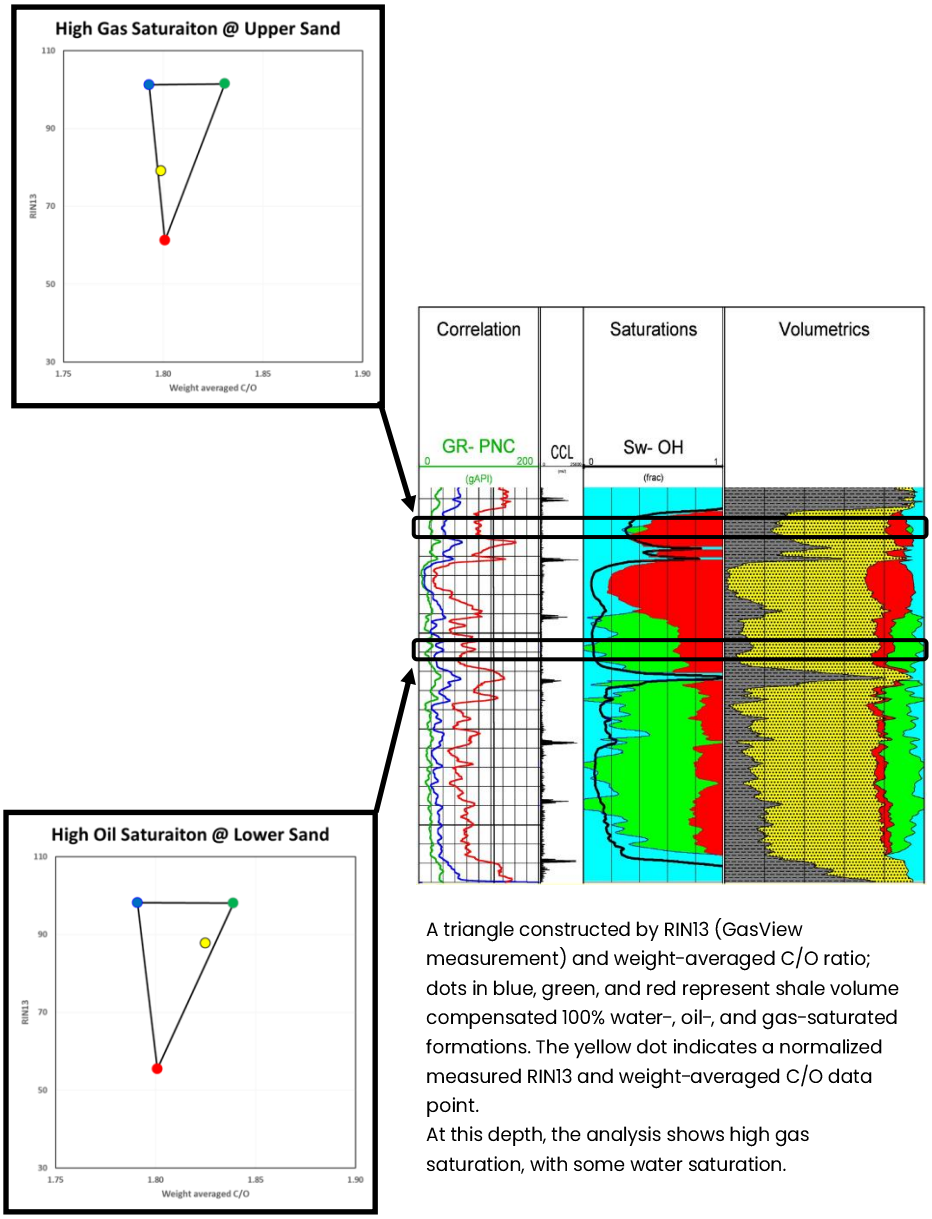
Three-Phase Saturation Monitoring

Baker Hughes deployed **Reservoir Performance Monitor™ (RPM™)** instrument based **OmniView™** salinity-independent three-phase formation fluid saturation service to identify gas, oil and water saturation through the casing. RPM, which is industry-first multi-detector pulsed neutron instrument, improves gas sensitivity by up to 300%. The results clearly identified contraction of gas cap, which resulted in GOC moving up from the original depth due to reservoir re-pressurization by water injection. OmniView service utilizes a patented triangulation technique integrates the C/O analysis with **GasView™** salinity-independent quantitative gas saturation service, to simultaneously derive oil, water and gas saturation.

Well-specific modeling enables pre-job sensitivity evaluation

Well-specific forward modeling of RPM responses is crucial for delivering OmniView results. Monte Carlo N-particle (MCNP) software is used to provide pre-job sensitivity analysis even in the most complex well completions, including dual tubing well completions. Saturation uncertainty can be estimated based on the comparison of the predicted MCNP responses and known statistical errors of measurement.

In this particular case, the well was completed with 7-inch casing, 3.5-inch tubing in a cemented 8.5-inch hole.



A triangle constructed by RIN13 (GasView measurement) and weight-averaged C/O ratio; dots in blue, green, and red represent shale volume compensated 100% water-, oil-, and gas-saturated formations. The yellow dot indicates a normalized measured RIN13 and weight-averaged C/O data point.
At this depth, the analysis shows high gas saturation, with some water saturation.

Baker Hughes