Generating Value through New Logging Technology and Analytical Methods - Case Study from Offshore West Africa*

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Abstract

The West Africa basin encompasses a vast diversity of geological depositional settings, in and from which hydrocarbons are being explored and produced. Offshore, Cretaceous aged turbidity slope-channels and fan systems still prove to contain volumetrically significant oil and gas reservoirs. An intelligent petrophysical evaluation is essential to enable the most adequate development and production strategy to be deployed. The siliciclastic rock units can be structurally heterogeneous, with the reservoir distribution and quality highly variable, making it hard for conventional logs data to pick potential reservoirs with pay. This article illustrates remarkable examples of intelligent logging assessments in highly complex reservoir units with focus on successful applications of novel technology deployed in effective and efficient fashion.

These reservoirs have variable thickness and generally medium permeability (200-800 mD); but silt and clay laminations and tight material are affecting the reservoir quality in some layers, resulting in changes in the well productivity and sweep properties. The fresh to very fresh formation water environment diminishes the contrast of water to hydrocarbons making it difficult for any salinity based measurement technique, like resistivity, to easily unravel hydrocarbon bearing intervals. Besides, some of the reservoirs are stacked sand bodies with varying salinity values among the different hydraulic units and cannot be accessed by conventional open-hole logging. Novel dielectric dispersion and high definition spectroscopy technology are game changers in their respective range of applications. Whether run in combination with other measurements and analyzed in an integrated approach or as stand-alone analysis if needs arise, the appropriate use of these techniques highly reduce uncertainty of hydrocarbon volume and net producible fractions. Comparison of the formation evaluation results to actual well testing confirms the improvements in reservoir description from the addition of advanced logging measurements (at early stage of reservoir development) into reservoir models. The information provided guides optimal perforation and completion design and helps in defining future field development plans.
Reference Cited

**Introduction**

The Gulf of Guinea is a very appealing oilfield venue with prolific oil and gas production fields; yet the current market price requires reviewing proven reserves evaluation programs that find additional oil of to maintain production increase.

Logging has a primary role on proper description of existing reservoir systems and screening of new productive sand units for optimal development plan and production strategy. Decisions need to be made instantly and be effective for quick robust selection of completion intervals and recoverable rates. Case studies from Gulf of Guinea show the life and importance of applying advanced tools and techniques such as NMR and dielectric spectroscopy to determine the presence of hydrocarbon and quality of reservoir intervals.

This study documents two recent development wells drilled through a complex shale sand sequence in the Dahomey Basin. The Location is in the middle of the continental margin of the Northern Gulf of Guinea including the South of West Africa, Benin, Togo, and Nigeria.

Multiple reservoir rocks and a variety of potential trapping mechanisms are encountered in the sedimentary basin of interest. The lithology ranges from coarse sandstones and conglomerates to thin layers of silty sands or shales.

The are proven to be an oil prone after the discovery of the gave of oil in 1969 (Maro et al., 1994). Oil from the main sand reservoir within the field is fairly heavy, low sulfur crude; with lower viscosity compared to water.

Carnate water are fresh with low and variable salinity. A wet formation could show a resistivity spike due to presence of fresh water filled porosity help to delineate reservoir potential using cased hole or after setting the casing. The log results confirm the presence of quality sands intercalated by shale layers and cementation at certain levels. The accurate mineralogy helps understanding of other large reservoirs, which was immediately converted to fluids volume across the reservoir of interest.

The complex lithology and fluids profile of low contrast reservoir sequence.

**Case Study A:** Open Hole Advanced Technology Application

Development well drilled with water base mud through a shale sand sequence. Carbonate layers and silt and clay laminations affect the reservoir quality. The vertical connectivity across the fluid column may be compromised, increasing the chances of the reservoir being compartmentalized. Dielectric dispersion measures permittivity and conductivity at multiple frequencies, whereas acquired using on-site and off-site measurements. Curve-fitting techniques and signals' deconvolution are integrated with high-resolution anisotropic water volumes and saturation, formation water salinity, rock texture in the near-wellbore regions; salinity into the formation (shallow & deep).

**Case Study B:** Cased Hole Advanced Technology Application

Subsequent well developed drilled in a complex sector of the field. Formation evaluation was planned through open hole logging. However accessing the target reservoirs is risky; hence the decision to immediately set the casing. A first attempt to delineate reservoir potential using cased-hole density and neutron with resistivity while drilling was not successful, but data was analyzed with formation evaluation when compared to regional experience and offset data. The formation resistivity is generally low, and responds to variation in mineralogy and connate water properties, but offset completion lithology and matrix properties from capture and delineation gamma ray spectra analysis, the advanced measurement determined accurate organic carbon content which was immediately converted to fluids volume across the reservoir of interest.

The results of the oil saturation are directly linked with high resolution of resistivity-based methods and variation in water salinity and clay content; hence resistivity and confidence. This is the first successful application of the methodology in the region and challenging cased hole conditions in West Africa.