SPWLA INDIA CHAPTER



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Novel approach for estimating water saturation and net pay in laminated shale sand reservoirs

Authors: Team CEWELL Vadodara, ONGC

The pay sands within Kamalapuram Formation, Cauvery Basin are characterized by low formation resistivity values, due to the combined effects of high formation water salinity and laminated nature of the reservoir.

Conventional, resistivity based, approach for estimating water saturation & net pay returns pessimistic figures in laminated reservoirs and therefore, effective alternatives need to be explored to address this challenge. In this quest, a resistivity independent computation has been attempted using Saturation Height Modelling for realistic estimations of saturation & net pay. In the absence of any hi-resolution log data which could have possibly resolved thin laminated sequences, an integrated methodology using conventional logs and a wide range of core data was adopted.

Nearly 73 core plugs were subjected to extensive studies at the Petrophysics & NMR labs of CEWELL. The Winland plot for core derived porosity & permeability from 67 plugs indicated four different rock facies, each having different pore throat sizes. The Pc vs Sw plot, using capillary pressures derived from centrifuge method on 28 core plugs, also indicated four different rock type facies. The T2 cutoffs determined on core samples at NMR lab were found to be in the range of about 25-28 ms for Kamalapuram field whereas for Vijayapuram field it was about 13-14 ms, the lowering of which may be due to silty nature of the reservoir.

Electro-facies were generated using advanced statistical algorithms viz., Self-organizing Map (SOM) and were mapped with corresponding core derived reservoir facies with the help of specific poro-perm relationships. A continuous permeability curve was generated using individual poro-perm relationships for the identified facies and was then correlated with NMR derived permeability and core measured permeability.

The advanced capillary measurements on cores were further modelled and regressed for deriving the constants in the selected facies and absorbed in the considered saturation height function. The level-by-level water saturation computation was carried out using Saturation height model with known free water level and estimated permeability constrained by capillary pressure and facies. The computed water saturation was in good agreement with that of conventional methods against thick clean layers validating adopted work flow. The developed workflow helped compute additional pay thicknesses within the top shaly reservoirs of the ES-2, ES-3 and ES-3A & 3B sand packages of Kamalapuram Formation.

CEWELL Vadodara, which developed the novel approach, earned itself a patent for the methodology. Granted in 2023, the patent is valid for a period of 20 years.





Fig2: Workflow adopted for the study

Fig1: Linking of reservoir facies with litho facies

SPWLA India Chapter-Technical

Formation fluid detection and quantification using multidetector PNL (SAT-G) in carbonates

Authors: Seshadev Rana (ONGC Mumbai), Nishi Chauhan, Ravinder Kumar & Sandeep Ramakrishna (HLS Asia Ltd)

This paper presents special case for maximizing the hydrocarbon gain with an approach based on standalone integrated formation fluid identification using multidetector pulsed neutron tool. Cased-hole PNL logs are the best suitable technology for brown fields. Pulsed-neutron tool with at least three detectors can provide three-phase formation fluid analysis in cased wells giving a clear idea of formation fluid, hydrocarbon quantification, porosity and lithology.

Exploration and development of more complex reservoirs require three-phase analysis (oil, water, and gas) and this requirement has led to the development of true gas saturation measurements in addition to the traditional measurements of oil and water saturations. Previously, gas saturation was determined only by inference: If the sum of oil and water saturation was less than 100%, the difference was considered gas. All three saturation measurements can be made with a single instrument, providing a powerful set of data that can be used in Petrophysical or well diagnostic cases.



A water injector in L-III reservoir of the matured field of Western Offshore had to be zone transferred to L-I. Carried out RMT job against L-I reservoir. Based on RMT derived saturations & log motifs, zones were identified in L-I-b (carbonate) & L-I-c (clastic). Initially 6 m was perforated with 4 1/2" Tag Gun and the well became active soon after perforation. Subdued the well with 10.9 ppg brine and completion string was lowered. Another 4 m of perforation is still left in the carbonate segment L-I b which would be carried out with Through Tubing Perforation later.

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The RMT job was planned by Logging Services Mumbai & MH Asset. This adds another dimension to L-I reservoir exploitation. Based on RMT interval xx30.0-xx36.0m were perforated.

Well is flowing at around 286 BOPD with 45 % water cut. Water cut will reduce on further knock out as the produced water salinity is in the range of 29000 ppm which is technical water.

In absence of basic logs within the reservoir section, RMT-3D was acquired with Sigma up/down pass at 4.5 meter per minute and 3 CO up passes at 1mpm to quantify the leftover hydrocarbon and SAT-G measurement helped in identifying gas in the formation. Volume calculation of shale and porosity estimation has been done using standalone pulsed-neutron tool.



RMT was recorded in another well in Western Offshore where Open hole logs were not available. Based on the RMT-3D logs, gas saturation was computed and the zones identified were perforated resulting in substantial gains in hydrocarbon.

Conclusion: PNL logging has proven to be a remarkably efficient, effective, cost-saving, and with a reduced carbon footprint application in brownfields, both in the present and in the near future. By utilizing this tool to record logs in mature fields and subsequently identifying bypassed hydrocarbons through log interpretation, substantial gains can be accomplished in a cost effective manner.

SPWLA India Chapter-Technical

ProximaTM Advanced Logging Services Delivers Value in Deepwater Exploratory Well

Authors: Jonathan D'Silva, Harsh Vardhan - Baker Hughes

In the realm of Deepwater exploration, where time is synonymous with significant expenses on offshore rigs, the importance of seamless data integration and operational efficiency cannot be overstated. This article unveils the first-time application of Baker Hughes' ProximaTM advanced logging services during ONGC's recent east coast Deepwater operations. ProximaTM not only met formation evaluation objectives but also saved crucial rig time, strategically addressing challenges associated with drilling in high-pressure zones. Challenge

Accurate data required to generate pore pressure results and effectively predict high pressure zones to bring in drilling mitigation factors.

Solution

Proxima[™] advanced logging service was selected based on its ability to log fast and deliver uncompromised data in real time. New generation Smaller and lighter tools enable a faster Rig up/ Rig Down and 2x data recording speed.

Shorter tool string enabled ONGC to get better well bottom coverage from all tool sensors and gave the flexibility to reduce the number of conventional runs from 3 to 1 run, saving valuable rig time. Results

Rig Time Savings: A minimum of 40 hours of total rig time was conserved, equivalent to approximately \$700,000.

Uncompromised Data Quality: The high-fidelity data obtained enabled ONGC to make swift decisions regarding the further logging program.

Drilling Plan Mitigation: Leveraging pore-pressure predictions generated from Proxima[™] data, particularly acoustic data from the Proxima X-Diploe (PXD) sensor in conjunction with VSP lookahead data, ONGC successfully mitigated risks in their further drilling plan.



Figure 1: Output to predict pore pressure lookahead using Proxima™ Advanced Logging Service data and VSP lookahead result

Figure 2: Composite Log data with processed Proxima X-Diploe (PXD) results.

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SPWLA India Chapter-Activities

SPWLA INDIA Chapter- Activities

SPWLA India Chapter conducted a Technical Session on 20th October 2023 at Dehradun. The Technical session was attended by 20+ Petrophysicists. President of the chapter Mr. S K Singhal welcomed the gathering and Vice President (Education) Mr. Sanjay Vohra gave a short brief on Technical presentation. The Technical Presentation on "A modern day approach to Electrofacies using MRGC Technique" was delivered by Mr. Sumanta Sarkar, Senior Petrophysicist Aspentech. The Presentation brought out different Unsupervised Clustering algorithms used for Electro Facies classification, their efficacy and how MRGC (Multi-Resolution Graph-based Clustering) is superior to other clustering algorithms. The presentation was followed by a lively discussion on the topic.



Sumanta Sarkar is a seasoned Petrophysicist with more than 18 years of oil and gas industry experience, currently serving as a Senior Petrophysicist at AspenTech, formerly Paradigm Geophysical/Emerson. Sumanta holds a wealth of academic qualifications, including an ongoing Ph.D. from IIT Bombay, an Executive MBA from ITM University, a Master of Science in Applied Geology from IIT Roorkee.

Glimpses of Technical Session



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