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Estimation Of Water Saturation Use Well Logs Technique In X Oil Wells, By TECH-LOG 2015 Software.

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A B S T R A C T

The aim of this study is to analyze water levels in the X oil field in Libya, with a particular focus on reducing unwanted water production and enhancing oil recovery. Petrophysical data extracted from well logs, including Gamma Ray, Spontaneous Potential, Sonic, Bulk Density, and Deep Induction Resistivity, were used to analyze two selected wells. The analysis concentrated on determining the average depths of water occurrence zones and evaluating their corresponding water saturation levels. The results of the analysis indicate the presence of water at approximately 8830 feet, with water saturation levels varying between wells, ranging from 0.14% to 0.94%. The interpretation of the log readings, using the cross-plot method for each well, was performed using Schlumberger Tech-log 2015 software.

The shale volume was determined based on the gamma ray log and the results showed that the Shale volume in the Wells formation ranges from about 17% to 40 % and this value increases toward the top of the formation. By identifying these depths and water entry zones, the study provides insights into water control techniques that can be implemented to improve well productivity and extend the productive life of wells.

Keywords: *well logs, formation evaluation, Petrophysical data, water saturation.*

1 Introduction

Formation evaluation is known as well log interpretation, by the process of analyzing geological and petrophysical data obtained from well logs, cores, and other sources to determine the properties and characteristics of subsurface rock formations. This information is essential for oil and gas exploration and production, as it helps geologists and engineers to better understand the geology, lithology, porosity, permeability, fluid content, and other properties of the reservoir. The data obtained from formation evaluation is used to make decisions about the feasibility and profitability of drilling and producing from a well {1}.

Excessive water production is one of the main well-known problems that would face any oil operation in the world. Although this problem is typical in older wells, it can also occur in new developed wells as well. That expands the working expense and prompts a lower the drawdown. For instance, on the off chance that the well is a gas lifted well, how much gas infused to lift the liquid from the wellbore to the surface is higher with the development of unreasonable water than without creating it {2}. Water creation likewise improves the presence of scales, erosion, and debasement in the field offices beginning from the wellbore to the surface offices. Another major problem is that the cost of separating, treating, and disposing the produced water is a great burden to oil company budgets {3}.

There are various types of formation evaluation techniques used in the oil and gas industry:

1. Geological Formation evaluation: This process involves analyzing geological data, including well cores, cuttings, and seismic data
2. Petrophysical Formation evaluation: This process involves analyzing well logs, petrophysical data, and other geophysical measurements to determine the porosity, permeability, and other physical properties. {4}
3. Mud Logging: This process involves analyzing the drilling mud and cuttings samples obtained during drilling to assess the geology, lithology, and hydrocarbon content of subsurface formations.

2 Statement of problem

The current understanding of the petrophysical properties of the reservoir rocks in the X oil field plays a crucial role in determining fluid saturation and water encroachment in oil wells. Water encroachment can be categorized into two types: unavoidable bottom water influx and avoidable "bad water," which is caused by phenomena such as water coning or "water fingering" in high permeability layers. In the case study of two oil wells in the X oil field. The problem of high-water saturation in oil wells is considered a fundamental challenge in petroleum engineering, as it significantly impacts both the efficiency of oil recovery and the management of water production.

3 Objectives:

The study involves analyzing the data collected from the X oil field to identify the sources of excessive water production in the wells by monitoring reservoir performance, efficiency, completion issues, and treatment effectiveness. This study selected wells in the X field, the largest oil field in Libya. The field is characterized by a sandstone reservoir with a strong bottom water drive.

This study also aims to investigate the following objectives:

1. To identify the water zone by evaluating well logs.
2. To integrate the results of petrophysical analysis from well logs.
3. To interpret the results of the plot charts.

4 Materials and Methods

1. Data collection: The first step is to collect all the necessary data.
2. Log Data Quality and Validation: All log passes were good and the data generally repeats very well. The reference curves were used for the interpretation.
3. Depth matching: The field log is correlated to the supplied depth reference, run logging The individual log pass data is loaded into the interpretation program and verified for repeatability and depth matching.{6}
4. Data run: The next step is run the data in to Tech-log 2015software.
5. Data analysis: the results need to be analyzed.{7}

5 Results and Discussion

5.1 Analysis and Discussion result well X-01:

By running the input data of well X-01 using Tech-log 2015 software, the major petrophysical parameters, such as Gamma Ray (GR), Induction Resistivity (ILD), Spontaneous Potential (SP), and Water Saturation (SW), were calculated, as shown in **Figure (1)**. The data reveals significant variation in saturation caused by lithological changes between depths of 8814 ft and 8861 ft, just above the pay zone, where SW is high (close to 1) and ILD is low, generally indicating a water-bearing formation. The SP, which helps in identifying lithology, shows a value of -12.9 mV, and the GR reading is 54.30. **Figure (2)**presents the second plot of well X-01, where additional petrophysical parameters, such as Lithology, RHOB (Bulk Density), POROSITY (PORSON), KLOG, and V-SH (Shale Volume), were calculated.

Each of these parameters plays a critical role in interpreting subsurface geological formations, particularly in the context of reservoir characterization and hydrocarbon exploration. Lithological variation from 8614 ft to 8861 ft is evident, with varying colors indicating different lithologies: green represents shale layers, while other colors indicate sand layers. The **Table (1)** shows interpretation petrophysical parameter for each of following depth (8250,8500,8750 and 9000 ft).

Table (1): petrophysical parameter of the well X-01, by using Tech-log 2015 software.

Depth	GR	ILD	SP	SW	RHOP	PORS	KLOG	V-SH
8250	48.30	5.213	-28.27	1	2.58	0.027	0.973	0.13
8500	70.749	6.210	-27.77	0.98	1.90	0.157	0.0348	0.109
8750	17.401	14.774	-93.31	0.28	2.34	0.159	500.53	0.0493
9000	24.858	6.348	-97.33	0.91	2.43	0.109	3.612	0.23

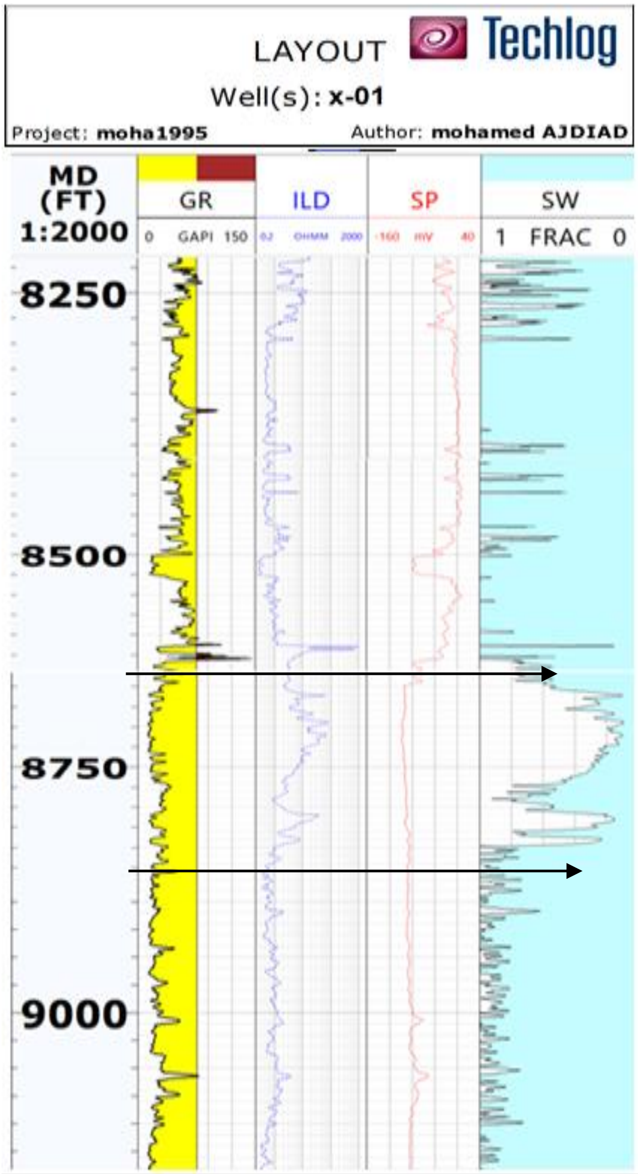

Figure (1): Delineation logs (GR, ILD, SP and SW) of the X-01 Well by using Tech-log 2015 software.

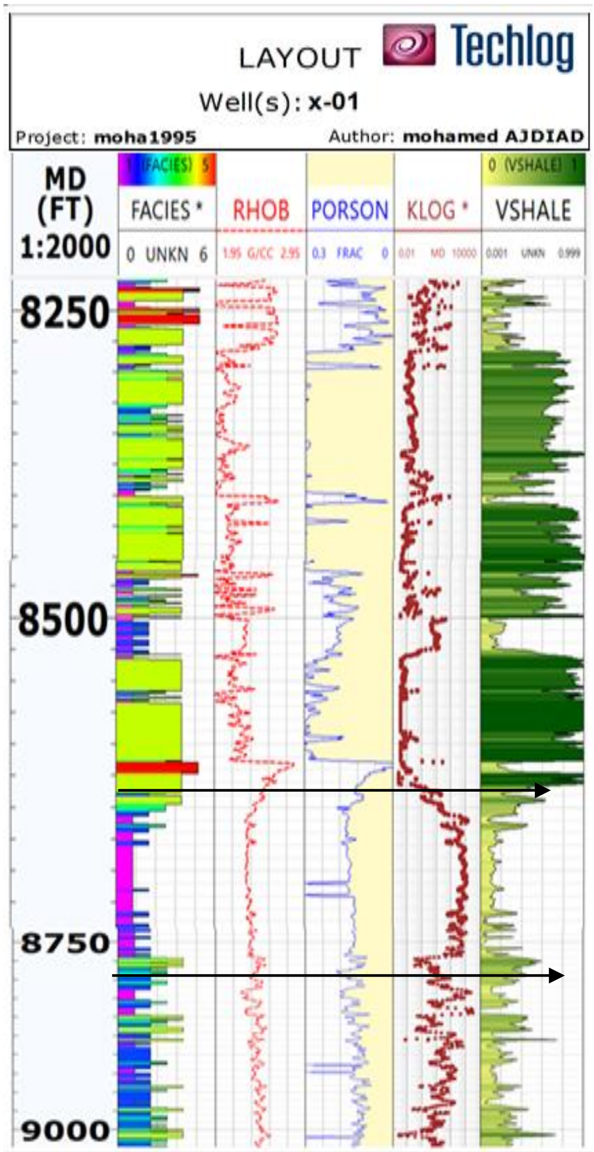

Figure (2): Delineation logs (Lithology, RHOB, PORSON, KLOG and V-SH) of the X-01 Well by using Tech-log 2015 software.

5.2 Analysis and Discussion result well X-02:

Running the input data of well X-02 using Tech-log 2015 software allowed for the calculation of major petrophysical parameters, such as Gamma Ray (GR), Induction Resistivity (ILD), Spontaneous Potential (SP), and Water Saturation (SW), as shown in **Figure (3)**. The interpretation of these logs reveals that the GR measures the natural radioactivity of the rock. At a depth of 8791 ft, the GR reading is 26.6, while the ILD value is very low (1.25 ohm-m), indicating high electrical conductivity in these layers, which suggests the presence of a water zone. Additionally, the SW chart shows a high ratio of 0.83%, indicating significant water saturation.

The petrophysical properties of well X-02 are presented **in Figure (4)**. Interpretation of the log data, including Lithology, RHOB (Bulk Density), POROSITY (PORSON), KLOG, and V-SH (Shale Volume), has been carried out. The plot indicates a V-SH value of 0.35%, representing shale content, which can influence the KLOG value (2.96 md). The RHOB curve shows a high rock formation density of 2.45 g/cc at 8791 ft. The **Table (2)** shows interpretation petrophysical parameters for each of following depth (8250,8500,8750 and 9000 ft).

Table (2): petrophysical parameter of the well X-02 by using Tech-log 2015 software.

Depth	GR	ILD	SP	SW	RHOP	PORS	KLOG	V-SH
8250	59.189	1.532	-30.37	0.98	2.685	0.0098	0.524	0.419
8500	49.688	0.427	-2.959	1	1.943	0.239	0.983	0.819
8750	52.317	2.819	-45.35	0.85	2.539	0.137	170.796	0.407
9000	27.393	1.468	-81.90	0.77	2.401	0.152	0.187	0.230

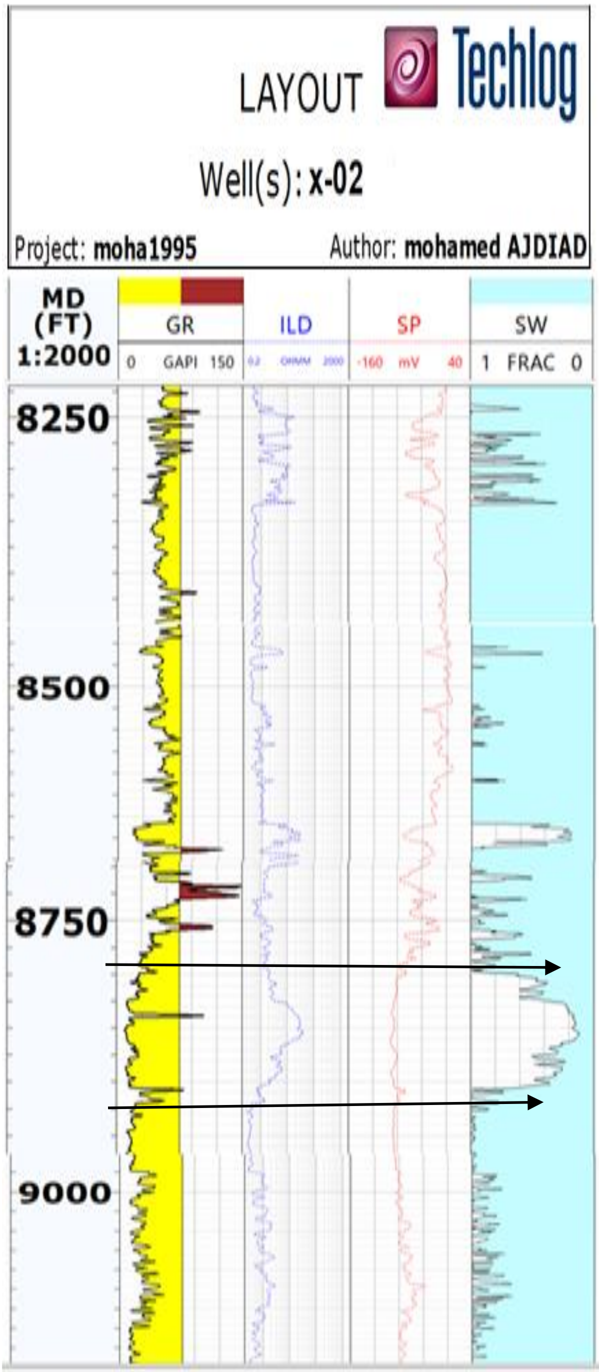

Figure (3): Delineation logs (GR, ILD, SP and SW) of the X-02 Well by using Tech-log 2015 software.

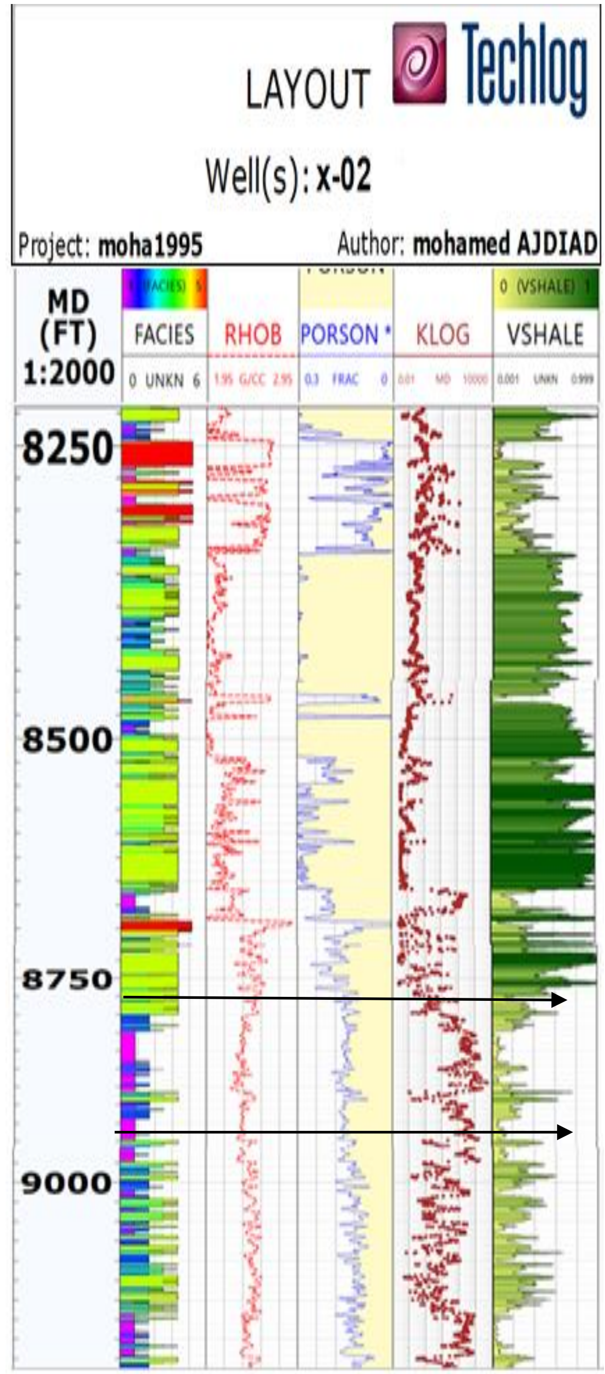

Figure (4): Delineation logs (Lithology, RHOB, PORSON, KLOG and V-SH) of the X-02 Well by using Tech-log 2015 software.

6 Conclusions

The aim of this study was to conduct a petrophysical evaluation of the reservoir in the X field, with the goal of gaining a comprehensive understanding of the area's geology and determining the key petrophysical parameters necessary for estimating water saturation. The results of this study were based on well log interpretations and the use of the cross-plot technique**.** As outlined below, the analysis focuses on key measurements and findings:

1. Based on the well log measurements, six types of data were considered: Gamma Ray (GR), Spontaneous Potential (SP), Sonic (SON), Bulk Density (RHOP), Deep Resistivity (ILD), and Shale zone.
2. The analysis of well X-01, particularly at the middle cross-section at 8714 ft, shows a deflection in the plot where the SW is 14% and the ILD is 30.90 ohm-m, which are favorable for commercial hydrocarbon accumulation. At a depth of 8861 ft, as shown in the plot, the SW is 0.98% and the ILD is 0.930 ohm, indicating a water-bearing zone. Similarly, the zones in well X-02 at a net thickness, with a depth of 8714 ft, show a porosity of 15.8% and a permeability of 360.43 md, indicating the best reservoir characteristics.

7 Recommendation

For future work, the study suggests that additional wells and more advanced reservoir simulation models could improve the understanding of the X-wells field behavior, particularly by running (PLT) or (RST) logs for re-evaluation. Furthermore, for accurate reservoir analysis and effective evaluation of subsurface reservoirs, core data should be obtained for the reservoir intervals. This will help confirm the results and provide more precise permeability values and seismic data, which are essential for a deeper understanding of the subsurface geology of the area. It is recommended that future research focus on acquiring core data to enhance the accuracy and precision of these analyses

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