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Petrophysical Properties of Nahr Umar Formation in Nasiriya Oil Field

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Abstract

Petrophysical characterization is the most important stage in reservoir management. The main purpose of this study is to evaluate reservoir properties and lithological identification of Nahr Umar Formation in Nasiriya oil field. The available well logs are (sonic, density, neutron, gamma-ray, SP, and resistivity logs). The petrophysical parameters such as the volume of clay, porosity, permeability, water saturation, were computed and interpreted using IP4.4 software. The lithology prediction of Nahr Umar formation was carried out by sonic -density cross plot technique. Nahr Umar Formation was divided into five units based on well logs interpretation and petrophysical Analysis: Nu-1 to Nu-5. The formation lithology is mainly composed of sandstone interlaminated with shale according to the interpretation of density, sonic, and gamma-ray logs. Interpretation of formation lithology and petrophysical parameters shows that Nu-1 is characterized by low shale content with high porosity and low water saturation whereas Nu-2 and Nu-4 consist mainly of high laminated shale with low porosity and permeability. Nu-3 is high porosity and water saturation and Nu-5 consists mainly of limestone layer that represents the water zone.

Keywords: petrophysical properties, neural network technique, Nasiriya oilfield

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1- Introduction

Petrophysical analysis plays a necessary role in reservoir characterization, particularly in discriminating between the hydrocarbon and non-hydrocarbon bearing zones[**1**].

Sand grains and particles of carbonate materials that make up sandstone and limestone reservoirs usually never fit together perfectly due to the high degree of irregularity in shape. The void space created throughout the beds between grains, called pore space or porosity, is occupied by fluids **[2]**.

Porosity is the result of the various geological, physical and chemical operation and varies significantly for a different type of rocks**[3]**.

The most crucial step in the shaly sand analysis is estimating the volume of clay. By knowing the amount of clay volume within a reservoir more accurate measurements of effective water saturation and effective porosity can be calculated.

Reservoir rock should have the ability to transmit hydrocarbon fluids to flow through its interconnected pores. The rock's ability to conduct fluids is known as permeability**[2]**.

Saturation is defined as that fraction, or percent, of the pore volume occupied by a particular fluid (oil, gas, or water).

All saturation values are based on pore volume and not on the gross reservoir volume**[3]**.

The Objectives of this paper are: determination the lithological layers in the reservoir and the type of shale based on the well logs' records.

The interpretation of logs is done by IP4.4 software and calculation of petrophysics properties which are consisting of clay volume, porosity, Water Saturation, and permeability.

The formation evaluation is depending on the petrophysical properties. So, it should be determined accurately.

1.1. Area of Study

Nasiriya Oil Field was discovered in 1975 of the past centuries. The structure of Nasiriya consists of three reservoirs which are Mishrif and Nahr Umar and Yammama, it is situated 38 km northwest of Nasiriya city as shown in Fig. **1**.

Nahr Umar formation is one of the promising reservoirs in southern Iraq .It has a complex lithology which mostly consists of Shaly sand **[4]**.

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Fig. 1. Location map of the studied wells along with oilfields

2- Methodology

The study consisted of the analysis of petrophysical properties using data acquired from the available open hole logs of well such as (spontaneous potential, gamma ray, density, sonic, neutron, and resistivity logs). One reading per 0.125 m depth is selected for recording the input data measurements, which is used in this study. Environment corrections and interpretations of well logs were carried out and plotted using IP4.4 software to demonstrate petrophysical properties of Nahr Umar Formation. IP4.4 software was used to determine reservoir lithology from density, sonic, and gamma ray logs and Petrel 2015 used for visualize the units of formation. Fig. **2** illustrates the steps to complete this study.

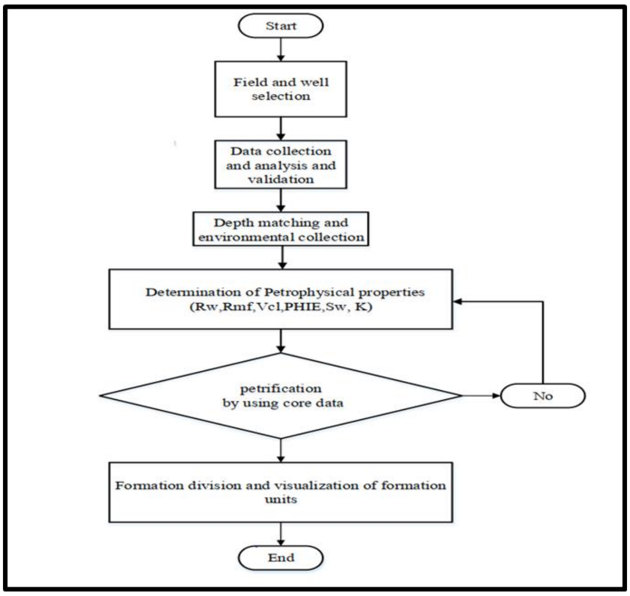

Fig. 2. Flow diagram of the methodology

3- Results and Discussion

3.1. Environmental Correction

The proper corrections (i.e. Shale effect, borehole conditions, depth of invasion, etc.) for Gamma-ray, neutron, density, and resistivity log, were applied before commencing the open hole well log analysis as based on Schlumberger's well log analysis basic Corrections. Schlumberger's environmental corrections **[5]**were used as mentioned earlier to correct raw well logs before conducting interpretation. Fig. **3** illustrates the effect of borehole condition on the well logs and its correction.

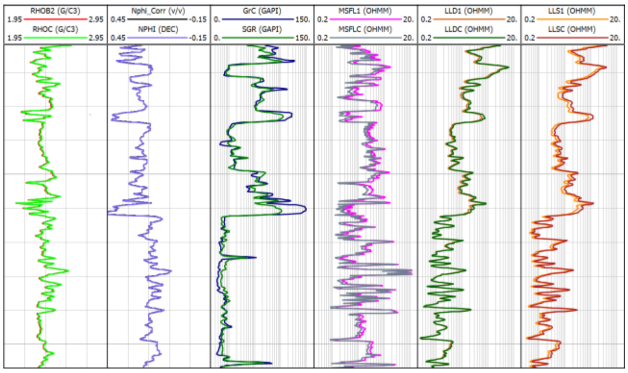

Fig. 3. Environmental correction for selected logs of NS-3

3.2. Formation Water Resistivity

Formation water called connate water is the water which is uncontaminated by drilling mud. The resistivity of formation water, (Rw) is an important interpretation parameter since it is required for the calculation of saturation (water and /or hydrocarbon) from basic resistivity information. The methods which are used are listed below.

a. Formation Water Resistivity from the SP

This method is one of the most important widely used methods to determine from SP log this method depends on the following relationship between R_w and SSP as shown in equation (1). The method is based on various laws of physical chemistry leads to the equation **[6]**:

$$SP = -(60 + 0.133\,T) * \log\left[\frac{R_{mf}}{R_w}\right] \qquad (1)$$

Where:
SP: spontaneous log recording at clean zone, (MV).
R_{mf}: Resistivity of mud filtrate, (ohm-m).
R_w : Resistivity of formation water, (ohm-m).

When saltwater base mud is used, good values of Rw can be easily found from the SP curve recorded in clean non-shaly formation because this type of mud provides electrical continuity between SP log and formation. The static SP value recorded opposite a porous, permeable zone.

The formation temperature is important because it used for Rw calculation. The average formation temperature for Nahr Umar in Nasiriya field is recorded equal to 173 F, and the Rw is determined for wells that have SP readings as shown in Fig. **4** for NS-1.

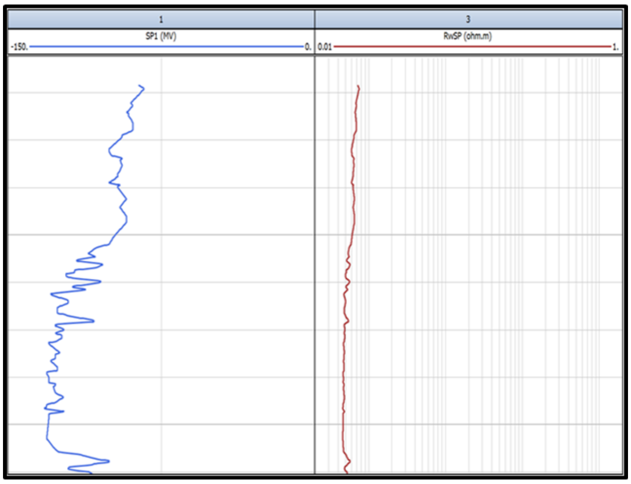

Fig. 4. Rw from SP log in NS-1

b. Formation Water Resistivity from Ratio Method

Ratio method obtained from the Archie equation, which assumes clean water-bearing formation. R_{wa} is defined by the following relationship**[7]**:

$$\frac{R_{XO}}{R_t} = \frac{R_{MF}}{R_w} \qquad (2)$$

Where:
R_{xo} : Formation Resistivity at Flushed Zones, (ohm-m).
R_{mf}: Mud filtrate resistivity, (ohm-m).
R_t: True Formation Resistivity, (ohm-m).
R_w : Resistivity of formation water, (ohm-m).

This method is preferred when freshwater base mud is used. (R_{wa}) is clarified in Fig. **5** for NS-3.

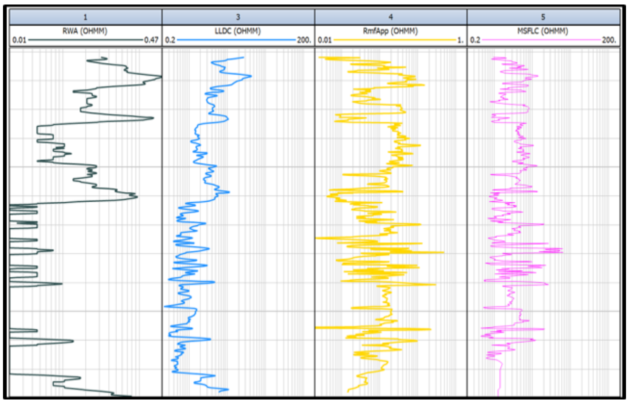

Fig. 5. Rw calculation by ratio method in NS-3

The following table illustrates the resistivity of formation water by SP log and ratio method in Nahr Umar formation in Nasiriya field.

Table 1. (Rw) values by two methods

wells	The resistivity of formation water	
	RwSP	Rwa
NS-1	0.0154	0.01
NS-2	-	0.02
NS-3	-	0.012
NS-4	0.014	0.014
NS-5	-	0.02

3.3. Clay Volume Calculation

The clay volume is a necessary input to estimate the effective porosity from logs and the magnitude of permeability by effecting on reservoir heterogeneity. Also, calculation of water saturation is affected by the clay presence in shale types**[8][9] [10]**.

There are two types of indicators to estimate clay volume; all method must be used to calculate clay volume and choosing one of them depends on wellbore condition. The methods divided into single clay indicators, Double clay indicators**[11]**.

Single clay indicator consists of clay calculation from Gamma-ray, the volume of clay from SP.log, the volume of clay by deep resistivity log, clay volume From Neutron log. Clay volume calculated by single indicators is shown in Fig. **6**.

The gamma-ray method is the most popular and probably one of the most accurate methods in determining the volume of clay.

Factors that cause errors in calculating the volume of clay using the gamma-ray method are hole size that means a high amount of drilling mud that effects on the gamma-ray recording, high amounts of radioactive non-clay minerals (potassium feldspars), for borehole size, the factors which cause errors in recording can be eliminated. For borehole, the reading can be corrected by the environmental correction.

The log readings corrected to the hydrostatic pressure provided by drilling mud. For radioactive non-clay minerals, can be predicted by comparison VCLGR with VCLSP because SP. The log can distinguish the permeable zones and the non-permeable zone. Radioactive non-clay minerals can present in sandstone layers which are permeable zones.

The ability of the SP log to distinguish permeable zones is primarily related to an electrochemical effect. SP log can work under the right conditions, has been used as one of the prime indicators of clay volume but SP log cannot record to the thin layers of shale and it is not good sensor to structural and dispersed shale.

The volume of clay by deep resistivity log has a weakness.

Where water saturation increases, true resistivity is increased, thus the volume of clay is overestimated. Clay volume From Neutron log is affected by washing out of layer and gas Pockets.

Fig. **6** shows the clay volume calculation by a single indicator of NS-3. The equations of single indicators are listed below.

a. Gamma Ray Method

$$\text{Vcl} = \frac{GRlog - GRmin}{\text{GRmax} - \text{GRmin}} \quad (3)$$

Where:
Vcl: gamma-ray index.
GRlog: gamma-ray reading in interested zone.
GRmin: minimum gamma-ray reading (clean zone).
GRmax: maximum gamma-ray reading (Shale zone).

b. Neutron Method

$$\text{Vcl} = \frac{\emptyset_{N}\text{ (Shaly Sand)}}{\emptyset_{N}\text{ (Shale Zone)}} \quad (4)$$

Where: -
V_{cl} : Clay volume
$\emptyset_{n}$ (Shaly Sand): - neutron porosity at shaly sand zone.
$\emptyset_{n}$ (Shale): - neutron porosity at shale zone.

c. Resistivity Method

$$Vcl = \left(\frac{R_{cl}}{Rt}\right)^{\frac{1}{1.5}} \quad (5)$$

Where:
V_{cl} : Clay volume.
R_{cl}= resistivity of clay (Adjacent Shale Bed)
R_{t}= resistivity of shaly sand
R_{lim}= resistivity of a clean hydrocarbon zone.

d. Sonic Method

$$V_{cl} = \frac{\emptyset_{s}\text{ (Shaly Sand)}}{\emptyset_{s}\text{ (shale zone)}} \quad (6)$$

Where:
V_{cl} : Clay volume.
$\emptyset_{s}$ (Shaly Sand): - sonic porosity at shaly sand zone.
$\emptyset_{s}$ (Shale): - sonic porosity at shale zone.

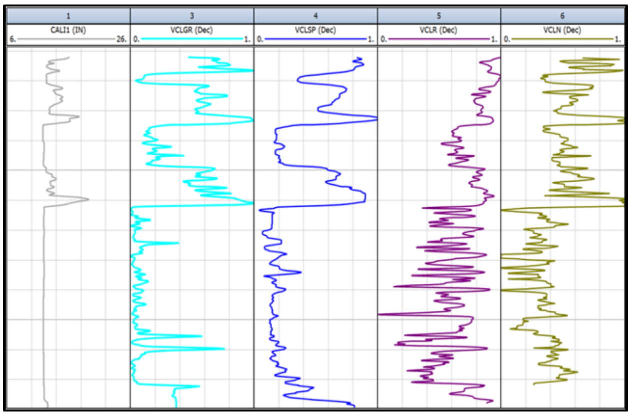

Fig. 6. Clay volume calculation by single indicators in NS-3

For double Clay Indicators, there are three types of double indicators: - volume of clay from neutron and density logs, the volume of clay from neutron and sonic logs and volume of clay from density and sonic logs.

Conditions that can affect the volume of clay determination using the neutron-density method are borehole conditions and the presence of gas, hole conditions can affect both the neutron and density logs.

Thus, that result in clay volumes that are either too low or too high.it happens because these logs are pad type therefore and the caving or excessive swelling affecting on the logs reading.

The presence of gas will result in neutron porosity values that are too low because the neutron log is a measure of a formation of hydrogen content and the gas has low hydrogen content. As a result, the difference between the neutron and density porosities will be underestimated and the volume of clay calculated will be either a good approximation or too low.

The volume of clay from density and sonic logs cannot estimate clay accurately in all type of shale because dispersed clay can effect on sonic waves.

From neutron and sonic logs, the difference in porosity provides by these two logs used for estimation of clay volume

However, because clays have such a large effect on the neutron and the sonic porosities, estimation of clay volumes may not be accurate. Fig. **7** shows the clay volume calculation by a single indicator of NS-3. The laws of double indicators are listed below.

a. Neutron-Density Method

$$V_{cl} = \frac{\emptyset_{N}\text{ (Shaly Sand)} - \emptyset_{D}\text{ (Shaly Sand)}}{\emptyset_{N}\text{ (shale zone)} - \emptyset_{D}\text{ (shale zone)}} \quad (7)$$

Where:-
V_{cl} : Clay volume.
$\emptyset_{N}$ (Shaly Sand): - neutron porosity at shaly sand zone.
$\emptyset_{D}$ (Shaly Sand): - density porosity at shaly sand zone.
$\emptyset_{N}$ (Shale): - neutron porosity at shale zone.
$\emptyset_{D}$ (Shale): - density porosity at shale zone.

b. Sonic-Density Method

$$V_{cl} = \frac{\emptyset_{S}\text{ (Shaly Sand)} - \emptyset_{D}\text{ (Shaly Sand)}}{\emptyset_{S}\text{ (shale zone)} - \emptyset_{D}\text{ (shale zone)}} \quad (8)$$

Where: -
V_{cl} : Clay volume
$\emptyset_{S}$ (Shaly Sand): Neutron porosity at shaly sand zone.
$\emptyset_{D}$ (Shaly Sand): Density porosity at shaly sand zone.
$\emptyset_{S}$ (Shale): - neutron porosity at shale zone.
$\emptyset_{D}$ (Shale): - density porosity at shale zone.

c. Neutron-Sonic Method

$$V_{cl} = \frac{\varnothing_N\ (\text{Shaly Sand}) - \varnothing_S\ (\text{Shaly Sand})}{\varnothing_N\ (\text{shale zone}) - \varnothing_S\ (\text{shale zone})} \quad (9)$$

Where: -
V_{cl} : Clay volume.
$\varnothing_N$ (Shaly Sand): - neutron porosity at shaly sand zone.
$\varnothing_S$ (Shaly Sand): - sonic porosity at shaly sand zone.
$\varnothing_N$ (Shale): - neutron porosity at shale zone.
$\varnothing_S$ (Shale): - sonic porosity at shale zone.

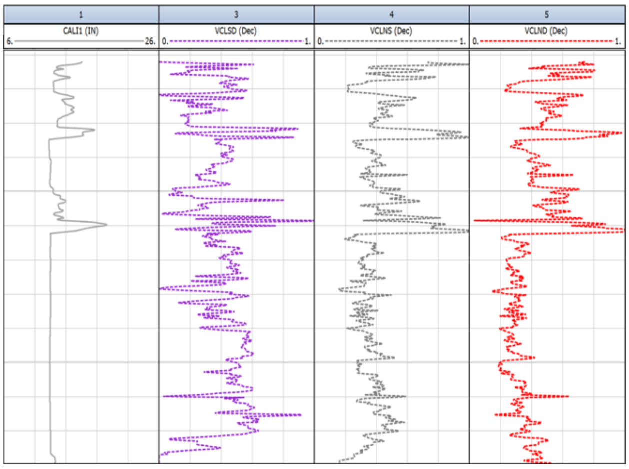

Fig. 7. Clay volume calculation by double indicators in NS-3

So, from all above, the volume of clay by Gamma-ray log is the best method for calculation. Fig. **7** shows the clay volume calculation by double indicators of NS-3.

3.4. Lithology Determination

It's difficult to estimate the porosity when the lithology of matrix is unknown or containing two or more minerals in unknown proportions. Cross plot technique is considered as an easy method to demonstrate these things.

A linear cross plot between density VS sonic porosities, for examples, is used to know the lithology of the matrix when the points fall on a curve (limestone, dolomite & sandstone, etc.), to visualize the lithology.

It combines all three porosity logs. From Fig. **8** and Fig. **9**, lithology of Nahr Umar formation in NS-3.it is consisting of shaly sand in the upper units and limestone in the lower unit.

The type of shale which is presented in sandstone can be determined by Thomas-Stieber cross plot as shown in Fig. **10**

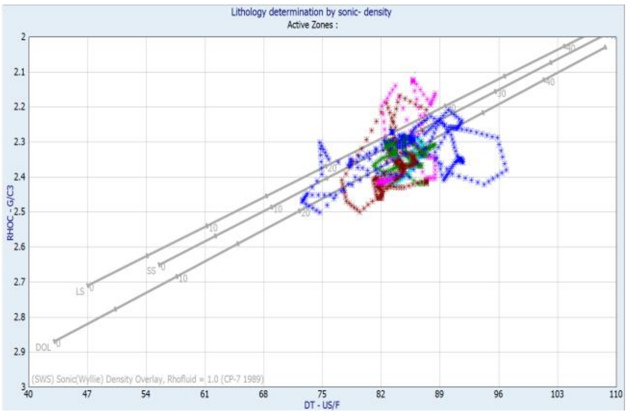

Fig. 8. Shaly-sand reorientation at the upper section of Nahr Umar formation in NS-3

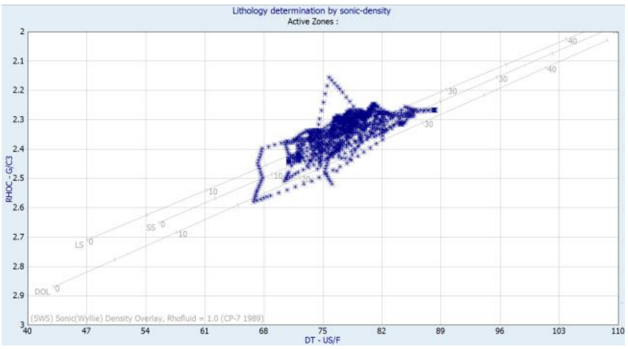

Fig. 9. Limestone representation at the lower section of Nahr Umar formation in NS-3

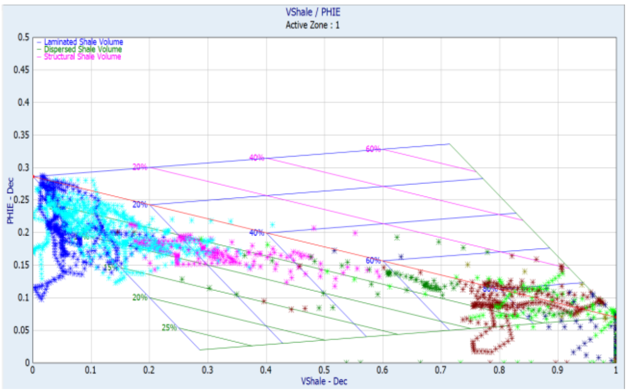

Fig. 10. type of clay determination in Nahr Umar

So, the lithological column of Nahr Umar in Nasiriya oil field is presented from the Fig. below.

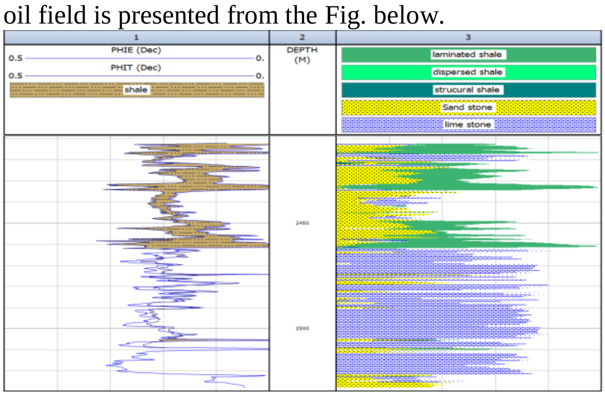

Fig. 11. the lithological column of Nahr Umar formation in Nasiriya field

The porosity of a rock is defined as the ratio of the pore volume to the bulk volume of the reservoir rock on percentage basis the measurement of porosity is important to the petroleum engineer since the porosity determines the storage capacity of the reservoir for oil. All methods for calculating the effective porosity are used in order to compare them with the porosity of core and choosing the suitable state. The porosity can be calculated by:

a. Sonic log

$$\emptyset_{\text{sonic}} = \frac{\Delta t_{\text{log}} - \Delta t_{\text{matrix}}}{\Delta t_{\text{fluid}} - \Delta t_{\text{matrix}}} \quad (10)$$

Where

$\emptyset_{\text{sonic}}$: Porosity by sonic log
Δt_{log} : The recorded travel time, (μsec/ft)
Δt_{matrix} : Matrix travel time, (μsec/ft)
Δt_{fluid} : Fluid travel time, (μsec/ft)

b. Density log

$$\emptyset_{\text{density}} = \frac{\rho_{\text{matrix}} - \rho_{\text{bulk}}}{\rho_{\text{matrix}} - \rho_{\text{fluid}}} \quad (11)$$

Where

$\emptyset_{\text{density}}$: Porosity by density log
ρ_{matrix} : Matrix density, gr/cc
ρ_{bulk}: The recorded bulk density, gr/cc
ρ_{fluid}: Fluid density, gr/cc

c. Neutron log

d. Neutron-Density logs

$$\emptyset_{\text{ND}} = \frac{\emptyset_N + \emptyset_D}{2} \quad (12)$$

Where

$\emptyset_{\text{ND}}$: Porosity by neutron –density logs
$\emptyset_N$: Porosity by neutron log
$\emptyset_D$: Porosity by density log

e. Neutron-Sonic logs

$$\emptyset_{\text{ND}} = \frac{\emptyset_N + \emptyset_s}{2} \quad (13)$$

Where

$\emptyset_{\text{Ns}}$: Porosity by neutron –sonic logs
$\emptyset_N$: Porosity by neutron log
$\emptyset_s$: Porosity by sonic log

Fig. **12** and Fig. **13** represent the porosity of logs and porosity of core in NS-3. The optimum method for porosity calculation is sonic porosity.

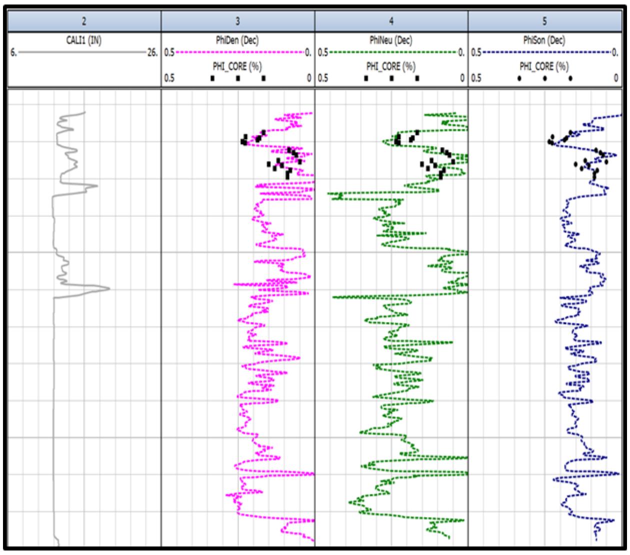

Fig. 12. Effective porosity by single logs vs core porosity in NS-3

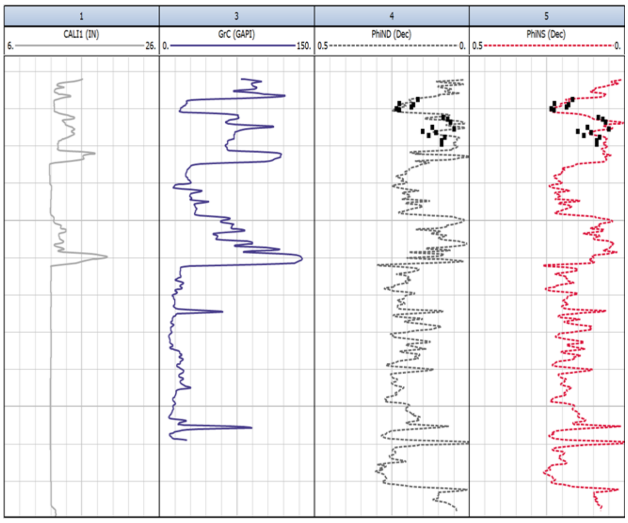

Fig. 13. Effective porosity by double logs vs. core porosity in NS-3

3.6. Determination of Archie's Parameters

The determination of water saturation in a shaly-sand reservoir is becoming more challenging. All models which are used for water saturation calculation deepening on these parameters.

a. Cementation Factor (m)

The cementation exponent m, indicates a reduction in the number and size of pore openings or reduction in the closed-off dead-end channels. It has been widely used in hydrocarbon and groundwater exploration, and in porous-media engineering studies **[12] [13]**.

Pickett plot is applied to estimate the value of the cementation factor and shown in Fig. **14** of NS-3. The values of all wells are tabulated in Table **2**.

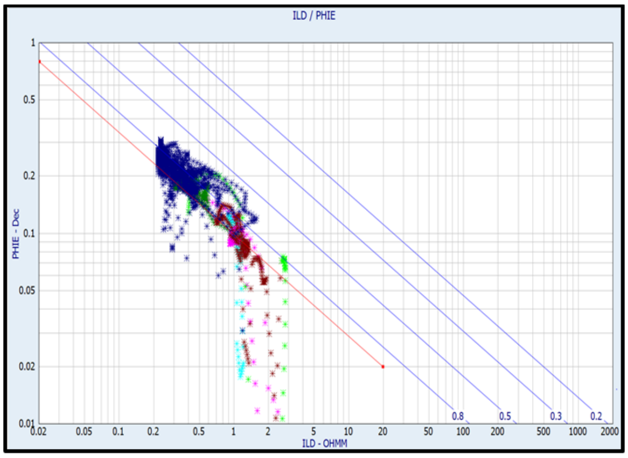

Fig. 14. Pickett plot of NS-3

b. Saturation Exponent (n)

Saturation exponent n in Archie's water saturation equation is the exponent value in water saturation that establishes the relationship between water saturation of the rock to the ratio of fluid-filled rock resistivity to the actual rock resistivity[14][15]. Several factors have been observed in the field that affects the value of n.

These factors are: -wettability, texture roughness, micro porosity .Saturation exponent can be calculated by Coates and Dumanoir method. Fig. **15** represents an example of this procedure in NS-3;. The values of (n) are tabulated in the Table **2**.

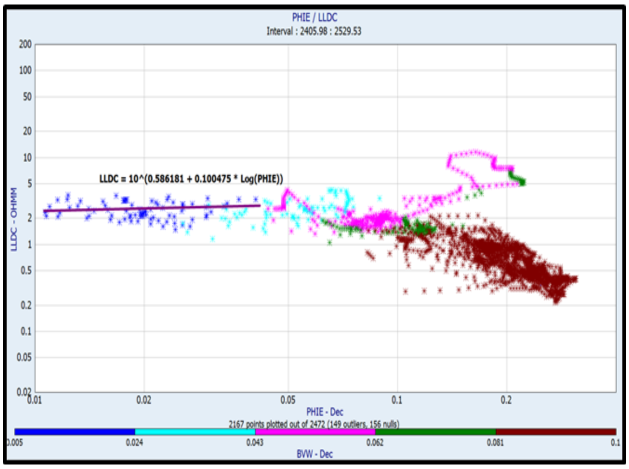

Fig. 15. (n) Exponent calculation by Rt vs. ø at minimum BVW of NS-3

c. Tortuosity Factor (a)

Tortuosity is known as the ratio of the actual length of a path flow to the length of a porous medium, parallel to the overall direction of flow**[14]**. At water zone, where Rt=Ro, tortuosity factor can be obtained from the equation below:

$$R_o = \frac{a}{\varnothing^m} * R_w \quad (14)$$

Table 2. Archie's parameters values

wells	Archie's parameters		
	a	m	n
NS-1	0.01	0.0154	0.01
NS-2	0.02	-	0.02
NS-3	0.012	-	0.012
NS-4	0.014	0.014	0.014
NS-5	0.02	-	0.02

3.7. Water Saturation Calculation

In order to calculate water saturation in Nahr Umar formation, there are a number of models for water saturation which are: - Archie equation, Dual water model, and Indonesia model, Waxman –smith model, Simandoux model, modified Simandoux model Archie model is the most common model but is not accurate in all formation. If Archie model is used to calculate water saturation in shaly sand, the water saturation is overestimated. In order to choose the optimum model, all water saturations model is compared with Archie model in the water zone only.

These processes are valid because no overestimation in water zone. So, the correct model is chosen when water saturation readings match with Archie water saturation in water zone. So, the model which is chosen to calculate water saturation is Indonesia model. Fig. **15** shows the water saturation calculation of NS-3.

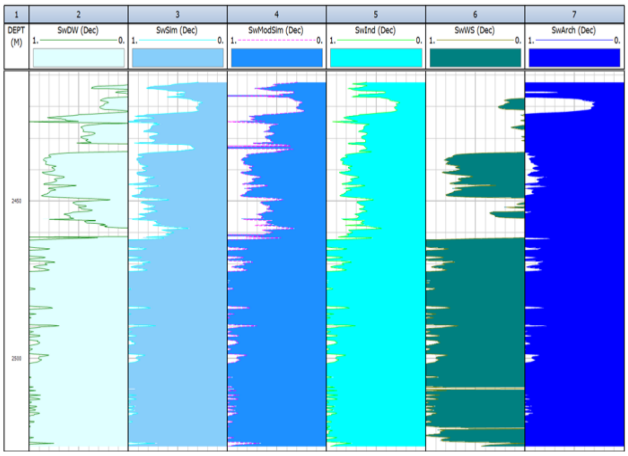

Fig. 16. Water saturation models in NS-3

3.8. Determination of Irreducible Water Saturation (Swi)

Irreducible saturation of water can be estimated at the lowest saturation of water at the minimum bulk volume of water (BVW). The irreducible water saturation (Swi) of Nahr Umar formation is equal to (0.18), Fig. **17** illustrates the process.

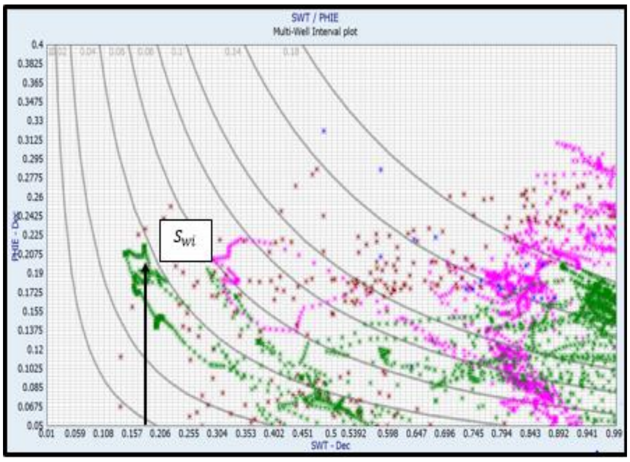

Fig. 17. Swi determination by ø vs. Sw plot

3.9. Permeability Prediction

Due to the number of permeability cores readings are too limited. Core's readings are provided to cover only 10 meters of the formation's thickness. The permeability values that provided by core report varies from 0.27 MD to 1792 MD. So, using the hydraulic flow unit method only to predict the permeability is not enough because this method needs a large number of core data to cover the reservoir's thickness. Timur method has a limitation that cannot estimate the permeability higher than 1000 MD. Thus, the neural network technique is used to predict permeability. The training data consists of:

1- Depth of the invasion is used because this depth is a function to the permeability. Where permeability decreases the depth of invasion is increasing **[16]**.
2- Deep resistivity log which is the function to compaction of rocks**[17]**.
3- Volume of clay is inverse proportional to the permeability**[18]**.
4- Permeability of core.
5- Timur equation used as indictor to permeability and sensor to predicted permeability against high shaly zones. Neural network technique is used in NS-3 because the core is provided in this well. Fig. **18** describes this technique.

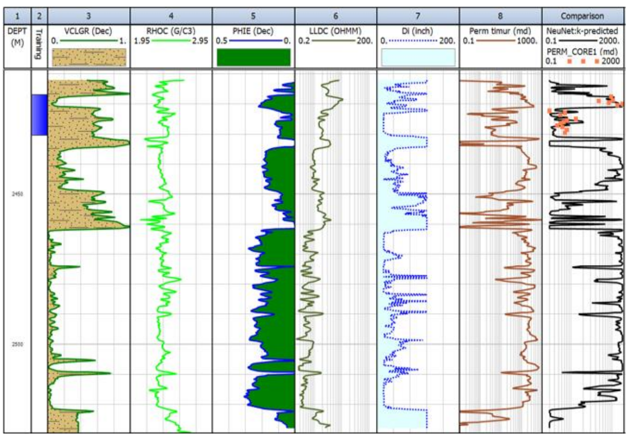

Fig. 18. (k) predicted by neural network NS-3

3.10. The Units of Nahr Umar formation

Depending on the calculated petrophysical properties, Nahr Umar formation is divided into five zones which are presented by Nu-1, Nu-2, Nu-3, Nu-4, and Nu-5. Nu-1 is characterized by low shale content with high porosity and low water saturation whereas Nu-2 and Nu-4 consist mainly of high laminated shale with low porosity and permeability.

Nu-3 is high porosity and water saturation and Nu-5 consists mainly of limestone layer that represents the water zone.the units are shown in Fig. **19**.

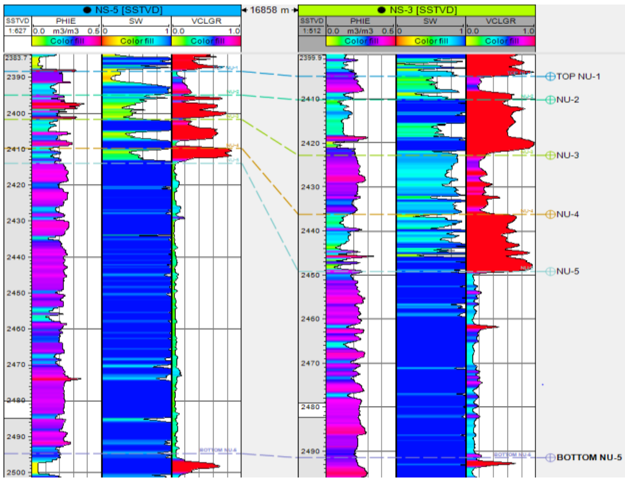

Fig. 19. Correlation between NS-3 and, NS-5

4- Conclusions

The study of Nahr Umar is consisting of estimation of the main petrophysical properties and building astatic model to calculate the oil in place by volumetric method and simple dynamic model by simulation method.
There are differences between the formation top in the final geological report and the tops which are determined by CPI.

1- By cross plot, the lithology of Nahr Umar reservoir is consisting of low shale in sand in upper unit, medium to high shale content in medium units, limestone layer in lower unit.
2- Depending on the petrophysical properties distribution (effective porosity (Øe), permeability (k), the volume of clay (VCL), water saturation (Sw)), the pay zone is NU-1 with high of porosity and permeability and low water saturation. NU-2 has high volume of clay and low porosity, NU-3 has medium to high water saturation, NU-4 low permeability and porosity. NU-5 has high water saturation and porosity and permeability.

Nomenclature

a:	tortuosity factor
n:	Saturation exponent.
m:	Cementation factor
ϕe:	Effective porosity.
Sw:	Sw: Water saturation;
Rt :	True Resistivity ohm-m.
Rw:	Water Resistivity ohm-m.;
Rmf:	Mud filtrate Resistivity ohm-m.
Rsh:	shale Resistivity ohm-m.;
Tf:	Formation temperature, °F
ρma:	apparent matrix density.
Δtma:	apparent transit time of the rock matrix.
Vcl:	clay volume

References

[1] T. Azeem et al., "An integrated petrophysical and rock physics analysis to improve reservoir characterization of Cretaceous sand intervals in Middle Indus Basin, Pakistan," J. Geophys. Eng., vol. 14, no. 2, pp. 212–225, 2017.

[2] D. Tiab, and C. Erle Donaldson. Petrophysics: theory and practice of measuring reservoir rock and fluid transport properties. Gulf professional publishing, 2015.

[3] John A Hudson,., and Feng. Xia-Ting *Rock engineering risk*. Vol. 1. CRC Press, 2015..

[4] R. M. Bateman, Richard M. Bateman, "Cased-Hole Log Analysis and Reservoir Performance Monitoring", 1985.

[5] A. J. Al-Khafaji, "The Mishrif, Yamama, and Nahr Umr reservoirs petroleum system analysis, Nasiriya oilfield, Southern Iraq," Arab. J. Geosci., vol. 8, no. 2, pp. 781–798, 2015.

[6] Schlumberger log interpretation Chartbook. 2011.

[7] O. Serra, "Well Logging and Reservoir Evaluation," Tech. Ed., vol. 3, p. 250, 2007.

[8] Gary Lee Causey, "Computer Determination And Comparison Of Volume Of Clay Derived From Petrophysical And Laboratory Analysis," 1991.

[9] R. A. M. Hussein, M. Eltahir, and B. Ahmed, "Petrophysical Evaluation of Shaly Sand Reservoirs in Palouge-Fal Oilfield , Melut Basin , South East of Sudan," vol. 13, no. 2, 2012.

[10] A. Al-Hasani, Saaed I. M., Salim A. M., and Janjuhah H. T. "Advanced Porosity Modeling and Lithology Analysis Based on Sonic Log and Core Data for Arkose Sandstone Reservoir: Habban Field." In *ICIPEG 2016*, pp. 617-641. Springer, Singapore, 2017.

[11] P. S. Senergy, "LIFTING THE FOG OF CONFUSION SURROUNDING CLAY AND SHALE IN PETROPHYSICS," no. 1922, 2014.

[12] M. M. Al-Hilali, M. J. Zein Al-Abideen, F. Adegbola, W. Li, and A. M. Avedisian, "A Petrophysical Technique to Estimate Archie Saturation Exponent (n); Case Studies In Carbonate and Shaly-Sand Reservoirs – IRAQI Oil Fields (Russian)," no. November, 2015.

[13] P. S. Adisoemarta, G. A. Anderson, S. M. Frailey, and G. B. Asquith, "Saturation Exponent n in Well Log Interpretation: Another Look at the Permissible Range," 2001.

[14] H. S. Salem and G. V. Chilingarian, "The cementation factor of Archie's equation for shaly sandstone reservoirs," J. Pet. Sci. Eng., vol. 23, no. 2, pp. 83–93, 1999.

[15] Z. Bassiouni,. *Theory, measurement, and interpretation of well logs*. Vol. 4. Henry L. Doherty Memorial Fund of AIME, Society of Petroleum Engineers, 1994.

[16] N. P. Singh, "Permeability prediction from wireline logging and core data: a case study from Assam-Arakan basin," J. Pet. Explor. Prod. Technol., vol. 9, no. 1, pp. 297–305, 2019.

[17] J. H. Schon and D. T. Georgi, "Dispersed Shale, Shaly-Sand Permeability- a Hydraulic Analog To the Waxman-Smits Equation," Spwla, 2003.

[18] JH Schön. *Physical properties of rocks: Fundamentals and principles of petrophysics*. Elsevier, 2015..

الخواص البتروفيزيائية لتكوين نـهر عمر في حقل الناصرية النفطي

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الخلاصة

تقييم الطبقات المكمنية هي من المراحل الأكثرأهمية في الاداره المكمنية ,حيت يتم توضيح الفائدة الإقتصادية للمكمن عن طريق احتساب الخواص البتروفيزيائية .إن هدف الدراسة هو تقييم مكمن نهر عمر في ذلك الحقل والذي تعتبر أحد المكامن المهمه من أصل ثلاث موجودات في ذلك الحق ، تم ادخال بيانات المجسات في برنامج (2016) IP4.4 حيث تم تحديد نوع الصخور بطريقة (sonic–density cross plot) وحساب حجم الطين والمسامية بعده طرق استنادا على البيانات المتوفره ومقارنتها مع بيانات اللباب الصخري.بعد ذلك ، تم حساب معامل التسميت (m) بواسطة (Pickett cross plot) ثم حساب معامل التشبع (n) بطريقة (Morris and Biggs) وحساب معامل التعرج (a) يقانون (Archie) في المنطقة المائية. تم استعمال عدة موديلات لحساب التشبع المائي ، تللك الموديلات تتضمن (Archie equation ، Dual water ، Indonesia ، Simandoux ، Waxman –smith،modified Simandoux) . كل تلك الموديلات قورنت مع طريقة(Archie) عند المنطقة المائية لإختيار الموديل الانسب . لقد كان حساب النفاذية من المهمات الصعبة وذلك بسبب قلة بيانات اللباب الصخري حيث تم دمج اكثر من طريقة للتنبؤ بالنفاذية. في المرحلة الأخيرة، تم استعمال برنامج (PETREL 2016) لتقسيم الطبقة المكمنية استنادا على الخواص البتروفيزيائية. وبالنظر الى ظروف البئر ، تم حساب حجم الطين على طريقة (gamma–ray) وحساب المسامية بطريقة (sonic log) حيث كانت نتائج تلك الطربقة الأقرب الى قراءات المسامية باللباب الصخري .وايضأ" تم اختيار (Indonesia model) لحساب التشبع المائي.إضافة" الى ذلك تم احتساب النفاذية عن طريق الذكاء الإصطناعي.

واستنادا على بيانات تقارير الحفر والنتائج البتروفيزيائية ، تم تحديد عمق جديد لطيقة نهر عمر وتقسيم الطبقة الى خمس وحدات إبتداءا" من (NU–1 الى NU–5). حيث ان (NU–1) تمثل الطبقة المنتجة بمسامية ونفاذية عاليتان وتشبع مائي قليل. الوحدتان (NU–2 ,NU–4) تحتوي حجم عالي للطفل .والوحدة (NU–3) تحتوي على تشبع مائي متوسط الى عالي .والوحدة (NU–5) تمثل المنطقة المائية حين ان نوع هو (limestone) والتشبع المائي يساوي 100% .

الكلمات الدالة: الخواص البتروفيزيائية, تقنية الشبكة العصبية, حقل لناصرية النفطي