Journal Homepage: http://ijcpe.uobaghdad.edu.iq
Iraqi Journal of Chemical and Petroleum Engineering
Vol. 25 No. 2 (June 2024) 151 – 159
EISSN: 2618-0707, PISSN: 1997-4884

Rock Typing and Flow Unit Identification in the Upper Cretaceous Carbonate Reservoirs in Jambur Oil Field

Nazaneen S. Amin [a, *], Ayad A. Al-haleem [a]

a Department of Petroleum Engineering, College of Engineering, University of Baghdad, Baghdad, Iraq

Abstract

The effectiveness of dynamic models in field development and predicting future reservoir performance depends on the accuracy and reliability of geological models. These models are constructed based on an accurate categorization of reservoir rock types and the identification of flow units. understanding the geological structure, lithological characteristics, and depositional processes is crucial in differentiating rock types and determining flow units within strata. This study focuses on identifying rock types and flow units within the upper Cretaceous reservoir/Qamchuqa formation of the Jambur oilfield. By employing four petrophysical techniques across six wells, it was determined that the Rock Fabric Number technique and the Winland porosity-permeability relation were insufficient for accurately estimating permeability, primarily due to constraints in regression analysis. The classification of flow zone indicators resulted in the identification of five distinct rock classes that offer a more reliable means of assessing permeability in intervals lacking core data. Subsequently, the cluster analysis process sorted the reservoir rock into cohesive groups based on the raw log data and calibrated it with the Flow Zone Indicator (FZI) method. In conclusion, permeability can be determined through equations derived from the FZI method, and the establishment of petrophysical characteristics within a geological model can be achieved by utilizing rock facies derived from cluster analysis.

Keywords: Rock Typing Technique; flow units; porosity–permeability relationship; Jambur oilfield, the upper cretaceous reservoir; Qamchuqa formation.

Received on 23/09/2023, Received in Revised Form on 03/01/2024, Accepted on 05/01/2024, Published on 30/06/2024

https://doi.org/10.31699/IJCPE.2024.2.14

1- Introduction

To improve reservoir performance prediction, reservoir rocks are classified based on geological properties [1]. The categorization is influenced by environmental and deposition conditions [2]. Knowing these conditions enables the construction of a more accurate three-dimensional model of the reservoir, thereby facilitating more exact prognostications regarding the spatial distribution of rock properties and fluid flow [3]. Identification of rocks and flow units starts with facies analysis using core data. It concludes with the Electrofacies definition of log data and is calibrated with the estimated petrophysical properties. The features of the facies are greatly affected by diagenetic processes like dissolving, compaction, and cementation [4]. The flow stream through a rock changes depending on diagenesis and deposition processes; hence, it cannot be accurately predicted from log survey data [5]. Therefore, several methods should be tested to determine the most reliable one. Researchers have developed and made available a range of categorization techniques based on log and core data [6]. One of these techniques is the Lucia classification (1983–1999), which categorized rock types based on fabric rock number using the interparticle porosity-permeability relationship. Another developed method is the empirical correlation found by Winland, which predicted the pore throat radius at 35% mercury saturation [3]. Additionally, Amaefule, in 1933, developed the hydraulic flow zone indication technique, which divides reservoir rock into units with similar hydraulic properties through pore-throat frameworks [7]. This method is widely used, and it identifies rock types by analyzing distinct permeability-porosity relationships and capillary pressure profiles [8, 9]. Accurate rock classifications are essential for providing precise distribution of rock attributes and dependable permeability estimates to predict uncored wells in reservoir models [3]. Building correlations between cored and uncored intervals is crucial for computing the permeability of uncored intervals [10]. In carbonate reservoirs, the rock types and facies may vary throughout time, complicating the pore networks and making it difficult to determine the flow unit and type of rock [11]. The formation of the reservoir under study is the Qamchuqa formation, first identified by van Belen et al., who discovered that the Qamchuqa limestone formation in northern Iraq has an excessive dolomite thickness [12]. With the aim of an accurate geological model construction for a reservoir, this study focused on characterizing rock types and determining flow units in the upper Cretaceous reservoir from conventional core data of six wells through porosity and permeability

*Corresponding Author: Email: nazeen.Saeed2108m@coeng.uobaghdad.edu.iq

relations employing three different procedures as well as implementing cluster analysis techniques by raw log data for differentiating the structure's facies and deriving formulas from a more valid approach to forecast permeability in an uncored region.

- Area of Study

The Jambur field is located in Kirkuk, northern Iraq. It is part of an oil and gas resource zone that developed among many northwest-southeast extending anticlines throughout the Zagros Fold Belt. The hydrocarbon systems in the field are Tertiary and Cretaceous in age [13]. The Cretaceous reservoir is composed of upper and lower Cretaceous reservoirs separated by the upper Sarmord Formation, which is marl-dominated and accounts for approximately 70% of the field's total production [14]. The Qamchuqa Formation is the main Cretaceous reservoir in the Jambur area. It comprises considerable shallow-water carbonate formation from the Aptian to the Albian times, with lithology and depositional environment varying from place to place, with an increasing marine influence on the southeast [15]. The research is centered on the upper Qamchuqa reservoir, which is mainly formed out of dolomite and limestone facies. The shape is an asymmetrical convex structure with a 4.5-kilometer-wide and 30-kilometer-long dip in certain places as it goes from northwest to southwest [13].

2- Methodology

According to core data, each type of rock has a particular relationship between porosity and permeability, an identical pressure differential profile, and the same saturation point of water at any depth above free water [16]. Based on this concept, several techniques for classifying reservoir rock were created. In this study, we focused on three theories based on core data as well as a clustering strategy based on log data, as outlined below:

2.1. Rock Fabric Number (RFN)

Lucia developed a method for classifying rocks according to their grain framework, and these could be divided into grain stone, grain-dominated - where open or closed intragranular porosity and grain-supported structure, and mudstone - where mud fills the spaces between particles. The size of the pores and the distribution of pore sizes alter the structure of the rock and, therefore, influence a rock's ability to flow and saturation point level [16]. Laboratory measures of porosity and permeability are used in Lucia's Petrophysical Rock Classification to link the distribution of pore sizes to the number of rock fabrics in a sample [17]. Lucia introduced the rock fabric number, denoted as RFN, as Eq. 1 [11].

$$\log K = (9.7982 - 12.0803 \log RFN) + (8.6711 - 8.2965 \log RFN \log \emptyset) \quad (1)$$

2.2. Winland porosity-permeability plot

Winland established a correlation between porosity and permeability as a function of throat diameter according to mercury injection-capillary pressure curves for three hundred twenty-one samples of sandstone. He observed that porous rock and R35 were most closely connected [11, 16]. Kolodzie provided the equation as follows:

$$\log R35 = 0.732 + 0.588 \log k - 0.8641 \log \emptyset \quad (2)$$

According to R35, five petrophysical flow units with varying source efficiencies are highlighted: the mega-porous unit with a pore throat diameter greater than 10 µm; the macro-porous unit with a pore throat diameter between 2.5 and 10 µm; the mesoporous unit with a pore throat diameter between 0.5 and 2.5 µm; the micro-porous throat diameter between 0.2 and 0.5 µm; and the nano-porous unit with a pore throat diameter less than 0.2 µm [11].

2.3. Hydraulic Flow Zone Indicator/FZI Method

In 1993, Amaefule et al. extended the Kozeny and Carmen correlation to include the quality of reservoir indicator ideas based on pores-throat, porosity, granular distribution, and other microfeatures to detect flow zone indicators [8]. The classification is obtained from the porosity and permeability core data, and the resultant equation may be used to predict permeability in uncored intervals [18]. summarizes the Kozeny and Carman equation which yields flow units as follows:

$$RQI = 0.0314\sqrt{\frac{K}{\emptyset}} \quad (3)$$

The normalized porosity index (($\emptyset$) to be:

$$\emptyset z = \frac{\emptyset}{1-\emptyset} \quad (4)$$

Then FZI is to be:

$$FZI = \frac{RQI}{\emptyset z} \quad (5)$$

Taking the logarithm of both sides of Eq. 5 will lead to the final correlation, which is expressed as follows:

$$\log RQI = \log \emptyset z + \log FZI \quad (6)$$

Log-log plots of RQI vs. FZI show HFU; each flow unit has an individual FZI. Any samples belonging to the same HFU will have the same pore-throat characteristics and will lay on a straight line with a slope of one. The same sloped parallel lines will connect data with the same FZI value but different from the first data [19, 20].

2.4. Electrofacies /cluster analysis

"Electrofacies" are facial features, rock types, or clusters used to differentiate rocks using well-log responses instead of cores, cuttings, or outcrops, eliminating the requirement for depositional conditions or minimum sediment formation evaluations. The Facies analysis is a useful method that may be defined, according to Serra and Abbott, as "splitting the log data into sets of log replies that reflect a sediment" [21]. Theoretically, data points that fall within the same group should share similar qualities and/or characteristics, whereas those belonging to other groups should have distinctly different features. Unsupervised learning methods like clustering are commonly used in the field of statistical data analysis [21, 22].

3- Results and Discussions

Analysis of conventional core data reports from six wells that reached the formation under study resulted in the collection of 32 core plug samples. These wells were selected based on their location: five wells from the north part and one from the south part of the structure. The data for each well was organized and compiled into an Excel spreadsheet. The scatter was significant in the generated plots of porosity versus permeability; as a result, they were classified based on three major facies types—dolomite, limestone, and dolomitic limestone—using the conventional method to determine the most reliable statistical correlation as in Fig. 1. the plot shows that dolomite samples have much greater permeabilities than limestone samples with the same porosity; R2 values for dolomite, dolomitic limestone, and limestone are 0.539, 0.4919, and 0.0228, respectively, but no apparent relationship has been formed between the data. The strategies outlined in the methodology section were used to establish the best correlation between permeability and porosity core data as follows.

3.1. Rock Fabric Number

This method is most often used to carbonate rock. The porosity-permeability relation reveals that the upper Qamachqa formation's geological structure consists of Class 1: Grain stone rocks are very permeable. Class 3: mud fabric rock represents the nature of the rock poorly, while Class 2: grain-packstone represents a specific type of rock effectively (Fig. 2 a). Based on this texture, the formation has been divided into three groups, as illustrated in Fig. 2 b. Depending on the correlation coefficient, the relationship seemed weak regression, making them inappropriate for estimating permeability. The result of this study concluded that the RFN method was best for skimming core porosity and permeability and identifying reservoir geological structures. However, the permeability estimation by using this technique has limitations because the upper Qamachq formation core sample contains fractures and various types of vugs, which required the extraction of additional information on separate and touch vugs from reliable SCAL data, which is currently unavailable.

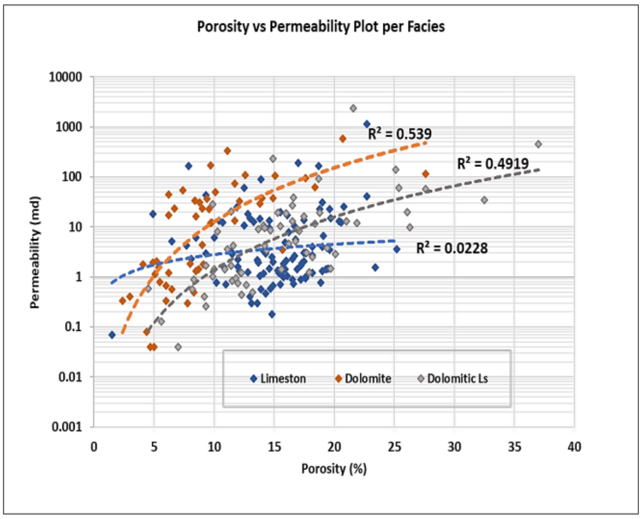

Fig. 1. Classical Correlation of Core Permeability and Porosity

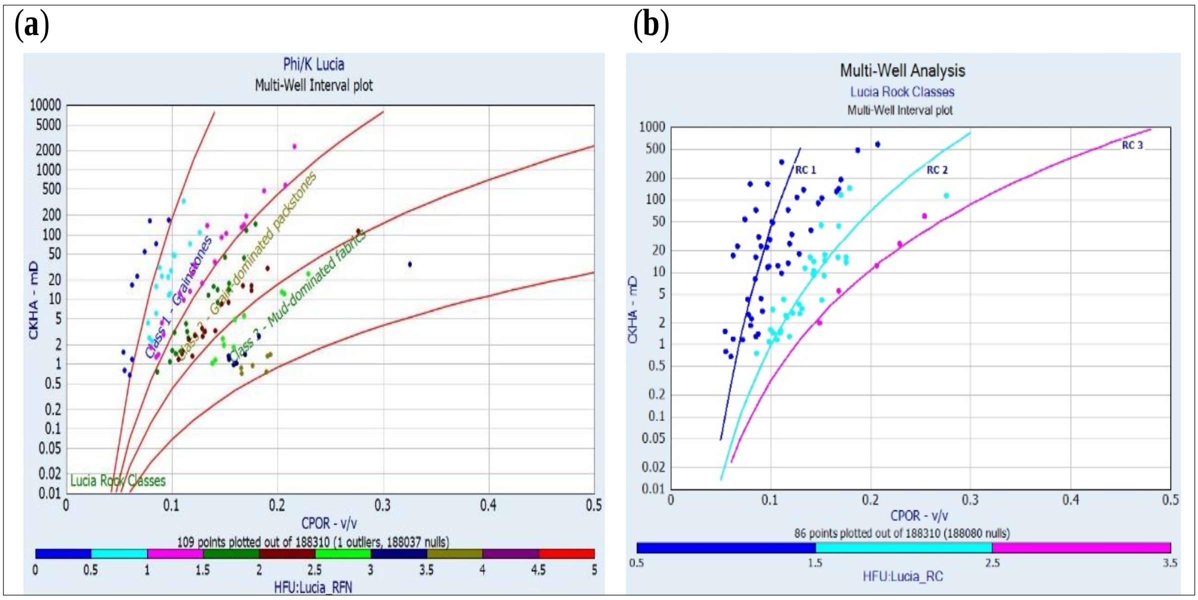

Fig. 2. The Classification of Rock Fabric Number for The Upper Qamachq Formation

3.2. Winland plot

This classification divides the formation into five rock classes based on the equivalent to pore throat diameters and equivalent reservoir properties, as depicted in Fig. 3. The petrophysical parameters have been obtained for each different rock type in Table 1. The categorization approach based on throat pore size revealed that nanopores had a permeability of less than 1 md is a bad quality reservoir rock. The rock that has a variety of pore sizes (micropores, mesopores, macropores, and mega-pores) with permeabilities ranging from moderate to excellent is considered a good reservoir rock. Mega pores are described as fractures with permeabilities of 2000 md. The Winland technique is the best way to separate the formation into rock-type units, but the weak regression reflected in the correlation coefficients of PRT-1 and PRT-2 makes it not the best option for predicting permeability.

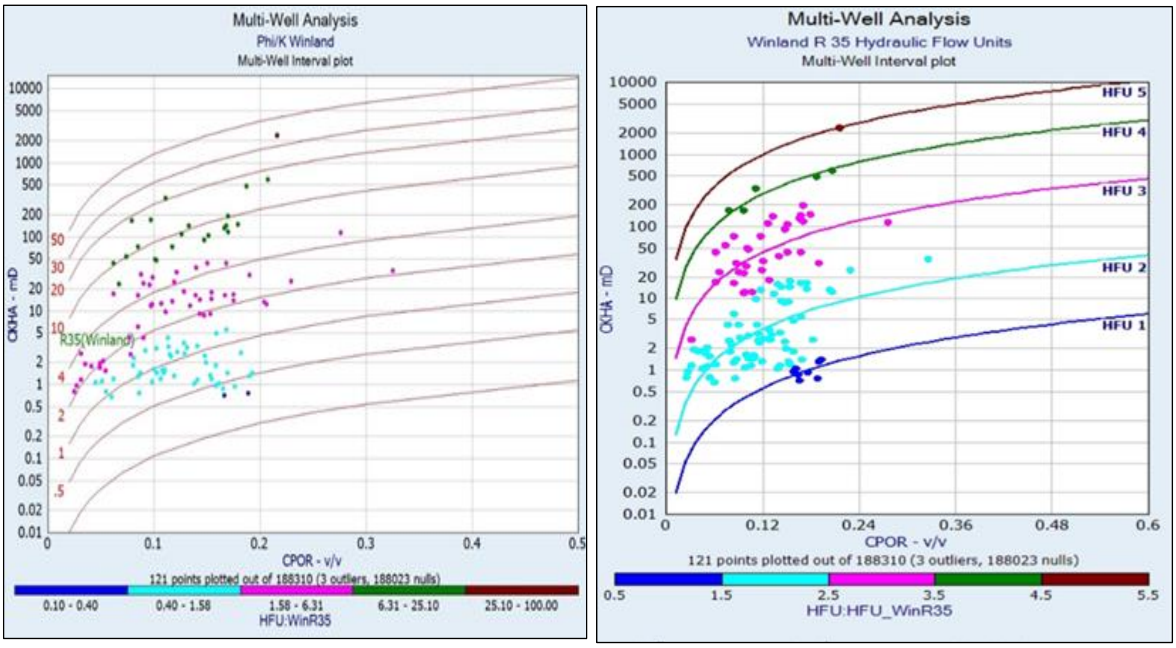

Fig. 3. Winland Plot Classification

Table 1. Winland Method Petrophysical Characteristics

No. Rock-type	Pore throat type	Pore throat size(μm)	Permeability (MD)	R^2
PRT-1	Nanopores	0.1 -0.4	Less than 1	0.19
PRT-2	Micropores	0.4– 1.58	1- 20	0.37
PRT-3	Mesopores	1.58– 6.31	20- 200	0.71
PRT-4	Macropores	6.31– 25.10	200 - 500	0.89
PRT-5	Mega pores	25.10-100	2000	1

3.3. Hydraulic Flow zone indication method

Based on the given core data, the rocks were divided into five distinct groups using Eq. 3, 4, and 5. Fig. 4 illustrates the results in a uniform FZI generation. The fourth and fifth groups have the best quality and deliverability, whereas the first group contains inferior reservoir rock with a deliverability of less than 2 md.

In Fig. 5, several parallel lines depict how RQI and porosity index relate on a log-log scale. Each line represents different core samples and has its slope. Samples with the same slope share the same pore throat description and flow unit at any given site on that line [19]. The FZI technique categorized the upper Qamchuqa formation into five units, similar to the Winland method. The correlation coefficient relations for each rock type showed that the FZI application connected permeability and porosity core data effectively, as shown in Table 2. As a result, the porosity and permeability relationships of the core data provided by the FZI approach are more dependable for estimating permeability. and the equations generated by the FZI technique from the cored intervals in Table 2 have been applied to well Ja-19, as shown in Fig. 6 to validate the permeability calculation when it is employed for uncored intervals.

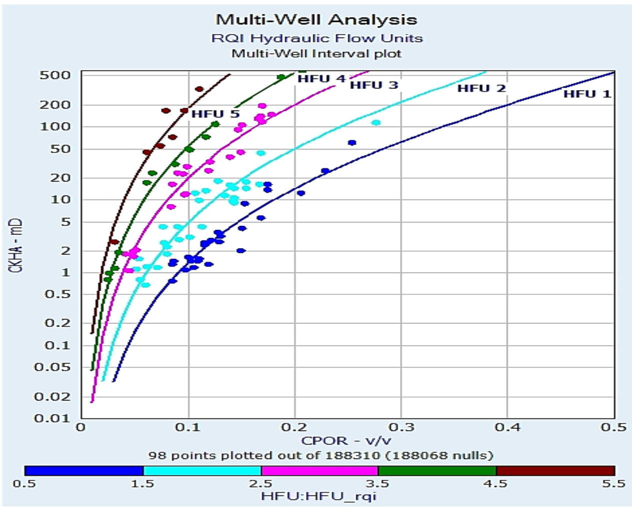

Fig. 4. Rock-Type Classification Based on FZI Method

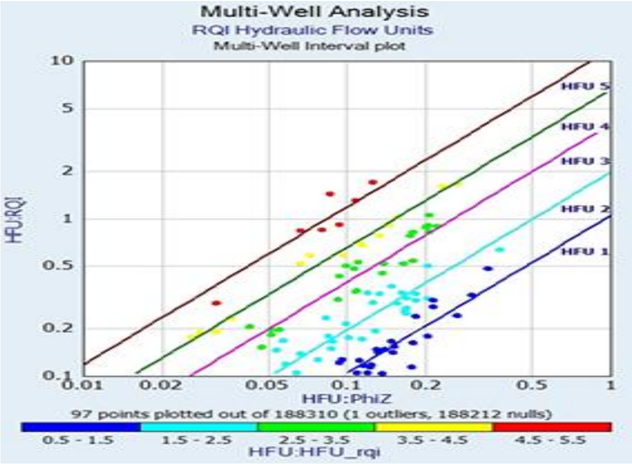

Fig. 5. Reservoir Quality Index Vs. Normalized Porosity

Table 2. Formulas for Permeability Regarding FZI Principle

FZI classification	Formula Equation	R²
FZI 1	$K = \emptyset^3[\frac{1.054}{0.0314 \times (1-\emptyset)}]^2$	$R^2 = 0.8842$
FZI 2	$K = \emptyset^3[\frac{1.98}{0.0314 \times (1-\emptyset)}]^2$	$R^2 = 0.8829$
FZI 3	$K = \emptyset^3[\frac{3.98}{0.0314 \times (1-\emptyset)}]^2$	$R^2 = 0.99557$
FZI 4	$K = \emptyset^3[\frac{6.593}{0.0314 \times (1-\emptyset)}]^2$	$R^2 = 0.9924$
FZI 5	$K = \emptyset^3[\frac{11.909}{0.0314 \times (1-\emptyset)}]^2$	$R^2 = 0.9287$

3.4. Cluster analysis

The IP program was used to conduct a cluster analysis on the studied region, using raw data (GR, DT, NPHI, and RHOB) obtained from six wells as input data. Minimizing the within-cluster sum of squares distance method was used to compute the average of forty randomly generated groups. The findings are almost identical to those of the FZI approach for core data. Thus, the facies model of the upper Qamchuqa formation was developed by cluster analysis and calibrated using the FZI approach. The dendrogram's categorization procedure is illustrated in Fig. 7. As can be seen in the cross-plot in Fig. 8, the formation was split into five groups to reflect different reservoir rock quality levels. Group 1 (green) represents poor-quality reservoir rock; Group 2 (red) represents intermediate-quality reservoir rock; Group 3 (yellow) represents moderate-quality reservoir rock; Group 4 (black) represents beneficial-quality reservoir rock; and Group 5 (blue) represents excellent reservoir rock. Fig. 9 and Fig. 10 represent the log views of wells 19 and 25, respectively, which reflect the created facies from cluster analysis and can later be used to estimate the reservoir characteristics in the static model.

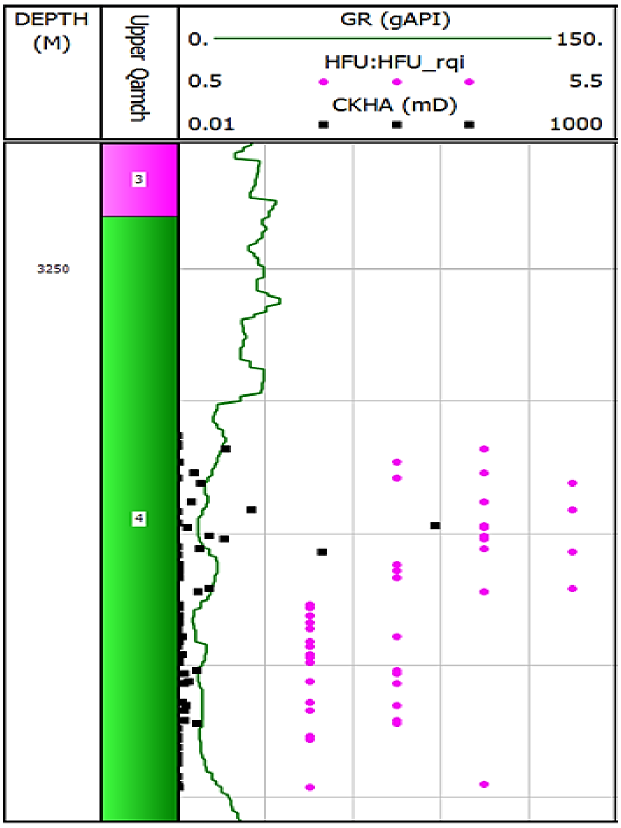

Fig. 6. Permeability Comparison (Core vs. Predicted)

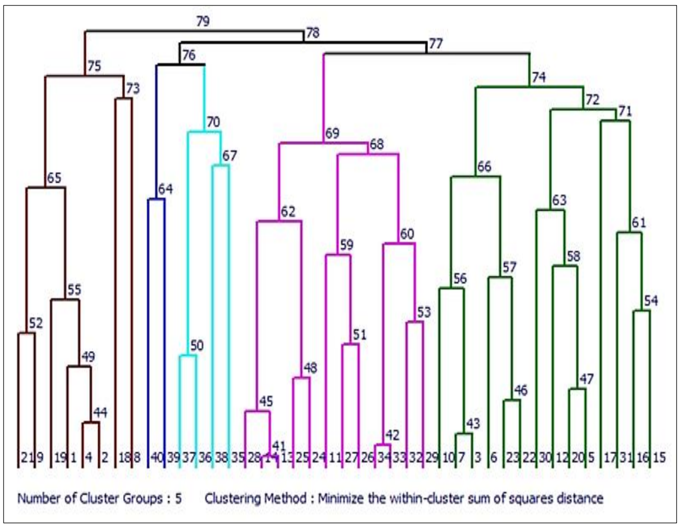

Fig. 7. Dendrogram of the Cluster Group

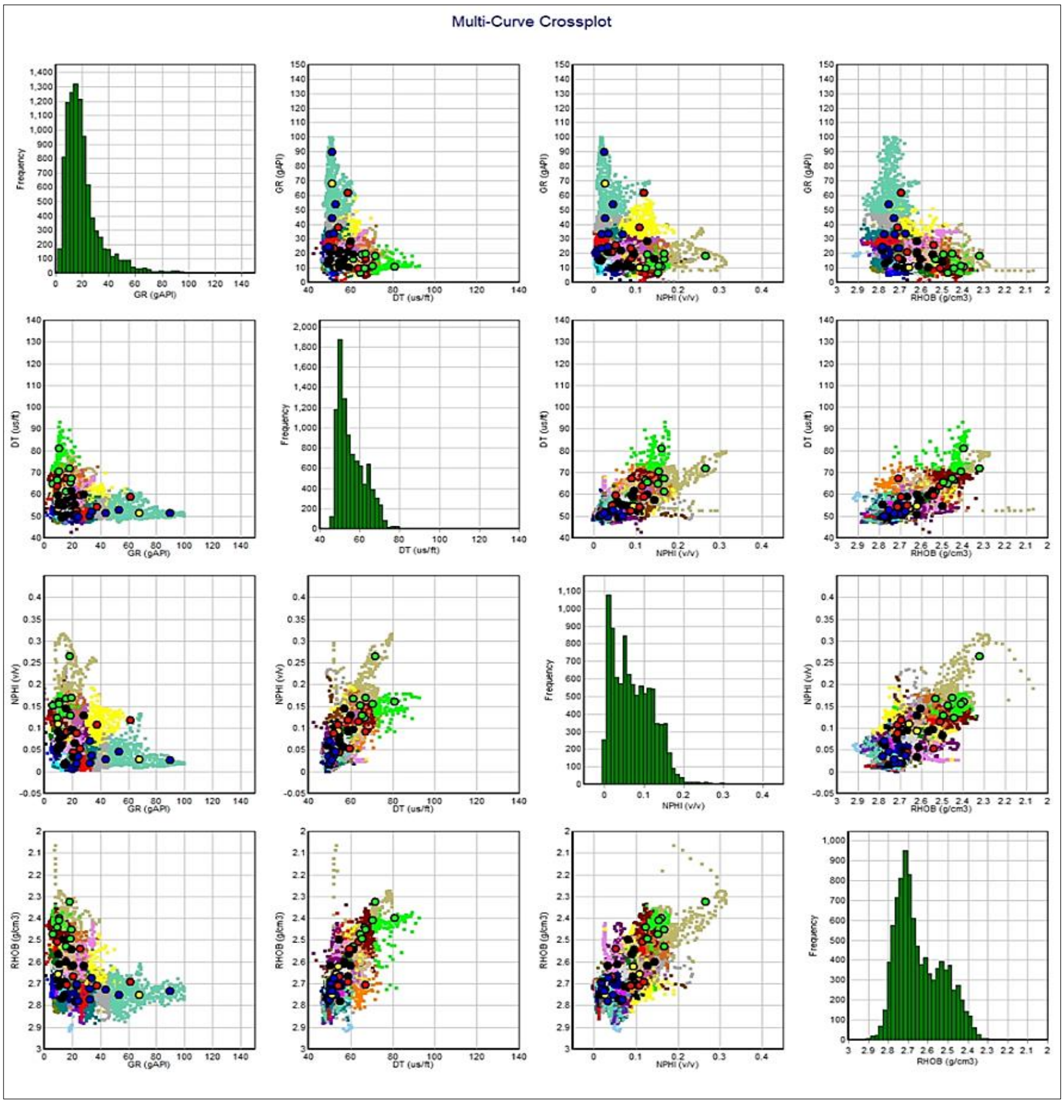

Fig. 8. The Cluster Analysis Cross-Plot for the Upper Qamchuqa Formation

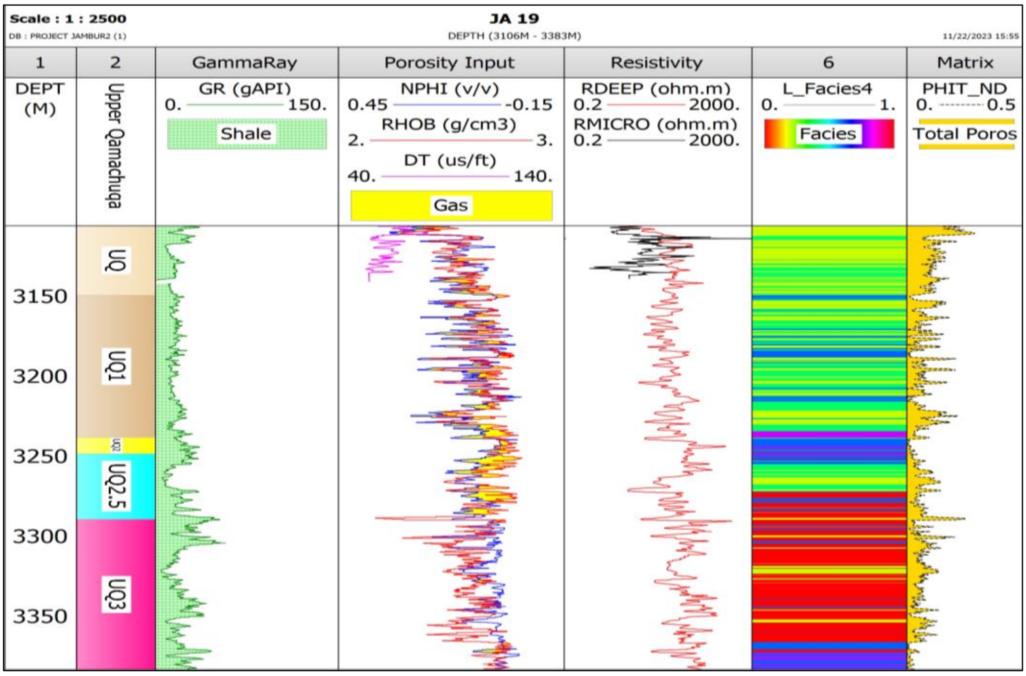

Fig. 9. The Log View of Cluster Analysis for Well Ja-19

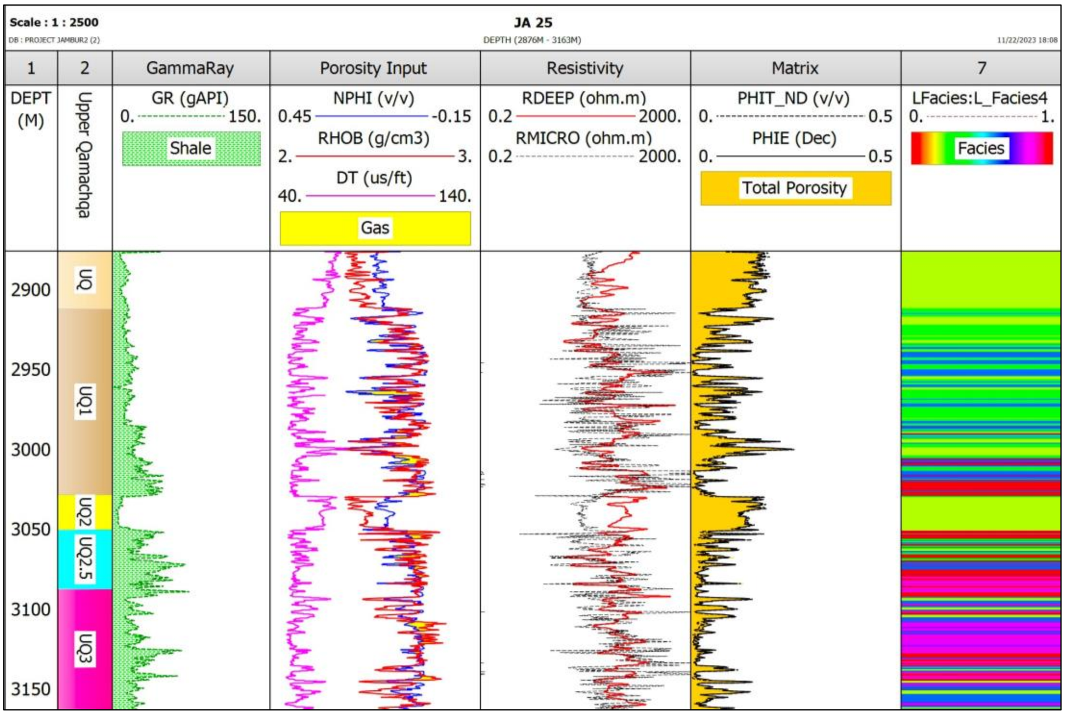

Fig. 10. The Log View of Cluster Analysis for Well Ja-25

4- Conclusions

To evaluate the rock types and flow units in the upper Cretaceous carbonate reservoir, specifically the upper Qamchuqa formation in the Jambur oilfield, plots of core porosity and permeability were generated for six wells. The results showed significant scattering, leading to the classification of three main facies types: dolomite, limestone, and dolomitic limestone. However, the correlation coefficient reflected a weak linear regression, indicating a lack of a clear connection between the variables. To address this issue, three alternative strategies were employed for reservoir rock categorization based on micro-facies features derived from core data (RFN, Winland, and FZI), as well as cluster analysis techniques based on electro-facies characteristics. The conclusions drawn from these analyses are as follows:

1. The RFN approach presented to be the most effective in detecting the reservoir geological structure, but it was noted that additional information from SACL data regarding the types of vugs (touch and separate) is necessary to enhance the accuracy of permeability estimation in the upper Qamchuqa formation.
2. The Upper Qamchuqa formation was categorized into five flow zones using both the Winland porosity-permeability plot and the flow zone index technique. While the Winland technique exhibited poor statistical regression, making it less reliable for permeability determination, the FZI approach is considered to be more reliable in this regard.
3. Cluster analysis was applied based on raw logs data, and calibrated with the FZI technique, to construct a facies model, serving as an initial step in determining the petrophysical properties of the Upper Qamchuqa formation.

Nomenclature

Abbreviations	*Description*
DT	The recorded travel time, µsec/ft
FZI	Flow Zone Indicator, µm
GR	The recorded gamma ray log, API units
HFU	Hydraulic Flow Unit, µm
K	Permeability, MD
NPHI	The recorded neutron log, API units
Øz	Normalized Porosity, fraction
PRT	petrophysical rock type, µm
R^2	Correlation Coefficient
R35	Pore Throat radius at 35% mercury saturation, µm
RFN	Rock-Fabric Numbers, µm
RHOB	The recorded bulk density, gm/cc
RQI	Reservoir Quality Index, µm
µm	Micrometers, 1µm =1x10-6m
Φ	porosity, fraction

References

[1] A. M. Ali and A. A. Al-haleem. "Applying Facies Characterization to Build 3D Rock-Type Model for Khasib Formation, Amara Oil Field ". *Iraqi Journal of Oil and Gas Research*, Vol. 3, No.1, pp 94-105,2023. http://dx.doi.org/10.55699/ijogr.2023.0301.1040

[2] A.M.R. Awadeesian, S. N.A. Al-Jawad, S. M. Awadh, M. M. Al-Maliki. "chronostratigraphic ally-based reservoir model for Cenomanian carbonates, southeastern Iraq oilfields". *The Iraqi Geological Journal*, vol.52, No.2, pp1–27, 2018. https://doi.org/10.46717/igj.51.2.1Ms-2018-12-23

[3] A. M. Ali and A. A. Al-haleem. "Determination of Reservoir Hydraulic Flow Units and Permeability Estimation Using Flow Zone Indicator Method". *Iraqi Journal of Chemical and Petroleum Engineering*, Vol.24, No.2, pp89-95,2023. https://doi.org/10.31699/IJCPE.2023.2.10

[4] N. M. Salih, I.M. Kamal, and A. Préat. "Classical observations and stable isotopes for identification the diagenesis of Jeribe formation at Jambur oil Fields-Kurdistan Region-Iraq". *Petroleum Science and Technology*, Vol. 37, Issue 13,2019, pp1548-1556. https://doi.org/10.1080/10916466.2019.1590405

[5] P. Rabiller, J.-P. Leduc, and S.-J. Ye. "The iterative use of clustering and modeling to improve permeability prediction". *SPWLA 42nd Annual Logging Symposium*, Houston, Texas, June 2001.

[6] H. Shuaibu and A. M. Attia."How to Prepare Input File of Reservoir Simulation by Using Reservoir Characterization". *International Journal of Scientific & Engineering Research*, Volume 6, Issue 5, PP 1365-1381, 2015.

[7] H. Nooruddin and M. E. Hossain. "Modified Kozeny–Carmen correlation for enhanced hydraulic flow unit characterization". *Journal of Petroleum Science and Engineering*, Vol.80. Issu1, pp107-115, 2011. https://doi.org/10.1016/j.petrol.2011.11.003

[8] H.H. Mahmood, and O. F. Al-Fatlawi. "Construction of comprehensive geological model for an Iraqi Oil Reservoir". *The Iraqi Geological Journal*, Vol. 54, No. 2F, PP 22–35, 2021. https://doi.org/10.46717/igj.54.2F.3ms-2021-12-20

[9] R. K. AbdulMajeed, and A.A. Alhaleem. "Estimation of shear wave velocity from wireline logs data for Amara Oilfield, Mishrif Formation, Southern Iraq". *The Iraqi Geological Journal*, Vol.53, No.1A, PP 36–47, January 2020. https://doi.org/10.46717/igj.53.1a.R3.2020.01.30

[10] D. K. Faidhllah and S. M. Hamd-Allah. "Prediction of Hydraulic Flow Units for Jeribe Reservoir in Jambur Oil Field Applying Flow Zone Indicator Method". *Iraqi Journal of Chemical and Petroleum Engineering*, Vol. 24 No.2, PP 65 – 70, June 2023. https://doi.org/10.31699/IJCPE.2023.2.7

[11] O. Salman, O. Al-Fatlawi and S. Al-Jawad. "Reservoir Characterization and Rock Typing of Carbonate Reservoir in the Southeast of Iraq". *Iraqi Geological Journal*, Vol.56, No. 1A, PP 221-237, January 2023. https://doi.org/10.46717/igj.56.1A.17ms-2023-1-29

[12] B. Al-Qayim, and F. Rashid. " Reservoir characteristics of the Albian upper Qamchuqa formation carbonates, Taq Taq oilfield, Kurdistan, Iraq". *Journal of Petroleum Geology*, Vol.35, No.4, PP 317-341, 2012. https://doi.org/10.1111/j.1747-5457.2012.00533.x.

[13] Iraqi- Minister of Oil-North Oil Company Jambur Field Data, 2022.

[14] F. A. Aljuboori, J. H. Lee, K. A. Elraies and K. D. Stephen,2019. "Gravity Drainage Mechanism in Naturally Fractured Carbonate Reservoirs; Review and Application". *Energies*, Vol.12, No. 19, PP 3699, September 2019. https://doi.org/10.3390/en12193699

[15] W. k. Al-memory, and S. Al-Dulaimi. " Biostratigraphy of Qamchuqa Formation in Jambur Oil Field in Kirkuk Area". *Journal of the University of Babylon for Pure and Applied Sciences*, Vol. (28), No. (3), pp 216-242, 2020.

[16] Z. Riazi. "Application of integrated rock typing and flow unit's identification methods for an Iranian carbonate reservoir". *Journal of Petroleum Science and Engineering*, Vol.160, PP 483-497, 2018. https://doi.org/10.1016/j.petrol.2017.10.025

[17] A. A. Bhatti, A. Ismail, A. Raza, R. Gholami, R. Rezaee, R. Nagarajan, and Eric Saffou. "Permeability prediction using hydraulic flow units and Electrofacies analysis". *Energy Geoscience*, Vol.1, Issu1–2, PP 81–91, 2020. https://doi.org/10.1016/j.engeos.2020.04.003

[18] W.M. Al-Qattan, A. H. Al Mohammed. "Permeability Prediction by Classical and Flow Zone Indictor (FZI) Methods for an Iraqi Gas Field". *Iraqi Journal of Chemical and Petroleum Engineering*, Vol.18, No.3, September 2017, PP 59–65, 2017. https://doi.org/10.31699/IJCPE.2017.3.5

[19] H. A. Baker, S. N. AL-Jawad, and Z. I. Murtadha. "Permeability Prediction in Carbonate Reservoir Rock Using FZI". *Iraqi Journal of Chemical and Petroleum Engineering*, Vol.14, No.3, 2013, PP 49-54. https://doi.org/10.31699/IJCPE.2013.3.5

[20] M. B. Alsinbili, S. N. Aljawad and A. A. Aldalawy. "Permeability Prediction of Un-Cored Intervals Using FZI Method and Matrix Density Grouping Method: A Case Study of Abughirab Field/Asmari FM., Iraq". *Iraqi Journal of Chemical and Petroleum Engineering*, Vol. 14, No. 4, PP 27-34, 2013. https://doi.org/10.31699/IJCPE.2013.4.4

[21] U. Alameedy, A.T. Almomen, and N. Abd. "Evaluating Machine Learning Techniques for Carbonate Formation Permeability Prediction Using Well Log Data". *Iraqi Geological Journal*, Vol.56, No.1D, PP 175-187, April 2023. https://doi.org/10.46717/igj.56.1D.14ms-2023-4-23

[22] D. A. Alobaidi. "Permeability Prediction in One of Iraqi Carbonate Reservoirs Using Hydraulic Flow Units and Neural Networks". *Iraqi Journal of Chemical and Petroleum Engineering*, Vol.17, No.1, PP1-11, March 2016. https://doi.org/10.31699/IJCPE.2016.1.1

تحديد نوع الصخور ووحدة التدفق في التكوينات الكاربوناتية للعصر الطباشيري العلوي في حقل جمبور النفطي

نازنين سعيد امين [١، *]، اياد عبد الحليم عبد الرزاق [١]

١ قسم هندسة النفط، كلية الهندسة، جامعة بغداد، بغداد، العراق

الخلاصة

تعتمد فعالية النماذج الديناميكية لتطوير الحقل والتنبؤ بأداء المكمن المستقبلي على موثوقية النماذج الجيولوجية، والتي تعتمد بشكل أساسي على تصنيف دقيق لأنواع الصخور المكمنية والكشف عن وحدات التدفق. يعد التعرف على البنية الجيولوجية والخصائص الصخرية وعمليات الترسيب هي المرحلة الأولية في فصل الصخور إلى أنواع وحساب وحدات التدفق في الطبقات.

تهدف الدراسة إلى تحديد أنواع الصخور ووحدات التدفق ضمن الخزان الطباشيري العلوي/ تكوين قمجوقة لحقل جمبور النفطي. تم استخدام أربع تقنيات بتروفيزيائية على بيانات ستة آبار. تقنية رقم النسيج الصخري وعلاقة وينلاند بين المسامية والنفاذية، وجد أن هذان طريقتان غير كافيتان لتقدير النفاذية بسبب فعاليتها المحدودة في تحليل الانحدار. أسفر تصنيف مؤشرات منطقة التدفق عن خمس فئات صخرية أثبتت أنها أكثر موثوقية لتقييم النفاذية في الفترات التي تغيب فيها البيانات اللباب. وأخيرًا، عملية التحليل العنقودي قامت بفرز الصخور المكمنة إلى مجموعات بناءً على بيانات المجسات الخام وتم معايرتها باستخدام طريقة FZI. في الختام، يمكن حساب النفاذية باستخدام المعادلات المستخرجة من طريقة FZI، ويمكن تحديد الخصائص البتروفيزيائية في نموذج جيولوجي بالاعتماد على سحنات الصخور المستمدة من التحليل العنقودي.

الكلمات الدالة: تحديد نوع الصخور، وحدات التدفق، علاقة المسامية–النفاذية، حقل جمبور النفطي، المكمن الطباشيري العلوي، تكوين قمجوقة.