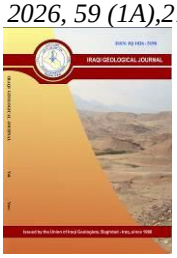
Iraqi Geological Journal

Journal homepage: https://www.igj-iraq.org



Reservoir Characterization and Petrophysical Evaluation for the Jeribe Formation in Tawke Oilfield, Duhok Governorate, Kurdistan Region, Iraq

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Received:
7 July 2025
Accepted:
16 October 2025

Published:
31 January 2026

Abstract

The study includes the analysis of three subsurface sections (Ta-2, Ta-5, and Ta-6) in the Tawke Oilfield, located in northwestern Iraq. Gamma ray, neutron, density, and resistivity logs were used, along with Techlog software. The current study aims to determine the lithological, petrophysical, and reservoir properties, as well as the variations in these properties within the Jeribe Formation section, both vertically and laterally, and their importance as oil reservoir rocks. The formation was divided into three reservoir units (Jer-1, Jer-2, and Jer-3) based on variations in shale volume, porosity, and permeability. The results revealed the presence of two main types of lithofacies (limestone and dolomite), as well as anhydrite nodules. The formation has an average shale content ranging from 10 to 19%, with thicknesses reaching 74 m in well Ta-2, approximately 49 m in well Ta-5, and 76 m in well Ta-6. The effective porosity ranges from 4 to 10%, the permeability ranges from 0.15 to 11.83 md, and the hydrocarbon saturation ranges from 0.16 to 0.73%. The formation in well Ta-2 has better petrophysical properties, with effective porosity ranging from 8-10%, hydrocarbon saturation ranging from 34-73%, and permeability reaching a maximum of 2.5 md, making it a strong candidate for hydrocarbon production. The net thickness of the Ta-2 well reached 52m, while Ta-5 reached 12m, and Ta-6 reached 7m. Horizontally, units Jer-2 and 3 in well Ta-2 have better properties compared to the rest of the wells, followed by unit Jer-2 in Ta-5, which also has better properties compared to the rest of the units in the same well. In contrast, well Ta-6 does not have good reservoir properties due to high water saturation, especially in the first and second units. Therefore, well Ta-2 has better reservoir properties.

Keywords: Jeribe; Miocene; Tawke; Techlog; Northern Iraq

1. Introduction

The Jeribe Formation consists of carbonate rocks. It was deposited in a shallow marine environment (Bellen et al., 1959; Al-Juboury et al., 2007; Abdula et al., 2017). The formation has a thickness of nearly 70 m in the type locality (Jassim and Buday, 2006a). The age of the Jeribe Formation was estimated to be Early Middle Miocene based on biostratigraphical studies in selected wells in Mansuriyha Gas Field, Eastern Iraq. The lower and upper boundaries of the formation are conformable with the underlying Dhiban Formation and unconformable with the overlying Fatha formations, respectively (Baban and Hussein, 2016). Based on the results of the quantitative interpretation of the petrophysical properties of the Jeribe- Euphrates Formation in H. Oilfield in Southern Iraq, the formation was divided into two reservoir units: the upper reservoir unit (JE-1) and the lower reservoir

unit (JE-2). The porosity of the formation ranges between 14 and 21%, and permeability values reach up to 11.14 md (Kamal and Jassim, 2022). In the Hamrin Oilfield, Kamal and Jassim (2022) divided the formation into two reservoir units, where the average effective porosity in the upper unit reaches 9.65%, while it reaches 4.92% in the lower unit. The effective porosity in the Ajil Oilfield is around 15%, with a shale content of 18%, and a water saturation of 33%. The Euphrates and Jeribe formations are characterized by low to moderate porosity (2.7–20.5%) and low matrix permeability (0.87–15 md) (Akram et al., 2023).

The results from all the wells within the Jambour Oilfield in northern Iraq indicated that the Larionov model is the most suitable for determining shale volume and that the presence of asphaltene and high water salinity affects the gamma-ray log. The non-linear models are more appropriate for future petrophysical evaluation of the Jeribe Formation.

Both log analysis and core data have shown that the Jeribe is a clean formation; no volume of shale has been considered in the STIIOP calculations. The average water saturation is calculated to be 31.5%, and the average porosity is approximately 22% with a temperature gradient of 1.2 °F/100 ft. This is based on Stock Tank Initial Oil in Place, calculated to be 6.519 X 10^9 Barrels of oil. Similarly, the study on reservoir characterization of the Jeribe and Euphrates formations in the Qaiyarah Oilfield indicates that the Jeribe Formation has a volume of oil initially in place of about 1.94 X 10^8 Sm^3.

Building on this regional framework, the present study focuses on the reservoir appearances of the Jeribe Formation in three selected wells from the Tawke Oilfield, namely Ta-2, Ta-5, and Ta-6, located in Duhok Governorate (Fig. 1), within the Unstable Platform of the Zagros-fold belt (Jassim and Buday, 2006b).

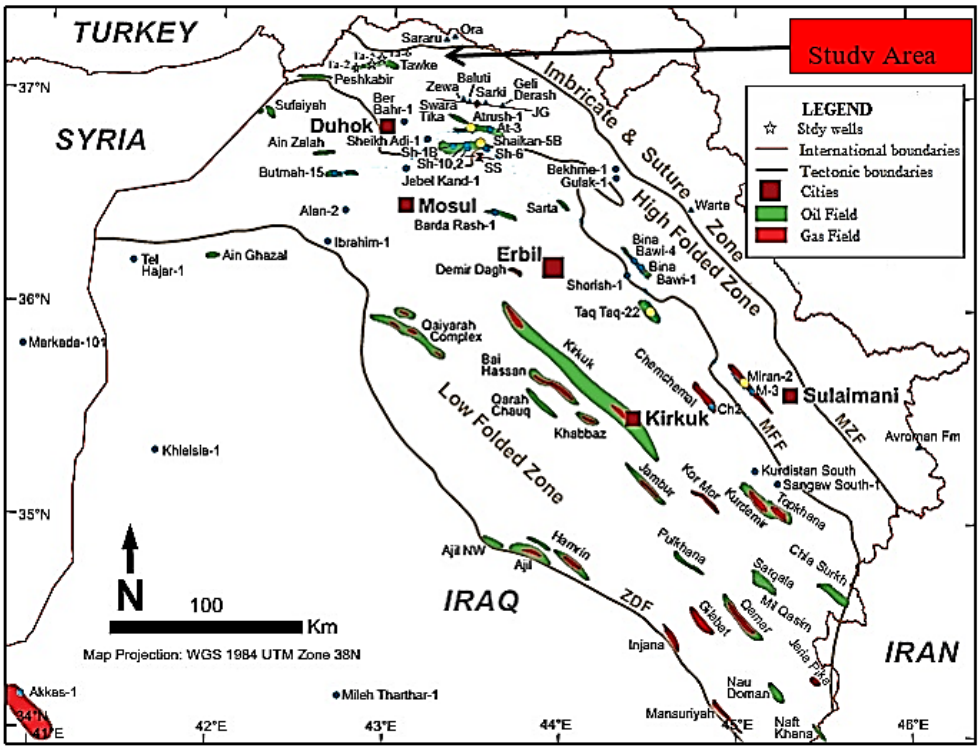


Fig. 1. Location map of the studied area (after Mohialdeen et al., 2022)

The current study aims to evaluate the petrophysical properties of the Jeribe Formation and how they vary both vertically within individual wells and laterally across different wells, highlighting the formation's significance as a hydrocarbon reservoir. Well log interpretation is considered one of the primary methods for characterizing reservoir rocks.

2. Materials and Methods

The analysis and interpretation of well log data were used to evaluate the reservoir properties of the subsurface section in the Tawke Oilfield. In this study, interpretation of well log data was carried out using gamma ray, neutron, density, and resistivity logs. This study utilized specialized software for data processing and interpretation, including Neuralog for digitizing well logs and Techlog 2018 for petrophysical analysis. The dataset used in this study was obtained by digitizing three key well logs: density, neutron porosity, resistivity, and gamma ray logs, which were employed to assess the petrophysical characteristics of the Jeribe Formation. The integration of these well log analyses, along with geological information, contributed to a better understanding of the reservoir's structural framework and hydrocarbon potential, thus supporting exploration and development activities within the Tawke Oilfield.

3. Results

3.1. Lithology of the Jeribe Formation in Tawke Wells

The Jeribe Formation in wells Ta-2, Ta-5, and Ta-6 is primarily composed of carbonate rocks, including limestone and dolomite, interspersed with minor shale (represented by points deviating upward/right on the cross plots) and anhydrite (indicated by points trending downward towards zero porosity) layers (Fig. 5).

- Well Ta-2: The cross plot (Fig. 2) exhibits a dominance of carbonate points, with some deviations upward/right suggesting minor shale presence and a few low-porosity points indicating thin anhydrite layers. This pattern implies relatively better reservoir quality compared to the other wells.

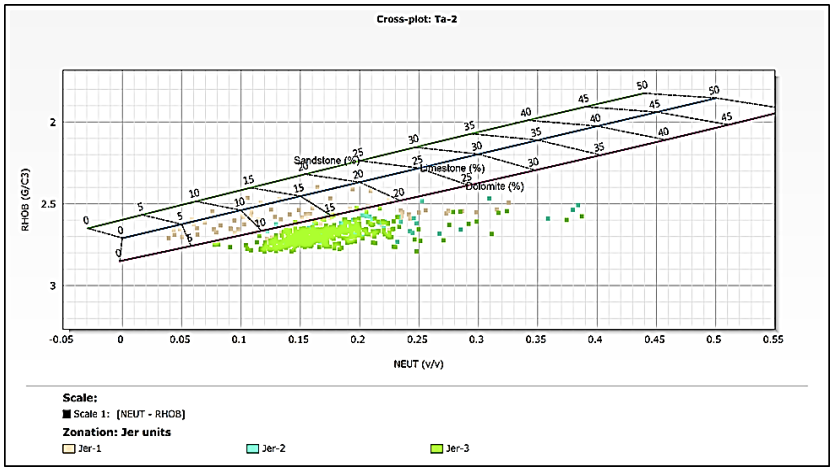


Fig. 2. Cross plot between neutron and bulk density for determining lithology of Jeribe Formation in Ta-2

- Well Ta-5: The cross plot (Fig. 3) indicates a higher proportion of anhydrite, evidenced by more points near zero porosity, along with shale occurrences. Carbonate layers are less extensive, reflecting poorer reservoir characteristics.
- Well Ta-6: The plot (Fig. 4) exhibits a similar distribution to that of Ta-5, with dominant anhydrite zones and minor carbonate and shale facies, indicating limited hydrocarbon storage potential.

Overall, the analysis of the cross plots highlights that carbonate content controls the reservoir quality. At the same time, the presence of anhydrite and shale layers negatively affects porosity and hydrocarbon storage potential across all three wells.

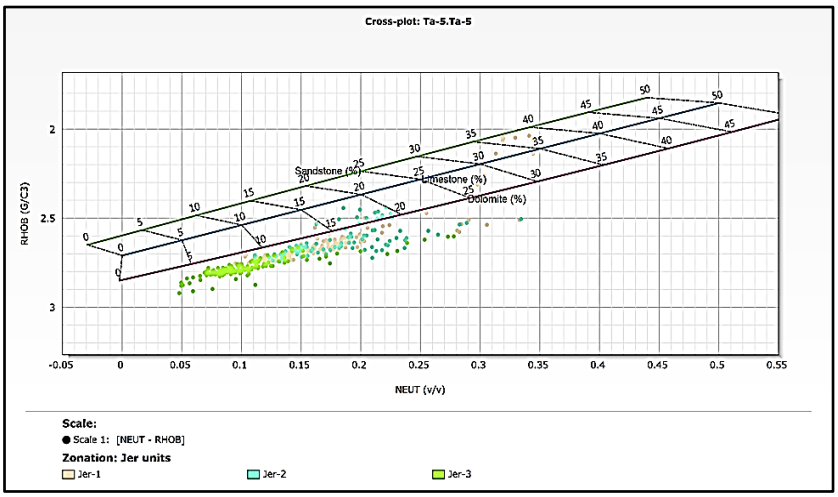


Fig. 3. Cross plot between neutron and bulk density for determining lithology of Jeribe Formation in Ta-5

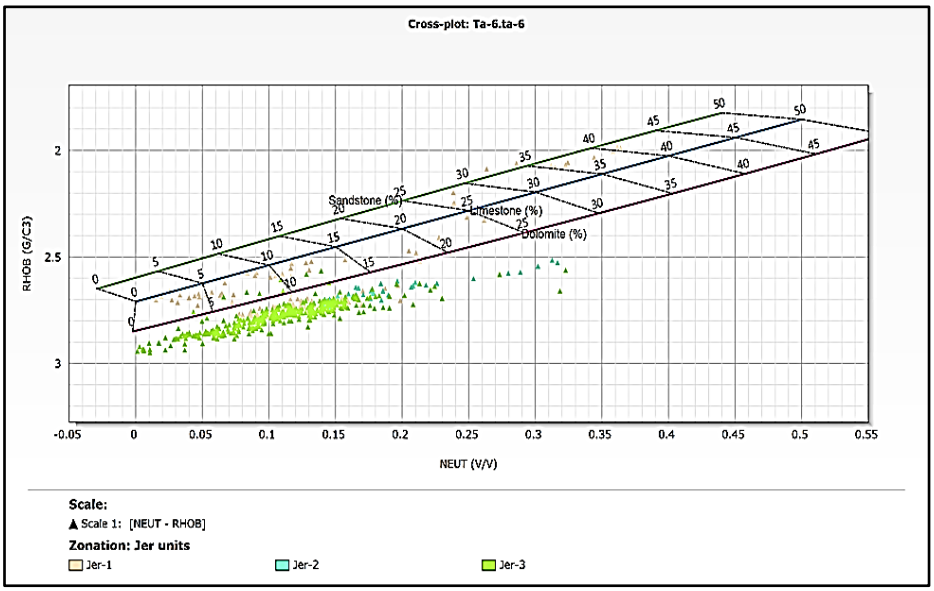


Fig. 4. Cross plot between neutron and bulk density for determining lithology of Jeribe Formation in Ta-6

3.2. Shale Content

The shale volume (V_{sh}) was calculated using the gamma ray log, which is considered one of the most effective tools for estimating shale content in geological formations (Mamaseni et al., 2024) The results indicate that shale content in wells Ta-2 and Ta-5 was generally low, with values below 10% throughout most of the formation, except for some narrow intervals where it reaches up to 50%. Therefore, the formation is classified as a clean formation in these wells. In well Ta-6, the shale content ranged between 10 and 20% in most of the formation, particularly in the upper and lower sections. The middle section, however, is considered part of the clean zone, as shale content drops to below 10%.

According to the classification adopted by Ghorab et al. (2008), the majority of the Jeribe Formation in all three wells falls within the clean zone, except for some shaly intervals where shale content exceeds 35%, which are considered shale zones (Figs. 6, 7, and 8).

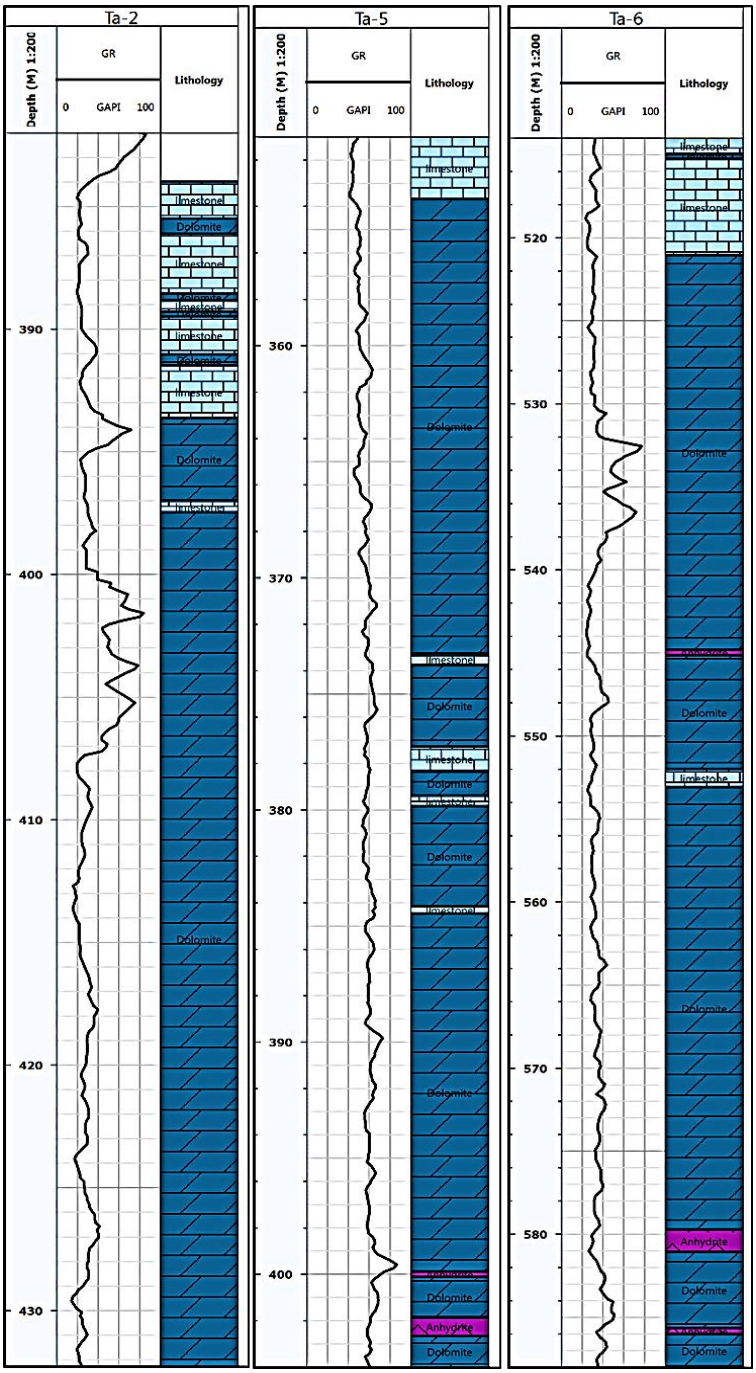


Fig. 5. Column lithology for the Jeribe Formation depends on the cross plot in Ta-2, Ta-5, and Ta-6

The gamma ray index was calculated using the following equation:

$$IGR = GRlog - GRmin \div GRmax - GRmin \quad (1)$$

IGR= Gamma Ray Index; GRlog= Gamma Ray reading of the wellbore at a specific depth or formation zone (measured in API units); GRmin= Minimum Gamma Ray reading recorded for clean formations (such as sandstones) within the well; and GRmax= Maximum Gamma Ray reading recorded for shale formations within the well. The shale volume was calculated according to the applied formula:

$$Vsh = 0.083 \times 2(3.7 \times IGR - 1) \quad (2)$$

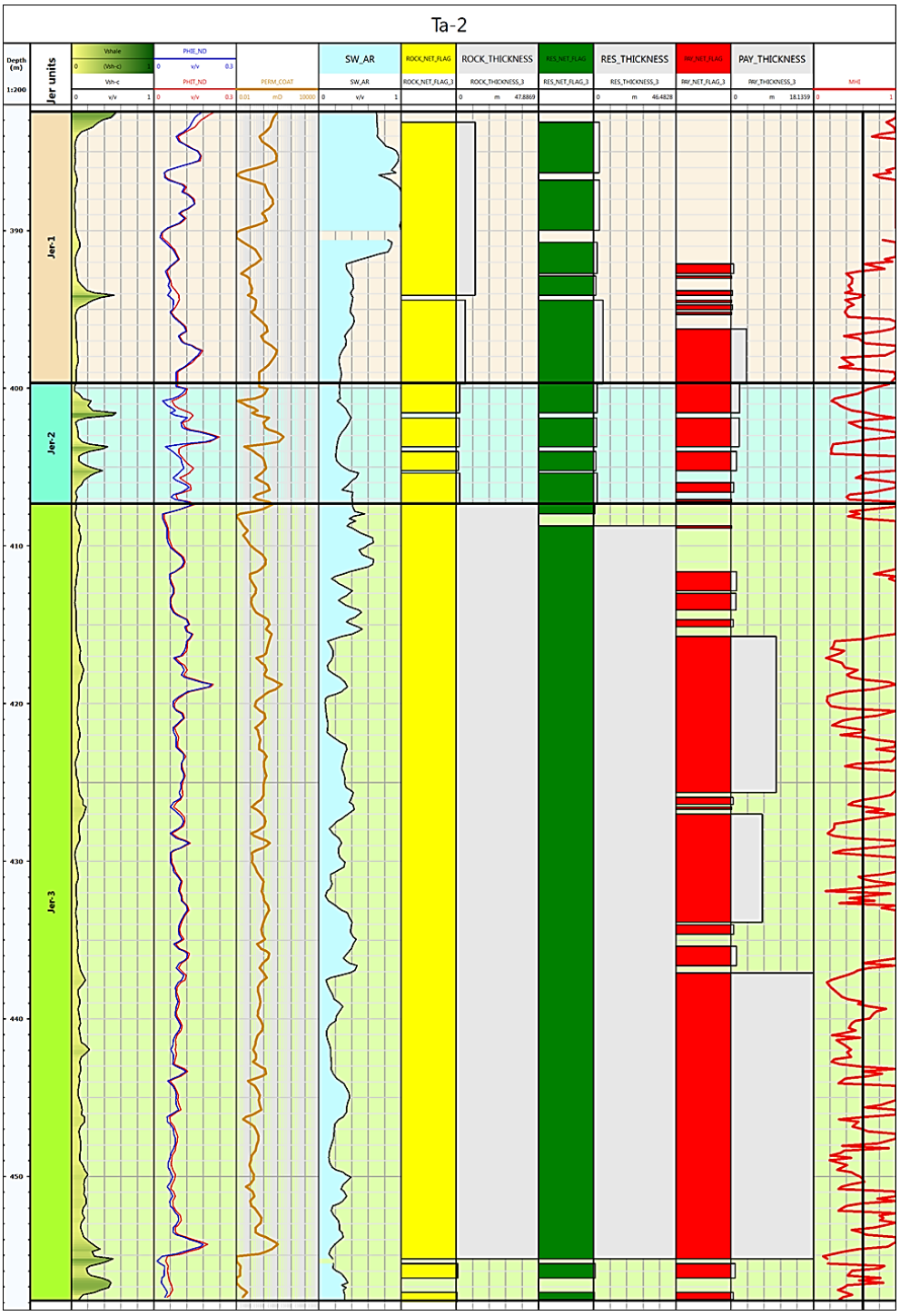


Fig. 6. Net pay when cutoff porosity = 0.048% and cutoff water saturation = 40% in Ta-2

The shale content in well Ta-2 is generally less than 20% throughout most of the formation, indicating favorable petrophysical properties. In contrast, wells Ta-5 and Ta-6 contain layers of anhydrite, which negatively affect reservoir quality. Anhydrite rocks exhibit very low porosity, often approaching zero, resulting in reduced reservoir performance in those zones.

3.3. Porosity

Porosity is one of the fundamental properties of reservoir rocks and is defined as the ratio of pore volume to total rock volume. According to Choquette and Pray (1970), porosity can be classified into two main types based on its origin. In this study, both total porosity and effective porosity were calculated using Neutron and Density log data, following the equation presented by Asquith and Gibson (1982) (Figs. 6, 7, and 8).

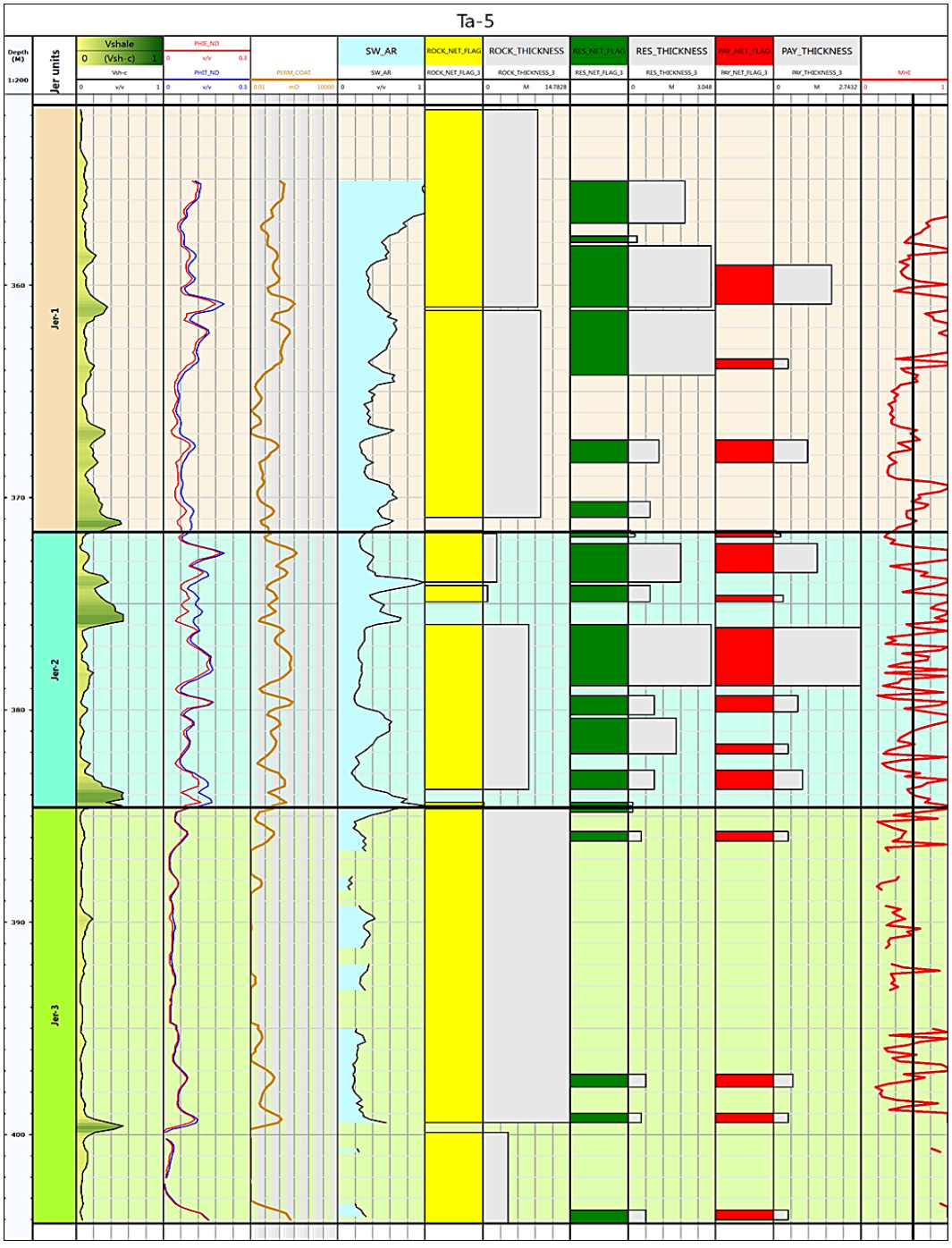


Fig. 7. Net pay when cutoff porosity = 0.071% and cutoff water saturation = 42% in Ta-5

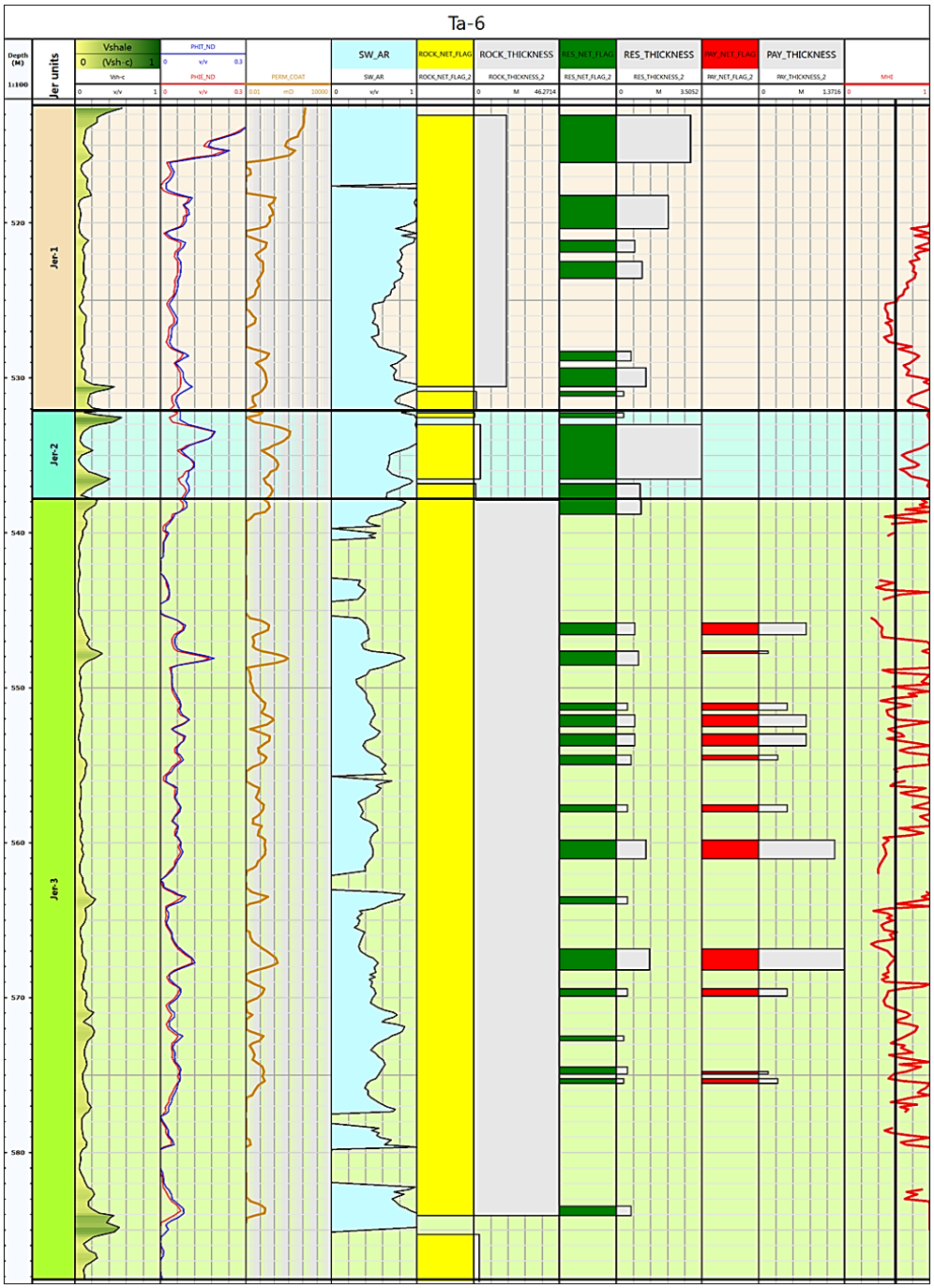


Fig. 8. Net pay when cutoff porosity= 0.067% and cutoff water saturation = 58% in Ta-6

The results show that well Ta-2 exhibits the highest porosity (~10%), indicating good reservoir characteristics in terms of fluid storage capacity. In contrast, wells Ta-5 and Ta-6 initially display an effective porosity of around 9% in the upper units (Jer-1 and Jer-2), which decreases to about 4% in the lower parts of the formation, reflecting the vertical variation and the influence of anhydrite layers on reservoir quality. Additionally, variations in shale content suggest that part of the porosity may be secondary, having developed after deposition.

Lateral variations between the three wells are minor, underscoring the influence of lithological changes on the potential for hydrocarbon storage. Overall, well Ta-2 demonstrates the best reservoir properties compared to Ta-5 and Ta-6.

3.4. Permeability

Permeability is defined as the ability of a rock to transmit liquids. Generally, permeability increases with higher porosity (Selley, 1984). In this study, permeability was calculated using the logs based on the values of total porosity and corrected porosity, as determined by the Techlog software, which relies on Timur's (1968) equation for calculating permeability (Figs. 6, 7, and 8).

The permeability values for the Jeribe Formation rocks in well Ta-2 ranged between 0.94 and 2.50 md. In well Ta-5, the range was between 0.20 and 1.60 md. In well Ta-6, permeability values ranged between 0.15 and 11.37 md.

*K= 62.5 *(PHIE^6/SWi2)* (3)

Where: PHIE= Effective porosity; SWi= Irreducible water saturation (assumed to be 0.2 if not available or missing).

3.5. Calculation of Formation Water Resistivity (R_w) in the Tawke Oil Field

Formation water refers to the native water present in the porous rock formations, unaffected by drilling fluids. Its resistivity (Rw) is a key parameter, essential for calculating water saturation (Sw) from well log data. In this study, since no direct formation water samples were available, Rw was estimated using the Picket Plot method, which is a standard approach for determining formation water resistivity from well logs (Asquith and Gibson, 1982). The method relies on cross-plots of porosity and resistivity to identify the intersection corresponding to the water resistivity trend.

The calculated formation water resistivity (Rw) values were subsequently used to determine the water saturation (Sw) in the Jeribe Formation across all wells under investigation, ensuring a consistent and scientifically supported evaluation of the reservoir properties. In this approach, a 100% water-saturated interval within the well is selected, characterized by low resistivity and high porosity (Asquith and Gibson, 1982). The resistivity value is then taken from the deep resistivity curve (Ro) and recorded. Finally, the following equation is applied to calculate Rw.

$$Rw = Ro \times (phi\text{^}m) \quad (4)$$

Where phi is porosity, the parameter (m) represents the cementation exponent, and due to the unavailability of laboratory data for the well, a default value of m= 2 was adopted.

3.6. Water Saturation (S_w)

Water saturation was calculated using Archie's (1942) Equation, which is one of the most widely used methods for determining water saturation. The water saturation for the wells was evaluated in both the contaminated and uncontaminated zones based on well log data including, deep resistivity, effective porosity, and formation water resistivity (R_w) (Figs. 6, 7, and 8).

Water saturation (S_w) plays a crucial role in calculating hydrocarbon saturation (S_h), as rocks containing hydrocarbons exhibit higher electrical resistivity compared to those filled with formation water (Tiab and Donaldson, 2004).

Due to the unavailability of mud filtrate resistivity (Rmf) and formation temperature data, water saturation could only be calculated for the uninvaded zone. Hydrocarbon saturation (Sh) in the reservoir rocks was then determined by subtracting this water saturation (Sw) from unity, as expressed in the following equation:

$$1 - SW = Sh \quad (5)$$

3.7. Analysis of Petrophysical and Lithological Properties of Formation Units

Based on the lithological and petrophysical properties of the formation, three main reservoir zones (Jer-1, Jer-2, and Jer-3) have been identified in the well sections of Ta-2, Ta-5, and Ta-6. The variations in porosity values, permeability, shale content, and lithological properties are summarized in Table 1 and Figs. 6, 7, and 8.

Table 1. Reservoir properti es of the Jeribe Formation in the Tawke Oilfield

Units	Properties	Ta-2	Ta-5	Ta-6
	Interval	383-399	355-371	512-532
	v_{sh} c	0.10	0.16	0.13
	PHIT_ND	0.10	0.09	0.10
Je-1	PHIE_ND	0.10	0.08	0.09
	S_W	0.66	0.54	0.83
	SH	0.34	0.46	0.16
	Permeability	1.87	0.83	11.37
	Interval	399-407	371-384	532-538
	vsh c	0.15	0.18	0.19
	PHIT_ND	0.12	0.11	0.10
Je-2	PHIE_ND	0.10	0.09	0.09
	S_W	0.30	0.39	0.84
	SH	0.70	0.61	0.16
	Permeability	2.50	1.60	1.95
	Interval	407-457	384-404	538-588
	v_{sh} c	0.11	0.10	0.12
	PHIT_ND	0.09	0.05	0.04
|Je-3	PHIE_ND	0.08	0.04	0.04
	S_W	0.27	0.19	0.43
	SH	0.73	0.45	0.38
	Permeability	0.94	0.20	0.15

3.7.1. Jer-1 Unit

Shale Volume (V_{sh}): Well Ta-2 shows the lowest shale volume (0.10), indicating that this unit in this well is cleaner in terms of sedimentation, enhancing the likelihood of a good reservoir. Well Ta-5 and Ta-6 exhibit higher shale volumes (0.16 and 0.13, respectively), which may negatively impact reservoir properties. Effective porosity (PHIE_ND): Well Ta-2: Records the highest porosity value (10%), indicating superior reservoir properties related to fluid storage. Well Ta-5 and Ta-6: Show lower values (9% and 8%, respectively), reflecting variability in porosity.

Permeability: Well Ta-6 exhibits the highest permeability (11.37 md), indicating better reservoir quality compared to Ta-2 (1.87 md) and Ta-5 (0.83 md). Water saturation (Sw) and hydrocarbon saturation (Sh): Wells Ta-5 and Ta-2 exhibit relatively higher hydrocarbon saturation (0.46 and 0.34, respectively), indicating better hydrocarbon potential. In contrast, well Ta-6 shows a high reservoir water saturation (0.83), which adversely impacts its reservoir quality.

3.7.2. Jer-2 Unit

Shale Volume (V_{sh}): Well Ta-2 shows the lowest shale volume (0.15), enhancing the potential for a good reservoir. Well Ta-5 and Ta-6 show higher shale volumes (0.18 and 0.19, respectively).

Effective Porosity (PHIE_ND): Well Ta-2 records the highest porosity (10%), reflecting good reservoir properties for fluid storage. Well Ta-5 and Ta-6: Show lower values (9% and 9%, respectively), but these values are similar to Ta-2, indicating the presence of secondary porosity formed after deposition.

Permeability: Well Ta-2 exhibits permeability (2.50 md), indicating better reservoir quality compared to Ta-6 (1.95 md) and Ta-5 (1.60 md).

Water saturation (S_w) and hydrocarbon saturation (S_h): Well Ta-2 and Ta-5 record the best hydrocarbon saturation (0.46 and 0.34, respectively). Well Ta-6 shows a higher water saturation (0.83), which negatively affects reservoir properties.

3.7.3. Jer-3 Unit

Shale volume (V_{sh}): Well Ta-5 shows the lowest shale volume (0.10), which enhances the potential for a good reservoir. Well Ta-2 shows a shale volume of (0.11), while Well Ta-6 shows a higher shale volume (0.12).

Effective Porosity (PHIE_ND): Well Ta-2 records higher porosity (0.8%), indicating better reservoir properties. Well Ta-5 and Ta-6 show lower values (4%), and the decrease in porosity is not due to shale content, as previously mentioned, but it is instead caused by the presence of anhydrite layers, which negatively affect reservoir properties.

Permeability: Well Ta-2 exhibits the best permeability (0.94 md). Well Ta-5 and Ta-6 exhibit lower permeability values (0.20 md and 0.15 md, respectively), which may negatively impact reservoir quality.

Water saturation (S_w) and hydrocarbon saturation (S_h): Well Ta-2 and Ta-5 record the best hydrocarbon saturation (0.73 and 0.45, respectively). Well Ta-6 shows a higher water saturation (0.43), which negatively impacts the reservoir properties.

3.8. Movable Hydrocarbon Index (MHI)

The movable hydrocarbon index (MHI) provides a quantitative measure of the proportion of hydrocarbons in a reservoir that can migrate under existing pressure and saturation conditions, making it a critical parameter for evaluating reservoir productivity. This index is calculated based on the ratio of water saturation in the washed zone (S_{xo}) to water saturation in the unaltered zone. If the MHI value is greater than 1, it indicates that hydrocarbons do not move within the formation. Hydrocarbons can move freely within the reservoir if the movable hydrocarbon index (MHI) is less than 0.7 in sandstones and less than 0.6 in limestones. This index is used to assess the ability of hydrocarbons to migrate within geological formations and serves as an important tool for understanding reservoir properties.

After calculating the movable hydrocarbon index (MHI) using the equation MHI= Sw/Sxo the distribution curve was plotted for all wells (Figs. 6, 7, and 8) illustrate the distribution of movable versus immovable hydrocarbons. In well Ta-2, the lower section exhibits a favorable MHI value, accompanied by high porosity (10%) and permeability (1.87 md), indicating good hydrocarbon mobility. The second unit displays variable MHI values, making it difficult to separate or clearly define due to formation heterogeneity.

The third unit, located in the lower section, also exhibits evidence of hydrocarbon movement, with porosity of approximately 10% and permeability of 2.50 md. In well Ta-5, the lower part of the first unit exhibits good MHI values with porosity of 8% and permeability of 0.80 md, indicating effective hydrocarbon movement. Conversely, in well Ta-6, most MHI values exceed 0.6, with a significant decrease in porosity, particularly in the third unit (porosity 4%, permeability 0.15 md), indicating resistance to hydrocarbon movement in this zone.

3.9. Gross and Net Thickness

3.9.1. Gross and net reservoir thickness

Gross thickness is defined as the total thickness of the hydrocarbon-bearing reservoir unit, while net thickness refers to the sum of the actual hydrocarbon-bearing zones within that unit. To determine the net pay thickness in the formation, three main criteria were applied: first, a shale cut-off of 35% was used. Second, the porosity cut-off was derived from the relationship between porosity and permeability for wells Ta-2, Ta-5, and Ta-6, ensuring the selection of zones with good storage potential. Third, the water saturation cut-off (Sw cut-off) was determined based on the relationship between water saturation and porosity, as summarized in Tables 2, 3, and 4 and Figs. 6, 7, and 8. This approach ensures that the net thickness accurately reflects the reservoir's ability to store hydrocarbons.

Table 2. Net pay when cutoff porosity = 0.048% and cutoff water saturation = 40% in Ta-2

Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Shale Volume	Av_ Porosity	Av_Water Saturation
Jer-1	PAY	382.52	399.66	17.14	5.10	0.30	0.09	0.11	0.31
Jer-2	PAY	399.66	407.33	7.67	5.72	0.75	0.12	0.12	0.28
Jer-3	PAY	407.33	457.87	50.54	41.61	0.82	0.11	0.09	0.23

Table 3. Net pay when cutoff porosity = 0.071% and cutoff water saturation = 42% in Ta-5

Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Shale Volume	Av_ Porosity	Av_Water Saturation
Jer-1	PAY	351.52	371.63	20.11	3.43	0.17	0.16	0.10	0.34
Jer-2	PAY	371.63	384.60	12.97	6.78	0.52	0.12	0.13	0.28
Jer-3	PAY	384.60	404.18	19.58	1.98	0.10	0.09	0.09	0.27

Table 4. Net pay when cutoff porosity = 0.067% and cutoff water saturation = 58% in Ta-6

Zones	Flag Name	Top	Bottom	Gross	Net	Net to Gross	Av_Shale Volume	Av_ Porosity	Av_Water Saturation
Jer-1	PAY	512.40	532.11	19.71	0.00	0.00	0.00	0.00	0.00
Jer-2	PAY	532.11	537.80	5.69	0.00	0.00	0.00	0.00	0.00
Jer-3	PAY	537.80	588.20	50.40	7.16	0.14	0.09	0.08	0.46

3.10. Cutoff

Ta-2 cutoff porosity = 0.048, water saturation cutoff = 0.40. Ta-5 cutoff porosity = 0.071, water saturation cutoff = 0.40. Ta-6 cutoff porosity = 0.067, water saturation cutoff = 0.58.

The tables provided a detailed analysis of the productive layer thickness and flow characteristics within the studied formations. It is noteworthy that all units in Well Ta-2 exhibit superior reservoir characteristics compared to those in other wells. The thickness of the various units has a significant impact on the reservoir's production potential.

By applying the cut-off values for porosity and water saturation, derived from the study, it becomes clear that accurately determining the net pay thickness enhances the precision in identifying the necessary production zones. Moreover, the results show that the Jer-3 and Jer-2 units in well Ta-2, along with the Jer-3 unit in well Ta-5, represent the best reservoir units in terms of movable hydrocarbons, due to their remarkably high porosity and permeability.

4. Discussion

The analysis of the Jeribe Formation in wells Ta-2, Ta-5, and Ta-6 reveals significant variations in reservoir quality and hydrocarbon production potential. Well Ta-2 exhibits excellent reservoir properties, with higher porosity and permeability compared to the other wells, indicating a larger pore space for hydrocarbon storage and easier fluid flow, thus suggesting higher production potential. Additionally, the low movable hydrocarbon index (MHI) values in the lower units indicate that hydrocarbons can move freely, further enhancing the likelihood of efficient oil recovery.

In contrast, wells Ta-5 and Ta-6 show more heterogeneous reservoir characteristics. The presence of anhydrite nodules, combined with high water saturation and lower porosity in some units, restricts hydrocarbon mobility and reduces the effective volume for production. In Ta-6, most parts of the reservoir fall within the immobile hydrocarbon range, indicating potential challenges in extracting hydrocarbons from this well.

These differences between the wells emphasize the importance of integrating petrophysical properties with lithological and structural analysis when evaluating reservoir performance. While well Ta-2 provides favorable conditions for hydrocarbon recovery, the results from wells Ta-5 and Ta-6 highlight the need for careful reservoir management, focusing on intervals with high water saturation or low permeability that may hinder fluid flow.

Overall, these observations demonstrate that hydrocarbon mobility is closely linked to porosity, permeability, and the distribution of non-reservoir rocks such as anhydrite. Understanding these relationships is essential for predicting reservoir behavior and optimizing well placement and production strategies.

5. Conclusions

The results highlight the petrophysical variations between wells and the pivotal role that borehole logs play in assessing reservoir properties and determining the hydrocarbon production potential in different formations, thereby contributing to the improvement of hydrocarbon resource exploitation strategies and guiding efforts towards high production areas. Based on the analysis of the Jeribe Formation in the selected wells, the following conclusions can be drawn:

- The Jeribe Formation consists of limestone and dolomite, with a noticeable increase in dolomite content in the upper part and the presence of an anhydrite layer in the lower part, as observed in wells Ta-5 and Ta-6.
- Well Ta-2 exhibits the best reservoir characteristics, with an effective porosity ranging between 8 and 10%, clay content between 10 and 15%, oil saturation between 34 and 73%, and permeability between 0.94 and 2.50 md. In comparison, well Ta-5 contains non-reservoir anhydrite layers that negatively affect reservoir properties, with effective porosity ranging between 4 and 9%, clay content between 10 and 18%, oil saturation between 45 and 61%, and permeability between 0.83 and 1.60 md. well Ta-6 also contains anhydrite layers that negatively affect petrophysical properties, with effective porosity ranging between 4 and 9% and oil saturation between 16 and 38%.
- Well Ta-2 showed the presence of movable hydrocarbons across all formation intervals, while wells Ta-5 and Ta-6 showed intervals outside the movable hydrocarbon range, indicating variations in hydrocarbon mobility between the wells.
- The net pay thickness in well Ta-2 is approximately 52.4 m, compared to 12.2 m in well Ta-5 and 7.2 m in well Ta-6.
- Based on the previous analysis, it can be concluded that the Jer-2 and Jer-3 units in well Ta-2 exhibit the best reservoir properties among all the wells, followed by the Jer-2 unit in well Ta-5. On the other hand, well Ta-6 does not have favorable reservoir properties due to the high water saturation,

especially in the first and second units. Therefore, well Ta-2 exhibits the best reservoir characteristics among the studied wells.

Acknowledgments

The corrections and suggestions provided by anonymous reviewers are highly acknowledged. Their help has been incorporated into the manuscript's improvement. We thank the Ministry of Natural Resources in Erbil for providing the well logs.

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