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The X Formation and its Impact on Tertiary Hydrocarbon Reservoirs in the AX Field, North Iraq

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Abstract

The study area (AX Field), located in Salah al-Din Governorate, northeast of Tikrit, alongside the structurally higher HY Field, is an area of significant geological interest, particularly concerning its Tertiary hydrocarbon reservoirs. This study aims to delineate the facies of the X Formation and their lateral extensions across drilled wells, focusing on how the increasing number of anhydrite beds impacts the active hydrocarbon reservoir thickness. Data from well logs (AX-ai, bi, ci, di, ei, fi, gi, and HN-hi), formation tops, and final well reports were utilized to construct geological sections, revealing the stratigraphic continuity and variability within the X Formation. Thickness variations were observed, ranging from 19 meters in AX-ei to 51 meters in AX-ji, indicative of a complex depositional environment influenced by tectonic settings, subsidence rates, and sediment supply for sedimentary basin.

The primary lithology of the X Formation is characterized by limestone and dolomitic limestone, with significant variations in anhydrite content. Wells such as AX-ei and AX-di have fewer anhydrite layers, whereas AX-ji and HN-hi show substantial evaporitic conditions with multiple anhydrite beds. These lithological variations suggest localized geological factors affecting sedimentation and diagenesis processes.

The study concludes that the X Formation is a critical component of the Tertiary reservoir system in the AX Field, serving as both a gas and oil reservoir. The spatial variability in anhydrite lithofacies, increasing northeastward, reflects the complexity of diagenetic processes and sedimentation patterns. Understanding these variations is essential for accurate reservoir characterization and effective hydrocarbon extraction strategies. This research provides valuable insights into the geological and sedimentary dynamics of the AX Field, emphasizing the economic importance thickness and facies of X Formation in the reservoir system.

Keywords: X Formation, Hydrocarbon Reservoir, Anhydrite Beds, Formation thickness, AX Field.

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تكوين X وتأثيره على المكمن الهيدروكربوني للعصر الثلاثي في حقل AX، شمال العراق

الخلاصة:

تقع منطقة الدراسة (حقل X) في محافظة صلاح الدين، شمال شرق تكريت، بموازات حقل HY الاعلى تركيبيا، وهي منطقة ذات أهمية جيولوجية، لا سيما فيما يتعلق بالمكمن الهايدروكاربوني للعصر الثلاثي. تهدف هذه الدراسة إلى تحديد السحنات الصخارية لتكوين X وامتداداتها الجانبية عبر الآبار المحفورة، مع التركيز على كيفية تأثير العدد المتزايد من طبقات الأنهايدرايت للتكوين على سمك المكمن الهايدروكاربوني الفعال.

تم استخدام بيانات من سجلات الآبار (AX.ai, bi, ci, di, ei, fi, gi and AY.hi)، أعالي التكوينات، والتقارير النهائية للآبار لرسم مقاطع جيولوجية بالمجسات، تبين الاستمرارية الطبقية والتغيرات في تكوين X. لوحظت اختلافات في السماكة، تتراوح بين 19 مترًا في البئر ei إلى 51 مترًا في البئر ji، مما يشير إلى بيئة ترسيبية معقدة تأثرت بالتكتونية، ومعدلات الهبوط، وإمداد الرواسب للحوض الترسيبي.

تتميز الصخارية الأساسية لتكوين X بالحجر الجيري والحجر الجيري الدولوميتي، مع تباينات كبيرة في محتوى الأنهايدرايت. تظهر الآبار مثل ei وdi عددًا أقل من طبقات الأنهايدرايت، في حين تُظهر البئر ji البئر ci ظروف تبخرية عالية مع وجود طبقات متعددة من الأنهايدرايت. تشير هذه التغيرات الصخارية إلى عوامل جيولوجية موضعية تؤثر على الترسيب والعمليات التحويرية.

تستنتج الدراسة أن تكوين X هو عنصر أساسي في نظام المكمن الثلاثي في حقل AX، كمكمن للغاز والنفط. تعكس التغيرات المكانية في صخارية الأنهايدرايت، التي تزيد نحو الشمال الشرقي، تعقيد العمليات التحويرية وأنماط الترسيب. فهم هذه التغيرات ضروري لوصف المكمن بدقة واستراتيجيات استخراج الهايدروكاربونات الفعالة. توفر هذه الأبحاث رؤى قيمة في الديناميكيات الجيولوجية والترسيبية للحقل، مشددة على الأهمية الاقتصادية لسمك وصخارية تكوين X في النظام المكمني للحقل.

1. Introduction

The AX Field is located within the administrative borders of Salah al-Din Governorate, parallel to the HY field, about 30 km to the northeast of the city of Tikrit. It is also structurally lower than the HN field. The main elements of this region's petroleum system, the cap rock that seals the reservoir units represented by the Fatha Formation and the reservoir units represented by the Je and ***Y*** Formations, were deposited during this mega sequence [5].

First discover the AX Field by White and Schlumberger in 1926, stands as a prominent surface structure characterized by a simple anticline longitudinal fold. Nestled within the field are sediments from the UF Formation, covering the main culmination, while recent sediments and the LB Formation mantle the field's edges. Notable geological features include exposed units of the LF Formation at the northwest culmination plunge, while the secondary culmination and northwestern extension remain concealed beneath recent sediments.

The Tigris River vicinity exhibits minimal rocky discoveries, limited to a few beds from the UF and LB Formations. The initiation of exploratory endeavors unfolded in 1977 with the drilling of AX-ai on the main culmination, revealing a substantial gas column approximately 275 meters in length. Subsequent wells, AX-ki, li, and mi, reinforced the presence of gas, setting the stage for plans to develop the field as a gas reservoir [9], [13]. However, the drilling of AX-ni at the

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northwest plunge uncovered an unexpected turn of events, as it exposed a short but significant oil column in the Oligocene formations.

The turning point came with the drilling of AX-oi, unearthing an oil column estimated at 90 meters within the Je and Es reservoirs. This discovery paralleled the oil column thickness in the AS Culmination of the HY Field, standing at 95 meters, accompanied by a gas column in the TBs /LF (Fat ha) Formation [9], [10]. Consequently, the decision was made to reorient the development plans towards establishing AX as an oil field. As of the latest data available, 91 wells have been drilled till now in the AX field.

Beyond the specific field, the Lower Miocene Cycle (Burdigalian) in Iraq boasts distinctive sedimentary characteristics and diverse depositional environments within its formations. Studying these formations contributes significantly to our comprehension of the region's geological history, shedding light on tectonic orogeny and drought periods that have influenced sedimentation patterns [12].

The study objective is to determine the facies for the X Formation and their lateral extensions in the drilled wells and focus on the effect of the increasing number of anhydrite beds on the total active thickness of the hydrocarbon reservoir (Tertiary age) in the field. Finally, a review of the economic feasibility of the study.

Ultimately, the study seeks to contribute valuable insights into the geological and sedimentary dynamics of the Tertiary reservoir of the AX Field, emphasizing the economic importance of the X Formation as a basic element of the hydrocarbon reservoir system.

The study provides a comprehensive understanding of the sedimentary architecture and gives a direction and a plan for drilling new oil wells and field development in the future. As well as, guide decision-making in the field of hydrocarbon exploration and production in the region.

Recent study, such as that by [5, 7], provided detailed evaluations of Petrophysical properties and permeability in the Tertiary reservoirs, contributing to a comprehensive understanding of the field. The following describes some recent published study dealt Tertiary reservoirs in AX Field, these are: the study determining permeability values for the Tertiary Reservoir (Je, X, and Es). The permeability values obtained through this study are crucial for assessing the economic potential of oil within the Tertiary Formation, providing a foundation for informed decision-making in the oil and gas industry. [7]

The study [8] subdivided the Tertiary Formation into seven zones (Je into J1, J2, J3, X into D1, D2, and Y into E1, E2).

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The Tertiary reservoir in the Hy Field comprises the Je and Y formations as the primary reservoirs, with the X Formation serving as a secondary reservoir, making it an attractive target for petroleum exploration. Understanding the Petrophysical properties is essential for optimizing well completions in the HY Field. Overall, this study shows that the petro physical properties of these formations were controlled by the depositional environment, diagenesis and tectonic activity. The evaluation of the petro physical for tertiary reservoir in HN oil field was necessary to choose the best interval for well completion. [5]

1.1. The study data:

There are many data used in study, include:

- Well Log of AX -ai, bi, ci, di, ei, fi, gi, and HN- hi.
- Tops of Formations using well Data (Ax- ai, ni, pi, ci, di, ei, fi, gi, and HN-hi), Final Well Reports [9], [10], and previous studies.

1.2. The study methodology:

The methodology of study as the following:

- The study involves a review of the top of formations (Je, X, Y, and Si) up to the B.A. bed, constructing geological sections using well data from final well reports, well logs, and previous studies.
- Geological sections were constructed to analyze the formations until to the B. A. bed.

2. Material and Methods

2.1. Stratigraphic Framework

The Miocene cycle in Iraq shows characteristic sedimentary characteristics and depositional environments within its formations. The study of these formations contributes to a better understanding of the geological history of the region, including tectonic movements and dry periods that influenced sedimentation patterns.

Further subsurface study and exploration may enhance our knowledge of these formations and their importance in geological aspects. The Miocene Cycle in Iraq is subdivided into two sub sedimentary cycles [6]. The Lower Miocene Sub cycle and the Middle-Upper Miocene Sub cycle. This report primarily focuses on the Lower Miocene Sub cycle, emphasizing the stratigraphic details and characteristics of its formations, (Figure 1).

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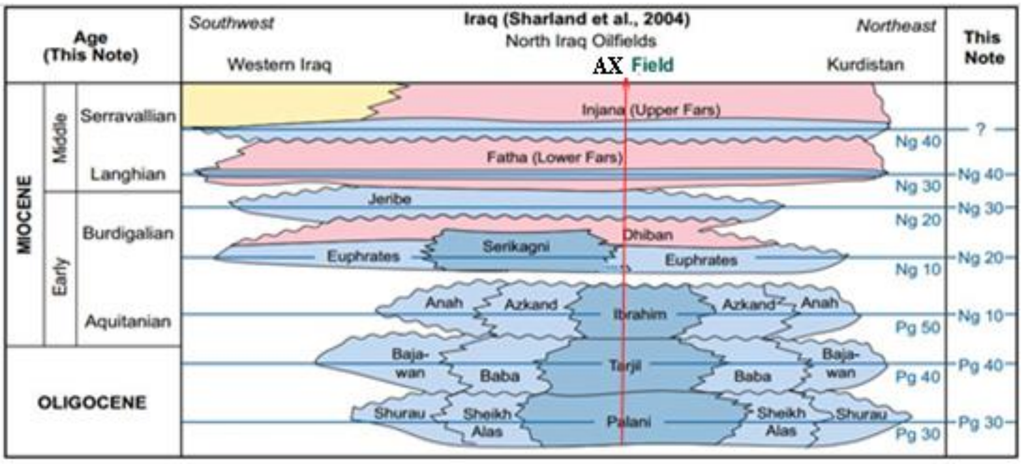

Fig. (1): The Tertiary sequence stratigraphy of Iraq, modify [16], [15].

The Lower Miocene Cycle in marginal basins is characterized by the predominance of calcareous sediments [14]. The Es and Si formations are key components, with an observed overlap in certain regions [16], [1]. possibly indicating the presence of a barrier potentially a Bryozoa and Algal reef, that allowed water exchange between lagoon and offshore regions [6].

2.1.1. Formations of the Lower Miocene (Burdigalian sub Cycle)

The following is a general description of the formations of the lower Miocene cycle (Burdigalian sub cycle) (Tables 1 and 2):

2.1.1.1. Si Formation:

The Si Formation, first described by Bellen in 1955, is approximately 150 meters thick and primarily composed of Cretaceous limestone with Planktonic Foraminifera (*Globigerina* sp.) [13]. While initially assigned to the lower Miocene, subsequent studies, such as [2] place its age in the Burdigalian period of the early Miocene [13].

The formations under consideration, namely the X, Y, and Si, collectively exhibit a relatively homogeneous average total thickness ranging from approximately 104.5 to 129.5 meters, (Table.1). The investigation reveals a nuanced interplay of sedimentation rates and structural inclinations across the field, leading to variations in the thickness of each formation. These variations are indicative of dynamic geological processes, with sedimentary discrepancies suggesting localized influences such as basin morphology and regional tectonic activity [4].

The X Formation, identified as the last deep facies in the stratigraphic column of Iraq, originates from a permanent basin situated in the eastern part of Iraq. Its distinct characteristics in the deep basin facies contribute to the overall stratigraphic complexity in the AX Field. Furthermore, the Si

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Formation, characterized by an average excavated thickness of 11-19 meters, (Table-1), exhibits specific sedimentary patterns that contribute to the overall stratigraphic evolution of the region.

2.1.1.2. Y Formation:

This formation was described for the first time in Van Bellen [16], where he described it in the typical section located southeast of the city of Anah at a distance of 32 km and indicated that it consists of well-layered, recrystallized limestone. He determined the age of the formation in the early Miocene. The formation is in contact in northern Iraq with each of the Si and X formations, and it consists mainly of sintered limestone. As for its sedimentary environment, it was represented by shallow marine environments, reefs and coastal lakes, and its thickness ranges between 60-70 meters [3], [6]. The thickness of Y Formation in AX Field is about 58.5-83 meters (Table-1).

2.1.1.3. X Formation:

The formation was described for the first time in an unpublished report [16], near the village of Umm Al-X in the Sinjar region, northwestern Iraq, with a thickness of 72 meters, which consists of Gypsum and skinny layers of shale and recrystallized limestone.

The age of tectonic movements coincides with periods of drought in the region, and is associated with the beginning of the emergence of *Orbulina* and *Borelis melo var. curdica* 16 million years ago, which ended before the disappearance of the *Miogypsina* species [4]. He also indicated that this drought period is older than 16 million years ago. The most of the literature that dealt the Evaporators in the Miocene age indicated the emergence of two main phases of drought, that caused severe salinity, known as Salinity Crises, in all basins of the Mediterranean region and their surroundings, namely:

- The first phase: It happened 5-7 million years ago, represented by the X Formation.
- The second phase: It occurred 13-16 million years ago in the Langhian -Serravielian stage, and it is represented by the LF (Fat ha) Formation.

This formation is considered one of the reservoir formations in the fields of the eastern region of Iraq, especially in the calcareous layers, and it was determined in the middle of Burdigalian period, according to the studies that were carried out in the North Oil Company. The thickness of the formation in the AX field is about 19-51 meters, (Tables 1 and 2).

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2.1.2. Formations of the Middle Miocene(Langian) Cycle:

2.1.2.1. Z Formation:

This formation was described for the first time near the village of Jaddala in the Sinjar fold, and its thickness in a typical section is 73 meters [16]. Which consists of re-crystallized dolomitic limestone. The formation in the study area consists of relatively thick limestone and dolomitic limestone facies located between the periodic formations of the Fatha and X formations, whose age is determined by a period below the Middle Miocene (Langhian).

The top of formation (which corresponds to the unconformity surface of the middle Miocene period) is proven by increasing the reading of the gamma-ray probe at the bottom of the last anhydrite layer to form a hole, while its lower limit (which corresponds to the unconformity surface globally established between the early and middle Miocene periods [11]. It is determined by the first occurrence of anhydrite in the X formation.

Table (1): The thickness of the drilled formations (Si - Y - X) in selected wells from the AX and HN Fields.

well Formation	Ax-ei Th. (m)	Ax-di Th. (m)	Ax-ci Th. (m)	Ax-ni Th. (m)	Ax-ai Th. (m)	Ax-ji Th. (m)	Ax-gi Th. (m)	Ax-pi Th. (m)	Ax-fi Th. (m)	HN-hi Th. (m)
X	19	21.5	29.5	45.5	32.5	51	47.5	30	42.5	45.5
Y	72.5	69	83	58.5	78	59.5	NP	74.5	NP	46.5
Si	13	15	14.5	11	19	15	NP	16.5	NP	17.5
Total thickness	104.5	105.5	127	115	129.5	125.5	+ 47.5	121	+ 42.5	109.5

Table (2): Top of formations (lower - middle Miocene) in AX and HN Fields.

well formation	Ax-ei RTKB(m)	Ax-di RTKB(m)	Ax-ci RTKB(m)	Ax-ni RTKB(m)	Ax-ai RTKB(m)	Ax-ji RTKB(m)	Ax-gi RTKB(m)	Ax-pi RTKB(m)	Ax-fi RTKB(m)	HN-hi RTKB(m)
Z	922	972.5	1069.5	897	788.5	966	989	1024.5	1097	479
X	948	1004.5	1113.5	927.5	813.5	1004.5	1019.5	1052	1130	527.5
Y	967	1026	1143	973	846	1055.5	1067	1082	1172.5	573
Si	1039.5	1095	1226	1031.5	924	1115		1156.5		619.5
B.A bed	1052.5	1110	1240.5	1042.5	943	1130		1173		637

2.2. Summary of the information for the X Formation in the oil wells drilled for the study area:

To determine the facies of the X Formation, Neutron and Density logs, along with gamma-ray data, were analyzed for selected wells in the AX field (Figures 2, 3, 4, and 5), (Table.1).

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Well AX-ei

- Location: Northwestern part of the field, 16 km northwest of AX-ci.
- Penetrated Sequence: Lower Miocene (Burdigalian), 104.5 meters thick.
- X Formation Thickness: 19 meters.
- Composition: Mainly limestone and dolomitic limestone with good porosity; nodular anhydrite in the lower part.

Well AX-di

- Location: Northwestern part of the field, west of AX-ci.
- Penetrated Sequence: Lower Miocene (Burdigalian), 105.5 meters thick.
- X Formation Thickness: 21.5 meters.
- Composition: Predominantly limestone and dolomitic limestone with nodular anhydrite in the lower part.

Well AX-ci

- Location: Northwest plunge of the main culmination, 13 km northwest of AX-ai.
- Penetrated Sequence: Lower Miocene (Burdigalian), 127 meters thick.
- X Formation Thickness: 29.5 meters.
- Composition: Mainly limestone and dolomitic limestone with an anhydrite layer in the lower part; nodular anhydrite scattered in the middle part.

Well AX-ai

- Location: Top of the main culmination.
- Penetrated Sequence: Lower Miocene (Burdigalian), 129.5 meters thick.
- X Formation Thickness: 32.5 meters.
- Composition: Limestone and dolomitic limestone with three anhydrite beds in the lower part; nodular anhydrite scattered in the middle part.

Well AX-ji

- Location: Northeastern flank of the main culmination, 3 km northwest of AX-ai.
- Penetrated Sequence: Lower Miocene (Burdigalian), 125.5 meters thick.
- X Formation Thickness: 51 meters.
- Composition: Predominantly limestone and dolomitic limestone with four anhydrite layers in the lower part; nodular anhydrite scattered throughout.

Well AX-gi

- Location: Southeastern plunge of the main culmination, 5.2 km southeast of AX-ai.

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- Penetrated Sequence: Stopped in the Y Formation.
- X Formation Thickness: +47.5 meters.
- Composition: Mainly limestone and dolomitic limestone with three anhydrite layers in the lower and middle parts; nodular anhydrite scattered in the upper part.

Well AX-fi

- Location: Southeastern plunge of the main culmination, 7 km southeast of AX-ai.
- Penetrated Sequence: Stopped in the Y Formation.
- X Formation Thickness: +42.5 meters.
- Composition: Limestone and dolomitic limestone with four anhydrite beds in the lower and middle parts; nodular anhydrite scattered in the upper part.

Well HN-hi

- Location: AS Culmination in the HN field.
- Penetrated Sequence: Lower Miocene (Burdigalian), 19.5 meters thick.
- X Formation Thickness: 45.5 meters.
- Composition: Mainly limestone and dolomitic limestone with five primary anhydrite beds and three secondary beds, making up about 46% of the total thickness.
- These findings highlight significant variations in the thickness and composition of the X Formation, reflecting a complex depositional and diagenetic history across the field.

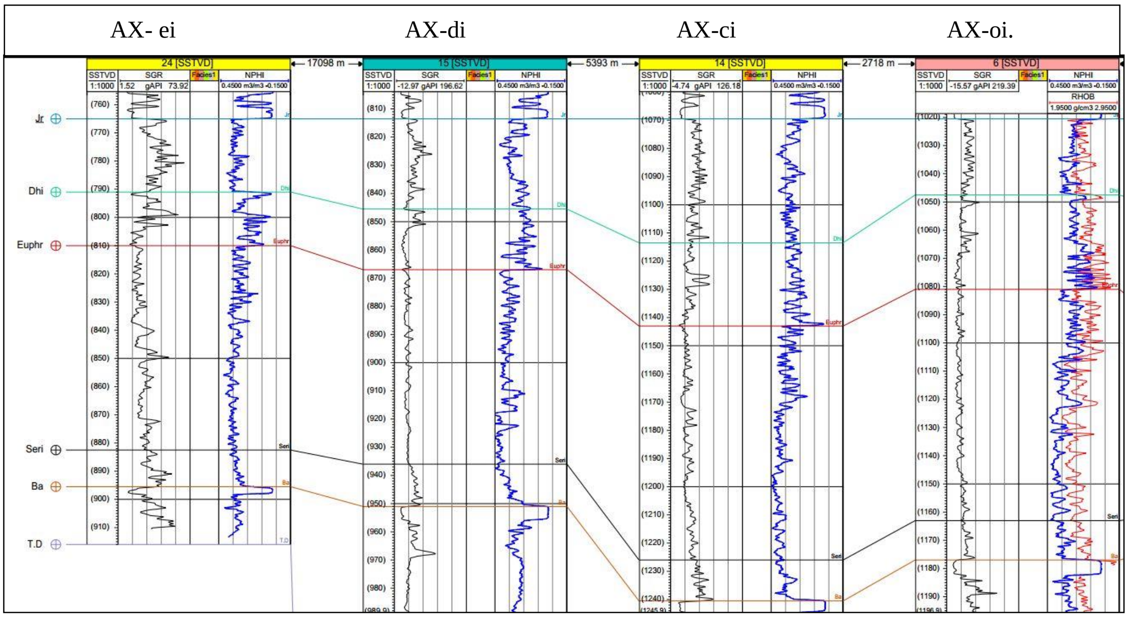

Fig. (2): Correlation section by logs for the studied wells AX- ei, di, ci and oi.

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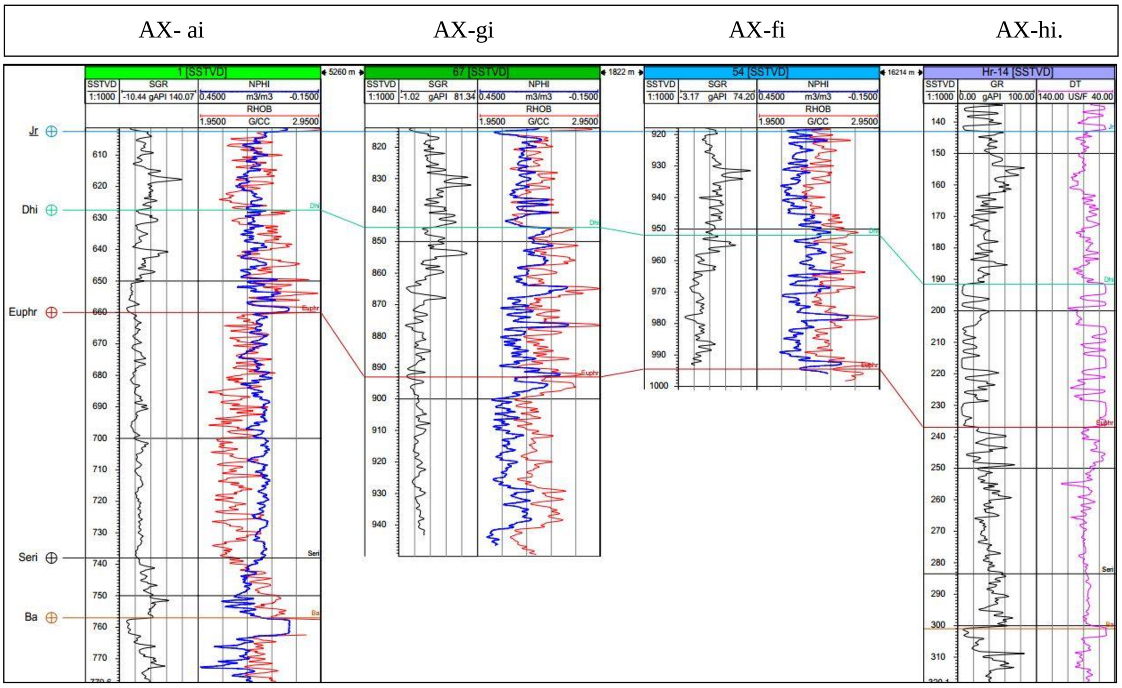

Fig. (3): A comparison section of the wire line logs among AX wells - 6, 1, 67 and 54

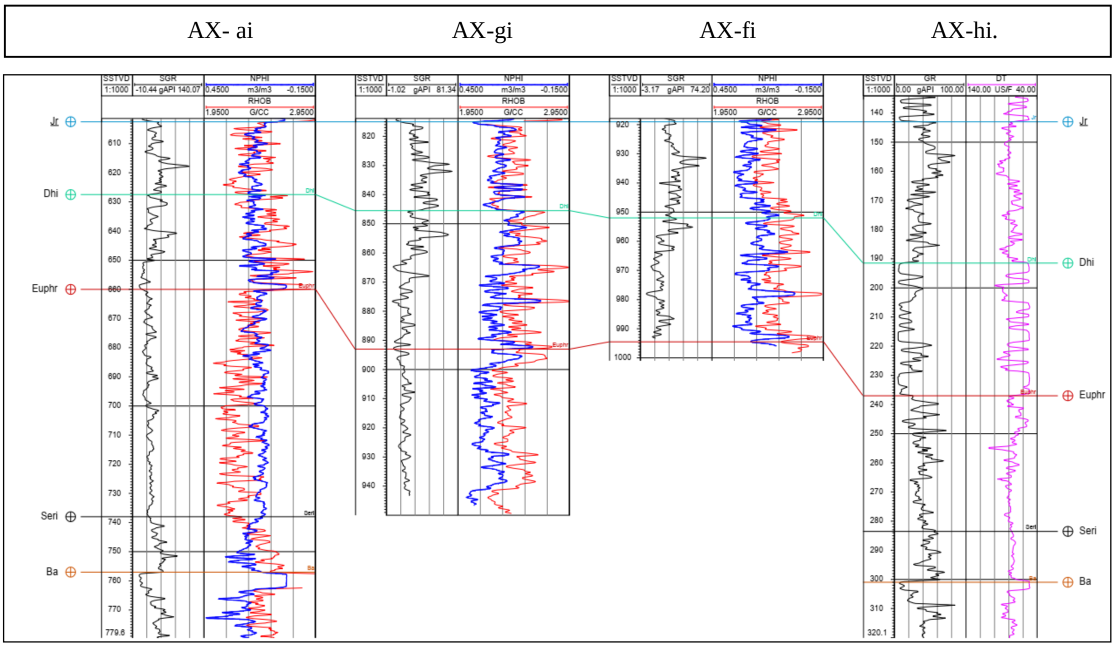

Fig. (4): A correlation section of the wire line logs among wells AX - ai, gi and fi and HY- hi.

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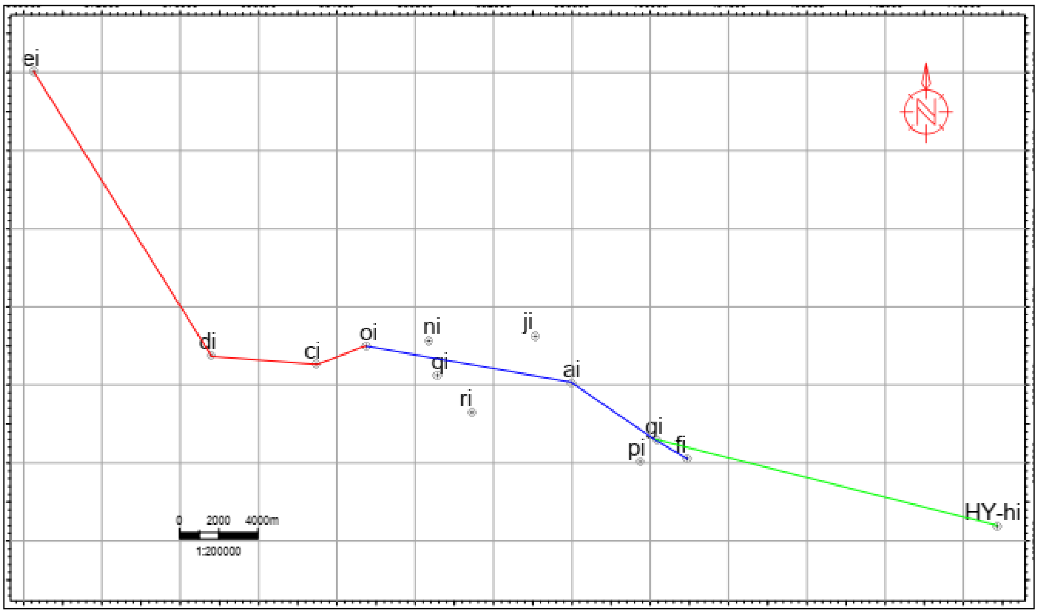

Fig. (5): The base map illustrates the location of selected wells in studied area.

The X Formation may represent the transgressive phase of a sequence (Transgressive System Tract), characterized by rising sea levels and the establishment of shallow marine environments. The X Formation in AX-13 likely represents deposition in a restricted interior platform environment. This environment is characterized by relatively shallow water depths and limited circulation, leading to the accumulation of carbonate sediments, (Figure 6), [17].

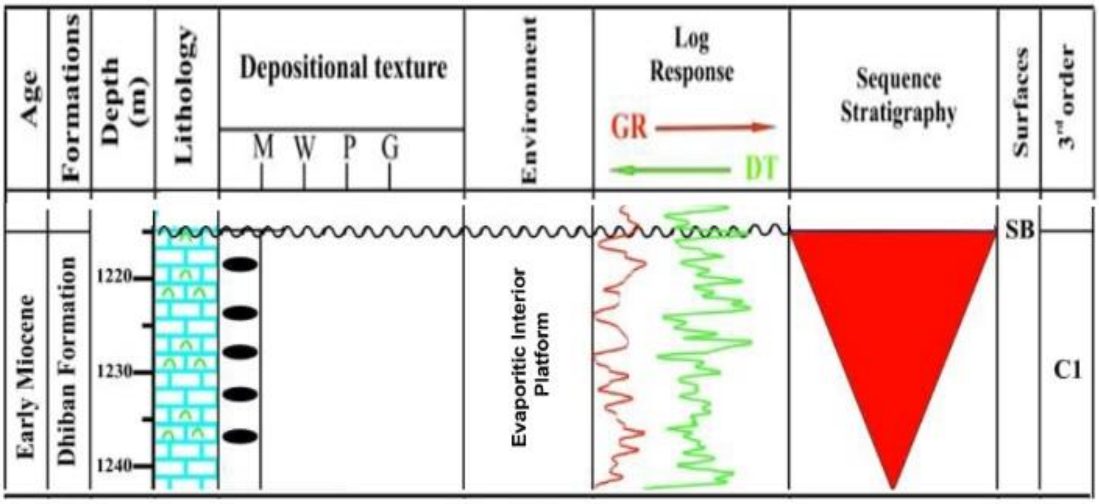

Fig. (6): Sequence Stratigraphic Section Depicting X Formation Facies Associations in the AX-si Well Study Area, modify [17].

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3. Results and Discussion

The X Formation, as observed from the data collected from various wells in the AX and HY Fields, exhibits significant variability in its thickness and composition, particularly concerning the presence of anhydrite beds. This variability is crucial for understanding the geological and depositional environment of the formation, which can have implications for reservoir characterization and resource extraction.

The thickness of the X Formation across different wells ranges from 19 meters in AX-ei to 51 meters in AX-ji. This variation suggests a complex depositional history possibly influenced by local tectonic settings, subsidence rates, and sediment supply during the period of deposition. Hence, there are new additions and new results in the study help the geologists to make drilling programs for new wells producing oil from the Tertiary reservoir.

- **AX-ei and AX-di** show the thinnest sections (19 meters and 21.5 meters respectively), indicating either a lesser rate of sedimentation or more erosional processes at these locations.
- **AX-ji and AX-gi** exhibit the thickest sections (51 meters and 47.5 meters respectively), suggesting higher sedimentation rates or subsidence in these areas.

The primary composition of the X Formation is consistently described as limestone and dolomitic limestone across all wells. However, the distribution and quantity of anhydrite layers vary significantly:

- **Lower Part Dominance**: In wells like AX-ei, AX-di, and AX-ci, anhydrite nodules or layers are primarily found in the lower part of the formation.
- **Three Anhydrite Beds**: AX-ai and AX-gi have three distinct anhydrite beds, with AX-gi layers extending into the middle part of the formation.
- **Four Anhydrite Beds**: Wells such as AX-ji and AX-fi exhibit four anhydrite beds, indicating more substantial evaporitic conditions during the time of deposition.
- **High Anhydrite Concentration**: HY-hi stands out with numerous (10) anhydrite beds, suggesting that this area experienced multiple episodes of restricted marine conditions conducive to evaporite formation.

The X Formation exhibits notable heterogeneity in both thickness and lithological composition across the studied wells in the AX and HY fields. This heterogeneity highlights the need for

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detailed geological and geophysical studies to understand the depositional environment and to develop effective reservoir management strategies. The observed variations also underscore the importance of localized geological factors that influence sedimentation and diagenesis within the formation.

This study investigates the lithological and thickness variations of the X Formation across several wells in the AX and HY fields. The formation's thickness ranges from 19 meters in AX-ei to 51 meters in AX-ji, indicating significant variability. The primary lithology consists of limestone and dolomitic limestone, with variations in the presence and quantity of anhydrite layers and nodules. In the lower parts of the formation, AX-ei and AX-di contain anhydrite nodules, whereas AX-ci, AX-ai, AX-ji, and AX-gi exhibit multiple anhydrite beds. Notably, AX-fi and HY-hi show more extensive anhydrite development, with AX-fi featuring four beds and HY-hi containing ten beds. These findings reflect the complex depositional and diagenetic history of the X Formation, influenced by local geological conditions. Understanding this variability is crucial for accurate reservoir characterization and effective hydrocarbon extraction.

3.1. The economic feasibility of the study

The economic feasibility of the study on the Lower Miocene Cycle (Burdigalian) in the AX field is evident through several key aspects:

- Resource Optimization: By conducting a detailed facies analysis and stratigraphic framework study, the study aids in optimizing resource utilization. Identifying the distribution of hydrocarbon-rich formations, such as the X Formation, allows for targeted drilling and exploration efforts, minimizing the risk of dry wells and maximizing the extraction of economically viable hydrocarbons.
- Well Planning and Development: The findings of the study, particularly the well-specific details and implications for exploration and production, provide essential information for planning and developing new oil wells. The recommendation to focus on the northwestern side of the field for drilling new wells indicates a strategic approach to resource extraction, potentially reducing drilling costs and improving overall well productivity.
- Reservoir Characterization: Understanding the facies and stratigraphy of the X Formation, including the distribution of anhydrite beds, is crucial for reservoir characterization. This knowledge contributes to the efficient design of well completions, enhancing the overall

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recovery rate of hydrocarbons. Optimized reservoir management can lead to increased production efficiency and, consequently, economic benefits.

- Decision-Making Support: The study findings serve as a valuable guide for decision-making in the field of hydrocarbon development and production. Informed decisions based on geological insights help prioritize investments, select optimal drilling locations and align exploration and production activities with economic objectives.
- Economic Importance of X Formation: The study emphasizes the economic significance of the X Formation as a key element of the hydrocarbon reservoir system. This recognition supports the justification for continued investment in the exploration and production activities targeting this specific formation, which is a part of the Tertiary reservoir, potentially leading to long-term economic benefits for the stakeholders involved.

In the ending, the economic feasibility of the study lies in its ability to inform strategic decision-making, optimize resource utilization, and contribute to the long-term economic viability of hydrocarbon development in the AX field. The insights gained from the study are instrumental in creating a roadmap for sustainable and economically beneficial exploration and production activities.

4. Conclusions

The most significant conclusions drawn from the study are summarized as follows:

X Formation as a Key Reservoir: The X Formation emerges as an important and continuous reservoir component alongside the Je and Y formations in the Tertiary Reservoir of the AX Field. It exhibits characteristics of a gas reservoir at the crest of the main culmination and an oil reservoir at the flanks, highlighting its diverse hydrocarbon potential.

Spatial Variations in Anhydrite lithofacies: The number of anhydrite beds and the apparent thickness of anhydrite facies exhibit spatial variations. An increase in the northeastern direction is noted, while these massive facies disappear, transforming into nodular anhydrite in the limestone and dolomitic limestone in the northwestern direction. This variation underscores the complexity of diagenetic processes and sedimentation patterns within the field.

The study not only enhances our understanding of the geological intricacies of the AX Field but also emphasizes important of the X Formation as a key and influential player on facies in the hydrocarbon reservoir system.

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