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Seismic Insights into the Albian-Cenomanian Sequence: Structural and Hydrocarbon Potential in the Alfadl and Al-Qadr Fields, Northeast Abu Gharadig Basin, Egypt

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Abstract

This study provides a detailed seismic interpretation of the Bahariya and Kharita formations in the Alfadl and Al-Qadr Fields, located in the Northeast Abu Gharadig (NEAG) Basin, Western Desert, Egypt. Through seismic data analysis, the subsurface structures of the Kharita (Lower Cretaceous, Albian) and Bahariya (Upper Cretaceous, Cenomanian) formations were mapped to improve understanding of their hydrocarbon potential. Two key seismic reflectors were identified: the top of the Kharita Formation, found at depths of 1400 to 1500 m, and the overlying Bahariya Formation, at depths of 1207 to 1234 m. A dominant structural feature is a large anticlinal fold, resulting from compressional forces associated with the Syrian Arc system, creating optimal conditions for hydrocarbon entrapment. The anticline is segmented by normal faults, indicative of extensional forces, which further enhance structural trapping mechanisms. The study's results, including detailed time and depth structure contour maps, illustrate the spatial distribution of these reflectors and related fault systems. This seismic analysis offers valuable insights into the hydrocarbon potential of the area, identifying promising targets for future exploration.

Keywords: Bahariya Formation; Kharita Formation; Seismic interpretation; Al-Fadl and Al-Qadr Fields, Abu Gharadig Basin.

Introduction

The Northern Western Desert of Egypt has proven to be a productive hydrocarbon province, despite its relatively featureless surface, which is generally a flat, barren plain (El Gazzar et al., 2016). This region comprises seven basins: Matruh, Shushan, Dahab, Natrun, Ghazalat, Gindi, and Abu Gharadig. These basins have attracted significant attention from many oil companies for hydrocarbon exploration. Badr El-Din Petroleum Company (BAPETCO) is one of the key operators in the area, having successfully drilled productive wells in the Al-Fadl and Al-Qadr fields within the Abu Gharadig Basin (Figs. 1 and 2).
Hydrocarbon exploration in these sedimentary basins is controlled by a complex geological

history and various depositional environments (El Gazzar et al., 2016; Sarhan et al., 2017a; Sarhan & Basal, 2020; Assal et al., 2021; Sarhan, 2019 & 2020; Shehata et al., 2018, 2019, 2023a; Shehata & Sarhan, 2022; Farouk et al., 2022, 2024a,b; Hassan et al., 2023; Selim & Sarhan, 2023; Sarhan & Abdel-Fattah, 2024a,b). Extensive studies have revealed a thick subsurface sedimentary succession ranging from Jurassic to Tertiary periods, which contains substantial petroleum resources, primarily derived from Jurassic-Cretaceous rock units. Notably, the Cenomanian Bahariya and the Turonian-Coniacian Abu Roash Formations account for over 90% of petroleum reserves in the Western Desert (El Diasty & Moldowan, 2012; Sarhan & Collier, 2018; Hewaidy et al., 2018; El-Bagoury, 2020; Elmahdy et al., 2020; Shalaby & Sarhan, 2021; Sabry et al., 2023; Reda et al., 2024).

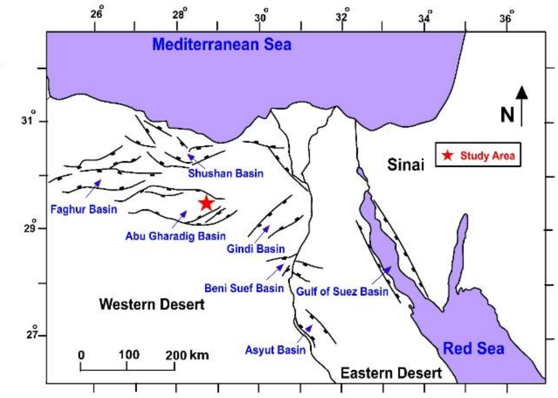

Figure 1: Location map of the study area within the Abu Gharadig Basin, Western Desert, Egypt. Modified from Sarhan & Collier (2018) and Bosworth et al. (2008).

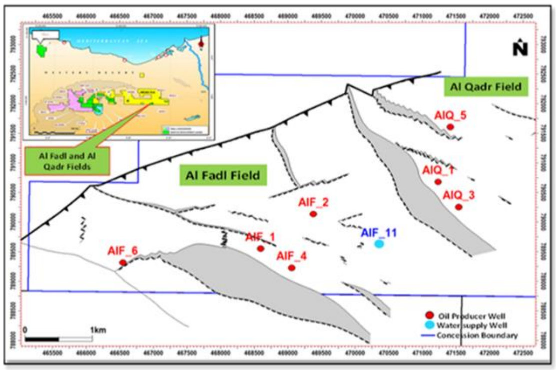

Figure 2: Location map of the Al-Fadl and Al-Qadr fields in the northeastern part of the Abu Gharadig Basin (NEAG), Western Desert, Egypt.

The structural evolution of the Abu Gharadig Basin (AGB) has been influenced by events such as the Syrian Arc tectonics and Late Cretaceous dextral wrenching, resulting in NE-SW compressional structures, including the Abu Gharadig anticline, as well as NW-SE and WNW-ESE extensional faulting (Sarhan, 2017b). This structural complexity plays a critical role in the distribution and accumulation of hydrocarbons within this basin (Guiraud & Bosworth, 1997; Moustafa, 2008; Soliman et al., 2022; Shehata et al., 2023b). According to Sarhan (2021a, b), the Bahariya sandstones and the sandy intervals of the Abu Roash E and C-sections represent the most promising hydrocarbon reservoirs in the AGB. The Al-Fadl field consists of Upper Cretaceous rock units, including, from bottom to top, the Bahariya, Abu Roash, and Khoman Formations (Fig. 3). The Kharita Formation, from the Lower Cretaceous, has also been penetrated in the field.

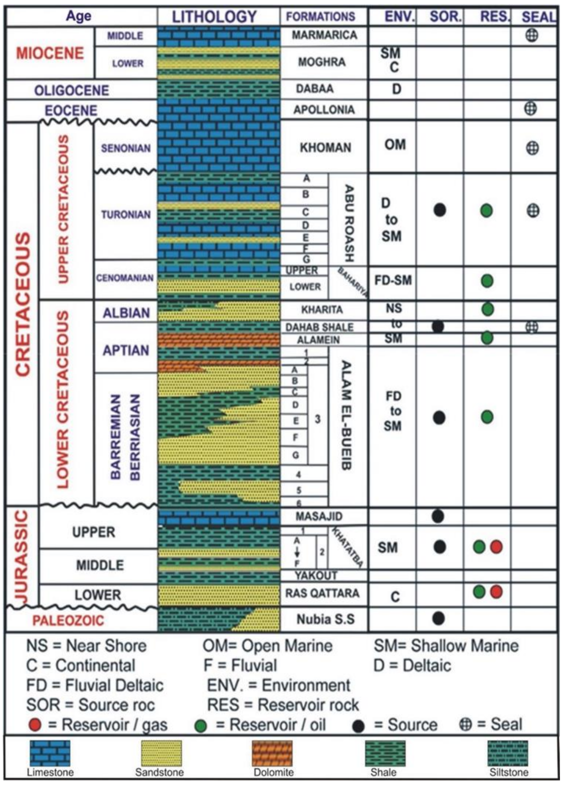

Figure 3: Regional stratigraphic column of the northern Western Desert (modified by Shalaby et al., 2011 after Schlumberger, 1984 & 1995).

This study concentrates on the Upper Cretaceous Bahariya Formation and provides an overview of the lithostratigraphy of the studied field. Numerous geologists have shown interest in this formation due to its significance (e.g., Abdelwahhab and Raef 2020; Mansour et al. 2020; Wanas and Assal 2021). This formation was deposited in a nearshore to the shallow marine environment during the early

Late Cretaceous transgression phase, it belongs to the Cenomanian age (Said 1990; El Ayouty 1990).

Al-Fadl and Al-Qadr fields, located within the Northeast Abu Gharadig (NEAG) development license, are operated by Badr El-Din Petroleum Company (BAPETCO) (Internal report, 2009). Successful exploration of the Al-Fadl-1 and Al-Qadr-1 wells in 2007 led to the granting of the NEAG1 license in January 2008 to support stakeholders such as Shell Egypt, Apache, and EGPC. These fields are part of the Upper Cretaceous potential within the NEAG Extension concession's eastern region (Fig. 2).

Al-Fadl-1 well, drilled to a total depth of 1,476 meters below the derrick floor (mbdf), contained oil-bearing intervals belonging to the Bahariya Formation, while the Kharita Formation tested wet (FDP BAPETCO, 2009). Initially, the well produced 600 barrels per day (BPD) with nitrogen lift, increasing to 1,200 BPD after hydraulic fracking, and later reaching 1,700 BPD naturally, with a maximum of 2,600 BPD using nitrogen lift. Similar results were observed for the Bahariya and Kharita formations in the Al-Qadr-1 well (Internal report, 2007).

The Upper Cretaceous Bahariya Formation, considered a primary focus of the Al-Fadl and Al-Qadr Fields, has also shown significant productivity in other fields within the middle Abu Gharadig Basin, including the BED-1, BED-2, and BED-3 Fields, which produce from the Abu Roash, Bahariya, and Kharita reservoirs. However, only minor discoveries have been made in the Sheiba Fields within the NEAG Extension concession. In Al-Fadl and Al-Qadr Fields, thick shales and carbonates of the Abu Roash "G" Member serve as the top seal. Structural analysis indicated that the Upper Cretaceous spill point in Al-Fadl is controlled by structural closure, as opposed to the Bahariya-Bahariya juxtaposition. The large fault offset places thin sands in the lower Abu Roash "E" section of the hanging wall against Bahariya sands on the footwall, with cross-fault sealing identified as a key prospect risk (Internal report, 2007).

Hydrocarbon source rock plays a critical role in oil generation at various stages of maturation and basin development. Burial depth and formation temperature are key factors controlling oil genesis (Awad, 1983). The Khatatba source rock is the primary charging source for the eastern NEAG Extension, while the Abu Roash “F” source rock remains immature in most areas. According to the analysis of the Khatatba Formation, the kerogen Type II/III are prevailing, which can generate both oil and gas in nearby fields (Internal report, 2007).

The Al-Fadl and Al-Qadr Fields span approximately 6 km by 3.7 km and consist of three-way dip fault closures at the top Bahariya level. These structures are located at the intersection of an inverted NE-SW trending reverse fault and NW-SE trending normal faults. Fault throw ranges from 25 to 500 meters, with the NW-trending normal faults in Al-Fadl and Al-Qadr forming a set of an-echelon faults, resulting in fault block compartmentalization. A central intra-field fault divides the area into the Al-Fadl and Al-Qadr blocks, acting as a seal, as evidenced by differences in hydrocarbon columns and oil-water contacts.

This paper aims to evaluate the Bahariya and Kharita Formations in the Al-Fadl and Al-Qadr Fields, located within the Northeast Abu Gharadig Basin in the Western Desert of Egypt, through seismic interpretation. These data are available for four wells: Al-Fadl-1, Al-Fadl-2, Al-Qadr-1, and Al-Qadr-6. The primary goal is to identify potential hydrocarbon-bearing zones and the structural features impacting the area.

Data and Methodology

The available seismic data include seismic sections and velocity measurements, with a total of twenty 2D seismic lines in SEGY format, comprising 10 in-line and 10 X-line profiles, as shown in the location map (Fig. 4). Seismic work is generally divided into three key stages: acquisition, processing, and interpretation. The objective of seismic data acquisition is to obtain accurate travel time measurements from energy sources to receivers. Seismic processing aims to enhance the data's quality, presenting it in a format suitable for geological interpretation. Integrating seismic interpretation, inversion techniques, and tectonic evaluations, recent studies have significantly advanced reservoir characterization and hydrocarbon exploration strategies, particularly in Egypt's Western Desert and other key basins (e.g., Abdel-Fattah et al., 2020; Fadul et al., 2020; Abdel-Fattah et al., 2021; El-Qalamoshy et al., 2023).

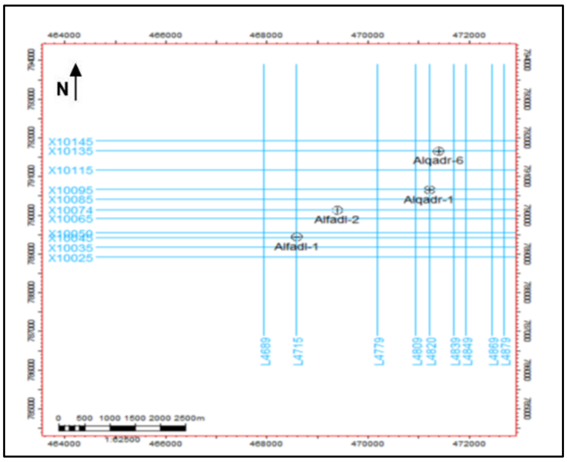

Figure 4: Map shows the seismic lines and wells within the study area of the NEAG field.

In this study, seismic interpretation is carried out using PETREL Seismic Interpretation software, which enables basin, prospect, or field-scale 2D seismic interpretation and mapping, providing an integrated view of the study area. The integration of stratigraphic data, seismic data, tectonics, and mathematical techniques helps produce a comprehensive understanding of the region.

Seismic interpretation involves using seismic reflection data to extract subsurface geological information by selecting key reflections associated with specific geological events and tracking the corresponding reflectors. This process must account for the engineering and geological implications of the project, as well as the current exploratory challenges (Nanda, 2021). Data evaluation, which extends beyond standard interpretation, adds value by assessing the economic viability of the prospects and aiding management in planning exploration strategies (Nanda, 2021).

Following and tracing the continuity of seismic reflectors and creating structural maps, we can delineate how tectonic forces have shaped geological boundaries over time. This is a fundamental aspect of seismic interpretation (Omran et al., 2023). One of the primary objectives of this process is the identification and presentation of significant reflectors as isopach and depth maps, which provide critical insights into subsurface structures (Eden et al., 1977).

Results

Identification of seismic reflectors

The process of identifying reflectors begins with picking continuous, prominent, high-amplitude reflectors using PETREL software version 2017. The selected reflectors were then correlated with composite and velocity logs by utilizing well-log data. In addition to highlighting areas with strong reflections, well logs provide valuable geological insights. The entire survey's picking process must be consistently linked to ensure that "all seismic line intersections are considered," which is achieved through a closed-loop system (Badely, 1985).

Seismic reflectors are identified based on their acoustic properties (Omran et al., 1998). These properties include seismic reflector continuity, geometry, attenuation, spacing, arrangement, and the interaction between sedimentary and structural features. The seismic data analysis employs these criteria and interpretation techniques to identify regional reflectors. In this study, two primary reflectors—the Bahariya and Kharita reflectors—have been identified across the study area. The seismic characteristics of these reflectors were determined through the interpretation of a grid of seismic profiles, providing detailed insights into the subsurface geology. A prominent fold structure, an anticline, dominates the area, with faults cutting through it, as observed in the seismic lines (Fig. 5). Below is a chronological description of the encountered reflectors, arranged from oldest to youngest, identified through the four wells.

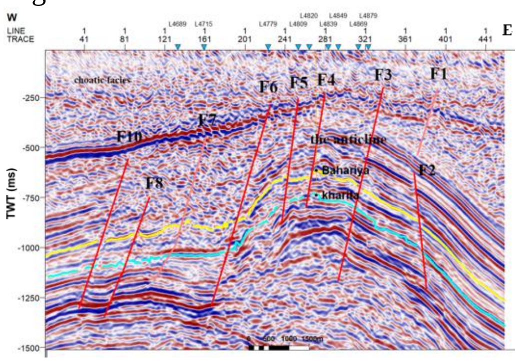

Figure 5: Interpreted seismic line X10145 displaying the recognized reflectors and structural elements in the E-W direction within the study area.

Interpretation of seismic profiles:

The NEAG field is covered by seismic data, classified into two sets: dip-oriented N-S lines and strike-oriented E-W lines. Together, these lines form a closed grid, which has been used to

delineate the structural and stratigraphic features of the study area. The seismic lines are partially represented in figures that accompany the line interpretations. Depth values are provided in meters below the seabed. The primary reflectors identified and analyzed are the Bahariya and Kharita formations.
The following section provides a brief interpretation of the four selected seismic profiles, represented as follows:

Seismic line X10145:

This seismic line is a dip line extending from east to west, intersected by multiple seismic lines within the grid (Fig. 5). Both Lower and Upper Cretaceous reflectors are easily picked throughout this section due to their continuity. These reflectors are influenced by an anticline fold and several normal faults.
The interpretation reveals that the oldest reflector, the Kharita Formation, is a Lower Cretaceous (Albian) unit observed at depths ranging between 1400 m to 1500 m true vertical depth (TVD) below sea level. It is characterized by strong lateral continuity across the Northwestern Desert and is clearly visible along the line. Above the Kharita reflector, the Bahariya reflector is prominently identified. This reflector occurs at depths between 1207 m to 1234 m TVD below sea level and is the second primary reflector observed on this line. The Bahariya Formation rests directly above the Albian Kharita Formation. Key features identified from the interpretation of this line include:

- The presence of concave reflectors creates a major anticline fold in the area, indicating the compressional forces associated with the Syrian Arc system. This fold forms excellent structural traps for hydrocarbons in the study area.
- The anticline is segmented by several normal faults (F1 to F10), which point to extensional forces, likely due to Late Cretaceous tectonic wrenching. These faults also contribute to creating effective structural traps for hydrocarbons.
- Most faults trend NE-SW, except for Fault F2, which trends NW-SE.
- Chaotic seismic facies are observed at shot point 41 and on the right limb of the anticline, likely indicating complex subsurface conditions in these areas.

Seismic line X10095:

This seismic line is a dip line extending from east to west, intersected by several seismic lines within the grid (Fig. 6). Both Lower and Upper Cretaceous reflectors are easily identified throughout the section due to their continuity. These reflectors are influenced by several normal faults.

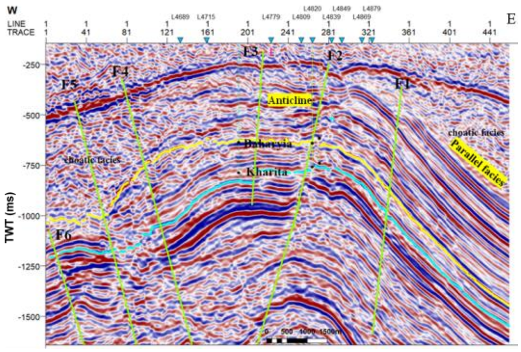

Figure 6: Interpreted seismic line X10095 showing the identified reflectors and structural framework in the E-W direction within the study area.

The interpretation indicates that the oldest reflector, corresponding to the Kharita Formation from the Lower Cretaceous (Albian), occurs at depths ranging from 1400 m to 1500 m true vertical depth (TVD) below sea level. This reflector is clearly observed along the entire line.
Above the Kharita reflector, the Bahariya reflector is distinctly visible. It is observed at depths between 1207 m and 1234 m TVD below sea level, making it the second primary reflector picked on this line. Key features identified from the interpretation include:

- Concave reflectors reveal a major anticline fold formed by compressional forces associated with the Syrian Arc system. This fold creates highly effective structural hydrocarbon traps within the study area.
- The anticline is segmented by six normal faults (F1 to F6), indicating the influence of extensional forces. These faults also provide additional structural traps for hydrocarbons.
- Faults F1, F2, and F3 trend NE-SW, while faults F4, F5, and F6 trend NW-SE.
- Chaotic seismic facies are observed at shot points 41 and 441, as well as on the right limb of the anticline.
- At shot point 401, from a depth of 550 ms, smooth and parallel facies are observed, unaffected by any structural deformations.

Seismic line L4849:

This seismic line extends from north to south and is intersected by multiple seismic lines within the grid (Fig. 7). Both Lower and Upper Cretaceous reflectors are easily distinguished throughout this section due to their continuity, though they are influenced by some normal faults. The interpretation reveals that the oldest reflector, corresponding to the Kharita Formation from the Lower Cretaceous (Albian), occurs at depths ranging between 1400 m and 1500 m true vertical depth (TVD) below sea level. This reflector is clearly visible along the entire line. Above the Kharita reflector, the Bahariya reflector is also distinctly visible, occurring at depths between 1207 m and 1234 m TVD below sea level. It is the second major reflector identified along this line. Key features identified from the interpretation include:

- Anticline Structure: Concave reflectors indicate a major anticline fold in the area, which suggests the presence of compressional forces from the Syrian Arc system. This fold forms highly effective structural hydrocarbon traps in the study area.
- Normal Faults: The anticline is segmented by ten normal faults (F1 to F10), confirming the presence of extensional forces, likely due to Late Cretaceous tectonic wrenching. These faults further enhance the potential for structural traps.
- Fault Orientation: Faults F1 to F7 trend NE-SW, while faults F8 to F10 trend NW-SE.
- Chaotic Facies: Chaotic seismic facies are observed at the top of the section and on the right limb of the anticline.

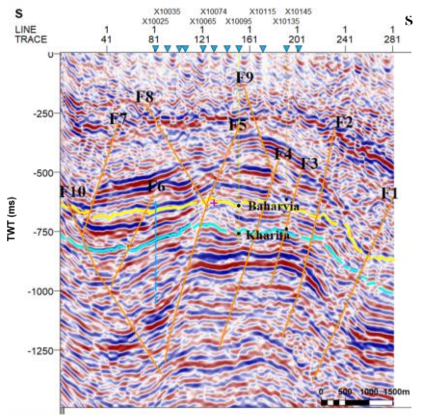

Figure 7: Interpreted seismic line L4849 showing the identified reflectors and structural elements in the N-S direction within the study area.

Seismic line L4779:

This seismic line extends from north to south, intersected by several seismic lines within the seismic grid (Fig. 8). Both Lower and Upper Cretaceous reflectors are easily identified throughout the section due to their continuity. These reflectors are influenced by a number of normal faults. The interpretation indicates that the oldest reflector, corresponding to the Kharita Formation of the Lower Cretaceous (Albian), is observed at depths ranging from 1400 m to 1500 m true vertical depth (TVD) below sea level. This reflector is clearly visible along the entire line.

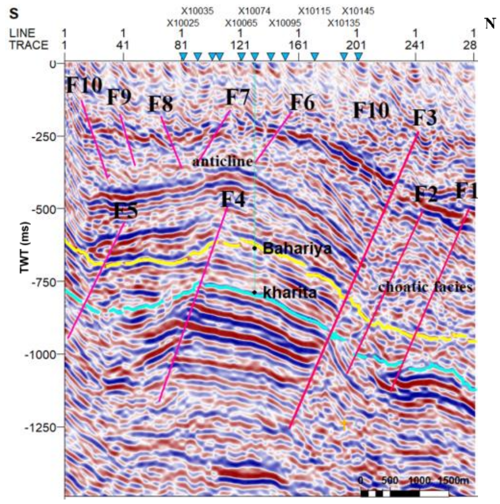

Figure 8: Interpreted N-S seismic section no. L4779 seismic.

Above the Kharita reflector, the Bahariya reflector is prominently identified, occurring at depths between 1207 m and 1234 m TVD below sea level. This is the second key reflector identified along the line. The interpretation has led to the identification of the following features:

- Anticline Structure: Concave reflectors indicate the presence of a major anticline fold in the area, which is attributed to compressional forces from the Syrian Arc system. This fold has created excellent structural hydrocarbon traps in the study area.
- Normal Faults: The anticline is segmented by ten normal faults (F1 to F10), confirming the presence of extensional forces, likely resulting from Late Cretaceous tectonic wrenching. These faults also act as effective structural traps for hydrocarbons.
- Fault Orientation: Faults F1 to F7 trend

NE-SW, while faults F8, F9, and F10 trend NW-SE.

- Chaotic Facies: Chaotic facies are observed on the right side of the major fault, F3, indicating complex subsurface conditions.

Bright spots:

One of the most widely recognized features of direct hydrocarbon indicators (DHI) is the "bright spot," which can signal the presence of hydrocarbons on seismic sections and reduce the risk of drilling a dry exploration well (Hammond, 1974). Bright spots result from changes in seismic wave amplitude, which are influenced by the physical properties of the rocks and the fluids contained within their pores (Gardner et al., 1974). In the NEAG Concession, multiple bright spots are observed (Fig. 9) within the Jurassic to Miocene section. The oil-bearing zones identified in this study are primarily located within the sheet sands of the Bahariya Formation and the Kharita Formation.

Mapping of the identified reflectors:

The mapping of reflectors is primarily determined by acoustic impedance contrasts and their reflectivity. The true vertical depths of the picked seismic reflectors along each section were utilized to map the depths of these reflectors. These depth values were then transferred onto a base map to construct structural contour maps.
The picked depth values, along with the locations of fault segments, were posted on the base map of the study area. This allowed for the construction of two depth contour maps using the average depth values. These maps illustrate that both horizons are influenced by a major anticline and are intersected by several normal faults.

Mapping of Baharyia horizon:

The horizon was picked, and the structural elements were defined. Correlating seismic events, tying their times, closing loops, posting the time values and fault segments, constructing the fault pattern, and contouring the arrival times are fundamental steps in seismic interpretation (Coffeen, 1984). The fault polygons were placed at their respective locations on the seismic shot point base map. Additionally, the two-way travel times were positioned on the base map and contoured to generate the time structure contour map for the top of the studied formation.

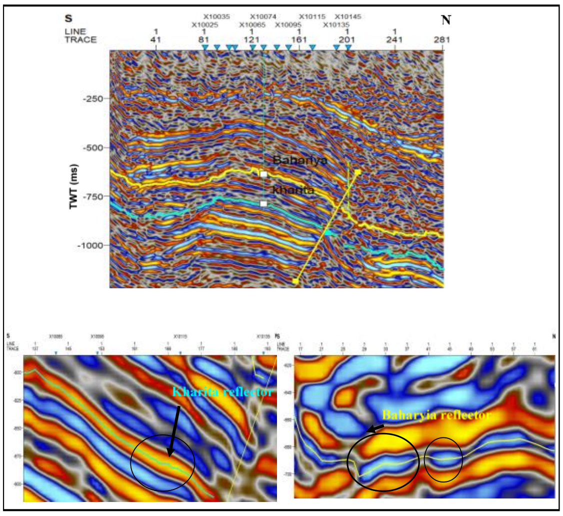

Figure 9: Interpreted bright spots within the Bahariya and Kharita formations, potentially indicating stratigraphic hydrocarbon traps, as highlighted in the circled zones.

Two-way time structural contour map.

Figure (10) presents the two-way time structure contour map for the top of the Bahariya Formation. This horizon is characterized by a strong reflector with significant lateral extension across the study area. The two-way time values for the Bahariya Formation range from -300 to -1550 milliseconds (ms), with the maximum value occurring at the center of the map.

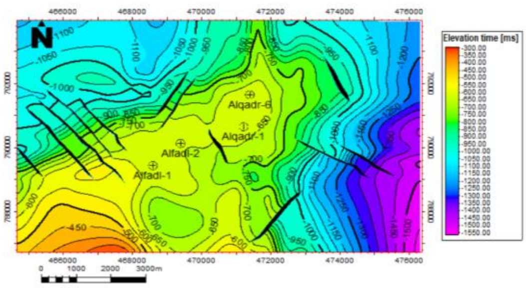

Figure 10: Structural contour map for the top of Bahariya Formation (in time unit).

Average velocity map:

The average velocity (Vav) is the velocity over a certain reflecting surface below the seismic reference datum (Dobrin, 1976).

$$Vav = X/T$$

(X): is the depth of the studied surface from well

in feet.
(T): is the one-way time to the reflector of the studied surface in ms.
The average velocity map of the Baharyia horizon shows that the velocity increases in the southeast direction and decreases in the northwest direction as shown in the following (Fig.11).

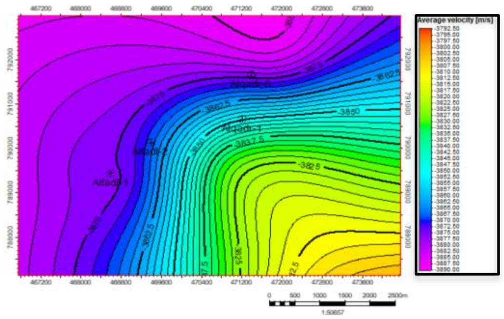

Figure 11: Average velocity map for the top of the Bahariya Formation.

Depth structural contour map:

To construct the depth contour map of the Bahariya Formation, the time and average velocity maps were used to convert time to depth. The Bahariya reflector is the youngest identified in the study area. The depth map for this reflector, shown in Figure (12), is drawn with a contour interval of 100 meters. The contour values range from 600 meters to 3000 meters. The minimum depth of 600 meters is observed in the southwestern part of the map, gradually increasing toward the northern and northeastern parts, where the maximum depth reaches approximately 3000 meters (Figure 12). The longest fault measures 3885 meters, while the shortest one is 1190 meters, both trending NW-SE. This reflector is affected by an anticline fold and several normal faults, as depicted in the depth map.

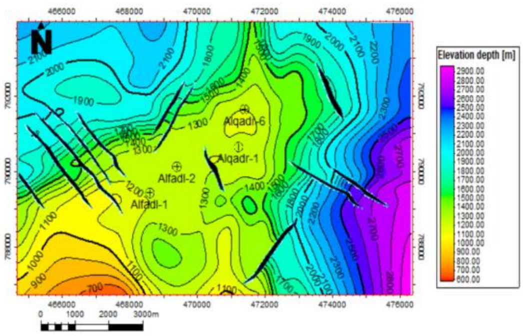

Figure 12: Structural contour map for the top of Bahariya Formation (in depth unit).

Isopach contour map (thickness map):

The depth contour map for the Bahariya Formation, shown in Figure (13), is drawn with a contour interval of 50 meters. The thickness of the Bahariya unit ranges from 75 meters to 575 meters. The formation thickness increases southward, as indicated by moderately spaced contour lines. The minimum thickness, found in the northern area, is represented by widely spaced contour lines and is depicted in orange.

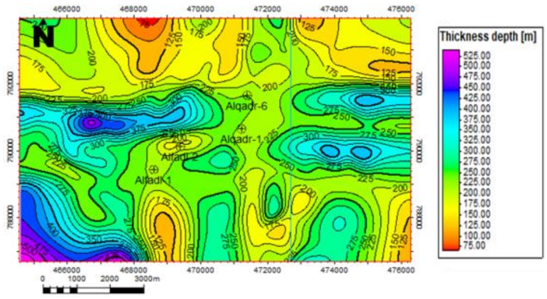

Figure 13: Thickness map of the Bahariya Formation with a contour interval of 25 meters.

Mapping Kharita horizon:

Time structural map.

Figure (14) illustrates the two-way time structure contour map for the top of the Kharita Formation. This map highlights a strong reflector with significant lateral extension across the study area. The two-way time for the Kharita Formation ranges from -650 to -1650 milliseconds, with the maximum value located at the center of the map.

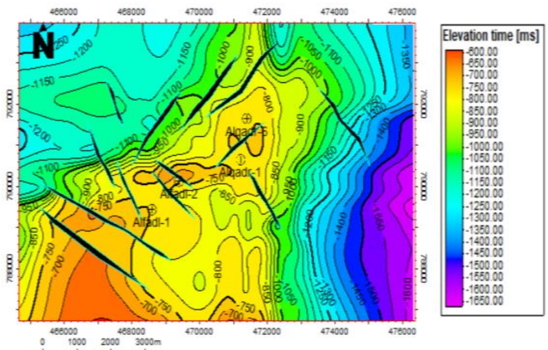

Figure 14: Structural control map for top of Kharita formation (in time).

Average velocity map:

Figure (15) presents the average velocity map for the Kharita horizon. This map indicates that the average velocity increases towards the northeast and decreases towards the center of the map.

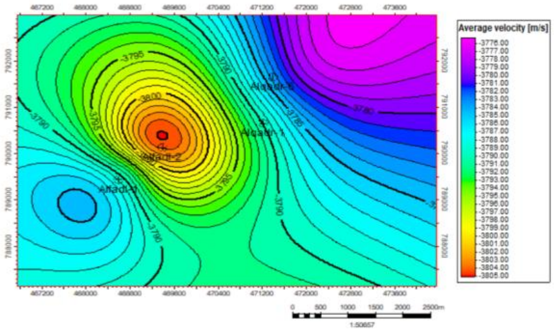

Figure 15: Average velocity map for the top of the Kharita reflector.

Depth structural contour map.

Figure (16) displays the depth map for the Kharita reflector, with a contour interval of 100 meters. The depth values range from 1200 meters to 3100 meters. The minimum depth of 1200 meters is observed in the southwestern part of the map, while the maximum depth of approximately 3100 meters is found in the northern and northeastern regions. The longest fault on this map measures 4090 meters, and the shortest is 1104 meters, both trending NW-SE. The depth map reveals that the Kharita reflector is influenced by an anticline fold, with normal faults intersecting the fold.

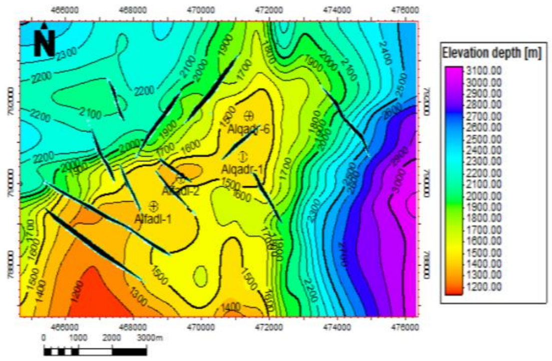

Figure 16: Structural contour map for the top of reflector Kharita (in depth unit).

Discussion

The seismic interpretation of the Bahariya and Kharita formations in the Alfadl and Al-Qadr fields of the northeast Abu Gharadig Basin has provided significant insights into the subsurface geology and hydrocarbon potential of the region. The study reveals a complex structural framework characterized by a major anticline fold and a network of normal faults, which are critical for evaluating hydrocarbon traps and reservoir potential.

Structural Analysis

The identified Kharita reflector, situated at depths between 1400- and 1500-meters TVD, represents a Lower Cretaceous (Albian) geological unit. Its strong lateral continuity and clear reflectivity throughout the seismic sections indicate its robustness as a regional stratigraphic marker. Positioned above the Kharita reflector, the Bahariya reflector, ranging from 1207 to 1234 meters TVD, further defines the stratigraphy and offers insights into the overlying depositional environments.

The anticline fold, a prominent feature observed in the study, is a product of compressional forces linked to the Syrian Arc system's tectonic activity. This fold creates an ideal structural trap for hydrocarbons, suggesting a high potential for hydrocarbon accumulation within the study area. The segmentation of the fold by normal faults, which trend predominantly NE-SW and NW-SE, introduces additional complexity to the structural framework. These faults not only influence the distribution of hydrocarbon traps but also indicate extensional tectonic forces that have played a significant role in shaping the current structural configuration.

Faults and Seismic Reflection Characteristics:

The normal faults identified in the study, ranging from 1104 to 4090 meters in length and varying in trend, contribute to the overall structural complexity. The interaction between these faults and the anticline fold likely enhances the compartmentalization of potential hydrocarbon reservoirs, offering multiple trapping mechanisms. The presence of chaotic facies in some areas further underscores the influence of faulting and folding on sedimentary deposition and reflectivity.

Hydrocarbon Potential:

The bright spot anomalies observed within the Jurassic-Miocene section suggest the presence of hydrocarbons, particularly in the sheet sands of the Bahariya and Kharita formations. These anomalies are indicative of high amplitude reflections, which often correlate with hydrocarbon-bearing zones. The mapping of reflectors and the construction of structural and depth contour maps reinforce the potential for significant hydrocarbon accumulation in the study area.

This study provides a comprehensive seismic interpretation of the Albian-Cenomanian sequence, revealing key structural features and their implications for hydrocarbon exploration. The integration of seismic data with structural analysis offers valuable insights into the subsurface conditions and potential reservoirs. Future work should focus on further refining the structural models and conducting detailed petrophysical analyses to better understand the reservoir characteristics and optimize exploration strategies in the northeast Abu Gharadig Basin.

Conclusion

- This study focuses on the seismic interpretation of the Bahariya and Kharita formations in the Alfadl and Al-Qadr fields, located in the northeast Abu Gharadig Basin in the Western Desert of Egypt.
- The interpretation of seismic data has provided a comprehensive view of the study area. This approach allowed for detailed basin, prospect, and field-scale 2D seismic interpretation and mapping, contributing to a robust understanding of the area's geological features.
- The Kharita reflector, identified as a Lower Cretaceous (Albian) reflector, occurs at depths ranging from 1400 to 1500 meters (TVD) below sea level. This reflector is clearly visible in the seismic sections.
- Above the Kharita reflector, the Bahariya reflector is observed at depths between 1207 and 1234 meters (TVD) below sea level, representing the second key reflector identified in this study.
- The dominant structural feature in the study area is a major anticline fold, formed due to compressional forces related to the Syrian Arc system movement. This fold provides excellent structural traps for hydrocarbons.
- The anticline fold is further segmented by several normal faults, indicating extensional forces that also create potential structural traps.
- Mapping of the identified reflectors involved defining structural elements, correlating seismic events, closing loops, and constructing fault patterns and time structure contour maps for the top of the formations.
- Fault polygons and two-way time values were integrated into the base map to construct the time structure contour maps, providing a clear representation of the subsurface features.

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الملخص العربي

عنوان البحث: رؤى سيزمية في تتابع العصر الألبياني-السينوماني: الإمكانات الهيكلية والهيدروكربونية في حقلي الفضل والقدر، شمال شرق حوض أبو الغراديق، مصر

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تقدم هذه الدراسة تفسيرًا سيزميا مفصلاً لتكوينات البحرية والخريطة داخل حقلي الفضل والقدر الواقعين في شمال شرق حوض أبو الغراديق، الصحراء الغربية، مصر. باستخدام البيانات السيزمية، قمنا برسم خرائط وتحليل التراكيب تحت السطحية لتعزيز فهم إمكانات الهيدروكربون في هذه المنطقة. حددت الدراسة عاكسين رئيسيين: تكوين الخريطة (العصر الطباشيري السفلي، ألبيان) على أعماق تتراوح من ١٤٠٠ إلى ١٥٠٠ متر، وتكوين البحرية (العصر الطباشيري العلوي، سينوماني) الذي يقع فوقها على أعماق تتراوح من ١٢٠٧ إلى ١٢٣٤ مترًا. السمة الهيكلية السائدة هي طية محدبة رئيسية، تُعزى إلى قوى الضغط المرتبطة بنظام القوس السوري، مما يخلق ظروفًا مواتية لاحتجاز الهيدروكربون. بالإضافة إلى ذلك، يتم تقسيم المحدب بواسطة الصدوع العادية، مما يشير إلى قوى التمدد التي تساهم أيضًا في آليات الاحتجاز الهيكلي. تتضمن نتائجنا خرائط تفصيلية لبنية الوقت والعمق، والتي توضح التوزيع المكاني لهذه العاكسات وأنظمة الصدع المرتبطة بها. يوفر هذا التحليل الزلزالي الشامل رؤى قيمة حول آفاق الهيدروكربون في منطقة الدراسة، مما يسلط الضوء على الأهداف المحتملة للاستكشاف في المستقبل