Al-Azhar Bulletin of Science: Section D, Vol. 32, No. 2, (December) 2021, pp. 33-48
http://doi. 10.21608/ABSB.2021.101535.1149

Al-Azhar Bulletin of Science: Section D

PETROLEUM SYSTEM OF GINDI BASIN AND MUBARAK SUB-BASIN, QARUN CONCESSION, WESTERN DESERT, EGYPT

Moustafa M. Hussien [a,*], Tharwat H. Abdel Hafeez [b], Mohammad M. Fathy [b], Mohammad N. El Ghamry [c]

[a] Marina Petroleum Company, MAADI, Cairo, Egypt.
[b] Geology Department, Faculty of Science, Al-Azhar University, Nasr City, Cairo Egypt.
[c] Merlon International Co. (unitholder), Maadi, Egypt.

* Corresponding Author: mostaswany@gmail.com

Received: 17 Oct 2021; Revised: 23 Dec 2021; Accepted: 23 Dec 2021; Published: 31 Dec 2021

ABSTRACT

The study area is located to the west-southwest of Cairo, which includes Qarun and East Bahariya Concessions. Two main prolific sedimentary basins included; Gindi and Mubarak basins. Geophysical and 3D seismic data integrated with well logs, as well as geochemical data from 5 wells, all resulted in an accurate delineation of the structure traps and a reassessment of the elements of the petroleum system in this area. Mentioned basins are formed as a result of Late Cretaceous wrench tectonics. Such tectonic regime was responsible for generating oil entrapment and conduit faults in Cretaceous reservoirs. Detailed geochemical analysis proved that the Jurassic Khatatba shales, and the Cretaceous Abu Roash "F" act the main source rocks in these basins. On the other hand, isopach maps prepared for Apollonia and Khoman carbonates clarified that such formations are considered the main top seal in this area. This study aimed to re-evaluate the elements of the petroleum system, and to provide new opportunities to select the best locations for drilling. The result of the current study showed that most of the oil entrapments are in the form of three-way dip-fault-dependent closures, and the fault system acts as the main conduit for oil migration. Also, the Cretaceous Abu Roash "F" carbonates and the Jurassic Khatatba shale are the main source rocks, with an oil window at 4500-5500 ft. depth for Abu Roash "F" Member and at 7500-8500 ft. depth, and a gas window at 12000-13000 ft. depth for Khatatba Formation. Oil to oil correlation suggested that two types of oil are there (type I and type II).

Keywords: Gindi; Mubarak; Qarun; Wrench; Petroleum system.

1. INTRODUCTION

Oil and natural gas are among the most Oil and natural gas are among the most prolific energy resources all over the world. Unfortunately, such important energy resources of our planet are on the verge of depletion. It is hard to imagine the world's energy without crude oil and/or natural gas, due to their vital needs in our lifetime. This necessitates exploring new areas and deeper horizons to add new reserves.

According to [1], levels of hydrocarbon investigation include; sedimentary basin, petroleum system (elements and processes), play, and prospect evaluation.

Sedimentary basin investigations emphasize the stratigraphic sequence and structural style of sedimentary rocks. These investigations were obtained from the subsurface study because subsurface geology involves the interpretation of the stratigraphic, structural, and economic values below the earth's surface [2]. These interpretations are based on information obtained from boreholes (well log data), geophysical (seismic) data, ditch samples and core data.

The petroleum system includes the essential elements and processes needed for the existence of oil and gas accumulations. The elements are the source rock, reservoir rock, seal rock, and overburden rock, and the processes include trap formation and the generation-migration-accumulation of petroleum.

So a complete evaluation of the petroleum system would requires three types of studies; subsurface study, to come up with the stratigraphic and structural setting of the study area, (using seismic, magnetic, gravity data and well log data), petro-physical study, to come up with the petro-physical characteristics of the rock units of interest, (using well log data), and geochemical study, to come up with the origin, maturation, migration, accumulation, and alteration of petroleum, (using core data and geochemical log data).

The study area is located in the northern part of the Western Desert of Egypt, with an area of about 14,900 sq. kilometers and lies between Latitudes: 29° 15′ to 30° 00′ N and Longitudes: 29° 10′ to 31° 00′ E (Fig. 1). This area comprises several highly productive oil fields that were previously discovered at different parts such as Qarun, North Qarun, Southwest Qarun, Harun, North Harun, WD-19 (El-Ahram) and Wadi Rayan, Karama, Diyur, Asala and Misaada oil fields. They are all produced from cretaceous reservoirs. The above-mentioned oil fields are charged from Gindi and Mubarak basins.

2. AIM OF THE PRESENT STUDY

The present work aims to carry out subsurface geological and petro-physical studies to evaluate the petroleum potentialities in Gindi basin and Mubarak sub-basin area. It is an attempt to elucidate a complete subsurface and petro-physical overview of the study area, by integrating the available subsurface geological and geophysical data to understand the effect of the different geologic events on it, and their relationship to the expected petroleum potentialities.

Thus, it can be said that one of the most important goals of this study is to try to explore a new hydrocarbon area using all the available data mentioned above.

To achieve this goal, the following steps are followed:

1- Determining the subsurface geologic setting, in terms of stratigraphic and structural settings, through construction of litho-stratigraphic cross sections, isochrones and litho-Facies maps, seismic sections, geologic structural cross sections and structure contour maps.

2- Investigation of the hydrocarbon potentials, by interpreting the results of the presented subsurface and petro-physical and geochemical studies, and integrating them with the conclusions of the previous related works carried out on the same area.

3. MATERIALS AND METHODLOGY

The present study uses different composite well logs (i.e. Resistivity, SP, GR, Density, Neutron and Sonic) of 100 wells distributed in the area of study. In addition to this, data of 3D seismic lines were used to delineate the subsurface structural setting. Besides, geochemical analysis was conducted for five wells to evaluate the source rock and to identify the oil type.

3D Seismic data interpretations were carried out to construct various depth structure maps. Well log data (GR, Resistivity, Density, and Neutron), and Geochemical analysis was conducted for five wells to evaluate the source rock and to identify the oil type. The Isopach maps constructed for all of these formations, from Apollonia to the Khatatba formations by using formation tops for several drilled wells.

This work is carried out by using the specialized software, such **Charisma, Land Mark, Interactive Petro-physics version 3.5, Tec-log version 2.2, Z-Map and Petrel 2015**. Schlumberger company provides Al-Azhar

University a free copy license from this software's.

4. GEOLOGICAL SETTING:

The Mubarak sub-basin (East Abu Gharadig basin) and Gindi basin are considered as the most petroliferous basin in Western Desert, as far as hydrocarbon production and potential, Abu Gharadig basin divided to three parts West Abu Gharadig, Middle Abu Gharadig and East Abu Gharadig (Mubarak sub-basin).

The northern margin of these mentioned basins are marked by a major border fault zone which up-throws basement to about 10,000 feet forming Sharib-Sheiba ridge, whereas its southern boundary is also bounded by a major fault forming what is called Sitra platform **[3].**

4.1. TECTONIC setting

Qarun concessions (Qarun and East Bahariya area), and most other Western Desert is inverted structures were formed by extension (rifting phase) and associated subsidence in the Late Jurassic to Early Cretaceous, followed by wrenching phase in the Late Cretaceous to Eocene. The Late Cretaceous inversion, or "Santonian event", was by far the most significant strike-slip movement tectonics to affect the northern Western Desert during the Phanerozoic. The Gindi basin is bounded from the north by Kattaniya highly inverted basin and from the south by Wadi El Rayan-Sila high (both boundaries are experienced right lateral strike-slip movement). As to east Abu Gharadig basin (Mubarak –sub-basin) is bounded from the north by Qattara ridge and from the south by Sitra platform (both boundaries are experienced right lateral strike-slip movement). Both two basins are separated by the Kattaniya platform, as well as other basins in the north Western Desert, are NE-SW, ENE-WSW trending Jurassic to Early Cretaceous Rift basins. The Kattaniya uplift is an inverted Jurassic/Cretaceous basin containing thick Khatatba oil-prone source rocks that believed to be responsible for generating the oil which migrated to the south and east to charge the Qarun field. The East Bahariya oil fields are located in the middle and west of the study area, to the south and southeast of Mubarak sub-basin (east part from Abu Gharadig main basin) and to the west of Gindi basin.

4.2. STRATIGRAPHIC SETTING

The stratigraphic section penetrated in the study area includes a Paleozoic to recent sedimentary section overlying the Precambrian crystalline basement rocks, these rock units are presented in the generalized stratigraphic column of this area, (Fig. 2).

The sediments recorded by deep drilling in the northern Western Desert have shown that this large area is differentiated beneath its flat cover of younger sediments into a number of major paleo geographic basins. These sedimentary basins were the scope of numerous investigations by many geologists such as [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22]. [23] and [24].

The stratigraphy of this province is characterized by a reduce sequence of Paleozoic rocks overlain by Jurassic section Khatatba and Masajid. The Jurassic section is unconformity overlain by the Kharita Formation. A variation of Formation thicknesses as explained by the stratigraphic correlation. The lateral variation in the thickness of Dabaa and Moghra formation reflect as sold evidence on reactivation of some NW-SE oriented faults during the late of Oligocene and early Miocene (**Figs.3**), and several isopach maps. The seismic line interpretation (**Fig. 4)** figured out that the shallow formations were thicker to the S direction but thinner to the N indicates that there is a variation in the thickness from S to N crossing Mubarak sub-basin. Nine isopach maps are constructed for all formations, from Apollonia to the Khatatba formations. The Apollonia Formation reaches a maximum thickness equal to 2440 m in the Gindi basin. The depocenter of the Apollonia Formation lies to the southeast of the Jurassic– Early Cretaceous inverted basin. The Khoman Formation also shows an increase of thickening to the southeast of the Kattaniya inverted basin, but its depocenter lies relatively closer to the

Kattaniya inverted basin. This indicates that, during this later phase of basin inversion and growth of anticline development, the deposition of the Khoman and Apollonia formations occurred with continued migration of the depocenter away from the inverted basin**.**

5. PETROLEUM SYSTEM ELEMENTS

A petroleum system encompasses a group of active source rocks and all related types of oil and gas, the occurrence of hydrocarbons is closely linked to the elements of petroleum system and includes the essential elements and processes needed for the existence of oil and gas accumulations in a high economic value. The essential elements are the source rock, reservoir rock, seal rock, and overburden rock, and the processes include the trap formation and the generation-migration-accumulation of petroleum.

Positive inversion anticlines represent considerable interest features for oil and gas explorationists, as they have many effects on all aspects of petroleum systems. The hydrocarbon trap has to be covered by an impermeable rock known as a seal or cap-rock in order to prevent hydrocarbons escaping to the surface, the causes of inversion decrease the amount of the overburden and top seal rock. In Qarun area, the first oil discovery is located on the southeast flank of the Kattaniya uplift and the northwest flank of the Gindi basin where there is a thick thickness of Apollonia and Khoman top seal rock.

a. Seal Rock

The main regional top seal rock in this area is represented by Apollonia carbonates, and Khoman chalk. In addition, the Abu Roash "G" shales and interbedded shales and carbonates are also providing good lateral seals for different reservoirs (e.g. Abu Rash "G channel sandstone, the Bahariya and Kharita sandstone reservoirs). Apollonia Formation acts as a good cap rock (top seal), therefore, in areas where Apollonia is thick, oil prospectively and potentiality success are high. The Isopach map (Fig. 5A) showed that the Apollonia depocenter is getting thicker to the southeast of the area, and has a ENE-WSW structural trend, possibly due to the right-lateral strike-slip movement that occurred in the post-Cretaceous time, and rejuvenated during the Eocene time, forming what is called pull-apart structure basins. In addition, The Isopach map (Fig. 5B) showed that Khoman Formation, that acts as a good lateral and cap seal rock, therefore, in areas where Khoman Formation has a moderate thickness, an oil prospectively success ratio, and the opportunity of hydrocarbon potentiality appears to be higher than other areas which has very thin Khoman Formation, as clearly shown on the Khoman isopach map of the study area.

b. Source rocks

The geochemical study (Figs. 6) indicated that the hydrocarbons were generated in the Gindi and Mubarak basins from source beds within the Lower Kharita shales, and Jurassic (Khatatba Formation), in addition to the Abu Roash "F" carbonates, which subsequently migrated into the different traps located in the upper dip locations of the flanks of the basins. The models (Figs. 7) demonstrate that type **III** source rocks in the Lower Kharita shales, as well as Abu Roash "F" carbonates generated hydrocarbons with expulsion from source kitchens in the late Cretaceous during Campanian/Maastrichtian times. Expulsion also took place in the late Eocene and continued into Miocene where gentle uplift inhibited or prohibited expulsion through the remaining Tertiary and Quaternary in which type **I** & **II** (Mixed oil) source rocks of Abu Roash "F" member reached maturity level in the late Tertiary, as shown in Qarun area at Gindi basin.

Basin modeling petrel software calculated the time of oil generation from Khatatba source that was started most likely during the middle to late Santonian (Abu Roash deposition), about 95 million years ago (Fig. 8). However, expulsion did not commence until 85 million years ago during the Santonian, and stopped expelling oil 65 million years ago during the Campanian (Khoman deposition), while the generation and expulsion of gas from the Khatatba source continues actively to this day. On the other hand, Abu Roash "F" source was started most likely during the Maastrichtian, about 70 Ma ago, and expulsion did not commence until about 60 Ma ago during the Middle Paleocene and did not stopped expelling oil until now.

The gas Chromatograms of the oil recovered from the Upper Bahariya sandstone in East Bahariya Concession, suggested that the oils were generated from a source rock containing mainly terrigeneous organic matter (type **III**), deposited under oxic to sub-oxic depositional conditions, typical of Khatatba Formation, and the thermal maturity of that oil is estimated to be around 0.9% of Vitrinite reflection equivalent. All the Abu Roash "F" sediments are considered source rocks (type **II**) with fair to excellent potentiality except the area at El Sagha-2 well, where no samples from Abu Roash "F" were available. The isopach map (Fig. 9) of ARF overburden sediments shows a high thickness to the NE and NW directions of the study area but they appear to be thinner to the south and thinner to the north direction of this area.

c. Maturation:

The study of Vitrinite reflectance (or VR) is a key method for identifying the maximum temperature history of sediments in sedimentary basins. We noticed in ARF and Khatatba regional Vitrinite map (Figs.10 & 11) that the Vitrinite increases in maturity with depth, which appears in the central part of the study area at Gindi basin and to the NW at Mubarak sub-basin. Vitrinite reflectance measures the percentage of incident light reflected from a polished surface of Vitrinite, and it is presented in %Ro units, the measured percentage of reflected light from a sample which is immersed in oil (%Ro = % reflectance in oil). When the source rock is mature – source rocks have been exposed to sufficient heat for thermal generation of oil or gas. In this stage, the hydrocarbons are in oil window - onset of oil generation is related to VR of 0.5-0.6 % Ro and the termination of oil generation is between 0.85-1.1 % Ro.

It seems from the ARF source rocks that the organic matter started to change with the increase of temperature from kerogen, a solid form of hydrocarbons, to oil. The oil window of the interval where oil is generated and expelled from the source rock (T max. more than 440 °C). In this work with integrated more than 100 drilled wells and geochemical analysis of some wells to understand the source rock maturation, throughout built many oil map windows (Figs. 12, 13, and 14), in these maps observed that the oil window of Abu Roash F source rock, it showed within a depth interval ranges from 4500 to 5500 ft., and Khatatba shale which represent are the main source rocks, with an oil window ranges from 4500 to5500 ft. as shown**.**

d. Migration:

Migration indicates the movement of oil upward along the bedding planes, faults, and depositional breaks. In some parts of the Western Desert, the Upper Jurassic and Lower Cretaceous are thick enough to induce early hydrocarbon generation from the Khatatba Formation before the end of the Cretaceous **[25].** Faults play a significant role in the trap, lateral seal and migration pathway compartmentalization in the Western Desert. In terms of charge probability, a structure that could be charged, whatever the fault hydraulic connectivity over time, is obviously less risky (i.e. the structures are charged on both sealing and non-sealing models (Figs. 15 & 16).

e. Reservoir:

Reservoir rocks are the rocks that have ability to store fluids inside its pores, so that the liquid (water and oil), and also natural gas can be accumulated. In petroleum geology, reservoir is one of the elements of petroleum system that can accumulate hydrocarbons (oil or gas). Reservoir rocks must be having good porosity and permeability to accumulate and drain oil in economical quantities. The fundamental property of a reservoir rock is its porosity, however, to be an effective reservoir rock, the fundamental property is permeability. Both porosity and permeability are geometric properties of a rock and both are the result of its lithological (composition) character. The physical composition of a rock and the textural properties (geometric properties such as the sizes and shapes of the constituent grains, the manner of their packing) are truly important when describing the reservoir rocks rather than the age of the rock. Five sandy reservoirs are identified in this study (Figs.17A, 17B,17C, and17D). They include Kharita sands, the Bahariya Formation, Abu Roash "E" and Abu Roash "C" and Abu Roash “G” Members. The characteristics of these reservoirs indicate a thick sand in the north and east directions (**Fig.18and 19)**, which means there is a chance to have large amount of oil in the vertical oil column, but they are going to be thinner in the south and southwest directions that reflect thinner reservoir with a remarkable decrease in the vertical oil column. After seismic re-interpretation and re-evaluation by using data of new drilling wells, petro-physical evaluation performed to proposed a new prospect in this area. For example, the petro-physical evaluation for Yomna-1X showed that the well has encountered more than 20 ft. of the oil bearing sandstone against Upper and Lower safa Members**(Fig.20).**

f. Oil entrapment

Most of the hydrocarbons in the north Western Desert, including the Abu Gharadig and Gindi basins were discovered by focusing the exploration processes on the structural prospects in sandstone and carbonate reservoirs. These structural traps are mainly in the form of three-way dip fault-dependent closures. Four-way structure closure are also there, but less abundant. Both closures are identified in the Cretaceous rocks. These traps are possibly formed during the post Cretaceous strike-slip tectonic (wrenching tectonics) movement that affected the northern part of the Western Desert.

Structural closures located away from the highly inverted area with a good top seal are better hydrocarbon prospects compared to those in the highly inverted province without adequate top sealing (Fig. 21).

6. OPPORTUNITIES AND CHALLENGES FOR THE HYDROCARBON PROSPECTIVITY AND EXPLORATION

In the Western Desert, all exploration activities and development plans can be targeting on inversion and fault-dependent closure traps, so, the element of petroleum system should be analyzed for any new prospects in a basin, due to it is distinction in each basin from another. There are several proven inversion structures (Figs.22and23), in the Western Desert containing reasonable quantities of hydrocarbon such as (Qarun, Razzak Inversion Structure, Mubarak Anticline and Kattaniya High).

A strike-slip tectonic phase related to the Laramide tectonic event strongly affected the Upper Cretaceous sedimentary succession in the entire sedimentary basins in the northern Western Desert including the Gindi basin and Mubarak sub-basin. This tectonic episode started during the Santonian age and continued through the Early Tertiary as a result of the NW-SE compressive stress related to the movement of Africa relative to Laurasia [26]. This tectonic episode plays an important role in constructing most of the oil traps, such as Qarun and Yomna fields (Fig24).

Accordingly, seismic re-interpretation and structure and petro-physical analysis of the Yomna field, from this analysis we expect hydrocarbon potentiality at Jurassic reservoirs in Yomna area. From this analysis information proposed a new three-way dip closure that can to drill as a new prospect which located to the south from Yomna-1X discovery (Figs.25 and 26).

7. CONCLUSION AND RESULTS

The main petroleum system source rocks were recognized at Gindi and Mubarak sub-basin and were related to phases of basin evolution. They are Early syn-rift transgressive deltaic petroleum system Type III (Khatatba Formation), Late syn-rift transgressive deltaic petroleum system Type II and Type III (Kharita

Formation), and Post-Rift Sag shallow marine petroleum system Type II (Abu Roash-F Member).

In the areas where Apollonia and Khoman formations are thick, oil prospectively and potentiality success are high. There is a proven petroleum system in Gindi and Mubarak basins named as Khatatba and Abu Roash "F" petroleum system, with ARF oil window ranges from 4500 to 5500 feet. Exploration opportunities and prospects in these basins are structural play (three-way dip – fault dependent closures and four-way closures). The cross plot throughout the study area that shows the relation between Ph/n-C18 and Pr/n-C17, it seems from this plot there are different ratio between Ph/n-C18 and Pr/n-C17.If the oil generated from terrestrial source rock, in this case put this well in the (A) area. Some wells have high ratio (Ph/n-C18 and Pr/n-C17), which found in bituminous coal that means in oxidizing environment within Oxic conditions in the terrestrial deposits through the early stage of degradation, but other wells have low ratio(Ph/n-C18 and Pr/n-C17) it means have mixed source, but the little bit of wells have high Ph/n-C18 and low Pr/n-C17 which reflects a high reduction environment by catalyzed degradation , but other wells have low ratio it means have mixed source, but the little bit of wells have high Ph/n-C18 and low Pr/n-C17 which reflect high reduction environment by catalyzed degradation. The cross plots appeared for example in Qarun-18 well that located in peat/coal source (B), in the other hand most east Bahariya well located in peat/coal source except Yomna (ARE) and Amana (ARG 20) were locate at the border between peat/coal source (B) and mixed source(C), Fig (7). There is no any chance to snatch hydrocarbon potentiality for Alam Al Bueib (Lower Cretaceous) and Masajid (Jurassic) sand reservoirs at the southern part of the Gindi. Petro physical evaluation for the well Yomna-1X in the Mubarak sub-basin showed that the well has encountered more than 20 ft. of oil bearing Sandstones against Upper and Lower Safa Members. These intervals still need to apply a modern technique as Qemescan to understand how to improve the porosity and permeability to produce the oil from these tight reservoirs and to open the new chance and to increase exploration activity and to get opportunities in this deep tight reservoir in the western desert which the oil production still questionable in this mentioned reservoirs.

Through the isopach maps of the Cretaceous (Alam al-Bueib reservoir) and Jurassic (Masajid reservoir), it was found that there is no chance for the presence of any hydrocarbon reservoirs or potentials of the Alam al-Bueib sand reservoirs (Lower Cretaceous) and the Masajid reservoir (Jurassic) in the southern part of the Gindi basin, but it may there is an opportunity in the northwest direction of this area in the direction of the Mubarak sub-basin. While the petro-physical evaluation of Yomna-1X well in the Mubarak Basin showed that this well recorded more than 20 feet of oil-bearing sandstone in the upper and lower part in Safa reservoirs. These oil-bearing still need more details study and analysis by applying modern techniques such as Qemescan, in order to understand how to improve the porosity and permeability for these mentioned reservoirs to produce oil from these tight reservoirs, which oil production is still a question for all those interested in investing in the Egyptian petroleum sector, and work to open up new opportunities that help increase exploration activity in the Western Desert.

ACKNOWLEDGMENTS

The authors are grateful to the authorities of the Egyptian General Petroleum Corporation and Qarun Petroleum Company for providing the necessary subsurface data presented in this work, and permission to publish this paper. Sincere thanks to all the staff of Al-Azhar University.

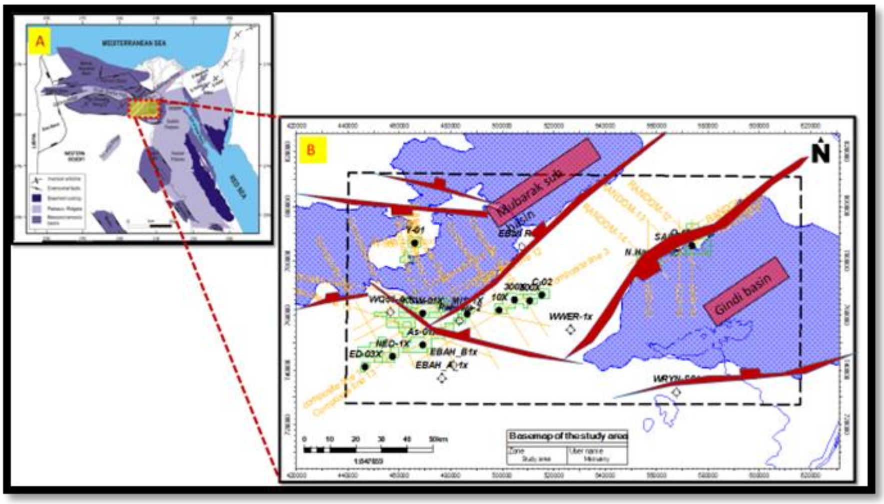


Fig. 1: (A) Mesozoic and Cenozoic basins in Egypt (modified after Dolson et al. 2001; Moustafa2008; Bevan and Moustafa 2012). Upper Egypt basins are added after Bosworth et al.2008) and (B) Location map of the study area (El Gindi and Mubarak basins).

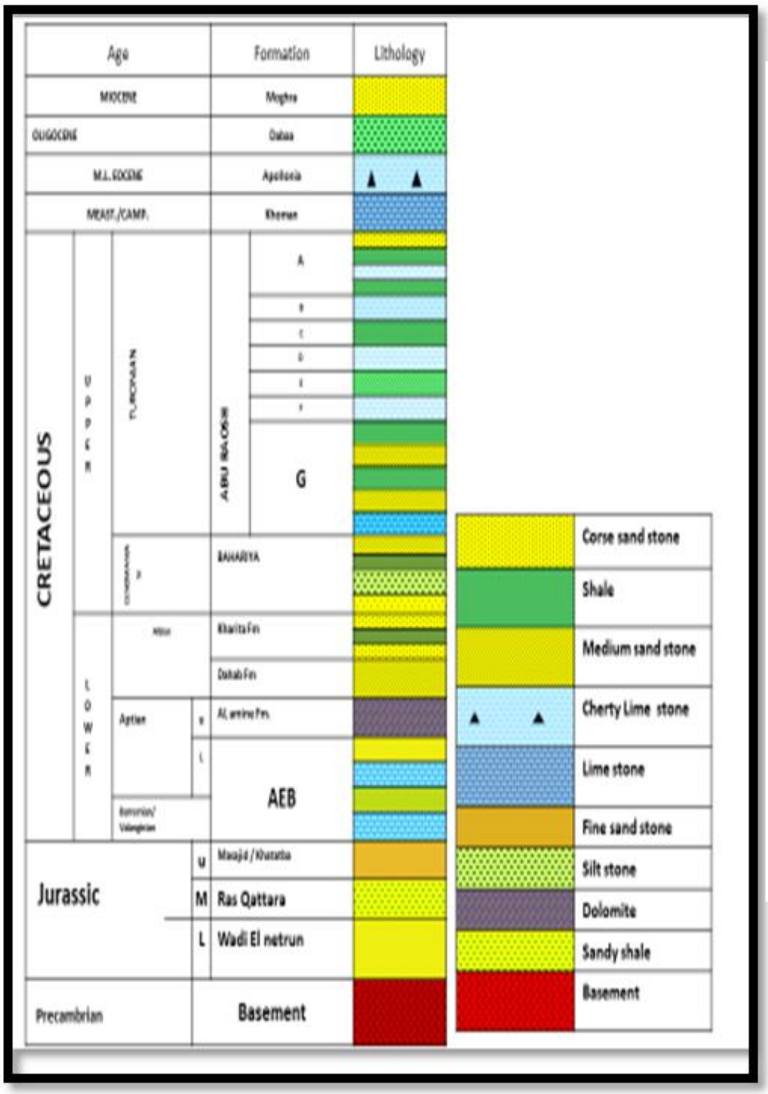


Fig.7: Generalized stratigraphic column of the study area(after Mostafa Hussein, 2021).

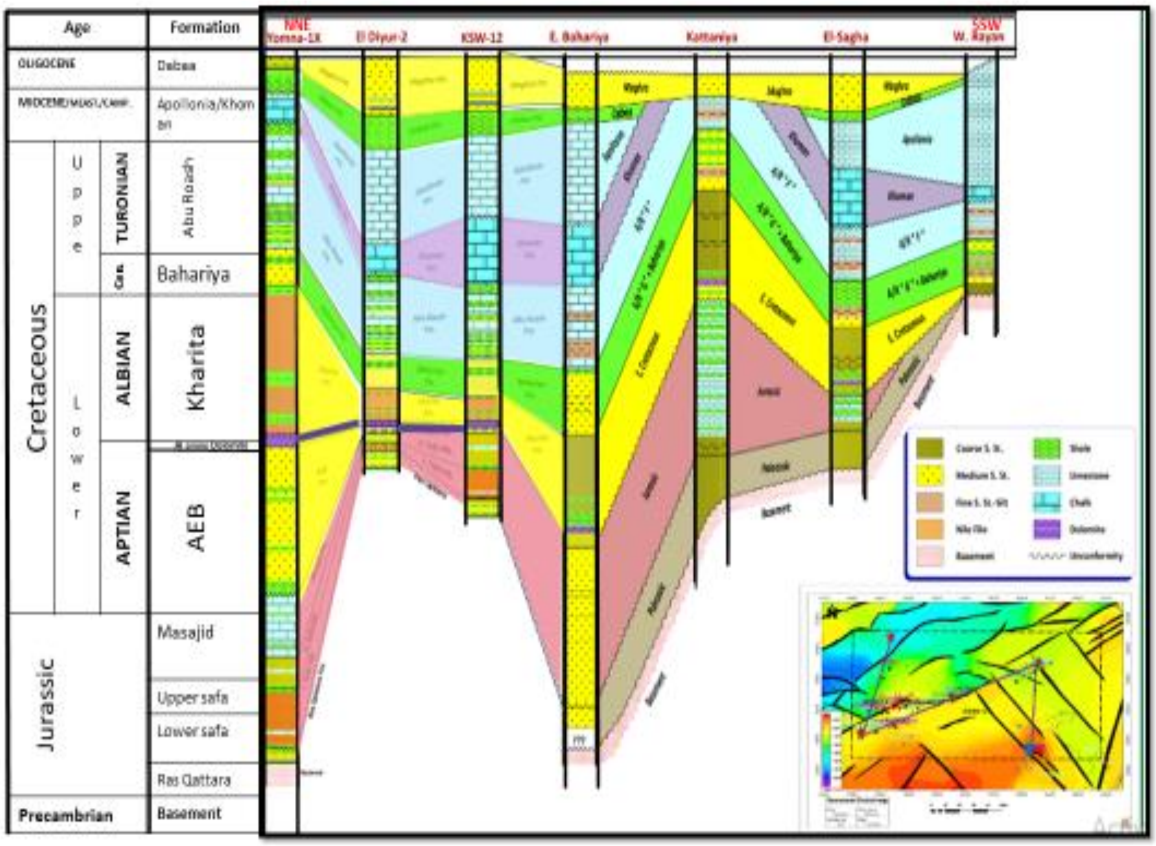


Fig. 3: NNE- SSW oriented stratigraphic profile shows the main stratigraphic provinces in the Gindi basin and Mubarak sub-basin.

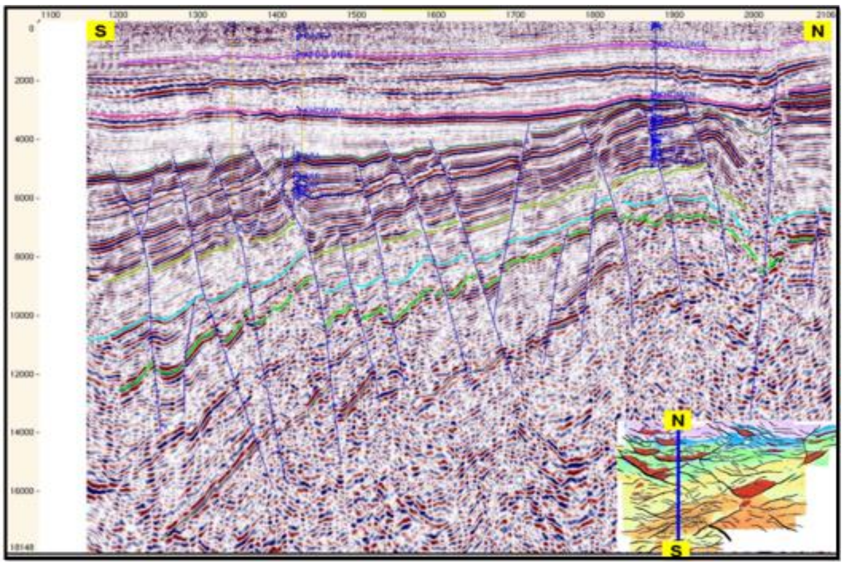


Fig. 4: S-N seismic cross line shows the variation of thicknesses in source rock at study area.

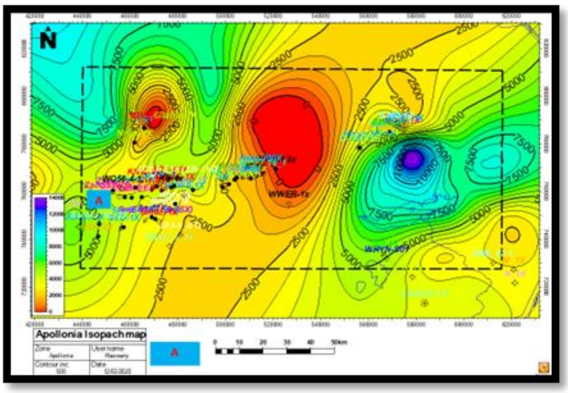


Fig. 5A: Regional isopach map of Apollonia Formation.

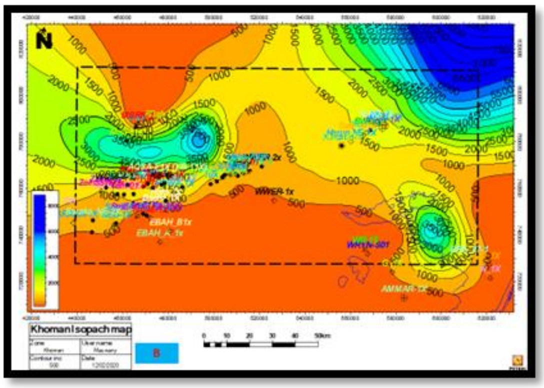


Fig. 5B: Regional isopach map Khoman Formation.

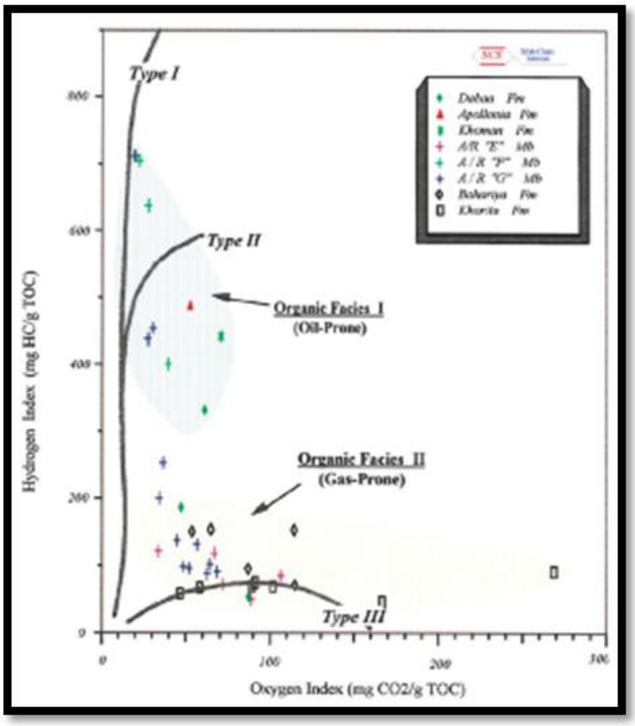


Fig.6: Van Krevelen diagram shows Oxygen index versus Hydrogen index that characterize the source rock organic matter - for Harun 1X in Qarun area at Gindi basin.

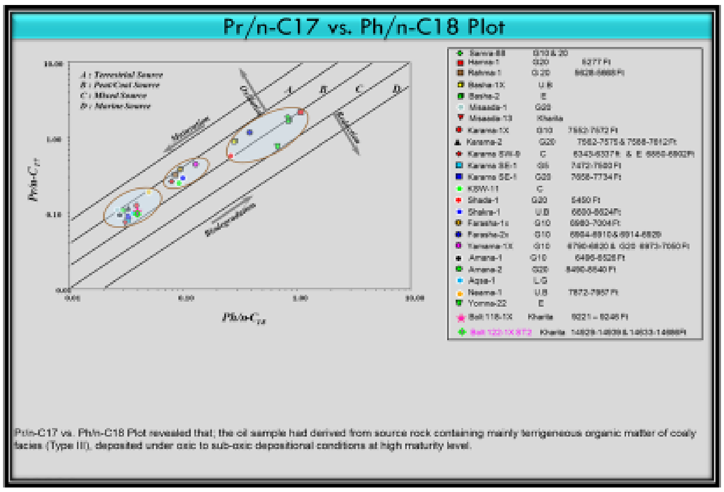


Fig.7: Pr n-C17 vs Ph n-C18 ratio revealed that the main source rocks are of Type III (terrigeneous organic matter) in East Bahariya area at Mubarak basin.

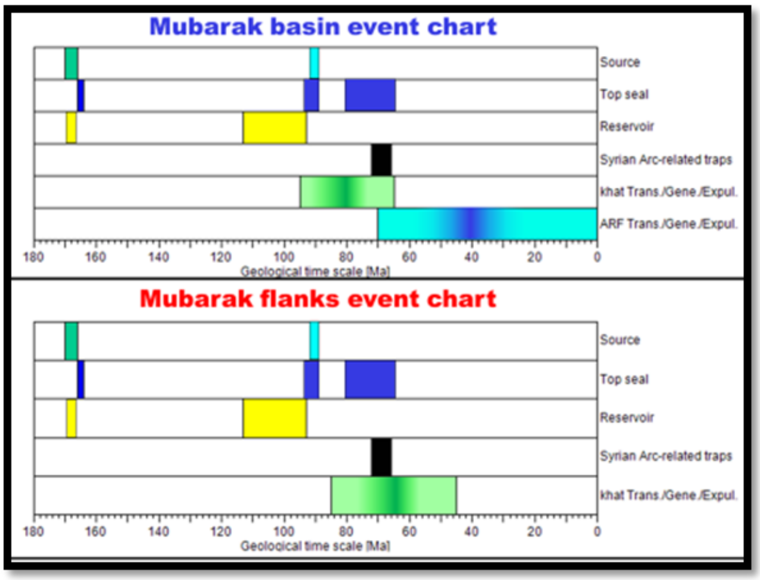


Fig.8 The Petroleum system event chart in Mubarak Sub-Basin.

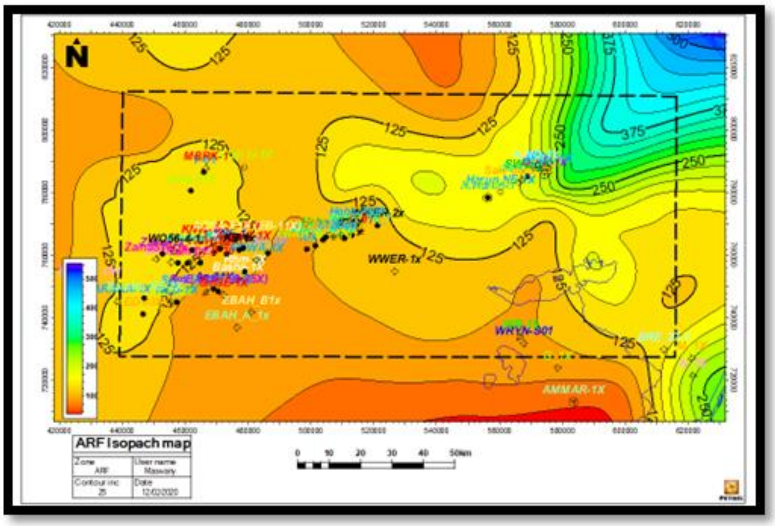
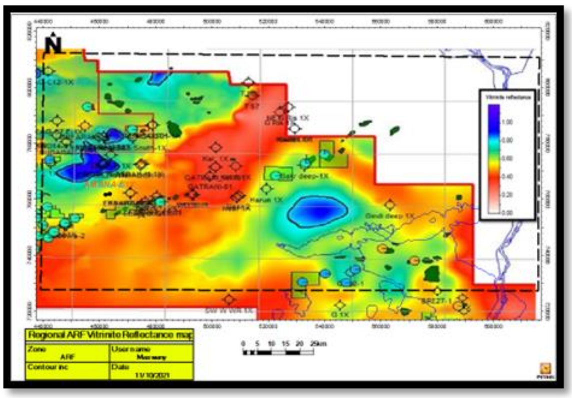


Fig. 9: Regional ARF Isopach map through Mubarak sub-basin and Gindi basin.



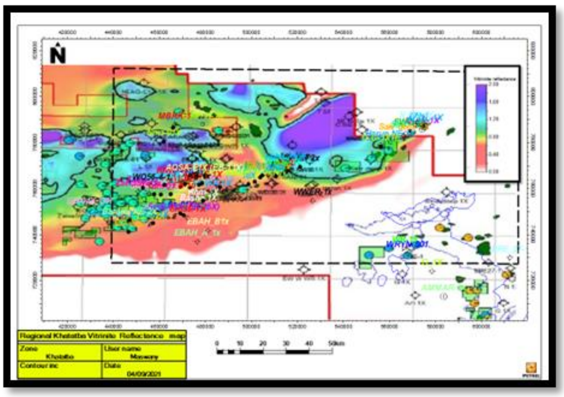


Fig.10: Vitrinite (RO) map of ARF source rock maturation

Fig.11: Vitrinite map of Khatatba source rock maturation.

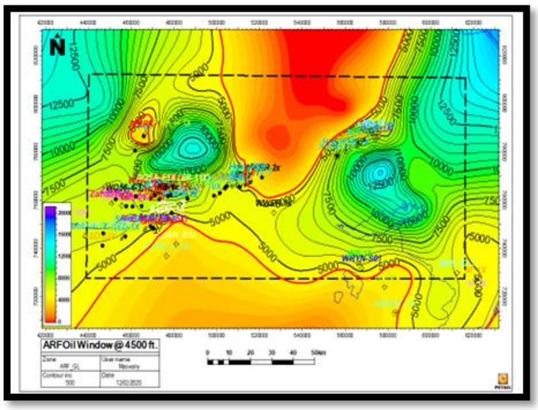


Fig.12: ARF oil window @4500 ft.

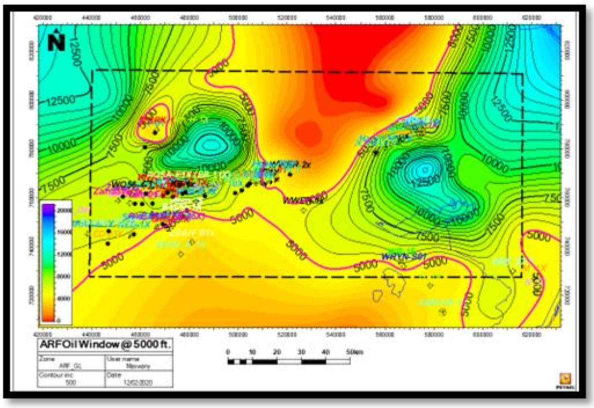


Fig. 13: ARF oil window @5000 ft.

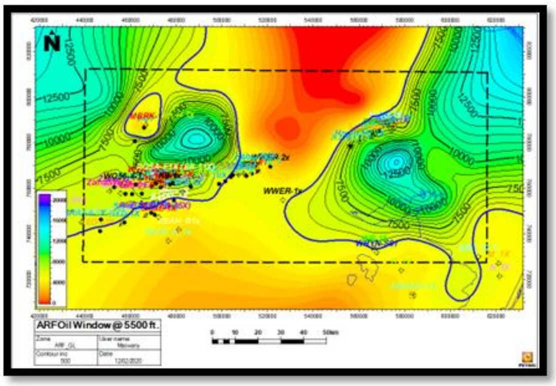


Fig. 14: ARF oil window @5500 ft.

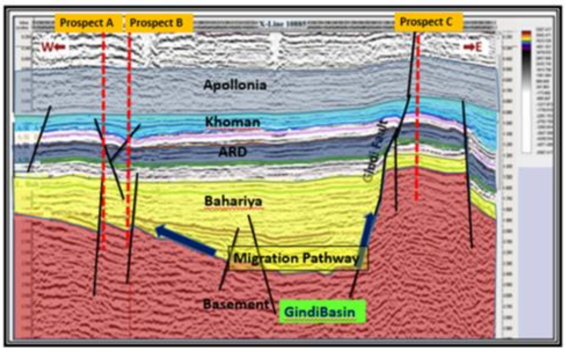


Fig.15: W- E 3D interpreted seismic section that illustrate the up dip migration at Gindi basin through a conduit faulting structure

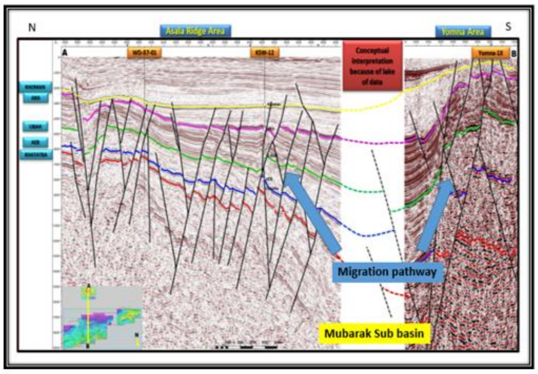


Fig. 16: N-S 3D interpreted seismic section that illustrate the up dip lateral migration at Mubara sub -basin through a conduit faulting structure

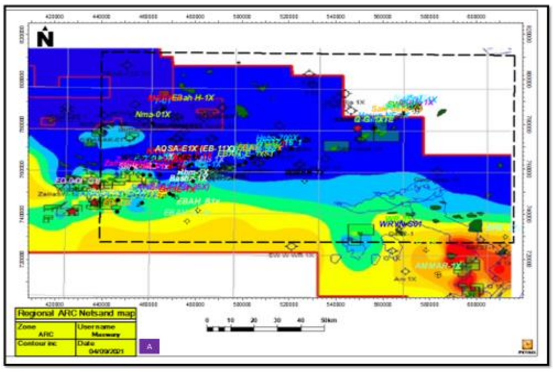


Fig.17A: Regional Net sand maps for Abu Roash "C" reservoir at Gindi and Mubarak basins.

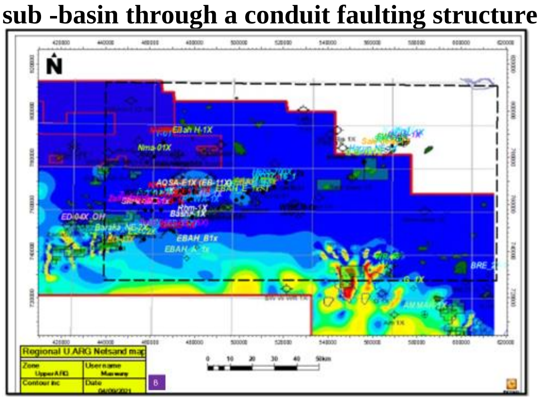


Fig.17B: Regional Net sand maps for Abu Roash "U.ARG" reservoir at Gindi and Mubarak basins.

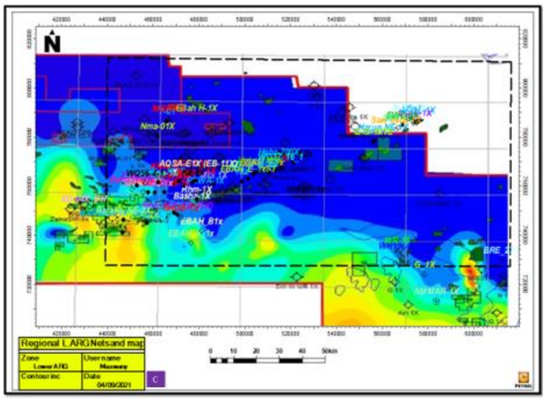


Fig.17C: Regional Net sand maps for Abu Roash "L.ARG" reservoir at Gindi and Mubarak basins.

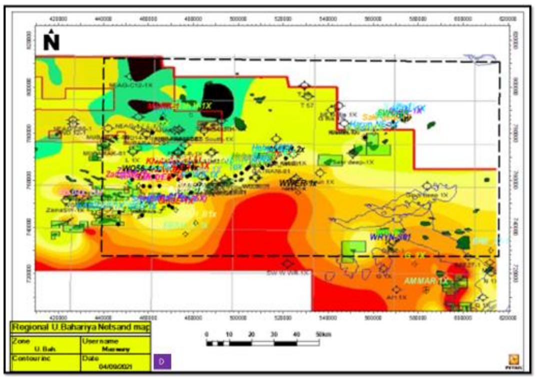


Fig.17D: Regional Net sand maps for "Upper Bahariya" reservoir reservoirs at Gindi and Mubarak basins.

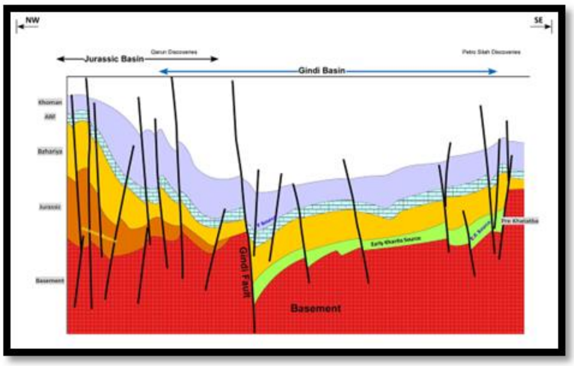


Fig. 18: NW-SE Geoseismic sections shows different reservoirs at Gindi and Jurassic basins

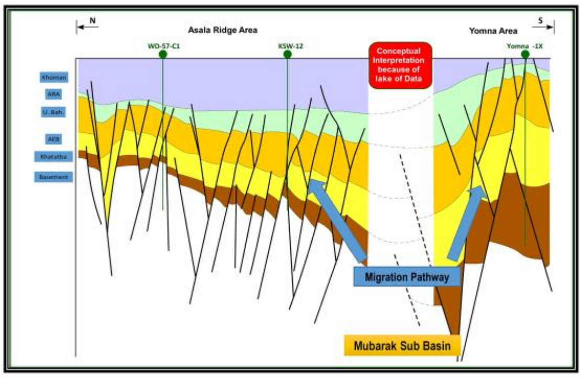


Fig.19: N-S Geoseismic structure section shows different reservoirs at Mubarak sub-basin.

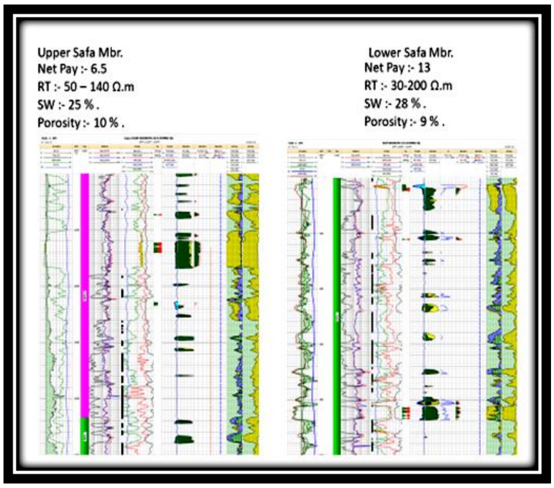


Fig.20 Petro-physical analysis of Yomna-1X in Safa Formation.

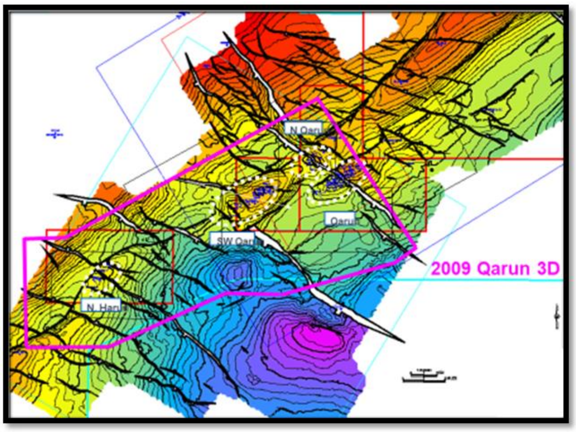


Fig.21: ARG depth structure map at Gindi basin area shows the oil fields structure-closures.

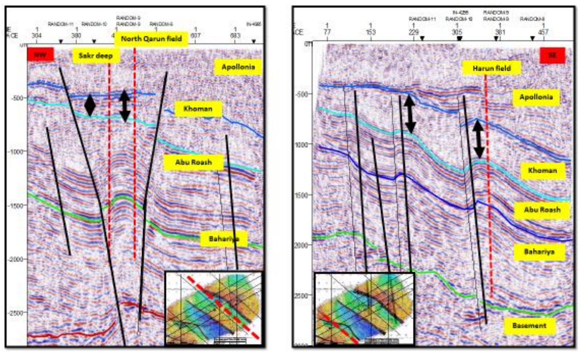


Fig.22: NW-SE 3D seismic lines show the example of inversion at Gindi basin.

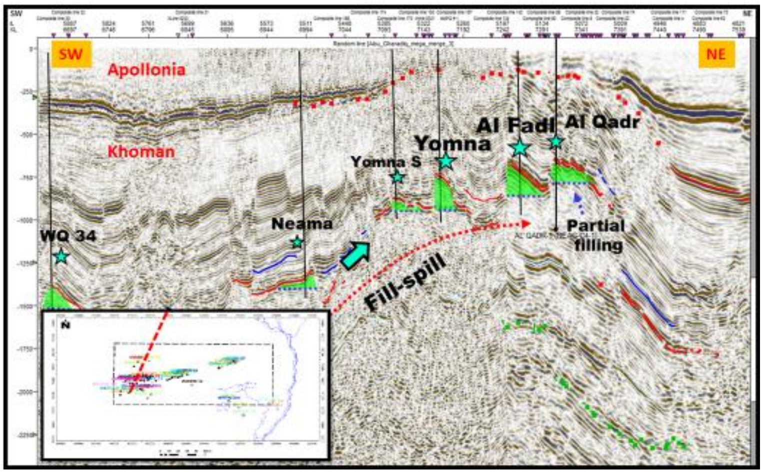


Fig.23: SW-NE 3D seismic line shows tectonic inversion at Mubarak sub-basin

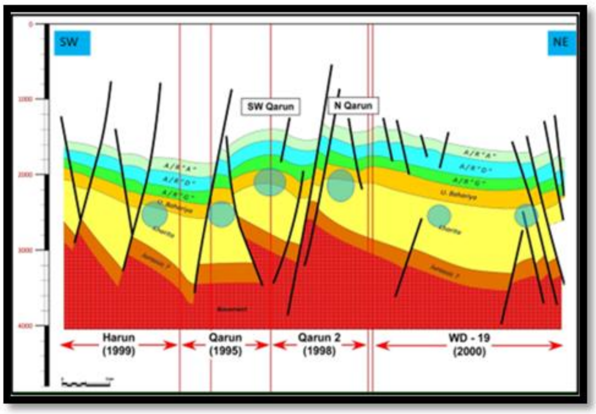


Fig. 24: SW-NE Geological cross section shows traps structure style at Qarun discovered fields (blue circles) in Gindi basin.

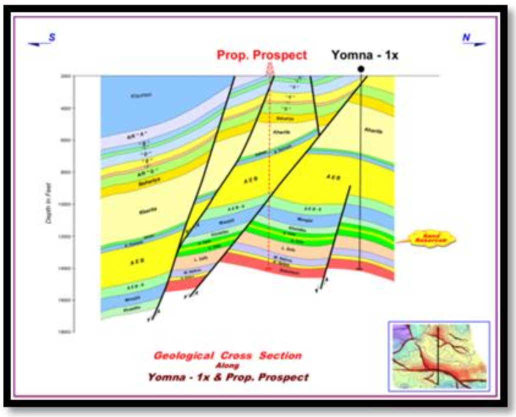


Fig. 25: S-N Geoseismic structure section shows new prospects at Yomna area (Mubarak sub-basin).

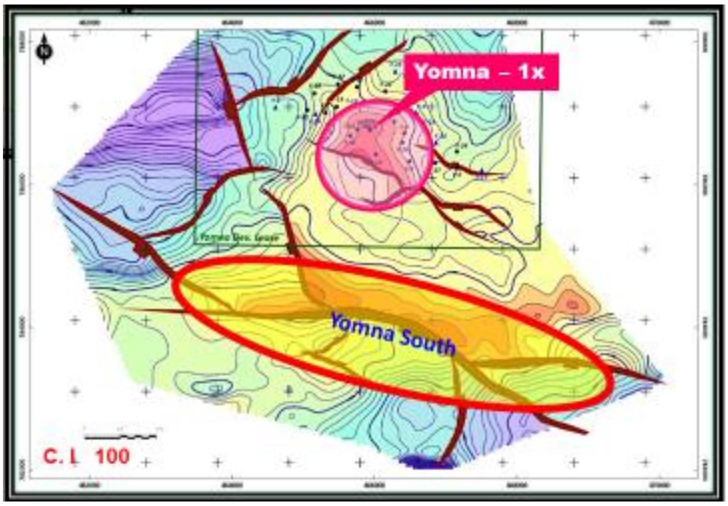


Fig.26: Jurassic depth structure map at Yomna field shows Yomna south new prospect (three-way dip fault-dependent structure closure).

REFERENCES

[1] Magoon LB, Dow WG. The Petroleum System—From Source to Trap [Internet]. American Association of Petroleum Geologists,1994;Available from: https://doi.org/10.1306/M60585

[2] LeRoy LW, Le Roy LW. Subsurface Geologic Methods: A Symposium. Colorado School of Mines, Department of Publicationsv. 1950;v.44,no.3,p.26-57

[3] Enayet, Sharib-Sheiba ridge, and the southern boundary is called Sitra platform The structurally enhanced view of economic basement (SEEBASE) map was first published in Dolson et al. (2004) and Loutit et al. 2001.

[4] Amin MS. Subsurface features and oil prospects of Western Desert, Egypt, 3rd Arab Petrol. In: Conf Alexandria, Egypt. 1961;p2-8.

[5] Said R. The Geology of Egypt, El Sevier Publ. Comp Amsterdam, New York. 1962; 377p

[6] Norton P. Rock stratigraphic nomenclature of the Western Desert. Egypt Int Rep GPC, Cairo, Egypt. 1967; 557.

[7] El Gezeery MN, Mohsen SM, Farid M. Sedimentary basins of Egypt and their petroleum prospects. Proc 8th Arab Pet Congr Algiers. 1972; 1–15.

[8] El Gezeery NH, O'connor TE. Cretaceous rock units of the Western Desert, Egypt. In: Proceedings of the 13th Annual Meeting of Geological Society of Egypt. 1975.

[9] Metwalli MH, Abd El-Hady YE. Petrographic characteristics of oil-bearing rocks in Alamein Oil Field; significance in source-reservoir relations in northern Western Desert, Egypt. Am Assoc Pet Geol Bull. 1975; 59(3): 510–23.

[10] Ahmed MA, Hegab OA, Awadalla AS, Farag AE, Hassan S. Hydrocarbon Generation, In-Source Conversion of Oil to Gas and Expulsion: Petroleum System Modeling of the Duwi Formation, Gulf of Suez, Egypt. Nat Resour Res. 2019; 28(4): 1547–73.

[11] Abdine AS, Meshref W, Safi Wasfi A, Aadland A, Aal A. Razzak Field--Egypt, Razzak-Alamein Basin, Northern Western Desert. 1993.

[12] Abdelhafeez TH, Fathy M, Abd Elaal HH, Abd Ellatief A. Characterisations of the Late Cenomanian reservoirs in Asala Field, East Bahariya concession, Northern-Western Desert, Egypt. NRIAG J Astron Geophys. 2019; 8(1): 220–30.

[13] Khalil A, Abdel Hafeez TH, Saleh HS, Mohamed WH. Inferring the subsurface basement depth and the structural trends as deduced from aeromagnetic data at West Beni Suef area, Western Desert, Egypt. NRIAG J Astron Geophys. 2016; 5(2): 380–92.

[14] Schrank E, Ibrahim MIA. Cretaceous (Aptian-Maastrichtian) palynology of foraminifera-dated wells (KRM-1, AG-18) in northwestern Egypt. Vol. 177. Selbstverlag Fachbereich Geowissenschaften, FU Berlin. 1990;p177.

[15] Said R. The geology of Egypt: balkema. Rotterdam, Brookf. 1990; 734.

[16] Guiraud R, Bosworth W. Phanerozoic geodynamic evolution of northeastern Africa and the northwestern Arabian platform. Tectonophysics. 1999; 315(1–4): 73–104.

[17] Issawi B, El Hinnawi M, Francis M, Mazhar A. The Phanerozoic Geology of Egypt. A Geodynamic Approach. Special publ. No. 76. Geol Surv Cairo Egypt. 1999;462

[18] Mahmoud MS, Schrank E. Early Cretaceous (Neocomian-early Barremian) spores and pollen grains from the Six Hills Formation, Kharga area, Egypt abb: 7. Neues Jahrb für Geol und Paläontologie-Abhandlungen. 2003; 153–74.

[19] El Beialy SY, El Atfy HS, Zavada MS, El Khoriby EM, Abu-Zied RH. Palynological, palynofacies, paleoenvironmental and organic geochemical studies on the Upper Cretaceous succession of the GPTSW-7 well, North Western Desert, Egypt. Mar Pet Geol. 2010; 27(2): 370–85.

[20] Kulke H. Regional Geology of the world, part 2: Africa, America, Austrialia. Antarct Berlin Gebrulder borntraeger, Kulke Ed. 1995; 143–72.

[21] El Beialy, S. Y., El Atfy, H. S., Zavada, M. S., El Khoriby, E. M., and Abu-Zied, R. H. "Palynological, palynofacies, paleoenvironmental and organic geochemical studies on the Upper Cretaceous succession of the GPTSW-7 well, North Western Desert, Egypt", Marine & Petroleum Geology, Vol. 27 Issue 2. 2010; 370-385.

[22] Moustafa AR. Mesozoic-Cenozoic basin evolution in the northern Western Desert of Egypt. In: 3rd symposium on the sedimentary Basins of Libya, the Geology of East Libya. 2008; 29–46.

[23] Sestini, G., Egypt. In: Kulke, H. (Ed.): Regional petroleum geology of the world, Part II: Africa, America, Australia and Antarctica (Beiträge zurregionalen Geologie der Erde, Gebrüder Borntraeger Verlagsbuch hand lung, Stuttgart .1995; (22): 66-87.

[24] Taylor the burial history of a number of horizons in the Mersa Matruh area which show that oil generation (and consequently accumulation) must have taken place sometime after the end of the Cretaceous.1984;p 588.

[25] Metwalli & Piggott 2005: Analysis of petroleum system criticals of the Matruh-Shushan Basin, Western Desert, Petroleum Geoscience, Egypt May 2005; 11(2):157-178.

[26] Moustafa, A.R. Mesozoic-Cenozoic basin evolution in the northern Western Desert of Egypt. Geology of East Libya, v.3. 2008;29-46.

تحسين النظام البترولي لحوضي الترسيب الجندي ومبارك ، امتياز قارون، الصحراء الغربية، مصر

مصطفى حسين [1] ، ثروت حلمي عبد الحفيظ [2] ، محمد فتحي [2]، محمد نجيب الغمري [3]

[1] شركة مارينا للبترول

[2] قسم الجيولوجيا -كلية العلوم –جامعة الأزهر-القاهرة-مصر

[3] استشاري الجيولوجيا بشركة ميرلون العالمية

المخلص:

تقع منطقة الدراسة إلى الغرب والجنوب الغربي من القاهرة، وتشمل امتيازات قارون وشرق البحرية. بها حوضى الجندى ومبارك من اهم الأحواض المنتجة للزيت. أدت البيانات الزلزالية ثلاثية الأبعاد والجيوفيزيائية المتاحة و سجلات الآبار المحفورة، والبيانات الجيوكيميائية المستخرجة من 5 آبار، لتحديد دقيق لمصائد الهيكل التركيبي وإعادة تقييم العناصر للنظام البترولي بمنطقة الدراسة، تشكل الحوضين نتيجة لعملية تكتونية تعود للعصر الطباشيري المتأخر، هذا الحدث التكتوني مسؤولاً عن تكوين مصائد بترولية وفوالق هاجر خلالها الزيت الى خزانات العصر الطباشيري . أثبت التحليل الجيوكيميائي أن صخور الخطاطبة وأبو رواش "ف "هي صخور المصدر. أوضحت خرائط السماكة المبنية لتكويني أبولونيا و خومان أنها الختم العلوى بمنطقة الدراسة .أمكن إعادة تقييم عناصر النظام البترولى ، لأختيار أفضل المواقع لحفرها .أوضحت نتيجة الدراسة أن معظم مصائد النفط شكلت إغلاق ثلاثى يعتمد على الفوالق المغلقة، ويعمل نظام الفالق كقناة رئيسية لهجرة النفط من خلاله. ، وأكدت أن نافذة الزيت كانت على عمق-٤٥٠٠ و-٥٥٠٠ قدم لصخور أبو رواش "ف" و على عمق ٧٥٠٠-٨٥٠٠ قدم لتكوين الخطاطبة، ونافذة الغاز على -١٢٠٠٠و-١٣٠٠٠ قدم لتكوين الخطاطبة. اقترحت العلاقة بين أنواع الزيت وجود نوعين من النفط (النوع الأول والنوع الثاني).من خرائط السماكة لصخور عصرى الكريتاوى والجوراسى لا توجد فرصة لتواجد اى مكامن او إمكانات هيدروكربونية لخزانات رمال العصر الطباشيري السفلي و الجوراسي في الجزء الجنوبي بحوض الجندي ، وقد تتواجد بالجزءالشمال الغربى لهذا الحوض باتجاة حوض مبارك. أظهر التقييم البتروفيزيائي لبئر Yomna-1X-بحوض مبارك أن هذا البئر سجل أكثر من 20 قدمًا رمالا حاملة للنفط بصخور الصفا العلوية والسفلية ،ولا تزال هذه النطاقات الحاملة للزيت بحاجة للمزيد من الدراسة والتحليل بتطبيق التقنيات الحديثة مثل Qemescan لفهم كيفية تحسين المسامية والنفاذية لهذه الخزانات المصمتة وكيفية فتح. فرص جديدة لزيادة نشاط الاستكشاف في الصحراء الغربية بهذه النطاقات والتي لا يزال إنتاج النفط فيها محل تساؤل لكل المهتمين بالاستثمار بقطاع البترول المصرى.