Reservoir Characterization of Abu Roash "G" Reservoirs, El Diyur Area, Western Desert, Egypt

Mohammed G. Alibiary[1], Ali M. Bakr[2], Ahmed A. Allam[3]

[1] Geology Department, Faculty of Science, Helwan University, Cairo, Egypt.
[2] Shell Petroleum Company, Cairo, Egypt.
[3]IPRGOC Petroleum Company, Cairo, Egypt.

Abstract: The study aimed to combine the different available data to under stand the subsurface system and the characteristic of Late Cretaceous reservoirs in El Diyur field to represent the vertical and lateral heterogeneity at the well, multi-well, and field scale, which could be used as a tool for reservoir management. Seismic interpretation was conducted on the seismic sections that concerned the study are atomakea detailed structural interpretation to determine the structural geometry of the Late Cretaceou shorizons. Petrophysical well log analysis of the reservoir rock of Abu Roash"G-10" and"G-20" zones have been done and mapped. The estimated volume of Original Hydrocarbon in Place of Abu Roash"G-10"and"G-20"zones have been calculated.
[Mohammed G. Alibiary, Ali M. Bakr, Ahmed A. Allam. **Reservoir Characterization of Abu Roash "G" Reservoirs, El Diyur Area, Western Desert, Egypt.** *Nat Sci* 2018;16(2):19-27]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 3. doi:10.7537/marsnsj160218.03.

Key words: Reservoir Characterization, Geophysics, Abu Roash "G", Western Desert.

Introduction

Study Area is located in North Western Desert about 120 miles southwest of Cairo in Egypt's Western Desert. El Diyur field lies on the southern eastern margin of Abu Gharadig Basin and west of East Bahariya Concession. The Abu El Gharadig Basin occupies the north-central part of the Western Desert of Egypt. It is bounded to the east by the Kattaniya high, to the north by the Qattara high, and to the south by the Sitra Platform. It extends for about 300 km in an E-W direction and is about 60 km wide. It is perhaps the largest basin in the northern Western Desert, which is bordered to the north by the Qattara high, to the south by the Sitra platform. (Figure-1).

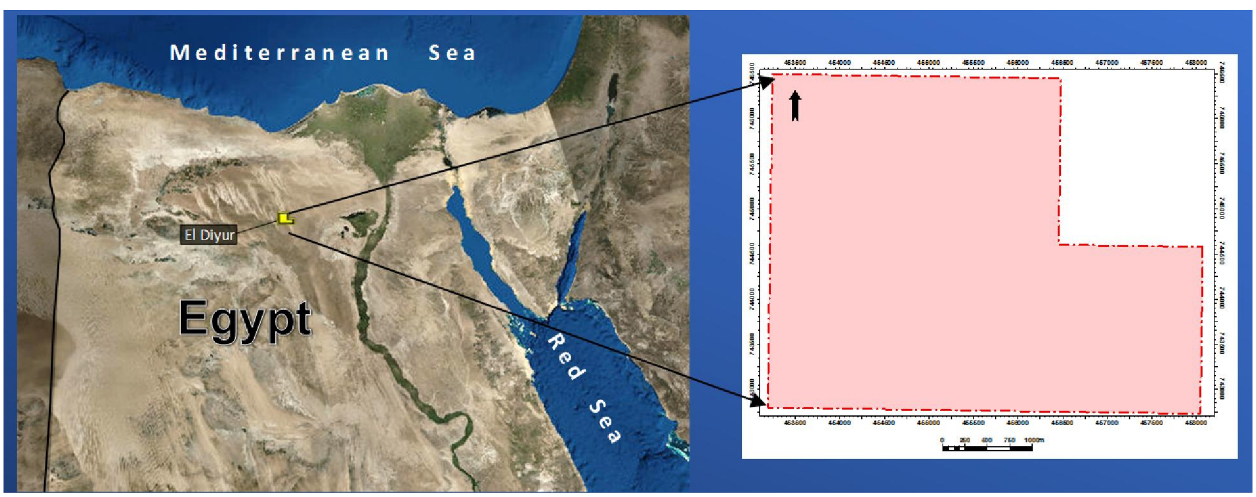

Figure 1: El-Diyur Field Base Map.

Aims of Study

The study aimed to combine the different available data to understand the subsurface system and the characteristic of Late Cretaceous reservoirs in El Diyur field to represent the vertical and lateral heterogeneity at the well, multi-well, and field scale, which could be used as a tool for reservoir management. Seismic interpretation was conducted on the seismic sections that concerned the study area to make a detailed structural interpretation to determine the structural geometry of the Late Cretaceous horizons. Petrophysical well log analysis of the reservoir rock of Middle Abu Roash "G" and Lower "G" zones have been done and mapped. The estimated volume of Original Hydrocarbon in Place of Middle Abu Roash "G" and Lower "G" zones have been calculated.

In reservoir studies in clastic environments, the two major problems that we encounter are reducing the risk of finding productive sands and defining the boundaries of these sands. In a broad sense, the objective of this research is to develop a framework under which we can improve the reservoir image by using the 3D seismic interpretation, build structural model, reservoir characterization study and a combination of the three methods. The study ends up with a comparison between all methods to conclude the best workflow to be used to tackle these problems. From this point of view, the study will be divided into three main parts: the 3D seismic interpretation part, structural model part and reservoir characterization part.

Workflow

To meet the aims of the study, the following workflow has been designed to guide the project (Figure 2). After the data gathering phase, the procedure can be divided into three main phases; seismic interpretation phase, the structure model phase and reservoir characterization. Both have end up with results that will be compared at the end of study. Data analysis, seismic interpretation, structure model and reservoir characterization will be done using Petrel software.

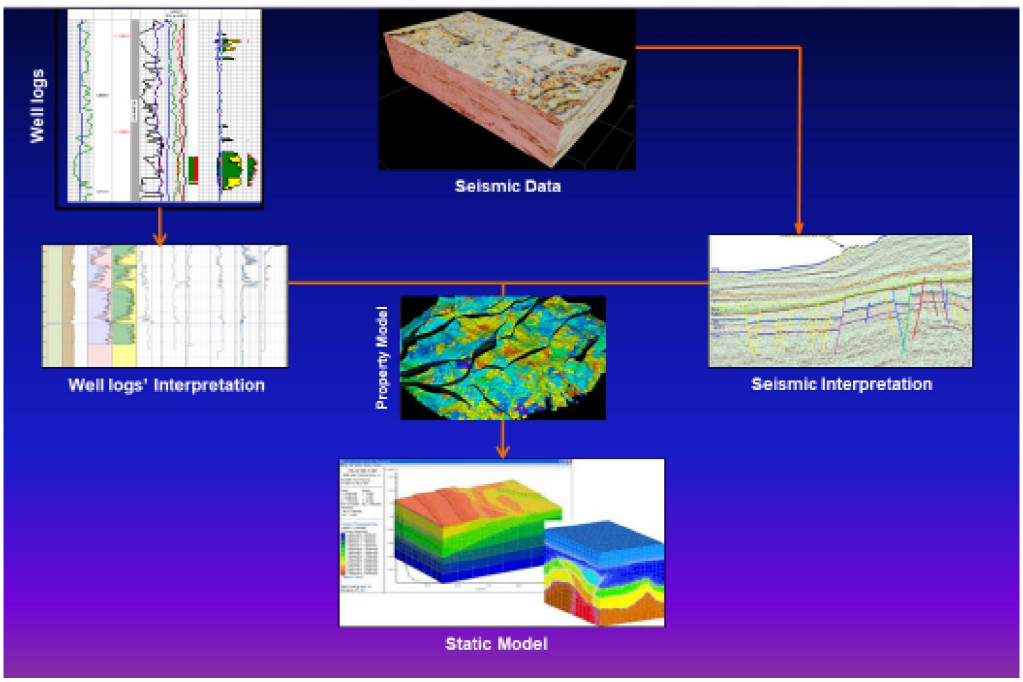

Figure 2: Flow diagram illustrating the steps of the workflow.

Geology of El Diyur field Overview

On April 2005, an oil discovery by the Apache Corp. El Diyur-2X well, drilled to 8,424 ft TD in Jurassic on the El Diyur concession in Egypt's Western Desert, is commercial, a concession partner reported.

The El Diyur-2X had oil and oil shows from seven zones of the Cretaceous Abu Roash and Bahariya formations, Apache logged 262 ft of net oil pay in the well. On a drill stem test, the well flowed more than 1,000 b/d of 26° gravity oil from 10 ft of perforations in the Bahariya sand, lowest of the indicated pay zones.

Stratigraphy

The stratigraphic section of the North-Western Desert is thick and includes most of the sedimentary succession from recent to Pre-Cambrian basement complex. The sedimentary sequence of the study area based on deepest drilled well ranges in age from the Early Jurassic Ras Qattara Formation to Miocene Moghra Formation at surface. The Cretaceous mega-sequence is divided into Lower and Upper sequences, the Lower Cretaceous includes Alam El Bueib, Alamein, Dahab and Kharita formations while the Upper Cretaceous sequence incorporates Bahariya, Abu Roash and Khoman formations. The Late Cretaceous Abu Roash "G" Member represent the main reservoirs in the study area, it is a Late Cenomanian in age. It is heterogeneous both vertically and laterally, and becomes sandy through Abu Gharadig basin. In the study area Abu Roash "G" member consist of shale, limestone, sandstone, with siltstone streaks. (Figure 3).

The stratigraphic sequence of Abu El Gharadig basin is rich in variety of lithological compositions and facies properties and extends in ages from

Paleozoic to Miocene. It is deposited in different depositional environment.

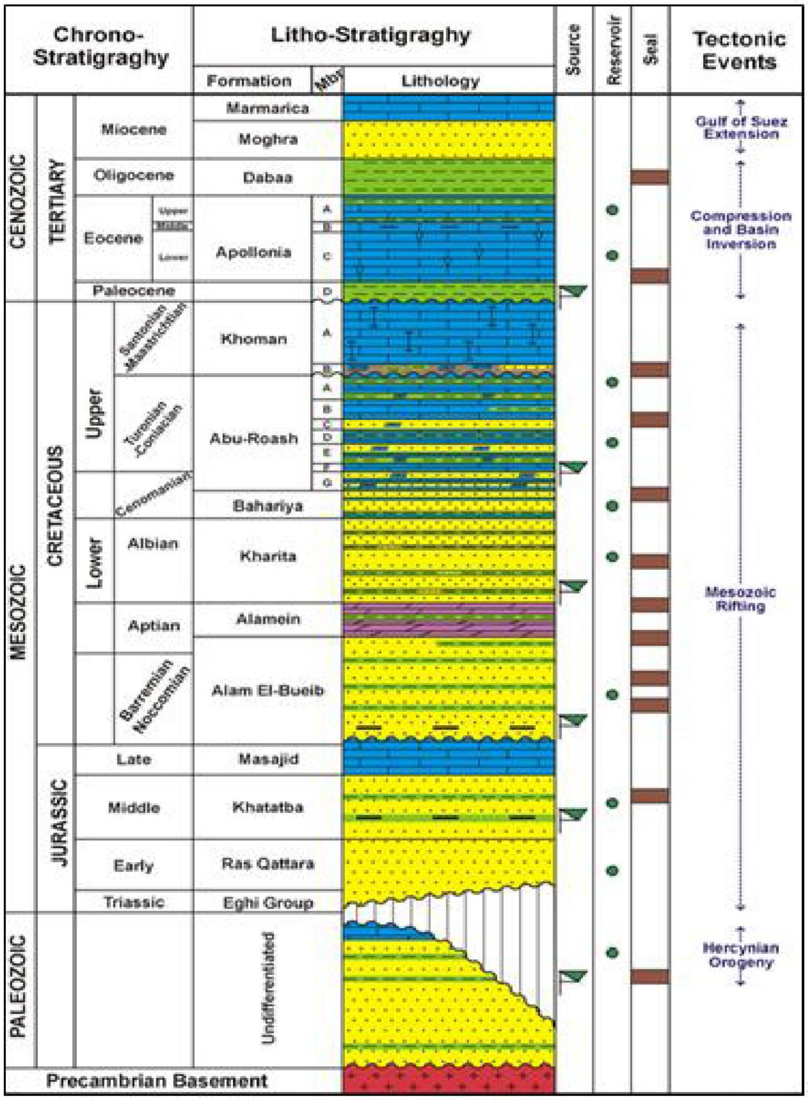

Figure 3: El Diyur Stratigraphic column. After QPC.

Well Logging Analysis and Interpretation

Well logging Analysis is the most important task for any well after drilling to detect the reservoir rocks among the all the drilled formations. It is one of the most useful and important tools available to a petroleum geologist. Beside their traditional use in exploration to correlate zones and to assist with the structure and isopach mapping; logs help defining petrophysical characteristic such as lithology, porosity, pore geometry, water saturation and permeability. Logging data is used to identify productive zones, to distinguish between oil, oil and water in a reservoir and to estimate hydrocarbon reserves. Also, geological maps developed from log interpretation help with determining facies relationships and drilling locations (Person, 1963).

Lithologic Identification

Different methods can be applied to calculate the type and the amount of each lithologic component, such as the lithologic identification (RHOB- NPHI x-plot) and (PEF-RHOB x-plot).

RHOB-NPHI crossplot for El Diyur wells

Middle Abu Roash “G” zone represent the middle clastic reservoir zone of Abu Roash “G” Member, (Figures 20 & Appendices 1 through 5) show the neutron density crossplots that have been applied on the Middle Abu Roash “G” zone. It is observed that, the reservoir sandstone plotted points are scattered and lay between sandstone and limestone lines with average grain density (ρma) is 2.67 gm/cc and neutron porosity ranging from 22% to 28%. The zone is mainly reservoir sandstone with non-reservoir siltstone scattered and lay between limestone and dolomite lines.

The neutron density crossplots that have been applied on the Lower Abu Roash "G" sand-I zone. It is observed that, the major plotted points are scattered and lay between sandstone and limestone lines with average grain density (pma) is 2.66 gm/cc and neutron porosity ranging from 20% to 30%. The zone is mainly sandstone with non-reservoir siltstone. While shows the neutron density crossplots of Lower Abu Roash "G" sand-II zone, the plotted points are scattered and lay between sandstone and limestone lines with average grain density (pma) is 2.67 gm/cc and neutron porosity ranging from 22% to 28%. The zone is mainly sandstone with siltstone. (Figures 4 & 5).

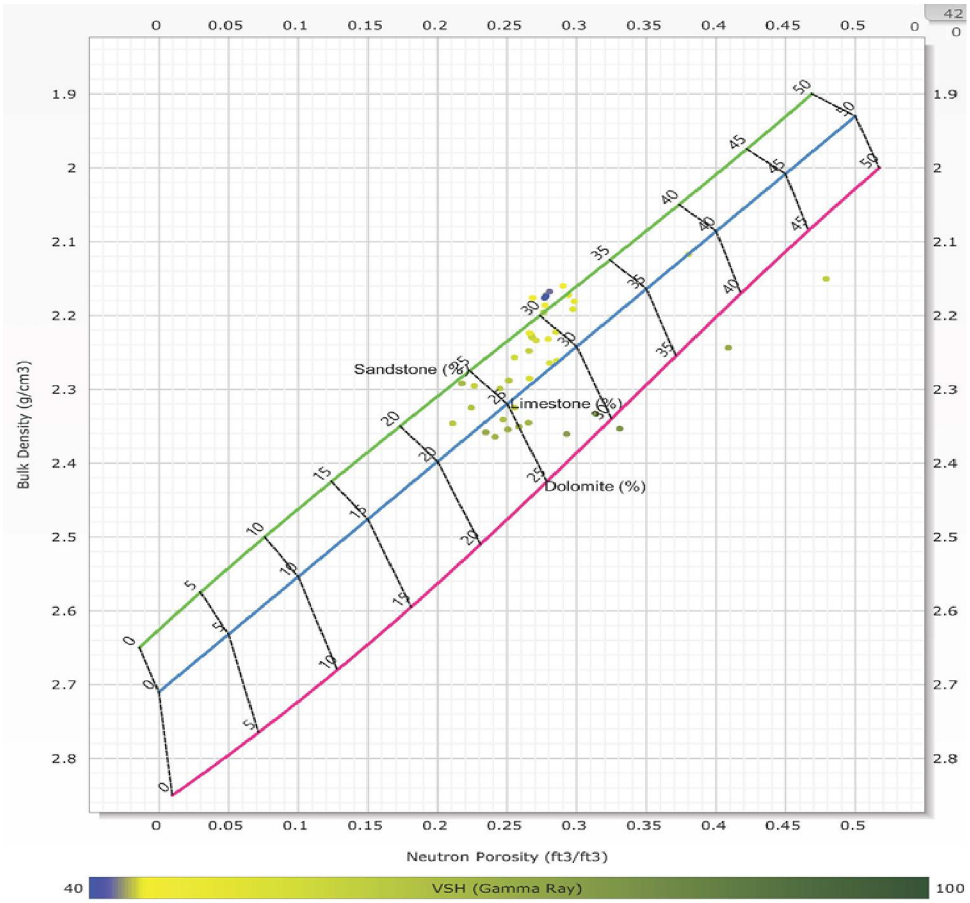

Figure 4: RHOB-NPHI Cross Plot for M. AR "G" sand zone in ED-2X Well.

Litho-Saturation Cross plots of El Diyur wells

The litho-saturation cross plots are designated in twelve tracks. The first track represents the measured depth (MD) in meter. The second track represents the zonation. The third track represents the true vertical depth subsea (TVDSS) in meter. The Fourth track represents the Caliper (CALI), Bit Size (BS) and Spectral Gamma Ray (GR). The fifth track represents the Density (RHOB) and Neutron (NPHI) and their shading to differentiate between shale and sand intervals. The sixth track represents Photo Electric Absorption Effect (PEF), Thorium percentage (HTHO) represented by brown shading to show the amount of shaliness at depth, the compressional sonic (DTCO) and shear sonic (DTSM) and their shading to show the oil effect. The seventh track represents the Resistivity curves in Logarithmic grid (RES_MIC, RES_SLW, RES_DEP). The eighth track represents the volume of shale (VSH). The ninth track represents the total and effective porosity (PHIT_D, PHIE_D). The tenth track represents the final water saturation and water saturation (SW). The eleventh track represents a lithology analysis for each well. The twelfth track represents the net pay flags. From litho-saturation crossplot of El-Diyur-1 the ODT at -5790 ft. From litho-saturation crossplot of El-Diyur-2 the GDT. (Figure 6).

Seismic Interpretation

It is the third step in seismic exploration in which we interpret the response of physical measurements in terms of Geological meanings to obtain a clear understanding of the area under study which lead to new hydrocarbon discoveries. (Figure-7).

Structural Contour Maps

As stated, the aim of this task of the study was to provide information on the structural geometry in sufficient detail for reservoir modeling purposes and to verify and improve the fault models generated in the Petrel model building workflow. (Figure 8).

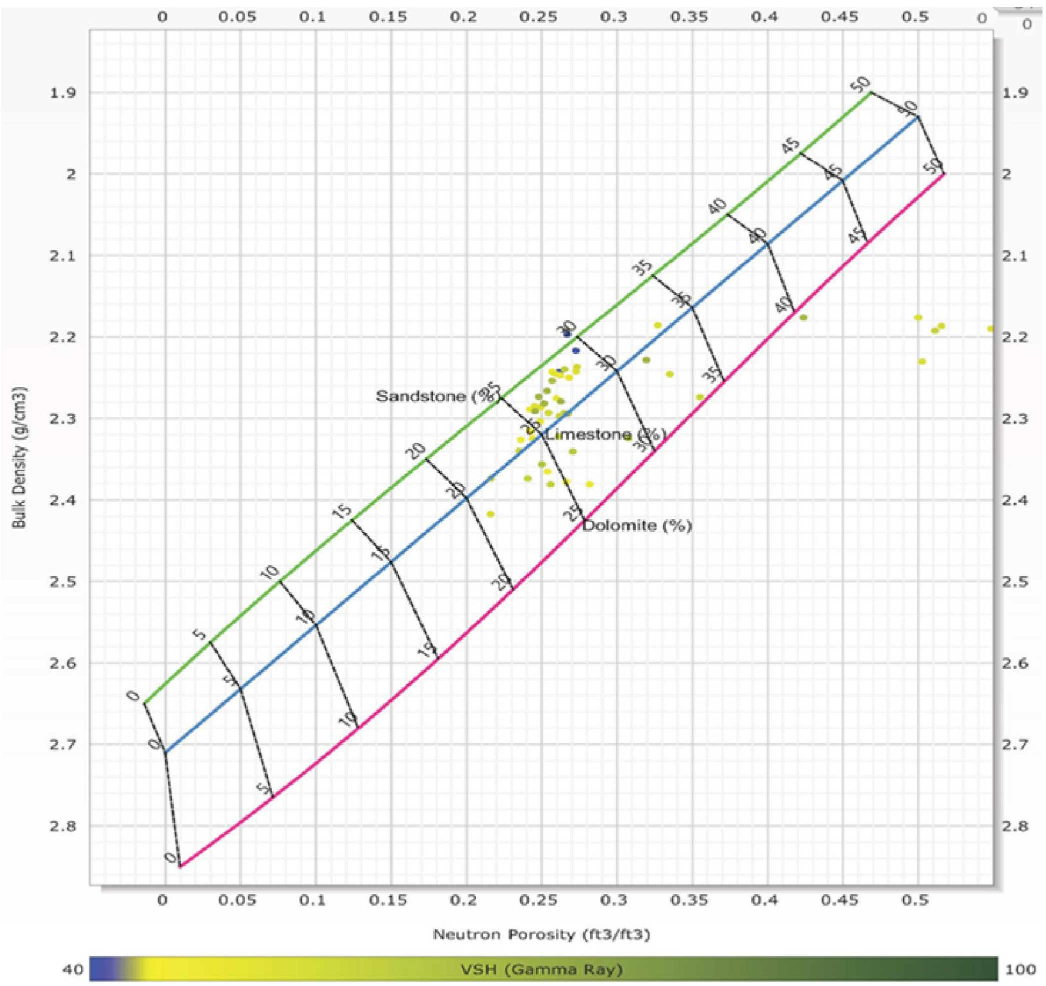

Figure 5: RHOB-NPHI Cross Plot for L. AR "G" sand zone in ED-2X Well.

Regionally, the Diyur area is structurally divided into three segments as follows:

1. The northeast-southwest oriented Agnes High in the north.
2. The northeast-southwest oriented Misawag Trough in the central part.
3. The northeast oriented southwestern extension of the Kattaniya Inverted Ridge.

Within this regional framework the El Diyur area is dissected by numerous faults that belong to two interactive fault systems; the northeast oriented Jurassic and the northwest running Cretaceous fault systems.

El Diyur structure is interpreted to be fault dependent three-way dip closure along the northeast – southwest trending normal fault down thrown towards the southeast direction.

Static Model

The static model process started by loading and quality checking all the available well data, seismic interpretation (surfaces, fault sticks and fault polygons), petrophysical analyses, engineering data and core data, in order to QC the input data.

The facies type with the best reservoir quality and highest poroperm ranges is the limestones. The facies model was QC'd at the well locations and matched the input facies types for each zone. Facies maps are illustrated on Figures 54 and 55 with the equivalent porosity. (Figure-9).

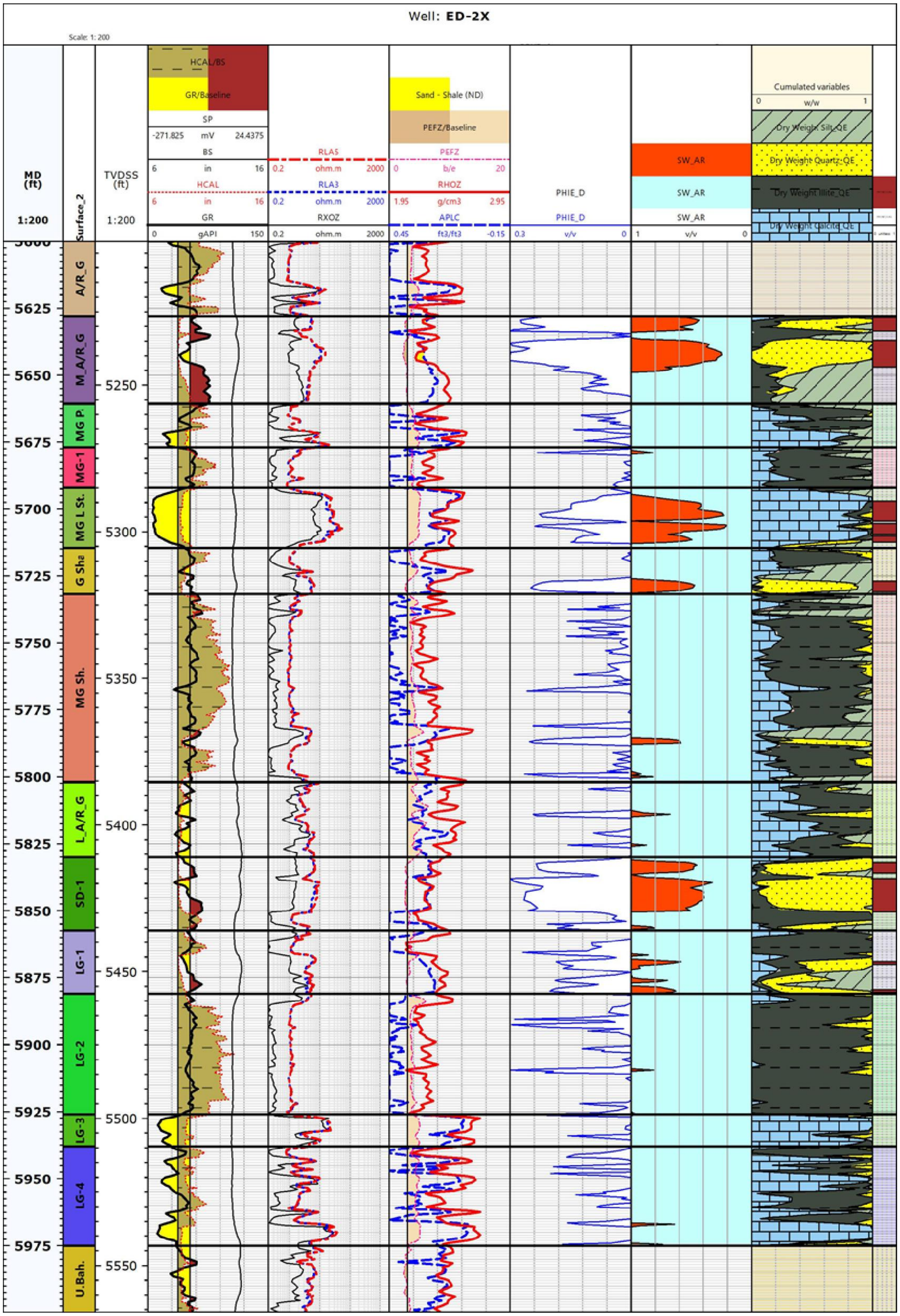

Figure 6: Litho Saturation Cross Plot for ED-2X Well.

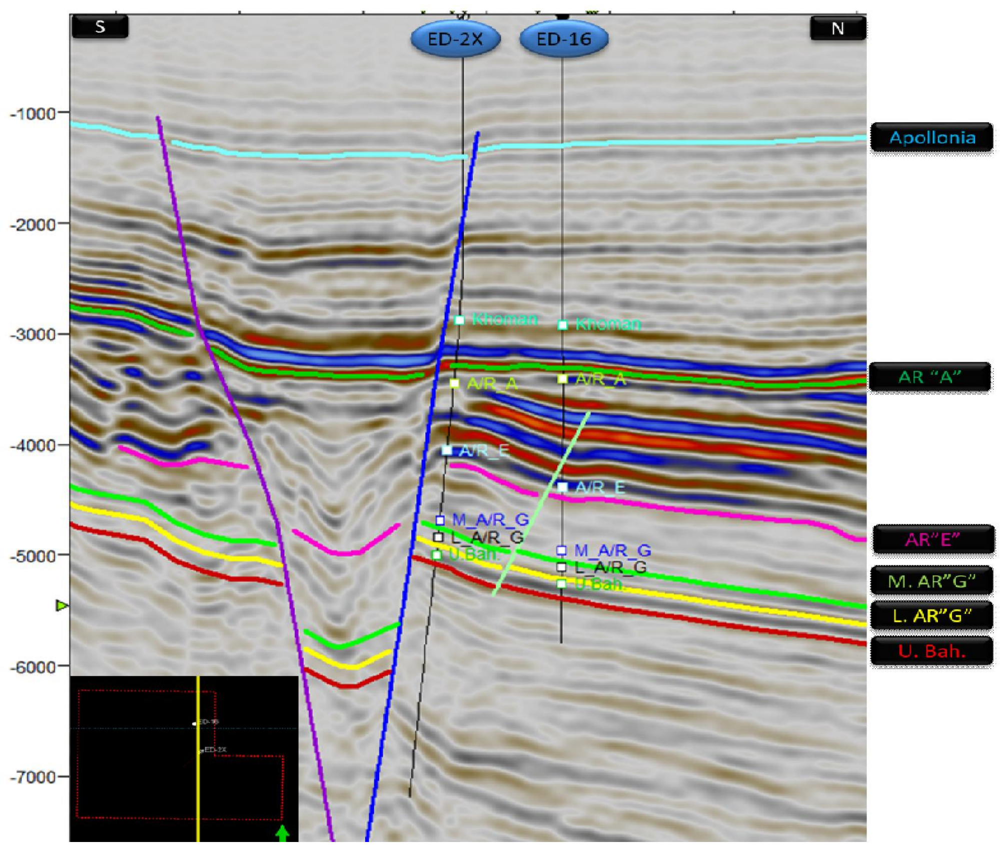

Figure7: Seismic X-line passing through ED-2X & ED-16.

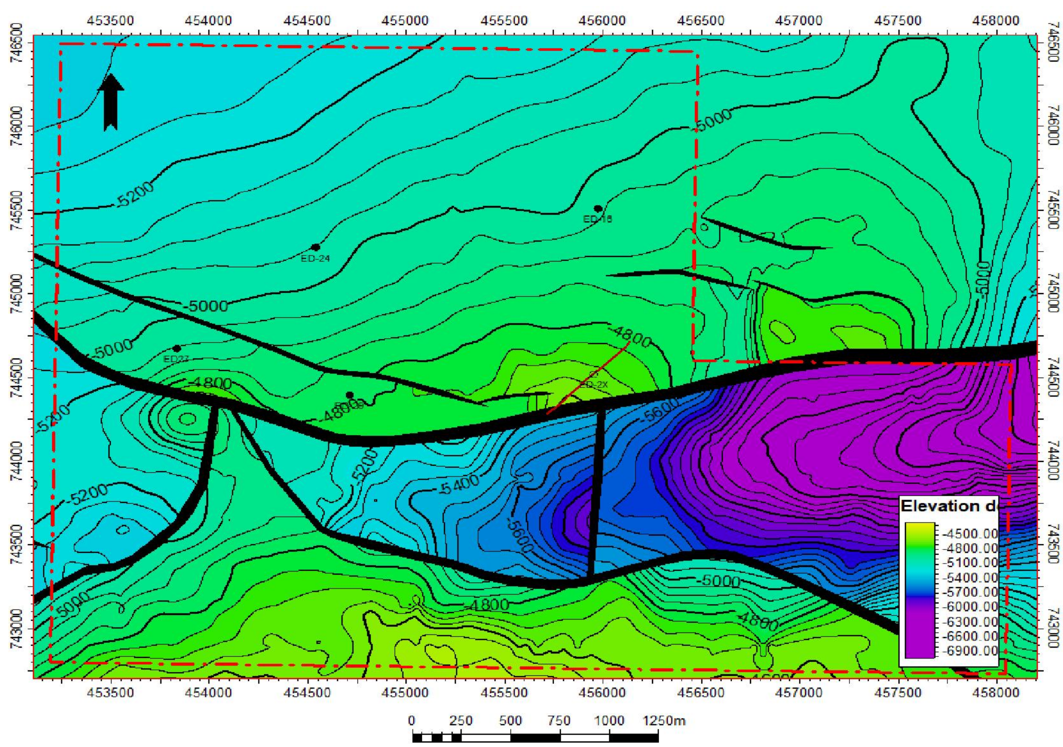

Figure 8: Middle Abu Roash "G" Depth Structure Map.

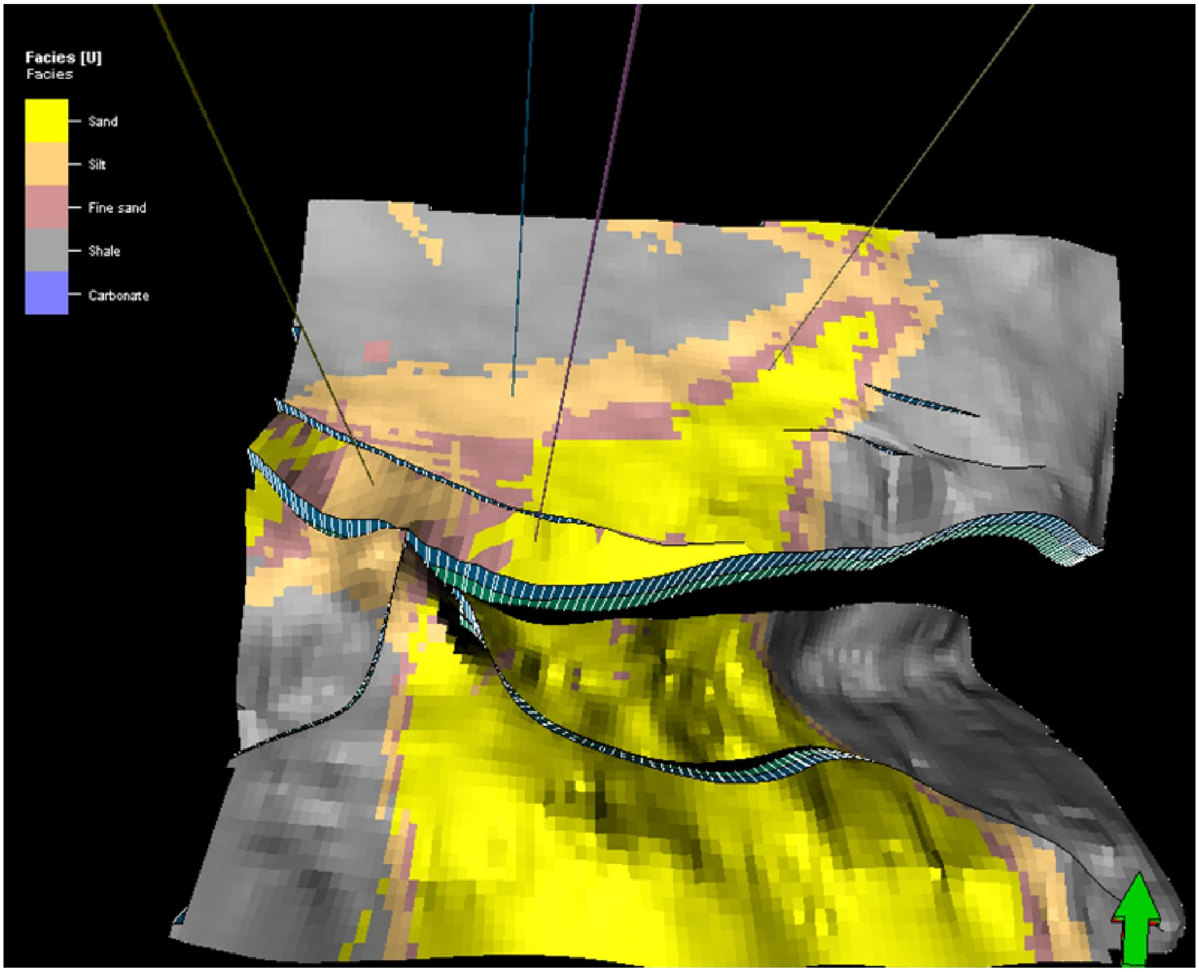

Figure 9: M A/R "G" layer-2 facies map.

Conclusion

The principal structure responsible for hydrocarbon entrapment in the study area was a structural high which correspond to the three-way dip closure of East-West major normal fault and the Northwest-Southeast normal fault of North El Diyur area. Middle Abu Roash "G" zone consist of sandstone were deposited as distributary river mouth bar and interdistributary fine sandstone graded to siltstone with net reservoir thickness between (max. 25 feet - min. 2 feet), effective porosity reaches (max. 29% - min. 6%) at the mouth bar facies and the interdistributary fine sandstone and siltstone respectively, water saturation values ranging between (max. 100% - min. 28%), water saturation was controlled by structural and facies elements while effective porosity and clay volume were controlled mainly by facies distribution. Lower Abu Roash "G" sand-I consist of sandstone deposited at tidal flat environment with net reservoir thickness between (max. 33 feet - min. 3 feet), effective porosity reaches (max. 23% - min. 11%) at tidal creek sandstone facies and fine tidal flat sandstone respectively. Water saturation values ranging between (max. 100% - min. 32%). Lower Abu Roash "G" sand-II reservoir composed of calcareous sandstone with net reservoir thickness between (max. 13 feet - min. 3 feet), effective porosity reaches (max. 21% - min. 9%), water saturation values ranging between (max. 100% - min. 46%). Water saturation values were controlled by structural elements while effective porosity and clay volume controlled mainly by facies distribution at Lower Abu Roash "G" Sand-I & Sand-II. The cumulative stock tank of original oil in place STOOIP estimated for the three zones is 104.6 Million Stock Tank Barrel.

Acknowledgment

The authors are greatly indebted to IPR`s Senior management for granting permission to publish this paper. The authors also express their appreciation to IPR Red Sea Exploration Staff and Secretary for their continuous support. Thanks, are also extended to EGPC management for granting permission to publish this paper.

References

1. Abdine A.S., 1974, Oil and Oil Discoveries in the Northern Western Desert of Egypt, EGPC 4th Exploration Conference, Cairo, Egypt, 27p.
2. Alistair R. Brown,2004, Interpretation of Three-Dimensional Seismic Data, 6th Edition, AAPG Memoir 42, p. 247-294.
3. Can't, D. J., Subsurface facies analysis, in Walker, R, G., and James, N. P. eds., facies models: response to sea level change, Geological association of Canada, st. Johns, new-foundland, 1992, P 27-45.
4. Hantar, G, North Western Desert, In Said, R. (1990), Geology of Egypt, (A. A. Balkema, Rotterdam, Brookfiled, 1990) pp.293-320.
5. Moustafa. A. R., Mesozoic-Cenozoic Basin Evolution in the Northern Western Desert of Egypt. Geology of East Libya, vol. 3, 2008, pp. 35-42.

12/24/2017