Application of well logging and Seismic techniques for Evaluation of Hydrocarbon Potentialities, East Abu Sennan Area, Western Desert, Egypt


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ABSTRACT

Abu Sennan Area (Study Area) is located in the northern western part of East Bahariya Oil Field which is located in the northern part of the Western Desert. The aim of this study was to combine the different available data to understand the subsurface system and properties of the Late Cretaceous reservoirs; represented by producer is Abu Roash (G) Member reservoir. Seismic interpretation was conducted on the available seismic data concerned with the study area to provide a detailed structural interpretation to determine the structural features of the study area for detecting the best localities for drilling new exploratory wells within the study area and to understand the petroleum system of the area. Two horizons have been identified and a depth structure contour map has been constructed on the top of main reservoir Abu Roash (G) Member. The structure contour map and the geological interpretation showed that the area was affected by tectonic deformation system caused regional uplift as shown by the 3D structural model, the main structure responsible for hydrocarbon entrapment in the study area is the structure trending NW-SE bounded by two normal fault; The structural set up has been configurated also through the constructed structural contour maps on top Abu Roash "G" Member. A relation between the facies change and the fault pattern was obvious, and proved a good trapping style in the study area.

Reservoir characterization analysis shows that The main reservoir Abu Roash “G” extend through the study area with good quality facies; the effective porosity ranges from 18-22 % with good net sand thickness about 10-30 feet with increasing toward the northern part from the study area.

INTRODUCTION

The area under study lies between Latitudes 28° 56’ 00” and 29° 00’ 00” N and Longitudes 29° 25’ 00” and 29° 50’ 00” E, about 150 Km. West of Cairo, and to the west of the Qattara Depression and it covers about 650
Km² area. The study is extended outside the mentioned boundaries for better regional understanding of the stratigraphic and structural aspects of the Abu Gharadig basin. **Figure (1).**

![Location map of the Study Area](image)

**Figure (1):** Location map of the Study Area.
General Geological Setting

The structural history of the Western Desert is complex. Major rifting characterized the Jurassic through Early Cretaceous time, followed by a passive margin phase that persisted until the Syrian Arc event, most of the productive oil fields lie within the Abu Gharadig, Shoushan and Matruh Basins. **Figure (2).**

**Surface Geology:**

The Surface Geology reflects the final network of accumulated litho-stratigraphic units on the earth surface. The Western Desert is essentially a plateau desert with numerous enclosed depressions. The Northern part of the Western Desert is a plateau covered with Neogene Sediments and occupying an area about 216,000 Km² (**Abu El-Naga, 1984**).

The northern basins of the Western Desert initially formed as a single rift, perhaps during the Permo-Triassic, which have been developed into a Pull apart structure. Marine conditions are first recorded in the Jurassic and Cretaceous sequence. Later tectonic events are presented to spilt the original basin into a series of smaller compartments. The Northern part of the Western Desert forms the major part of the unstable shelf as defined by (**Said, 1990**).
Stratigraphy

The stratigraphic column of the North Western Desert is thick and includes most of the sedimentary succession from Pre-Cambrian Basement Complex to Recent as shown by Figure (3).
Figure (3): Generalized Stratigraphic Column Of The North Western Desert Of Egypt

(Mustafa, et al., 1987).

The total thickness, despite some anomalies increase progressively from about 182 Meter (600 Feet) in the south
to reach about 7680 meters (25,000 Feet) to the north and northeast along the coastal area.

The main part of the North Western Desert is covered by thin blanket deposits of Miocene rocks which
unconformable overlie old Strata (Said, 1990). He divided the entire range of sedimentary sequence, from base
upwardly, into three main cycles, namely:

1- Lower Clastic Division: From Cambrian to Cenomanian, Predominantly Clastic.

2- Middle Calcareous Division: From Cenomanian to The Top Eocene, Predominantly Calcareous.

3- Upper Clastic Division: From Oligocene to Recent, Predominantly Clastic.

Abu Roash (G) Member is the main producing reservoir in the study area; it is of Upper Cenomanian age,
predominately composed of clastic sediments with some carbonate interbeds. The clastic sequence consists of
greenish brownish grey, fissile, pyritic shale and siltstone with some beds of fine to medium grain sandstone
which possesses a good reservoir potentiality. Franks (1982) proposed some sedimentation models for the
subsurface units of Upper Cretaceous sequence in Western Desert. He stated that sedimentation of the Abu
Roash "G" member took place in a transgressive sedimentation phase.

The detailed examination, lithological interpretation of electric logs and carefully correlation led to the
subdivision of the Abu Roash "G" member into three units:

- Lower Abu Roash "G" unit.
- Middle Abu Roash "G" unit.

- Upper Abu Roash "G" unit. **Results and discussions:**

In the study area Abu Roash (G) Member was penetrated by all the studied wells. This member (Abu Roash "G") rests conformably or/unconformably over the Bahariya Formation (Lower Cenomanian) and it is overlain by Abu Roash (F) Member, **Figure (4).**
Figure (4): Geological Cross-Section Passing Through The Study Area Wells (Flattened On Top Abu Roash “G” Member).

Structural Setting Of Abu Sennan Area

The Northern Part of The Western Desert of Egypt forms features-less plain with some exceptions of small folds and faults of Abu Roash complex that reflects its geological history (Said, 1990).

Structures result primarily from vertical movements of basement blocks, and consist mainly of draped over and/or fauanticlinal features (Sclumberger, 1984). The basic structural elements of the Western Desert are oriented NE to ENE, EW and WNE to NW, to some extent reflecting the two dominated WNW-ESE, ENE-WSW trends in the Basement, where ENE-WSW depressions and ridges alternate (Meshref, 1990). The dominated structural style of the Western Desert comprises two systems: a deeper series of low relief horst and graben belts separated by master faults of the large throw, and broad Late Tertiary folds at shallower depth (Sestini, 1984).

Regionally, the Abu Sennan Concession lies in the eastern side of the Abu Gharadig Basin, which is bounded from the east by the Kattaniya High and from the north by the Sharib-Sheiba High. Local highs bound the Abu Sennan Concession like the Mubarek High which lies at the northeastern corner and Agnes-Misaweg High at the southeastern end. On the flanks of those local highs sub-basins were developed within the main Abu Gharadig Basin (Figure 5). Abu Gharadig Basin; is a rift basin bounded to the North and South by two right-lateral shears and from the East and West by Northwest trending Normal faults (Meshref, 1990). It was formed during the Albian, reached maximum subsidence in Late Cretaceous (Maastrichtian) and was subsequently inverted during the Paleocene-Eocene (Lunning et al., 2004). It seems to be a continuous basin with a major uplift along its center that divided it into Abu Gharadig Basin and South Abu Gharadig Basin (Meshref, 1990). The structural
pattern of Abu Gharadig Basin is dominated by NE-SW oriented faults coupled with a strong pattern of NW-SE conjugate faults. These faults patterns suggest regional Wrench movement (Abd El Aal, 1988).
Methodology

The present study is based on the data supplied by Tharwa Petroleum Company upon the approval of the Egyptian General Petroleum Corporation (EGPC). The data used in the present study includes the following:

1. Reflection 2D seismic profile of Thirty lines created from both 2D and 3D Surveys in multi-directions which have been used to trace and detect the seismic features of the Abu Roash (G) Reservoir within the study area;
2. Well-Log Data of eight wells distributed in the study area, the type of well logs available includes the following (Resistivity, SP, GR, Density, and Neutron Log). Figure (6).
The subsurface geological setting is gained through the construction of seismic sections, structural cross sections, and geological correlation between wells within the study area, structure contour maps and 3D model. The Petrophysical evaluation is gained through the computer processed interpretation that passes through the quantitative interpretation technique. This study is carried out by using the computer software programs, such as Petrel 2010 software and Interactive Petrophysics Version 3.5.

Results:

Seismic Interpretation:

The seismic method is very important for petroleum exploration to detect locations of the exploratory wells, as well as for the development and evaluation of Oil Fields. The main target of the seismic data of the seismic data involves determination of the geological significances from the seismic data (Sheriff and Geldart, 1995). The interpretation of seismic reflection data is a process of transforming the physical response displayed by the seismic section into geological information of the interest, concerning either the structural style or the stratigraphic regime. In order to perform such process, knowledge about the velocity of propagation of the seismic waves is needed. Such seismic velocities, as shown earlier, are diversified into average velocities and interval velocities, as derived from the basic time-depth relationship of the given wells. The structural interpretation and modeling of the Upper Cretaceous rocks (Abu Roash “G” and Bahariya Formations) at Abu Sennan Area which lies at Abu Gharadig Basin, guides explorationist to the best locations for drilling exploratory wells in this study area. This goal was achieved through the interpretation of the available seismic data 3D and 2D seismic data of thirty seismic reflection lines take N-S and W-S trends. Examples for interpreted sections are shown in Figure (7 & 8).

The structural and stratigraphic features of these reflectors can be recognized; the Top of Abu Roash (G) Member reflector appears as a strong and continuous as it may be deposited after the uplift occurred in the area,
The seismic interpretation covered eight steps, namely reflectors identification, picking and correlation of reflectors, fault location, closing loops, velocity analysis, digitization, time to depth conversion, construction geo-seismic cross-sections and construction contours maps (Time and Depth); the seismic interpretation reflects the outstanding role of faulting and folding on the top of Abu Roash G Member in the studied area. The interpretation of the seismic reflection profiles is usually done by mapping a specific horizon representing a prominent seismic reflector recorded on the profiles with a considerable geological extent. This seismic reflector is commonly chosen representing a definite formation top. Usually, the interpretation starts with the seismic profiles passing through wells having well-log data. Moreover, in most cases, the seismic profiles that follow the direction of the regional dip are firstly used to facilitate the identification of the structural feature. The cross-sectional view reveals a system of fault modeled blocks, and a complex tectonic history affected the Abu Sennan Area, where extensional E-W and ENE-WSW faulting episode prevailed during the Paleozoic/Jurassic time resulted in the formation of local positive areas and sub basins especially in the Southern area of the concession. During the Early Cretaceous time, the area was affected by extensive NW-SE series of normal faults with indication of strike slip movements along these faults. This series of faults is predominant in the central and
eastern area. Wrenching and basin inversion started after the deposition of Abu Roash Formation. This episode was the result of an NW-SE compression during the Maestrichtian / Early Eocene time.

Figure (7): Interpreted 3D seismic Section N-S.
The tie between interpretation of 3D and 2D Seismic data correlated with the information resulting from the wells drilled within the block, have been interpreted geologically based on the identification of two horizons, corresponding to certain geologic boundaries. Based on the seismic interpretation and the available geological data the tectonic evolution of the area took place according to the following four phases:

- **Phase 1: Early Rifting Phase**

The first phase of deformation led to the development of a north-northwestward dipping Jurassic basin (in the form of a half graben) in the northern part of the study area. This basin was bounded by ENE oriented normal fault with downthrown toward the SSE. Continued opening of this rift during the Early Cretaceous is also evident. NW oriented faults were also active in the Early Cretaceous and controlled the thickness of those rocks.
- **Phase 2: Inversion Phase**

The second phase of the deformation took place after the deposition of the Cenomanian-Turonian, and Lower Senonian rocks which show slight gradual changes in thickness. Angular unconformities between the Abu Roash Formation and the middle or upper parts of the Khoman Formation or between the lower and upper parts of the Khoman Formation help date the beginning of this phase of the deformation at the Early Late Senonian.

- **Phase 3: End of Inversion and Deposition of the Apollonia Formation**

Inversion continued mildly during the Early (or Middle?) Eocene and resulted in the development of a thick basin to the south of the Mubarek High inverted zone. A thick section of the Apollonia Formation was deposited in this basin.

- **Phase 4: Rejuvenation of the NW Oriented Normal Faults**

The Dabaa and Moghra Formations were deposited with a uniform thickness over most of the study area except above the Wadi El-Rayan platform (where they are absent) and above the Mubarek high inverted zone (where they have small thickness). The fourth phase of the deformation post-dates the extension of the Lower Miocene basalt located at the base of the Moghra Formation. **Figure (9)** shows the location map of the seismic line (WQ-85.11D) that was chosen to prove the inversion. **Figures (10 A to F)** show the same seismic line with flattening different horizons to show the effect of inversion.
Figure (9): Shot points location map showing the seismic line (WQ-85.11D).
Figure (10.A): Flatten on top Alamein Dolomite.

Figure (10.B): Flatten on top Kharita Formation.
Figure (10.B): Flatten on top Kharita (Albian).

Figure (10.C): Flatten on top Bahariya.
Figure (10.D): Flatten on top A/R “C” (Touranian).
Structure Contour Maps

After the interpretation of the seismic sections and the seismic data, a structure contour map for the selected stratigraphic horizon (Abu Roash “G” Member) by using The Petrel Software Version, 2010. To illustrate the subsurface structural configuration of the study area and study the Prospectivity of the area. Abu Roash "G" horizon proved to be reservoir in the neighborhood Fields and tested Oil in East Abu Sennan Concession, the two horizons nearly parallel and all East Abu Sennan wells penetrated Bahariya Formation and Abu Roash "G" Member. According to the structure depth contour map that was constructed on Top Abu Roash (G) Member, the intersections of the NW-SE and NE-SW trending faults gave rise to varying structural closures at East Abu Sennan Area (The Study Area). These closures formed good traps for trapping hydrocarbons in main reservoirs (Abu Roash G Member). The structural closures formed in this study area is mainly of three way closure type and also four ways type. So, from the through interpretation of the seismic data, the depth structure contour map which were constructed on top Abu Roash "G" Member Figure (11) showed that the Northern part of the East
Abu Sennan Concession is more promising than the Southern part and many promising prospects on top Abu Roash "G" Member are found at the Northern part. At the southern part, there is only one prospect at Abu Roash "G" Member.
Figure (11): Depth structure contour map on top A/R "G" showing study area prospects.
Petrophysical Evaluation

This part of the study is concerned with the petrophysical characteristic of Abu Roash (G) Reservoir at East Abu Sennan Concession, North Western Desert, Egypt. The author needs to evaluate the reservoir in the term of petrophysical parameters of both rock and fluid constituents. In order to assess possible petroleum reservoir, the Porosity and hydrocarbon saturation are required to be evaluated, which together define the amount of hydrocarbons per unit volume of rock. Petrophysics, in its simplest form, its calculation of Porosity and Fluid Saturation of depth in a well (Luthi, 2001). In this study, the petrophysical analysis was performed for seven wells in the study area to determine the Net Sand and The Porosity to study the nature and performance of Abu Roash (G) Reservoir to help the explorationist to follow the facies change within the study area. The value of formation water resistivity (Rw) for Abu Roash (G) Reservoir is obtained from the composite-log data at Sw equal 100 %, by using the Archie’s Water Saturation equation (Schlumberger, 1987). Another method for determining Rw is the using of Pickett Plot, which is developed by plotting Porosity values with deep Resistivity values on Two-By-Three Cycle Log-Log Paper (Asquith and Gibson, 1982). Abu Roash (G) Member have been subdivided into Three Zones depending on the regional data and well logs response which represents the most important stage in the evaluation of the petrophysical characteristic. Interactive Petrophysics Software (IP) can be used to determine the shale type based on Thomas-Stieber plots (Shale Volume Porosity and Neutron Versus Density) plots were used to identify the shales types; Clay are usually distributed in the formation in 3 types:

1. Laminated Shale: Continuous bands of shale layers interbedded with sands layers.
2. Dispersed Shale: Clays found in pore spaces or coating sand grains.
3. Structural Shale: Clays that are part of the formation matrix.

The Module which used in Thomas-Stieber Sand Model was originally invented to resolve the problem of laminated shale-sand sequence, in the conventional methods, the correlation between Gamma Ray parameters and the shale volume is usually presented as one direct relationship. Because the shale can exist in three different forms in the sand: dispersed, laminated and structural, the method expects a correlation between the
varying gamma ray responses and the shale geometry (Thomas & Stieber, 1975). Abu Roash (G) Member (Middle and Lower Zone) shows that it is mainly characterized by sandstone and laminated shale.

**Vertical Distribution Of Petrophysical Characteristics and Petrophysical Maps**

The vertical variation of hydrocarbon occurrence can be represented through the Litho-Saturation logs. The results of cross-plots show the effective porosity, shale volume, matrix contents and Water Saturation.

- **Abu Roash "G" Member**

Abu Roash "G" is mainly composed of clastic deposits, ranging from shale to siltstone and sandstone beds with few intervals of limestone. The estimated petrophysical parameters for the encountered zones of the Abu Roash "G" Member in the studied wells are summarized as:

The shale content distribution map **Figure (16)** shows a general decrease towards north and northwest of the studied area. The undulations found in the northwestern part of the area are probably related to the fault system. The recorded shale content value in faulted well (e.g. Marmar-1 well) may not express the exact value which may be higher or lower than that estimated.

Generally, the Abu Roash "G" reservoir is divided into two parts

- Middle Reservoir.

- Lower Reservoir.
Figure (16): Shale content distribution map for Abu Roash "G" Member.
**Lower Abu Roash "G" Unit**

The Lower Abu Roash "G" is mainly composed of clastic deposits, ranging from shale to siltstone and sandstone beds with few intervals of limestone especially in the bottom part of this unit. Table (1) shows both the net sand thickness and effective porosity.

**Table 1: Petrophysical parameters for Lower Abu Roash "G" unit for the available wells.**

<table>
<thead>
<tr>
<th>Well</th>
<th>Net Sand / Meter</th>
<th>Effective Porosity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sw-Mubarak-1X</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Ramak-1X</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Hasana-1X</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Hg 44-7</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>WQ 37/7-1B</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>Maramar-1X</td>
<td>14</td>
<td>25</td>
</tr>
</tbody>
</table>

The isoporosity map distribution of Lower Abu Roash "G" Fig.(17 A) shows a general increase of porosity towards the central part of the study area. The porosity value reciprocates from 13 % in Sw-Mubarak-1X well (in the south western part of the study area) to 25 % in Marmar-1X well (in the north eastern part of the study area); from the sand content distribution map it can be noticed that the Sand content percentage increase towards the central part of the studied area. The normalized value for the sand content in the studied zones of the Lower Abu Roash "G" unit varies between 7 m in the Ramak-1X (in the southern western part of the study area) and 14
m in the Maramar-1 (in the northern eastern part of the study area) as shown by Figure (17-A). Net Sand thickness of this unit is shown by Figure (17-B).
Figure (17): A-Porosity and B-Net Sand distribution maps for Lower Abu Roash "G" Member.

- **Middle Abu Roash "G" Unit**

The Middle Abu Roash "G" is mainly composed of clastic deposits, ranging from shale to siltstone and sandstone beds with few intervals of limestone. Especially in the bottom part of this unit.

**Table 2: Petrophysical parameters for Middle Abu Roash "G" unit for the available wells.**

<table>
<thead>
<tr>
<th>Well</th>
<th>Net Sand / Meter</th>
<th>Effective Porosity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sw-Mubarak-1</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Ramak-1</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Hasana-1</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Hg 44-7</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>WQ 37/7-1B</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>Maramar-1</td>
<td>16</td>
<td>23</td>
</tr>
</tbody>
</table>

The isoporosity distribution map of Middle Abu Roash "G" Figure (18-A) shows a general increase of porosity towards the northern western part of the study area. The porosity value ranges from 16 % in Ramak-1X well (in the southern western part of the study area) to 23 % in Marmar-1X well (in the northern eastern part of the study area); From the Sand content distribution map it can be noticed that the sand content percentage increase
towards the central part of the studied area. The normalized value for the sand content in the studied zones of the Middle Abu Roash "G" unit varies between 9 m in the Ramak-1X (In the Southern Western Part of the Study Area) and 16 m in the Maramar-1 (In the Northern Eastern Part of the Study Area) Figure (18-A). Figure (18-B) shows the net sand thickness of this unit.
Figure (18): A-Porosity and B-Net Sand distribution maps of Middle Abu Roash "G" unit.

A complete evaluation (Figure 19) was achieved using IP Software using many equations as illustrated in the first part of this chapter. The best cut-off of effective porosity, clay volume and water saturation (With $R_w 0.045$ Ohm.m) for the Abu Roash G Member reservoir have been applied to the petrophysical evaluation for the main reservoir. The cut off values used are:

- Clay Volume Cut-off ($V_{cl}$): 35 %.
- Water Saturation Cut-off ($S_w$): 60 %.
- Effective Porosity Cut-off ($\phi$): 10 %.

And the petrophysical properties of Middle Abu Roash “G” Unite were summarized in the following:

- Net Pay : 16 Meter.
- Effective Porosity : 23 %.
- Water Saturation : 45 %.
Figure (19): CPI for Marmar-1 well (Middle Abu Roash "G" Member).
Prospects Generation And Leads

According to Hyne (2001), a prospect is the exact location where the geological and economic conditions are favorable for drilling an exploratory well. A prospect can be presented by using prospect maps that illustrate the reasoning for selecting that drilling location. The maps include at least structure and isopach map of the drilling target. According to Gluyas and Swarbric (2004), exploration wells are drilled into prospects. Prospects are volumes of rock in the Earth crust that are believed, but no proven, to contain the four key components; a vailed trap, an effective seal, a reservoir and petroleum source rock that has generated and expelled hydrocarbon into the trap. Once an exploration well penetrates a prospect, it cases to be a prospect. It became also a proven petroleum field or more likely a dry hole which means that it lacks petroleum. A lead is nothing more than an ill defined prospect. The boundary between what is lead and what is prospect is open to individual interpretation.

The intersections of the NW-SE and NE-SW trending faults gave rise to varying structural closures at East Abu Sennan Area (The Study Area). These closures formed good traps for trapping hydrocarbons in main reservoirs (Abu Roash G Member). The structural closures formed in this study area mainly three way closure type and also four ways type.

The structure depth contour maps which were constructed on top Abu Roash "G" based on thirty 2D Seismic lines showed that the Northern part of the East Abu Sennan Concession is more promising than the Southern part and many promising prospects on top Bahariya and Abu Roash "G" are found at the Northern and the southern parts.
Prospect-A

Prospect-A is located at the north east corner of East Abu Sennan concession (Figure 20), bounded by the eastern border of the concession. The structure is considered as three way dip closure anticline bounded from the south by WNW-ESE normal fault down throwing to the south with a throw ranging from 40 m to 320 m (about 131 to 1050 ft) on top A/R "E". The throw ranges from 20 m to 220 m (about 66 to 722 ft) on top A/R "G" and from 80 m to 170 m (about 262 to 557 ft) on top Bahariya Formation (Figure 21).

The Prospect has the same geometry shape for the mapped A/R "E", A/R "G", but is smaller in area for A/R "G" (7.07 Km2.) than in area for A/R "E", it reaches about (3.71 Km2.) in area for A/R "G", for Bahariya level, the geometry shape of the closure is different from that of A/R "E" and A/R "G". Good seismic grid coverage is passing by the Prospect. Prospect – A s expected to encounter multi reservoirs.
Figure (20): (SW-NE) Seismic Sections Passing Through Prospect-A.
Figure (21): Prospect-A fault seal analysis profile (A-B).
- **Prospect-B**

Prospect-B is located in the central part within the study area. It is situated about 2 Km North of Abrar Oil Field (North Bahariya Oil Company; the Oil Producer from Abu Roash G Reservoirs) where the recorded Oil Down To (ODT) in the drilled wells is -6100 TVD.SS Ft. and 4 Km South of West Qarun Oil Field (Sahara Oil Company). This prospect will explore a robust three-way fault depended trap within the Mesozoic formation. The primary objective of the proposed well is to explore the hydrocarbon potentiality of Abu Roash (G) Member of the Cretaceous-Time (Figure 22).

The NW-SE fault bounding the main structure of Prospect-B is possible Syn-depositional fault; the effect is clear in little thickness variation through the fault plane from the Upper thrown side to the down thrown side and this fault is considered the main bounding fault in Abrar Oil Field (North Bahariya Oil Company).

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**Figure (22):** Geological Cross-Section Showing Prospect-B.
Risk Assessment Analysis for Prospects (A, B & C)

By using the Rose and Associate (Risk Assessment Software) after taking the permission from Tharwa Petroleum Company, the author calculated the $P_g$ (Geological Success) which is dependent on:

- Source Components.
- Timing and Migration Components.
- Reservoir Components.
- Containment Components.

Figure (24, and 25) show the $P_g$ calculation for prospects-A, & B.

The $P_g$ for prospect- A, & B ranges from 27 to 36 % and this due to the previous history of the study area and the results of the drilled well.
**Figure (24):** Geological success for Prospect-A.
Figure (25): Geological success for Prospect-B.
CONCLUSIONS

Seismic data interpretation has been carried out of Abu Sennan area which is located at the North Western Desert of Egypt to clarify the structural elements of the study area using Petrel, 2010 version software through constructing the depth contour map on top of Abu Roash G Member to figure out the general geological setting and the features affecting the study area. From the interpretation of available 3D & 2D seismic data in the study area, two structure depth & time contours maps are constructed on top Abu Roash "G" Member and the 3D structural model have been applied to imagine the discontinuities and following faults dissecting the studied formation tops. Structurally, the Abu Sennan area is a complicated faulted structure, the fault of the study area have three main orientation, namely, E-W, NE-SW, and NW-SE. Oriented faults are common in the northernmost and the southernmost parts of the study area, these faults have an apparent normal slip. The structure depth contour maps which were constructed on top Abu Roash "G" based on forty 2D Seismic lines showed that the Northern part of the East Abu Sennan Concession is more promising than the Southern part and many promising prospects on top Bahariya and Abu Roash "G" are found at the Northern part and the southern part. The Abu Roash "G" Member is mainly consisting of clastic sequence which is shale and sandstone intercalations with few carbonate beds. Through the study of area, the Abu Roash "G" Member is divided into three lithologic units:

- The Lower Abu Roash "G", this unit is characterized by the predominated of fine clastics, particularly shales, especially in the southern sector.

- The Middle Abu Roash "G", this unit is designed by fine clastics, such as silt and shale particularly in the southern part of the Study Area. Sandstone acquire the form of two discontinues interbeds.

- The Upper Abu Roash "G", this unit is designed by silt and shale particularly in the southern part of the Study Area.

The detailed well logging analysis of the permeable zones in Abu Roash "G" member, encountered in the studied eight wells in the Abu Sennan Area, revealed the following:
- The Abu Roash G facies quality increasing trend towards the Northern Part.

- The petrophysical analysis conclude whenever Abu Roash G are clean Sand they will bear an oil as long as moving toward the Northern of the study area, however it becomes more thin and more shally as long as moving toward the Southern Part.

- The shale content in Abu Roash "G" member increase towards south and southeast, the maximum shale content 33 % is recorded in Abu Roash "G".

- The porosity of the Abu Roash "G" member increase towards south and southeast, the average porosity values in Abu Roash "G" varies between 13 to 25 %.

The interpretation of the geological and geophysical data showed many promising prospects; two prospects may be drilled depend on the current study:

- **Prospect-A**, which is located in the northern western part of the study area close to the neama-I and Yomna-I well (oil producers) at the North Bahariya and Yoman Fields. The risk assessment (Pg) calculated for this Prospect, which ranges from 31 to 35 %.

- **Prospect-B**, which is located in the northern western part of the study area close to the WD Field (Oil Producer). The risk assessment (Pg) calculated for this prospect, which ranges from 27 to 30 %.

From the above mentioned studies the following results are obtained:

- The integrated interpretation of the seismic data which was represented in the form of seismic section, depth structural contour map and the 3D structural model obtained reflects the prevalence of structure tectonic trends; these trends of local structure are believed to be produced as the result of comparable system of regional tectonic deformation affecting the surrounding area.

- The obtained results from the petrophysical analysis reveal that Abu Roash G Member one of interest for the presence of hydrocarbon potentiality and Sandstone reservoir of Abu Roash G Member acts as a good reservoir within the study area.
The Upper part of the Abu Roash G reservoir is well sealed by the fair thick, laterally continuous, mostly impervious Abu Roash F Carbonate. Even within Abu Roash G itself, lateral facies change of the Upper sand reservoir to shale is well observed denoting a considerable seal.

Wells drilled in the study area provide excellent models for the reservoir qualities, distributions and performance.

The interpretation of the 3D & 2D seismic data indicates eight interested leads areas 4 of them could be changed to drillable prospect.

The study area is located in an excellent hydrocarbon system which represented by the petroleum system (source, migration, reservoir, trap and seal).

Abu Sennan area (The Study Area) is considered a good model for hydrocarbon exploration in the Northern Western Desert which has a good impact on our country resources.

The hydrocarbon are accumulated in different levels depending on the reservoir rock type and the availability of the stratigraphic successions to these accumulations, the shale intervals of Abu Roash G Member act as source rock besides the other important exogenous sources represented in the Northwestern Abu El-Gharadig basin.

Based on the above conclusions, it is recommended:

As a result of the present study, using the subsurface and petrophysical evaluation, new locations are proposed to be prospects area which are named A, B, and C which are located on such a three and four way dip closures that are very suitable place for Petroleum Accumulations.

To search for a good closure to solve the problems of the lateral seal, as we know the main reason of the failure of pervious wells in the area of study or a 3-way dip closure and check the Seal Mechanism.

For better structures definition, it is recommended to acquire Basin Modeling Study to increase the confidence degree of prospects and leads.

Changing Exploration and Development Concept in drilling within the study area.
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