CHAPTER NINE

SUMMARY AND CONCLUSIONS

The thesis deals with the evaluation of the Upper and Lower Baharyia Formations in the study area through the analysis of seismic and well logging data. The work done and the obtained results can be summerized as follows:

9.1. Interptretation of Seismic data

The interpretation of the available seismic data covering entirely the studied area was employed to delineate the subsurface structural setting. Accordingly, three two way time contour maps representing the tops of Abu Roash, Bahariya and Alamein dolomite Formations were constructed.

These time contour maps show the structural pattern, which has the form of doubly plunging anticlines and synclines restricted by two main trends of normal faults. These faults are relatively decreasing in number as going up from top Alamein to top Abu Roash.

The faulting pattern distinguishing the studied area has two directional trends. The first fault group includes the faults B,C , D and N which trends from E-W to ENE – WSW direction. Faults C and D have moderate throw (100 ms.) and they are forming together a distinguished short block on the two way time map of top Alamein. Meanwhile the two way time map of Abu Roash Formation demonestrates that fault D is shifted towards the north while fault C is completely disappeared.

The second fault group that includes the faults A,E,F,G,H,L,K and M was affected by different tectonic events which resulted in change of their trends from N-S to NNW- SSE direction.The major fault A has not only a major vertical displacement (600 ms) towards the west direction, but also a cosiderable strike slip component. It was extensively affected the area leaving a gaint saddle structure that is consisted of two plunging anticlines and two plunging synclines. Fault N is a typical left strike slip fault of a small amount of vertical displacement. This fault in particular with the perpendicular faults are dissecting the south west portion of the studied area forming some minor structures. The small faults G, L, and K are considered the extentions of the faults F, H and M which had been exposed to the strike slip component of fault N. They are forming a down steep normal faults dissecting the area and constructing between them some minor synclinal and anticlinal structures.

Moreover, two high and four low structures have been delineated. The high-1 is a plunging anticline while the high-2 is most probably a part of domal structure. These two highs are separated from each other by the major normal fault A. Low-1 is a plunging syncline with a northeast axial direction. It is separating from the existing highs H1 and H2 by A and B faults. Lows 2,3 and 4 are considerably affected by the existed minor faults.

Generally, the near look on the two way time maps of tops Abu Roash, Bahariya and Alamein dolomite Formations indicated that the general dip characterizing these tops are to the north west direction in the northern and western portions and to the south in the rest of the concerned area.

9.2. Well Logging Analysis

The intensive well log analysis shows that the shale volumes have been estimated using gamma-ray and neutron methods. Gamma-ray method gives minimum values of shale volumes than that of neutron method in most zones. So, the values obtained from gamma-ray method are taken as representative of shale volumes except in the zones of high radioactivity.

Shale parameters such as Δtsh, ϕNsh, Psh and Rsh have been determined from GR-Δt, GR-ϕN, GR-Pb and Gr-Rt crossplots respectively. In the Upper Bahariya Formation, GRsh varies from 80 to 105 APIu as a maximum value and from 15 to 25 APIu as a minimum value. ϕNsh varies from 34 % to 38 % as maximum values, and 1 % to 3 % as minimum values. Pbsh ranges from 2.1 to 2.2 gm/cc, Δtsh from 94 to 99 μsec and Rt sh from 1.2 to 1.9 ohm. m. In the Lower Bahariya

Formation GRsh varies from 80 to 115 API as maximum values and from 10 to 26 API as minimum values. ϕNsh ranges from 29 % to 35% as maximum values and from 1 % to 2 % as minimum ones. Δtsh from 87 to 94 μsec, Pbsh from 2.15 to 2.3 gm/cc and Rtsh from 1.8 to 3 ohm.m.

The M-N plots of both the Upper and Lower Bahariya Formations indicate that, they consist of sandstone, limestone, dolomite and shale. Effects of gas and secondary porosity are observed on most of the M-N plots. Hingle cross plots of uninvaded zone resistivities (Rt) against (Δt) have been carried out. Rw of the Upper Bahariya Formation ranges from 0.001 to 0.064 ohm.m and that of the Lower Bahariya Formation ranges from 0.005 to 0.061 ohm.m.

Porosity has been determined from the sonic and neutron logs. The density logging data is affected by the presence of heavy minerals. The effective porosity has been chosen as the average value of the sonic and neutron porosities that had been corrected for shale effect. In the Upper Bahariya Formation the average effective porosity varies from 5.3 % to 8 %, while in the Lower Bahariya Formation this average ranges from 3.9 % to 10.7%. In general the effective porosity of the Lower Bahariya Formation is higher than that of the Upper Bahariya Formation. The difference in effective porosity values may be attributed to the percentage of sandstone in the Lower Bahariya Formation. The effective porosity values are high in the sandstones. The water saturation in uninvaded and invaded zones have been determined in the studied formations using Poupon and Leveaux equation (1971). Determination of Sw and Sxo leads to the estimation of hydrocarbon saturations. The total hydrocarbon saturation have been differentiated into movable and residual types.

In the Upper Bahariya Formation, the average saturation of Sw varies from 74.8 % to 96.8 %, Shr from 1.7 % to 11 % and Shm from 1.5 % to 14.2 % while, in the Lower Bahariya Formation the average Sw varies from 81.5 % to 94.5 %, Shr from 3 % to 8.7 %, and Shm from 2.5 % to 9.8%.

The petrophysical parameters and the matrix analyses results from well log interpretation are presented graphically in the form of analog to show their distribution vertically.

In addition, Carbonate rocks (limestones and dolomites), Sandstones and shales are present in different proportions. Moreover, hydrocarbons are presented as movable and residual.

The subsurface study was executed through the delineation of structural setting and construction of isopach and lithologies percentage maps. The isopach contour maps of both Upper and Lower Bahariya Formations are useful in configuration of their basins. The isopach contour line values of the two formations increase towards the basins.

The effective porosity reveals a considerable variation, it shows an obvious increase in the Lower Bahariya Formation and a decrease in the Upper Bahariya Formation, this variation can be attributed to their lithology contents. The movable hydrocarbons (Shm) in the Lower Bahariya Formation increases in the south east direction opposite to the porosity because of the presence of some obstacles such as faults. Residual hydrocarbons increase also in the same "SE" direction which means that the source rock is existing in the same area. The source of hydrocarbons is indigenous. It is observed that most of the movable hydrocarbons exist in the SE are found in the sandstone zones.

The isopach maps show variations in thickness of formations that may represent significant factors of geological history. Thickness variation of a formation within an area such as regional thickening in a given direction may point to a basin into which the formation was deposited while locally thinned areas may indicate structural activity with uplifts or doming that could have great importance in the allocating of hydrocarbons.

The depth maps illustrate that the general dip in the area is towards the SE direction and hence the expected direction of hydrocrbon migration is towards the NW.

The effective porosity increases towards the NW due to two reasons; the first increases of sandstone percentage in the NW direction and the second is decrease of depth and overburden pressure in the same direction.

It is observed that the residual hydrocarbons increase towards the SE in the direction of increasing carbonate rocks and decreasing of shales, which mean that the carbonate rocks are the main source rocks and the hydrocarbons may be generated indigenously.

The movable hydrocarbons increase towards the unexpected (SE) direction where depth and effective porosity reach their lowest values. This means that there are lithological and structural obstacles that control in the distribution of hydrocarbon in the area and hence the traps are of complicated type.