Egyptian Geophysical Society
EGS Journal, Vol. 14, No. 1, 107-112 (2016)

PETROPHYSICAL RESERVOIR CHARACTERISTICS FOR KOMOMBO BASIN AREA,UPPER EGYPT, EGYPT

A.A.A. Othman(1), M. Fathy(1) and A. Samy(2)

(1) Al-AzharUniversity, Faculty of Science, Geology Department, Nasr City, Cairo, Egypt.
(2) Ganoub El-Wadi Petroleum Holding Company,Nasr City, Cairo,Egypt.

خصائص الخزان البتروفيزيائية لحوض كوم امبو، صعيد مصر

الخلاصة: تقع منطقة كوم امبو فى جنوب الصحراء الغربية لمصر بين خطى عرض ٢٠` ٢٤° و ٢٥° شمالا وخطى طول ٣٠` ٣٢° ونهر النيل شرقاً. تم حساب المعاملات البتروفيزيائية مثل كمية الطين والمسامية ودرجة التشبع بالماء ودرجة التشبع بالهيدروكربونات، كما تم حساب السمك الصافى المنتج للهيدروكربونات لعضو التلال الستة (E)، كما تم عمل خرائط توضح توزيع كل معامل من هذه المعاملات فى المنطقة لعضو التلال الستة (E) وهذه الخرائط هى المسامية وكمية الطين ودرجة التشبع بالماء ودرجة التشبع بالهيدروكربونات وكذلك السمك الصافى المنتج للهيدروكربونات. وتبين من عمل هذه الخرائط أن هذه المنطقة واعدة ويمكن حفر آبار تنموية إضافية واستكشافية بها.

ABSTRACT: *The Komombo concession is located on the western bank of the Nile River, Upper Egypt, Egypt. The simple reason is that better reservoir characterization means higher success rates and fewer wells for reservoir exploitation. In this study, the seismic and well log data were integrated in characterizing the reservoirs on Al Baraka Field in Upper Egypt. The objective of this study is to use the well log data to determine the reservoir characteristics, fluid contents, evaluation of the prospectivity and hydrocarbon potentialities of the Komombo basin area and its importance in the development of this area. These petrophysical properties were mapped and helped in the delineation of sweet spots for the reservoir horizon which in turn helped, along with other elements, in the promotion of the leads interpreted from the seismic data into prospects and they will represent potential reserve additions in the studied area.*

INTRODUCTION

The studied area of Komombo basin lies in the southern Western Desert of Egypt, and restricted betweenlatitudes 24°20` N and 25° 00` N, and longitudes 32° 30` E and the Nile River E (Fig. 1).

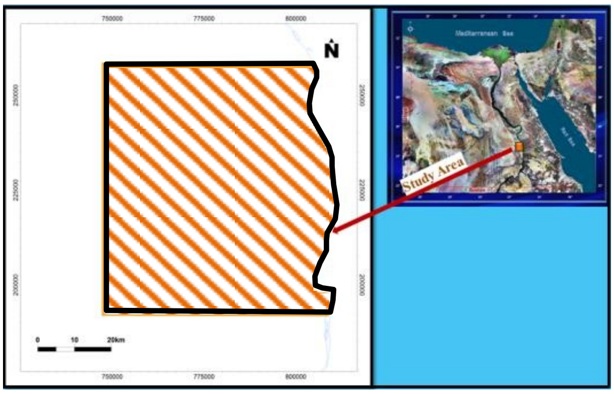

Figure (1): Location map of Komombo basinal area, Upper Egypt, Egypt.

GEOLOGIC SETTING

1. Stratigraphy:

The Western Desert is a huge platform with mean elevation of 500 m a.s.l. consisting of thick layered sedimentary rocks largely unaffected by tectonic disturbances (Said, 1962). Sandstone with a slight northward regional slope and dip makes up the largest part of the exposed and subsurface strata. Carbonate strata are confined to the resistant limestone cap of the Egyptian plateau.

The Late Mesozoic-Early Cenozoic rocks, which make the primary sedimentary cover in the area under discussion, are subdivided into a number of mappablelithostratigraphic units. The units are classified into: (a) a Jurassic-Campanian sequence, predominantly continental but with marine intercalations, and (b) a Campanian-lower Eocene, transgressive-regressive open marine sequence (Said 1990).

Sediments in the Upper Egypt basin are present in distinct depositional depressions separated by low uplifts or platform areas. Basins formed in the Jurassic - Lower Cretaceous as non-marine rifts (Mohamed Fathy et al., 2010).

The work presented here shows some preliminary results from an on-going U.S. – Egypt collaborative project that deals with the assessment of natural resources in an area located west of the Nile Valley near Aswan and Komombo in the Western Desert of Egypt (Magaly Koch, et al., 2012).

1.1. Jurassic-Campanian:

The Jurassic-Campanian sequence includes the predominantly continental sandstone and clay beds that were formerly lumped under the term 'Nubia'.

Recently, upon the detection of marginal marine clay-shale strata which occur persistently in outcrops at certain stratigraphical intervals within the sandstone sequences.Its subdivision into well-defined units of cyclical continental and marine deposition has become possible (Said 1990).

1.1.a. Komombo Formation:

This formation consists mainly of shale with sandstone and siltstone streaks. It is subdivided into (Repsol, 1998):

Komombo A, Komombo B, and Komombo C Members.

Komombo A Member and Komombo C Member are reservoirs, but Komombo B Member is the main source rock in the Komombo basin area.

1.1.b. Six Hills Formation:

It is generally assigned to Late Jurassic-Early Cretaceous age (Klitzsch and Lejal- Nicol, 1984). In the subsurface, based upon pollen investigations, Helal (1965) and Soliman (1977) refer the lower part of the Six Hills Formation to Late Jurassic. Soliman (1977) also identifies Late Jurassic foraminifera in some Kharga wells. Schrank (1987) describes pollen of Middle to late Jurassic from a horizon about 300 m below the well-defined overlying Aptianshales in Ammonite Well-1. Bisewski (1982) notes the presence of marine influence at a horizon 60 m below the top of the Six Hills Formation to the south of Abu Tartur. This may be considered a prelude to the Aptian transgression and is overlain by a fluviatile series.

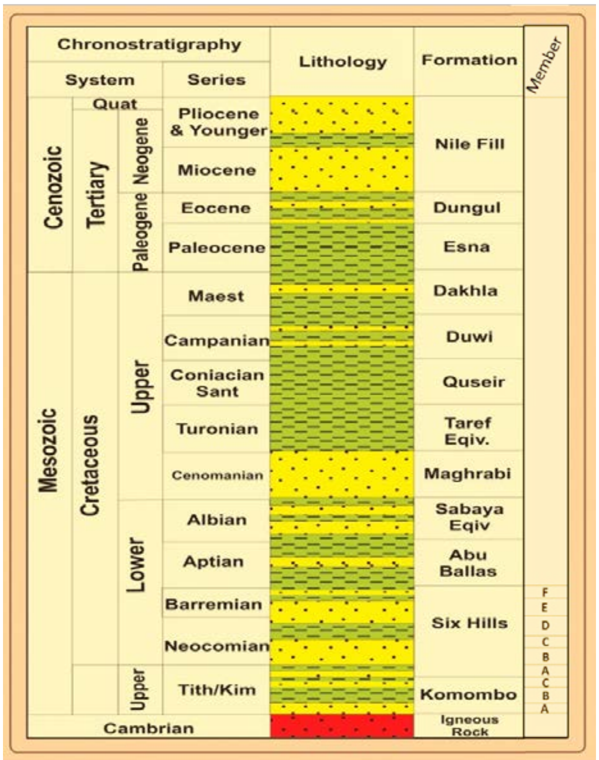

Figure 2: General Lithotratigraphic Column at Komombo Basin Area, (Repsol, 1998).

The basal unit is made up of up to 600 to 700 m thick fluvial sandstone, paleosol and, toward the top, minor nearshore marine sandstone. It is called basal Clastics (Klitzsch, 1978) or better Six Hills Formation (Barthel and Boettcher, 1978). These clastic sediments were deposited while the area was subsiding and before the Aptian transgression advanced from the north.

1.1.c. Abu Ballas Formation:

The transition between the fluviatile sandstones of the Six Hills Formation and the overlying marine clays and shales of the Abu Ballas Formation is easily recognized, although an erosional surface is not found everywhere (Bisewski, 1982).

The first transgression which reached the area of southwest Egypt during this new structural cycle was the Aptian transgression. It is represented by the second formation from the bottom, the Abu Ballas Formation (Barthel and Boettcher, 1978, Boettcher 1982, originally Lingula Shale, Klitzsch 1978).

It consists of up to 60 m of shale, siltstone and sandstone of a very shallow marine transgression of probably very high salinity. Parts of the strata are rich in fauna of mainly small species of lamellibranchiades, brachiopods and gastropods and they also contain plant remains including fossil fruit. An Aptian age for this transgression was also proven by palynological means (Schrank, 1982 and 1983).

2. Structural Setting:

Egypt is structurally divided into 3 regions: the stable shelf, the unstable shelf, and the Arabian-Nubian Shield (Fig. 3) (Meshref, 1990). The Arabian-Nubian Shield has the most clearly defined and agreed upon boundaries (Youssef, 2003). The Arabian-Nubian Shield is represented by the uplifted, and subsequently exposed, Precambrian crystalline rocks of the southern Sinai Peninsula and Red Sea Hills. The stable shelf covers the largest portion of the country and surrounds the Arabian-Nubian Shield. The stable shelf's origins lie with Egypt undergoing a period of relative tectonic quiescence during the Paleozoic era after enduring the intense magmatic and tectonic events of the Pan African Orogeny in the Neoproterozoic. This period of tectonic quiescence, along with the denudation of the Pan African highlands from glaciations, allowed for the peneplanation of the surface, which allowed widespread transgression and deposition of marine facies beginning in the Late Cretaceous (Morgan, 1990; Youssef, 2003). The unstable shelf dominates most of northern Egypt and is defined by severe rock deformation due to rapid basin subsidence from tectonism and wrench faulting from the closing of the Tethys Sea (Youssef, 2003).

The east-west Tethyan trend formed during the Paleozoic and part of the Mesozoic as the African continent was uplifted. As Pangea began to break up during the Mesozoic, uplifting throughout most of Egypt came to an end (Klitzsch and Squyres, 1990). Controversy surrounds much of the origins of the structural features formed during the Mesozoic but there is general agreement that it was a period of major extensional tectonics (Morgan, 1990). The two main tectonic forces were sinistralshearing during the Late Jurassic to Early Cretaceous, then a transition to dextral shearing until the Paleocene, as North Africa collided with Laurasia (Meshref, 1990). Nelson (1986) postulated that Mesozoic tectonics resulted from extensional wrench faulting acting on the preexisting east-west Tethyan trend, as well as re-activation of the older Precambrian trends.

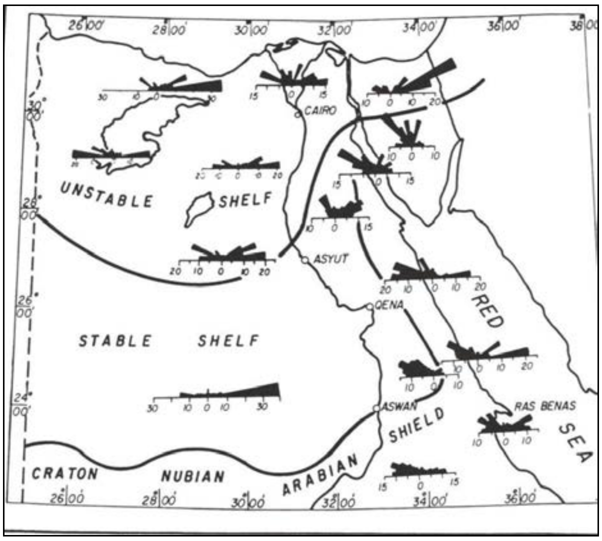

Figure 3: Rosetta diagrams showing the major tectonic trends of Egypt and the approximate boundaries of the unstable shelf, stable shelf, and Arabian Nubian Shield (Meshref, 1990).

The Aswan area is affected by many faults dating from the Cretaceous trending E-W, N-S, NE and NW. The majority of these faults are normal and dextral strike-slip faults, which displace Precambrian crystalline rocks, Late Cretaceous Nubian Sandstone and shale, Late Cretaceous shale of the Dakhla Formation, and Paleocene limestone of the Kurkur, Garra, and Dungul Formations (EGSMA, 1981; Issawi, 1969).

PETROPHYSICAL RESERVOIR CHARACTERISTICS

1. Available Well Logs:

The available well-log data used in this work are in the form of Gamma-Ray, Porosity (Density and Neutron) and DLL (deep and shallow) Resistivity logs.

The cut offs used for the Six Hills E of Komomboarea are as follows: effective porosity 10%, volume of shale 40% and water saturation 60%. The IP (interactive petrophysics v3.5) and (Techlog 2011.1) software mark of Schlumberger were used for petrophysical analysis.

2. Six Hills E Member:

2.1. Gross sand:

Fig. (4) illustrates the distribution of the gross sand in the area where it is observed within the range of 196ft - 440ft. The highest gross sand distributed at the eastern and northeastern parts of the area and decreases to the southwestern part of the studied area.

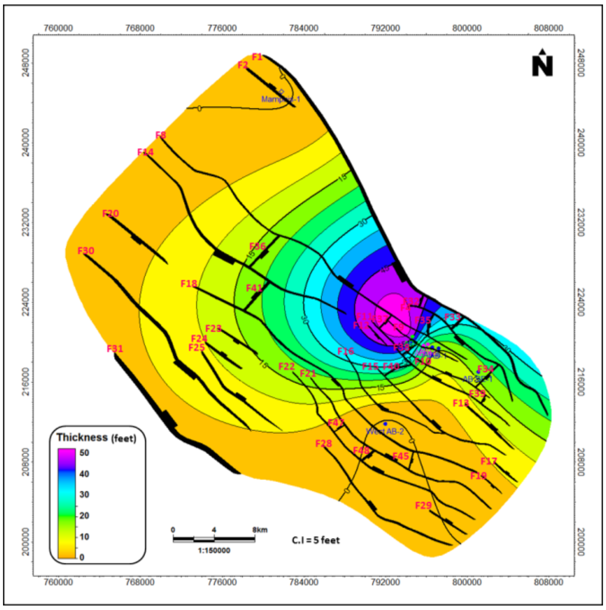

Figure 4: Gross Sand Thickness Map of the Six Hills E Member Based on Al Baraka Wells of Komombo Basin Area, Upper Egypt, Egypt.

2.2. Net pay thickness:

Fig. (5) illustrates a net-pay reservoir thickness map of the Six Hills E reservoir. The calculated net-pay ranges between 0 and 52 ft. This restricted the reservoir to the central and eastern parts of the Komombo area. The thickness of the pay-zone increases toward the east and central direction, but rapidly decrease to the north and west direction. This distribution pattern indicates that the hydrocarbon potential of the Six Hills E Member is promising at the central and eastern parts of the studied area.

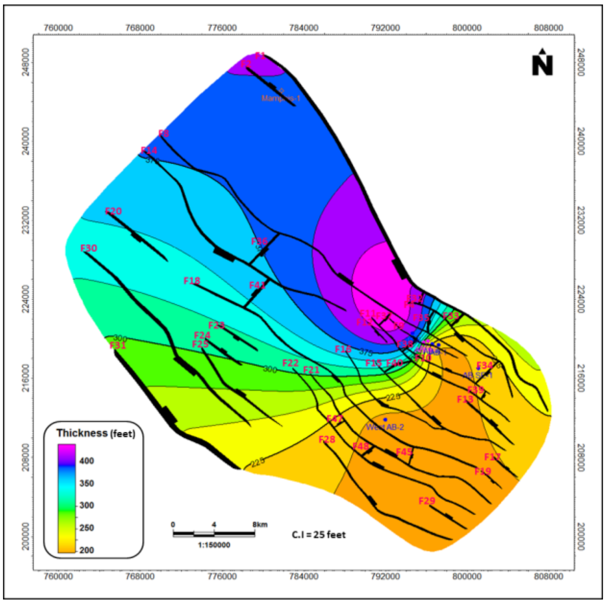

Figure 5: Net Pay Reservoir Thickness Map of the Six Hills E Member Based on Al Baraka Wells of Komombo Basin Area, Upper Egypt, Egypt.

2.3. Shale content:

Fig. (6) illustrates the distribution of the shale content (V_{sh}) in the area where it is observed within the range of 8-33%. The highest shale content distributed at the eastern and northern parts of the area and decreases to the southwestern part of the studied area.

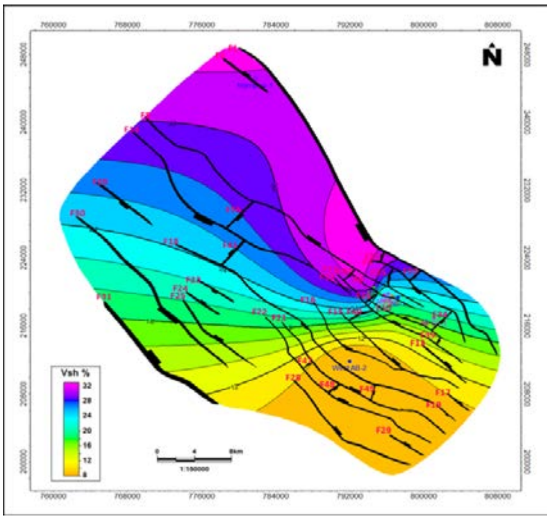

Figure 6: Shale Content (Vsh) Map of the Six Hills E Member Based onAl Baraka Wells of Komombo Basin Area, Upper Egypt, Egypt.

2.4. Porosity of the Six Hills E:

Fig. (7) illustrates the distribution of the Effective porosity in the studied area. The frequent porosity occurrences are observed within the range of 8-27%. The highest porosity distribution is found at northernpart of the studied area, whereas the lowest porosity distribution is found at the western partof thestudyarea.

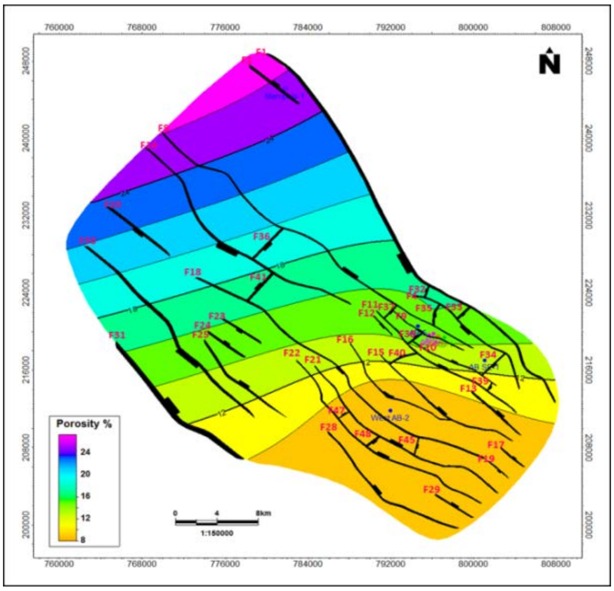

Figure 7: Effective Porosity of the Six Hills E Member Based on Al Baraka Wells of Komombo Basin Area, Upper Egypt, Egypt.

2.5. Water saturation of the Six Hills E:

Fig. (8) illustrates the distribution of the water saturation (S_w) in the area where it is observed within the range of 30-100%. The highest water saturation is distributed in the western part of the studied area and decreases toward the eastern part of the area.

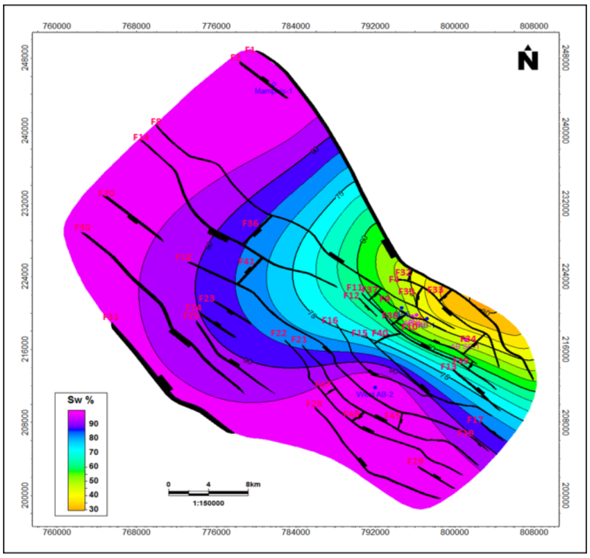

Figure 8: Water saturation (Sw) map of the Six Hills E Member Based on Al Baraka wells of Komombo Basin Area, Upper Egypt, Egypt

2.6. Hydrocarbon saturation of the Six Hills:

Fig. (9) illustrates the distribution of the hydrocarbon saturation (S_{hr}) in the area where it is observed within the range of 0-70%. The highest hydrocarbon saturation is distributed in the eastern part of the studied area and decreases toward the western part of the studied area.

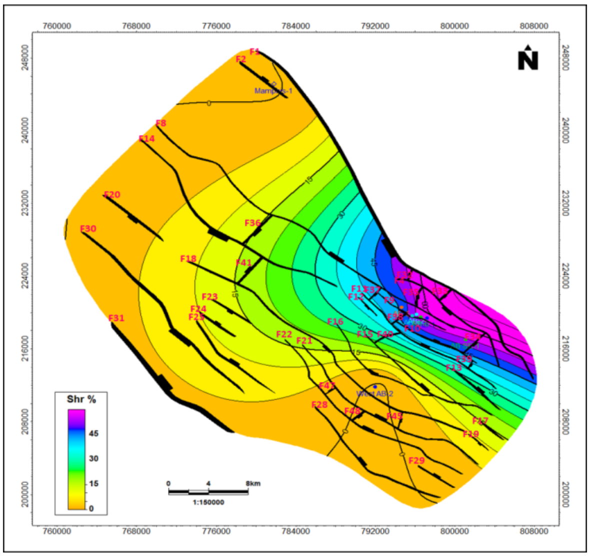

Figure 9: Hydrocarbon saturation (Shr) map of the Six Hills E Member Based on Al Baraka wells of Komombo Basin Area, Upper Egypt, Egypt.

IP EVALUATION OF THE SIX HILLS E

Fig. (10) shows a CPI plot of the studied interval of Al Baraka - 4 well. The Gamma ray curve show less shale content against sand intervals penetrated in the well. The high Gamma ray may represent shale or argillaceous sandstone interval. The resistivity curve indicates the presence of hydrocarbon accumulation where there is a good separation between deep resistivity curve and shallow resistivity curve. The petrophysical analysis for Six Hills E Member in the Al Baraka – 4 well reflects that:

Reservoir	Net pay reservoir thickness (ft)	E.Porosity (%)	Shale Volume (%)	Water saturation (%)	Hydrocarbon saturation (%)
Six Hills E	24	14.5	23	47	53

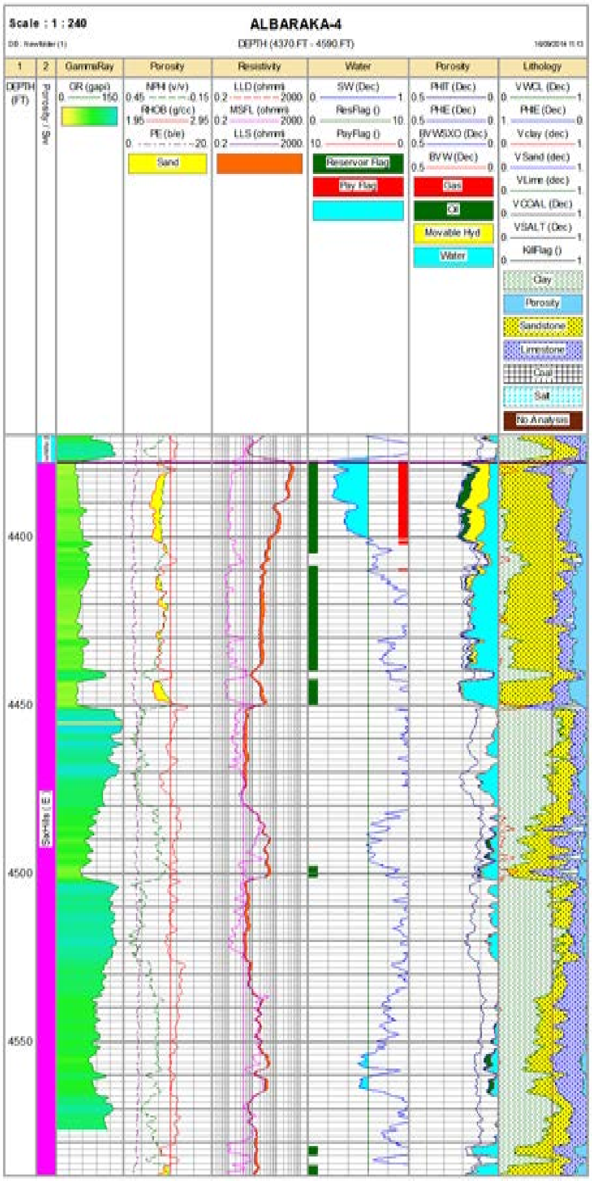

Figure 10: Computer Processed Interpretation (CPI) Plot for the Six Hills E Intervals in Well Al Baraka 4.

CONCLUSION

The last and most important element in the hydrocarbon trap is the reservoir rock. Evaluation of the reservoir rock parameters was only possible through using well log data sets available to this study. Properties for the reservoir encountered by the wells drilled in the studied area were obtained from detailed petrophysical analyses. Petrophysical analyses conducted for eight wells drilled in the studied area resulted in understanding of the reservoir rock parameters for reservoir of interest. These petrophysical properties were mapped and helped in the delineation of sweet spots for the reservoir horizon, which in turn helped, along with other elements, in the promotion of the leads interpreted from the seismic data into prospects. The results of the petrophysical analysis indicated the presence of oil-bearing sandstone reservoirs. Drilling more wells in these areas could result in adding more reserves in Komombo Basin area.

ACKNOWLEDGEMENT

The authors would like to express their gratitude thanks to the lab members of the Geology Department, Faculty of Science, Al Azhar University, Egypt, for their support during the progress of this study. We wish to thank the Ganoub El Wadi Petroleum Holding Company for providing the basic exploration data and encouraging us to proceedwith the study.

REFERENCES

Barthel, K.W. and Boettcher, 1978. Abu Ballas Formation; a significant lithostratigraphic unit of the former 'Nubian Series'. Mitt. Bayer. Stoats, Paleontol. Hist. Geol. 18: pp. 155 - 166.

Bisewski, H., 1982. ZUR Geologie des Dakhla Beckens (Siidwest Agyptens). Berl.Geowiss.Abh. 40(A): pp. 1 - 85.

Boettcher, R., 1982. Die Abu Ballas Formation (Aptian?) der Nubischen Gruppe Sudwest Agyptens. Berl. Geowiss. Abh. 39(A): p. 1 - 145.

Egsma, 1981. Geologic map of Egypt, Egyptian Geological Survey and Mining Authority.

Helal, A.H., 1965. Jurassic spores and pollen grains from the Kharga Oasis, Western Desert, Egypt N. Jb. Geol. Palaeontol. Abh. 123: p.160 - 166.

Issawi, B., 1969. The geology of Kurkur-Dungle area: Cairo, General Egyptian organization for Geological Research and Mining, 102 p.

Klitzsch, E.H., 1978. Geologische Bearbeitung Siidwest Agyptens. Geol. Rundschau 67: pp. 509 - 520.

Klitzsch, E.H. and A. Lejal-Nicol, 1984. Flora and fauna from a strata in southern Egypt and northern Sudan (Nubia and surrounding areas). Berl.Geowiss.Abh. 50 (A): pp. 47 - 79.

Klitzsch, E.H. and Squyres, C.H., 1990. Paleozoic and Mesozoic Geological History of Northeastern

Africa Based Upon New Interpretation of Nubian Strata: AAPG Bulletin, V. 74, pp. 1203 - 1211.

Magaly Koch, Ahmed Gaber, Benjamin Burkholder, and M. Helmi, Geriesh, (2012). Development of New Water Resources in Egypt with Earth Observation data: Opportunities and Challenges International Journal of Environment and Sustainability ISSN 1927 - 9566, V. 1 No. 3, p. 1 - 11.

Meshref, W.M., 1990, Tectonic Framework, in Said, R, ed, The Geology of Egypt: Rotterdam/Brookfield, Balkema,. pp. 113 - 155.

Mohamed, F., Leonardo, S., Glyn, R. and Moussa, A., 2010. A New Oil Province in Upper Egypt.AAPG Search and Discovery Article #90105 © 2010 AAPG GEO Middle East Conference and Exhibition, Manama, Bahrain, 7-10 March 2010.

Morgan, P., 1990, Egypt in the framework of global tectonics, in Said, R, ed. The Geology of Egypt: Rotterdam/Brookfield, Balkema,. pp. 91 - 111. Northeastern Africa Based Upon New Interpretation of Nubian Strata: AAPG Bulletin, V. 74, pp. 1203 - 1211.

Repsol Exploration Egypt S.A., 1998. Composite Well Log, Scale 1:500, Komombo 2, Exploratory Well.

Said, R., 1962. The geology of Egypt, Amstrdam-New York, Elsiver Publishing Co., 337 p.

Schrank, E., 1983. Scanning electron and light microscopic investigations of Angiosperm pollen from the lower Cretaceous of Egypt Pollen et Spores 25: pp. 213 - 242.

Schrank, E., 1982. Kretazische Pollen und Sporenausdem 'Nubischen Sandstein' des Dakhla Beckens (Agypten).Berl.Geowiss.Abh. 40(A): pp. 87 - 109.

Schrank, E., 1987. Paleozoic and Mesozoic palynomorphs from northeast Africa (Egypt and Sudan) with special reference to late Cretaceous pollen and dinoflagelates.Berl.Geowiss.Abh. 75(A), 1: pp. 249 - 310.

Soliman, H.A., 1977. Foraminifferes et microfossiles vege-taux provenant du 'Nubia Sandstone' de subsurface de I'oase El Kharga, d6s£rt de l'ouest, Egypte. Rev. Micro- paleontol 90: pp. 114 - 124.

Youssef, M.M., 2003. Structural setting of central and south Egypt: An overview: Micropaleontology, V. 49, pp. 1 - 13.