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DETECTION OF HYDROCARBON, BY USING ADVANCED WELL LOG TOOLS FOR KAFR EL-SHEIKH FORMATION AT SAPPHIRE FIELD, OFFSHORE NILE DELTA, EGYPT

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ABSTRACT

The present work is devoted to study the geologic setting, reservoir characterization and hydrocarbon detection with conventional and advanced well log methods for Kafr El-Sheikh Formation at Sapphire field, Offshore Nile Delta, Egypt. The used wells are Sapphire-Da, Db, Dc, De, Dh and Dq. By using open hole logging tools, advanced logging tool like Modular dynamic tester (MDT), Mud log during drilling and conventional core that analyzed carefully, to detect the clean sandstone and thin bedded sandstone of the study Location.

These basic well log tools (Gamma Ray, Resistivity, Density and Neutron) reflectclean sandstone reservoir with good way, but can't detectthin bedded sandstone reservoir, as a result of their low vertical resolution, this may miss several intervals charged with hydrocarbons during perforation and production from the field.So, we should run advanced tool like the Modular Dynamic Tester (MDT) and analyze conventional core, if found, and the hydrocarbons in Mud log to detect these missed intervals. Also by using the conventional cores and mud logging while drilling.

The results had showed clean sandstone and thin bedded sandstone reservoirsthroughthe advanced well log tools, which identify more than 68% deep water reserve didn't use beforethis should be takeninto consideration in the future wells, workover wells, excellent distribution of facies in both the static and dynamic models, to increase the hydrocarbon production and life time of producible wells. . The optimum location for forthcoming wells is south west of the field, because it has the best petrophysical parameters. It has high porosity, hydrocarbon saturation, and net to gross, in addition to low shale volume.

INTRODUCTION

General Outlookon the Nile Delta:

The Nile Delta has the classical shape of the Greek letter shape "Delta", which was compared by Herodotus in the fifth century. The recent Nile Delta covers about (50,000 km²) equally, distributed between onshore and offshore areas. (Fig.1).

The Sapphire Field is located at the northwestern margin of the Nile Delta, approximately 90km offshore from Alexandria. The field lies at the West Delta Deep Marine Concession (Fig.2). It lies at the interaction betweenLat32° 01' 43.192" N and long 30° 21' 10.707" E. The Sapphire block comprises approximately 90 km2 surface area. Gas was encountered in the Pliocene sandstones (Kafr El-Sheikh Formation) of that field. The reservoir consists of a succession of sandstones, claystones and siltstones in a general upward fining succession. Six wells in Sapphire Field are chosen for this study. These are (Sapphire-Da, Db, Dc, De, Dh and Dq), as shownin (figure 1).

MATERIALS AND METHODS

The present study is buildup on basic well logs (Gamma-Ray, Density, Neutron and Resistivity), Modular Dynamic Tester (MDT), Mud log and conventional cores. Six wells had been chosen from the Sapphire field(Sapphire-Da, Db, Dc, De, Dh& Dq).

Log Data

The available well log data for the present study are in digitized form the following table shows the available open-hole well logging tools of **six**wells studied in this work. The Interactive Petrophysics (Techlog) 3.4 Software was used for the all petrophysical calculations and for drawing all figures in this study, which developed by Schlumberger service company.

Workflow of WELL LOGS

Well logs represent the geophysical recordings of various rock properties in boreholes, and can be used for geological (stratigraphic and structural) interpretations. The most common log types that are routinely employed for facies and petrographical analyses (lithology, porosity and fluid evaluation), and stratigraphic correlations. These log types may be considered ‘conventional’ as have been used since decades. Well logs have both advantages and shortcomings, relative to what outcrops have to offer in terms of facies data. One major advantage of the geophysical logs over outcrops is that they provide continuousvertical record from relatively thick successions, often in a range of kilometers.

Petrophysical Evaluation of Sapphire Field.

In this part, we are dealing with the lithologic and petrophysical properties of the encountered reservoir rocks, based on the results of well log analysis carried out for the six chosen wells in the area of study, through to the detectionof the petrophysical parameters (clay volume, effective porosity and water saturation) by, using theTechlog software.

Detection of shale types, petrophysical

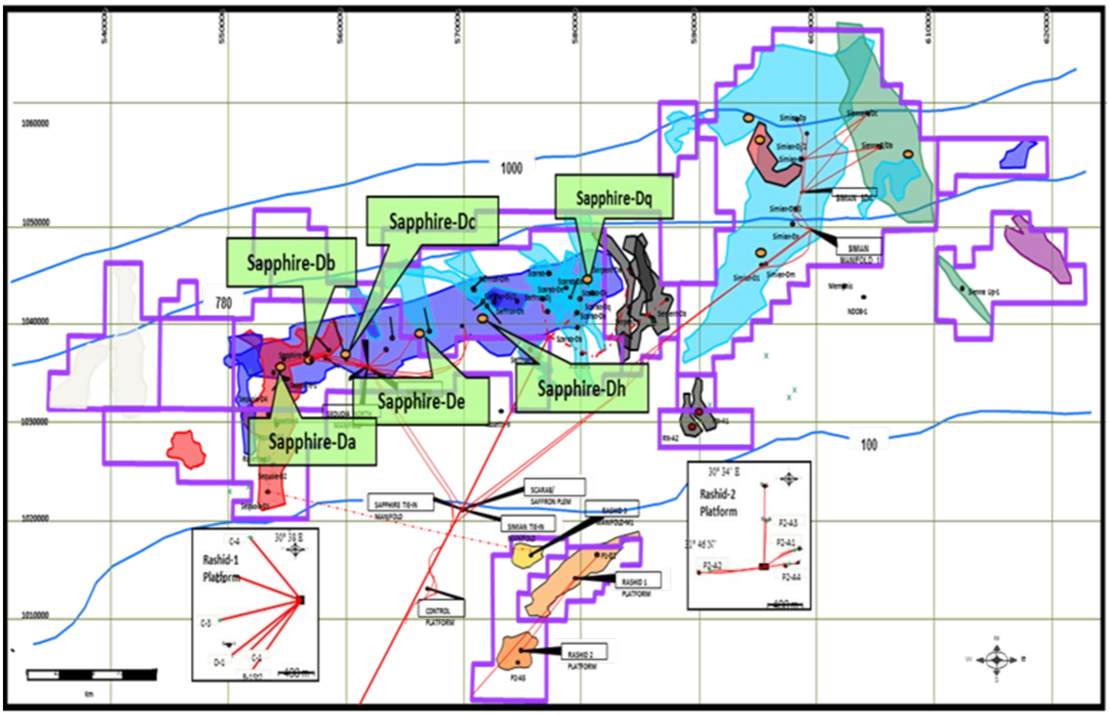

Figure 1. Location map of Sapphire Field that contains six wells used in the present study.

Table.1. Direct and indirect measurements of well log tools.

Well Logging Tool	Direct Measurements	Indirect Measurements
SP Log	Millivolts	Permeable Zones
Gamma ray Log	API units	Shaliness
Caliper Log	Hole Diameter	borehole Corrections
Density Log	Bulk Density	Porosity and Heavy Minerals
Neutron Log	Hydrogen Index	Porosity
Resistivity Logs	Resistivity	Fluid Saturation.
MDT	Pressure points	Permeability

parameters and different lithologies throughCross Plots

A number of cross plots for the various logging tools, like Density, Neutron, Resistivity and Gamma-ray had been done to make accurate detection of the shale types, lithologies and petrophysical parameters. These petrophysical parameters are very important to make accurate petrophysical evaluation like shale volume, total porosity, effective porosity,permeability, water saturation and hydrocarbon saturation.

Conventional Petrophysical Evaluation of Sapphire Field

properties of encountered reservoir rocks based on the results of well log analysis of Gamma-Ray, Density, Neutron and Resistivity which carried out from wells in the area of study through to detect Petrophysical parameters (clay volume, effective porosity and water saturation) by using Techlog software.

Modular Dynamic Tester (MDT)

MDT gives accurate real-time pressure readings and permeability measurements from high-resolution gauges and precise flow line control to ensure the monophasic flow. Also high-purity and -quality reservoir fluid samples laboratory analysis. Added using the

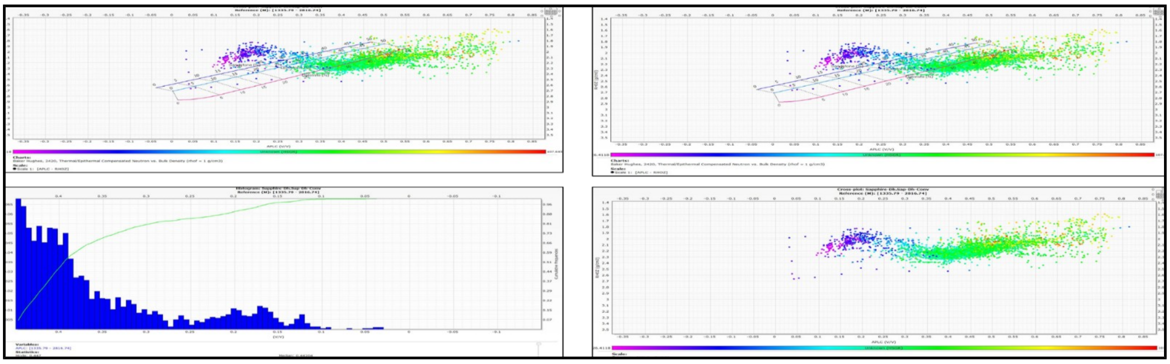

Figure 2.Histograms for Aplc and Resistivity. Aplc reads between 0.1 and 47 %, neutron reads between 1 and 50 %, and cross plot of potassium and thorium, which give mixed layers and illite of clay minerals. Cross plot of neutron and density which gives gas-bearing sand and shale of Sapphire-Dh Well.

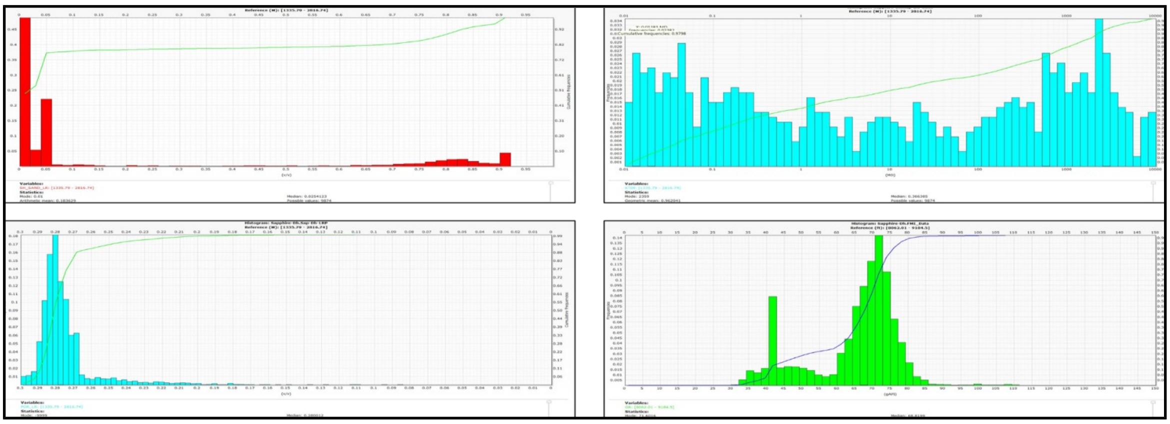

Figure 3. Histograms for porosity, gamma-ray, Hydrocarbon saturation in unconventional intervals and permeability. Porosity reads between 0.12 and 0.28 %, gamma-ray reads between 30 and 110 Api, hydrocarbon saturation reads between 0 and 0.9 % and permeability reads between 0.01 and 5000 md. for Sapphire-Dh well.

In Conventional petrophysical model, we are dealing with lithological and petrophysical

conventional cores to get lithologic description and all the petrophysical parameters. The advanced tools detect clean and thin bedded sandstone reservoirs, with very high accuracy and show where free fluids, hydrocarbon and permeability are for Production.

Detection of Hydrocarbon duringDrilling by Gas Chromatograph and Gas Detector

sandstone reservoirs basic tools can't catch them as a result of their low vertical resolution, but appears clearly during drilling.

Detection of Thin Bedded Sandstone by Conventional Core

surements and ne through the in bedded which didn't ol, which have ted bythe hole cal plugs had been taken, to make a very accurate lithologic interpretation.

Table 3. Shows pressure point which had been taken in both conventional and unconventional reservoirs in Sapphire-Da well.

Well:	Sapphire-Da	RTE (m amsl):	22.25	BURULLUS GAS COMPANY
Date:	15-Aug-04	Hole Size (in):	8.5	WIRELINE TEST REPORT - PRESSURE DATA
Suite No:	1	Reservoir:	Sapphire Sd	

File	Test	DEPTH (m)		Gauge	Initial Hydrostatic		PRETEST DATA Fmn Press.		Mob	SAMPLE DATA Min	Final	Time	Final Hydrostatic		Temp	Remarks	Test
No.	No.	RKB	TVDSS	Type	psia	ppge	psia	ppge	md/cp	FP	FP	(secs)	psia	ppge	(degF)		Type
82	1	2776.02	-2732.9	CQG	5655.04	11.94	4476.33	9.6	1131.7				5652.69	11.94	150	Excellent pressure test	N
83	2	2779.99	-2736.7	CQG	5661.28	11.94	4477.5	9.59	1984.1				5659.15	11.93	151	Excellent pressure test	N
84	3	2831.01	-2785.4	CQG	5762.15	11.93	4492.77	9.45	127.55				5757.56	11.92	154	Very Good pressure test	N
85	4	2862.03	-2815	CQG	5823.17	11.93	4603.38	9.59	354.73				5820.33	11.92	156	Very Good pressure test	N
86	5	2865.01	-2817.9	CQG	5826.41	11.92	4607.39	9.58	1096.6				5822.99	11.91	158	Excellent pressure test	N
87	6	2867.02	-2819.8	CQG	5827.26	11.91	4610.05	9.58	761.05				5825.31	11.91	160	Excellent pressure test	N
88	7	2875.52	-2827.9	CQG	5846.21	11.92	4508.52	9.35	1853.7				5843.66	11.91	161	Excellent pressure test	N
89	8	2877.02	-2829.3	CQG	5846.93	11.91	4509.17	9.34	308.86				5844.98	11.91	161.6	Excellent pressure test	N
90	9	2886	-2837.9	CQG	5867.29	11.92	4514.27	9.32	108.98				5864.19	11.91	162.8	Very Good pressure test	N
91	10	2888.02	-2839.8	CQG	5868.37	11.91	4516.83	9.32	208.67				5866.3	11.91	163.8	Very Good pressure test	N
92	11	2886.02	-2837.9	CQG	5871.26	11.92	4511.33	9.32	0.01				5868.33	11.92		WATER IDENTIFICATION	
93	12	2851.03	-2804.5	CQG	5790.77	11.91	4498.06	9.4	149.57				5792.82	11.91	166	Very Good pressure test	N
94	13	2847.45	-2801.1	CQG	5785.16	11.91	4497.18	9.41	26.72				5786.33	11.91	165	Good pressure test	N
95	14	2846.53	-2800.2	CQG	5784.24	11.91	4497.01	9.41	195.68				5784.63	11.91	164.8	Very Good pressure test	N
96	15	2799.52	-2755.3	CQG	5687.23	11.91	5005.05	10.65	367.95				5694.19	11.92		SUPERCHARGED	
97	16	2801.22	-2757	CQG	5697.25	11.92							5696.73	11.92		LOST SEAL	SF
98	17	2865.03	-2817.9	CQG	5826.54	11.92	4609.15	9.59	0.81				5825.06	11.92		DRY TEST	
99	18	2864.9	-2817.7	CQG	5823.58	11.92	5823.88	12.12	22.96				5823.28	11.91		LOST SEAL	SF
100	20	2867.02	-2819.8	CQG	5826.77	11.91							5826.34	11.91		DRY TEST	
101	21	2776	-2732.9	CQG	5640.29	11.91	4478.25	9.61	235.92				5598.98	11.82	162.5	Very Good pressure test	N
102	22	2697.5	-2657.9	CQG	5487.61	11.92	4449.3	9.81	7.51				5488.58	11.93	158.8	Fair pressure test	N
104	23	2508.52	-2475.9	CQG	5124.34	11.97	4274.67	10.12	1204				5123.3	11.97	148.6	Excellent pressure test	N
105	24	2381.99	-2353.9	CQG	4867.91	11.98	4093.13	10.19	87.77				4868.83	11.98	144.4	Very Good pressure test	N

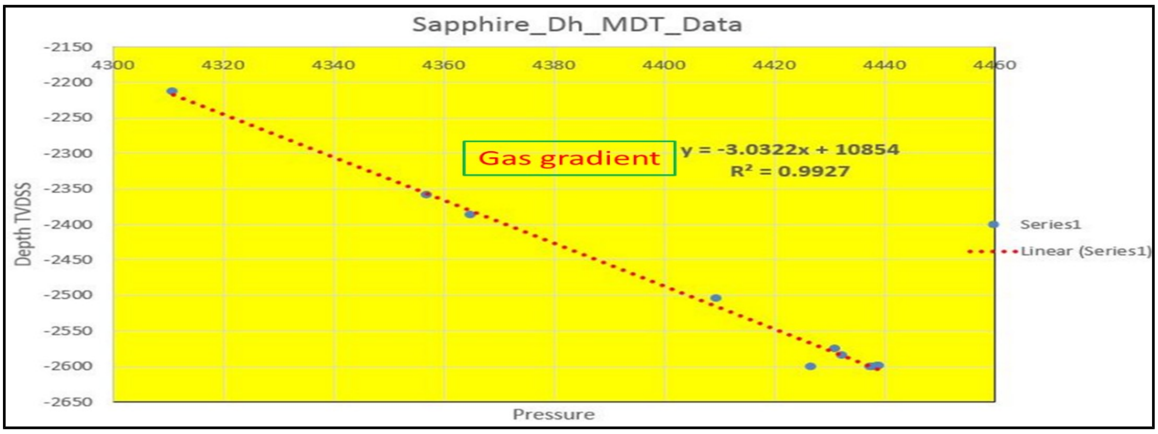

Figure 5. Shows the relation between depth (in meter) and pressure (in psi), which gives the gas gradient in both conventional and unconventional targets of Sapphire-Dh-well.

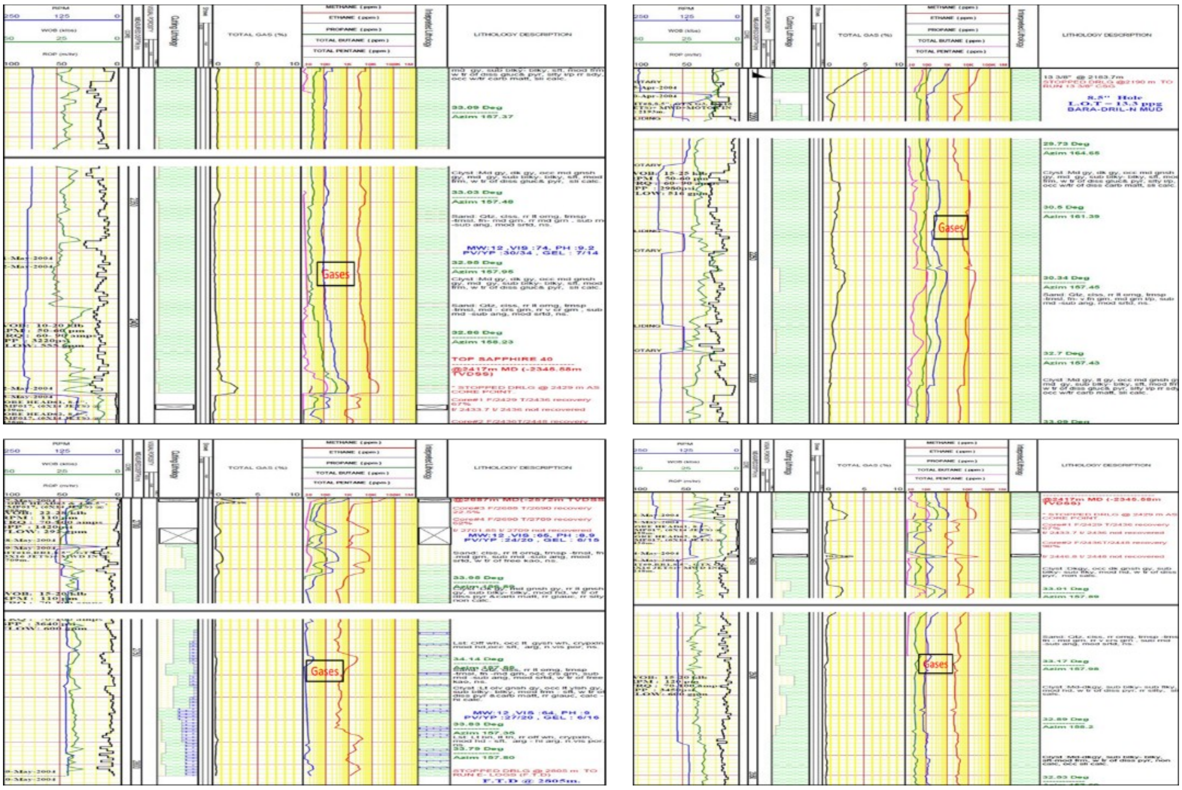

Figure 6. Shows detection of hydrocarbon by gas chromatograph and gas detector during the drilling of Sapphire-Dh well.

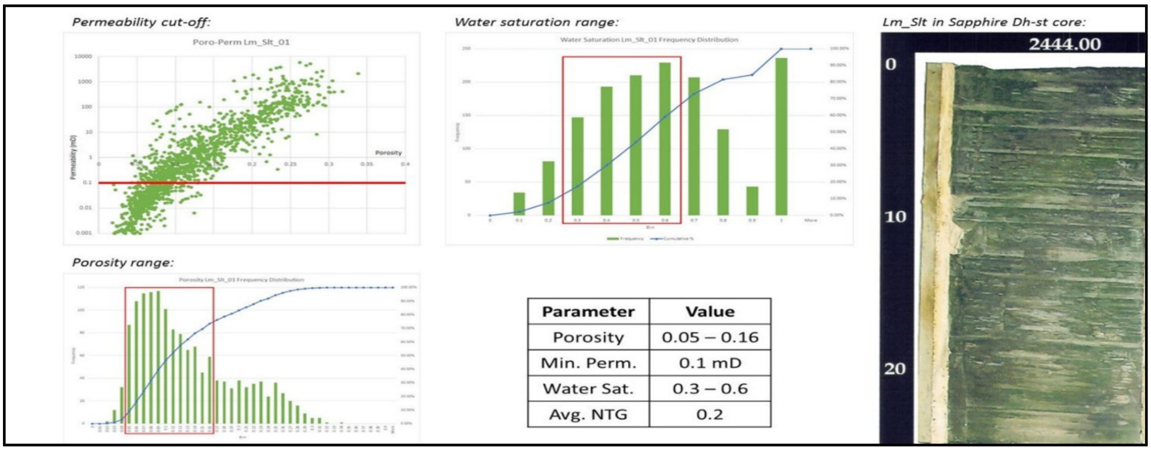

Figure 7. Shows laminated fine sandstone, including the petrophysical parameters (porosity, Permeability, Net to gross ratio and water saturation), porosity ranges from 0.05 to 0.16. Minimum permeability is 0.1 MD, water saturation ranges from 0.3 to 0.6 and net to gross ratio is 0.2 at depth 2444m.

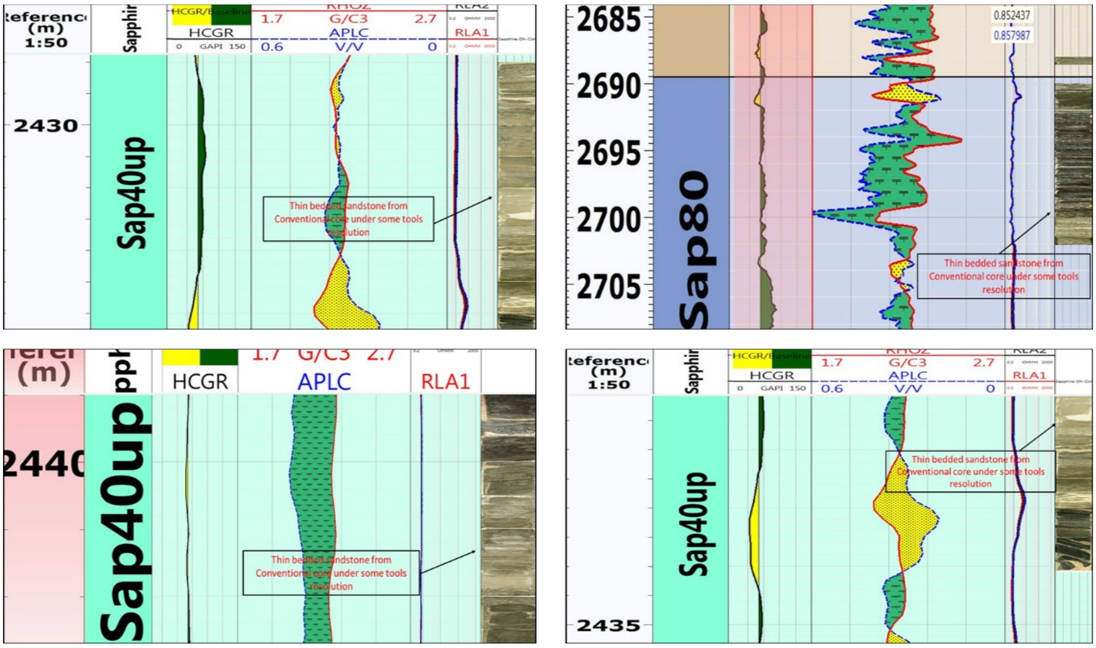

Figure 8. Shows conventional core versus logs at depth (2430m-2704m).

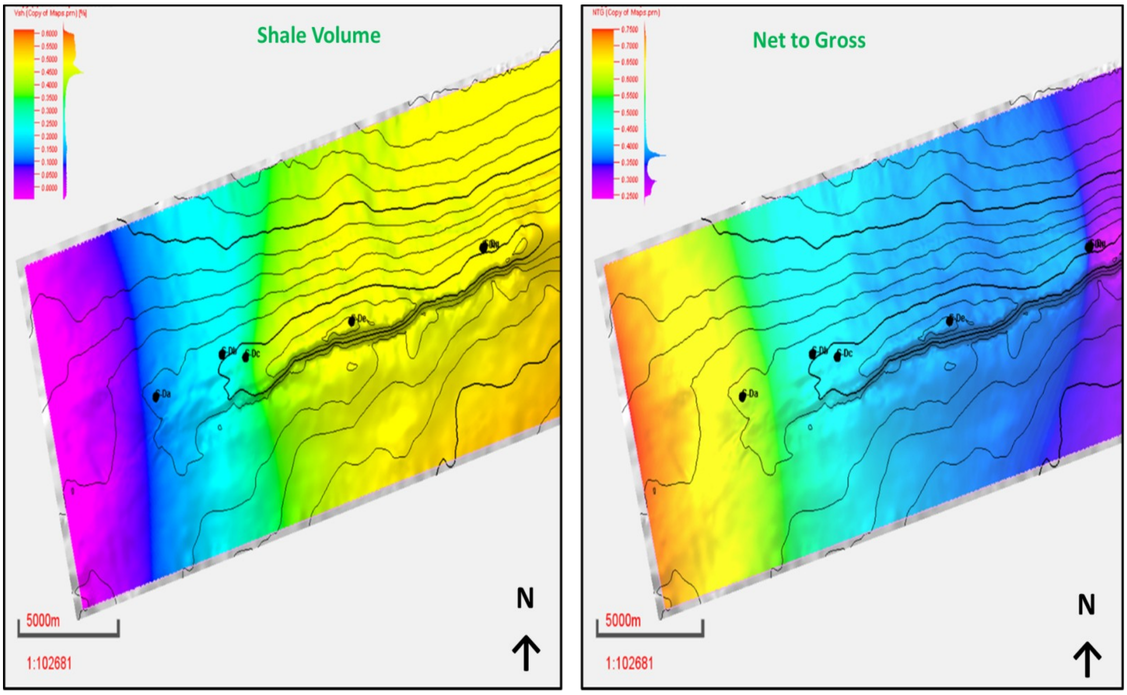

Figure 9.Shows Shale content and net to gross maps.

Detecting the amount of gas during drilling by gas

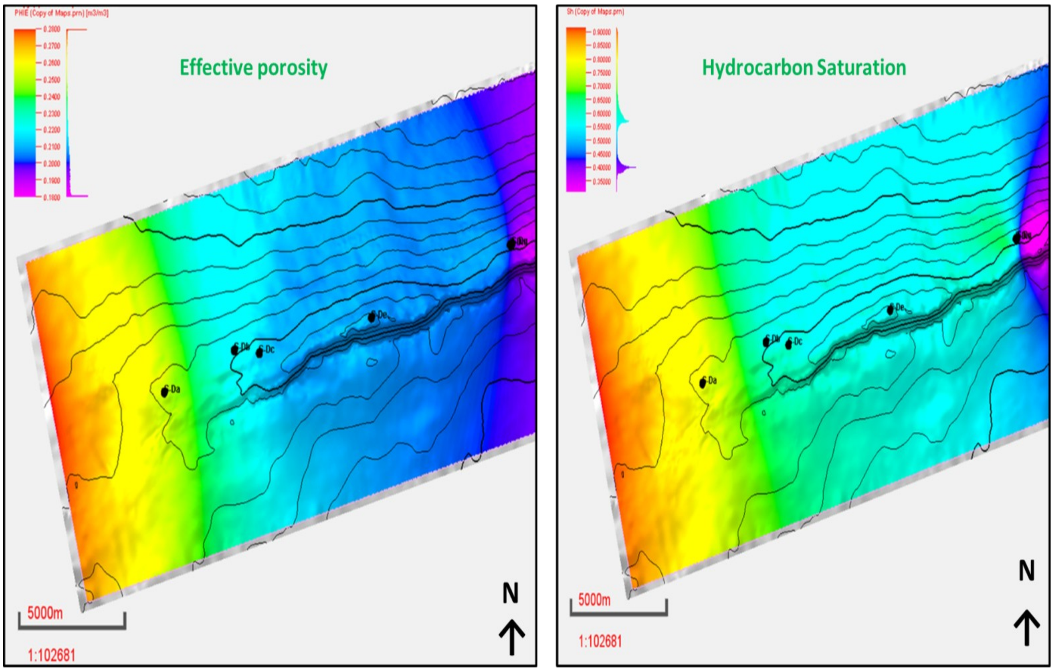

Figure 10.Shows effective porosity and hydrocarbon saturation maps.

CONCLUSIONS

The present work is devoted to the study of geologic setting, reservoir characterization and hydrocarbon detection through the conventional and advanced methods for Kafr El-Sheikh Formation at Sapphire field, Offshore Nile Delta, Egypt. The used wells are Sapphire-Da, Db, Dc, De, Dh and Dq.This is done through using the basic logging tools and advanced loggingtool, like the Modular dynamic tester (MDT) and Mud log during drilling also the conventional coresare analyzed carefully to detect the clean sandstone and thin bedded Sandstone of the studiedinterval.

These basic tools (gamma-ray, resistivity, density and neutron) reflectclean sandstone reservoir with good quality, but can't catch thin bedded sandstone reservoir, as a result of their low vertical resolution, this may miss several intervals charged with hydrocarbon during perforation and production from the field.So, we should run advanced tool like the Modular Dynamic Tester (MDT) and analyze the conventional cores, if found, and hydrocarbon in Mud log, to detect these missed intervals.

chromatograph and gas detector, is a very good indication of both clean and thin bedded sandstone reservoirs. This is because these gases come from the formation, as result of charging with hydrocarbon. In thin bedded sandstone reservoirs, the basic tools can't catch them as a result of their low vertical resolution, but appear clearly during drilling.

By making combination of all the basic logging tools, MDT, Mud logging and conventional cores,we can detect thin bedded sandstone reservoirs clearly and add new reserves toSapphire field didn't appear before.This is through detection of the amount of sands intercalated with shales and their hydrocarbon saturation, these new sands increase the life time of production and understanding Sapphire field in deep.

The results had showed clean sandstone reservoirs and thin bedded sandstone reservoirsthrough the advanced tools, which identify more than 68% deep water reserve should be takenin consideration in the future wells and workover wells.Excellent distribution of facies in both the static and dynamic models are established to increase the hydrocarbon production and the life time of producible wells.. The optimum location for forthcoming wells is south west of the field, because it has the best petrophysical parameters. It has high porosity, hydrocarbon saturation, and net to gross, in addition to low shale volume.

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تحديد الهيدروكربون بالطرق التقليدية والمتطورة لمتكون كفر الشيخ في حقل سفير البحري دلتا النيل مصر

<u>الخلاصة</u>:

يكرس هذا العمل لدراسة البيئة الجيولوجية وتوصيف الخزان والكشف عن المواد الهيدروكربونية بالطرق التقليدية والمتقدمة لمتكون كفر الشيخ في حقل الياقوت في دلتا النيل البحرية بمصر

الآبار المستخدمة في تلك الدراسة هي (سفير-دي اي و سفير دي بي و سفير دي سي و سفير دي ايه و سفير دي اتش وسفير دي كيو) باستخدام البيانات السيزمية،وتسجيلات الابار الاساسية والمتقدمة و العينات الصخرية الناتجة من حفر الابار و التتابع الصخري خلال الحفر

وتم الكشف عن الخزانات التقليدية باستخدام الأدوات الأساسية مثل (أشعة جاما، المقاومة، الكثافة والنيوترون)

اشعة جاما هي الإشعاع الصادر من من العناصر الموجودة في قشرة الأرض التي تخضع للتحلل الاشعاعي حيثتنبعث جسيمات ألفا وجزيئات بيتا وجسيمات أشعة جاما نتيجة تفكك انوية الذرات. من الجسيمات الثلاث المتولدة خلال الاضمحلال الإشعاعي الطبيعي، أشعة جاما هي الوحيدة التي يمكن أن تخترق الصخور لمسافة ملحوظة

أداة الكثافة توفر قياسات كثافة التكوين، وتشكيل عامل الكهروضوئية وقطر البئر وتستخدم بيانات الكثافة لحساب المسامية وتحديد الصخور. يتم استخدام مزيج من بيانات سجل النيوترونات والكثافة والتعويض للإشارة إلى وجود الهيدروكربون

المقاومة هي أداة مهمة جدا للدلالة على محتوى الصخورمن السوائل عن طريق إرسال التيار الكهربائي إلى الطبقة من قبل أجهزة الإرسال وقياس مقاومة الطبقات على أجهزة الاستقبال. انخفاض المقاومة هو مؤشر على وجود المياة او الصخر الزيتي، ومقاومة عالية هو مؤشر على وجود الهيدروكربون في الرمال. مزيج من المقاومة وأشعة جاما تعطي مؤشرا جيدا جدا على الغاز الموجود في طبقات الرمال

هذه الأدوات الأساسية (أشعة جاما، المقاومة، الكثافة والنيوترون) ,تحدد الخزان التقليدي بطريقة جيدة، ولكنها لا تستطيع أن تحدد الخزان غير التقليدي نتيجة دقتها المنخفضة، ولتحديد هذا الخزان الغير تقليدي لابد من استخدام ادوات متقدمة ذات دقة عالية

مثل والمتقدمة مثل اداة قياس الضغط وادوات قياس الهيدروكربون خلال الحفر والعينات الصخرية التقليدية

وأظهرت النتائج خزانات من الحجر الرملي الرقيق المتداخل مع الصخر الطيني بأدوات متقدمة مثل ادوات قياس الضغط والغازت الناتجه من الفتات الصخري خلال عمليات الحفر والاستدلال علي وجود حجر رملي دقيق متداخل مع الحجر الطيني من خلال تحليل العينات الصخرية في المعمل تحليلا دقيقاوسوف نأخذها في الاعتبار هذة الطبقات ليتم الانتاج منها في الآبار المستقبلية وتوزيع هذة السحنات في النموذج الساكن والنموذج الديناميكي لمضاهات الواقع التحت سطحي وعدم فقد طبقات محملة بالهيدروكربون ولإطالة حياة الآبار المنتجةوافضل الاماكن للحفر في هذا الحقل الجنوب الغربي من حيث احتوائه علي افضل المعملات البتروفزيائيه