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PETROPHYSICAL EVALUATION OF MIT GHAMR FORMATION, TAURT GAS FIELD, RAS EL-BARR CONCESSION, OFFSHORE NILE DELTA, EGYPT

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التقييم البتروفيزيقي لتكوين ميت غمر، حقل الغاز تورت، منطقة امتياز رأس البر، دلتا النيل البحرية، مصر

الخلاصة: تعتبر دلتا النيل البحرية من أهم المناطق الواعدة لاستكشاف حقول الغاز بمصر والشرق الأوسط. يختص البحث بدراسة حقل تورت في الجزء الشرقي بمنطقة امتياز رأس البر، دلتا النيل البحريه، مصر، عن طريق تسجيلات الآبار المتاحة التي تساعدنا في الحصول علي المعلومات الخاصة بالخواص الفيزيائية لتتابع الصخورتحت السطحية المتواجدة في الابار أثناء الحفر.الهدف الرئيسي من الدراسة هو التقييم الشامل للرسوبيات الرملية الحاوية للغاز بتكوين ميت غمر المتواجد في العمرالجيولوجي البلستوسين المبكر لحقل تورت، منطقة امتياز رأس البر، دلتا النيل البحرية بمصر عند دائرة العرض N "0.3768 '32 °29 وخط الطول14.5020"E '16 °31 . وقد تم التقييم البتروفيزيقي لحقل تورت بواسطة دراسة وتحليل لتسجيلات الابار المتاحة المتواجدة بالحقل (T-01, T-02, T-03, T-04 and T-05)، الرسومات البيانية المختلفة بين تسجيلات الآبار، دراسة البيانات الخاصة بتسجيلات الضغط داخل الآبار وذلك لحساب حجم الطين (Vsh)، المسامية الفعلية (Φe)، مقاومة الماء (Rw)، التشبع الهيدروكربوني (Sh) وخصائص أخري متنوعه. كشفت هذه الدراسة عن ثلاث خزانات رملية (S10, S20 and S30) بتكوين ميت غمر حاوية للغاز بحقل تورت وعمق السطح الفاصل بين الغاز والماء يصل ١٣٧٠ متر تحت سطح البحر، معرفة التغيير الراسي والافقي للخصائص البتروفيزيقية والصخرية عن طريق رسم الخرائط والرسومات البيانيه، تواجد اتصال رأسي وأفقي بين الآبار وخزانات الغاز (S10, S20 and S30) بواسطة تحليل بيانات الضغط.

ABSTRACT: *Well logging is a study of acquiring information on physical properties of rocks that are exposed during drilling of wells. The present study deals with evaluation of the gas-bearing sand formations of Early Pleistocene sediments (Mit Ghamr Formation) of five wells located in Taurt field, Ras El-Barr Concession, Offshore Nile Delta of Egypt at latitude 29° 32' 0.3768'' N and longitude 31° 16' 14.5020''E. The petrophysical evaluation of Taurt field by using the available well logs, cross plots and the pressure datasets for determining the different petrophysical parameters such as shale volume (Vsh), effective porosity (Φe) , formation water resistivity (Rw), hydrocarbon saturation (Sh)..etc, necessary for reservoir evaluation. This study reveals the presence of three gas-bearing sand zones (S10, S20 and S30) of Taurt field that located in eastern offshore part of the Nile Delta, Egypt with good hydrocarbon potential, encountered at different depth levels at the Pleistocene Mit Ghamr Formation.*

In all studied wells, three hydrocarbon bearing levels were delineated from well logs. These horizons were analyzed and the petrophysical parameters were estimated. Well log analysis revealed that the gas-water contact is at 1370m TVDSS. The constructed litho-saturation cross plots reflect the vertical variation of the petrophysical characteristics and iso-parametric maps to verify the lateral variation of petrophysical properties. The analysis of pressure data is concerned mainly with locating the different fluid contacts, vertical and horizontal connection between reservoirs and determining the pressure gradients of the gas-bearing zones. Very close pressure regimes are detected for most of the investigated gas zones throughout the study area.

INTRODUCTION

The offshore Nile Delta is one of the most promising areas for gas exploration and production in Egypt and the Middle East. Taurt field is located in the Mediterranean Sea approximately 72Km from offshore in the East Nile Delta area at a fault block to the northeast of Ha'py Field and northwest of the Denise Field in 108 m water depth (Fig.1). BP has 50% working interest and is the operator for the concession with IEOC as the equal partner of the Taurt project holding the other 50%. The field discovered with the drilling of Taurt-1 well in March 2004 and then Taurt-2 appraisal well in June 2004. Taurt is the first subsea-to-shore gas field development in BP's portfolio and the first subsea well production for BP Egypt. Taurt consists of six sand Pleistocene reservoir units called S10, S20, S30, S40 and S50 and the recent study for S10, S20 and S30. Down holes fluid samples have been collected from the exploration and the appraisal wells, which indicate that the reservoir fluids are considered dry gas.

Accurate petrophysical evaluation of Taurt field, gas reservoir composed of sand-shale sequences is crucial in the economic decision to explore, develop, and produce these reservoirs so that advanced and conventional logging techniques are used to identify reservoir characteristics accurately and select the best model for this area to determine water saturation, porosity, shale volume as there are different saturation models as there is no precise limitations to use certain model than others, so there should be many researches to help log analysts to choose the most suitable and representative shaly sand model for a certain formation.

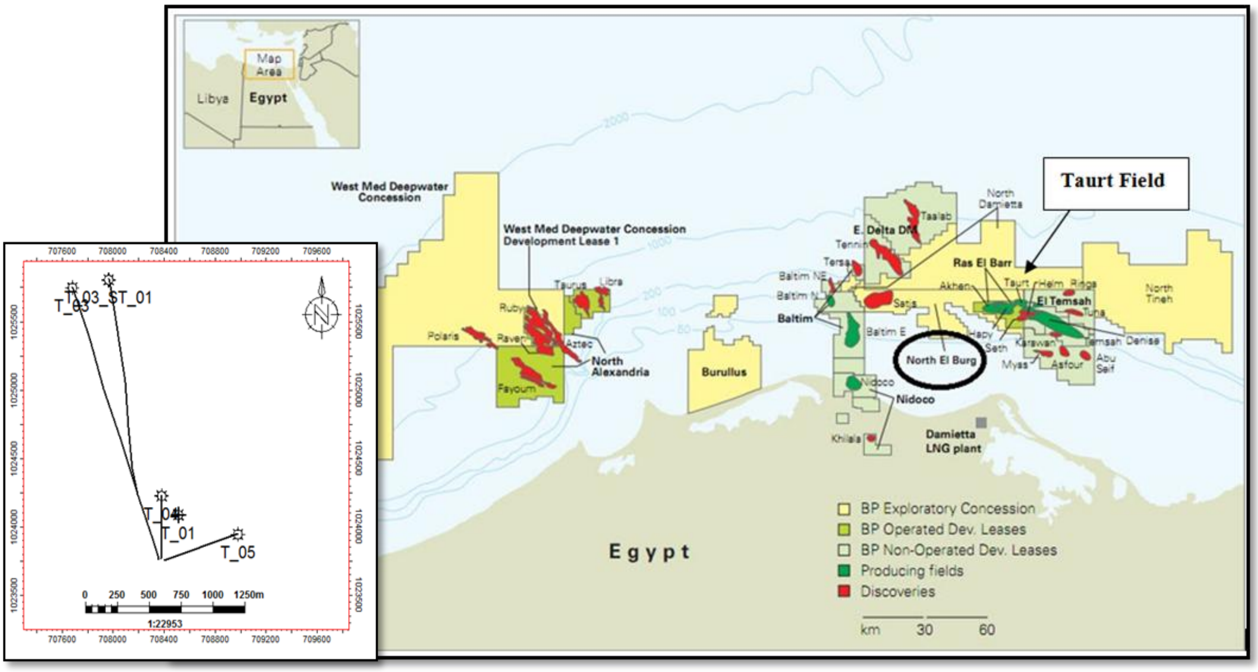

Fig. (1): Taurt Field location map, Offshore Nile Delta (Bb, internal report 2007).

GEOLOGIC SETTING

The offshore Nile delta basin was structurally divided into eastern, central and western sub-basins. The structural pattern of the study area is the result of a complex interplay between three major fault trends: 1) NW-oriented Misafq-Bardawil (Temsah) trend; 2) NE-oriented Qattara-Eratosthenes (Rosetta) trend (Abdel Aal, et al., 1994); and 3) E-W trending faults delineating the Messinian salt basin.

Taurt field accumulation is trapped in a tilted fault-block between two N-dipping listric growth faults. The faults of the S10, S20 and S30 reservoirs are trapped in a tilted fault-block between northeast-southwest (NE-SW) fault and northwest-southeast (NW-SE) fault which are listric growth faults (Bb internal report 2007).

The Early Tertiary to Plio-Pleistocene sequence in the eastern Mediterranean region forms several sedimentary basins. The present study for the Pleistocene Mit Ghamr Formation that contains thick layers of sands and pebbles, which represent the filling of the basin by costal sands or by deposits from Nile flooding that reflects shallow marine to fluvial environments (Barakat, 2010).

The sands are medium to coarse grained quartzite. The pebbles consist of quartzite, chert and dolomites. The sands can also contain shells of pelecypods (Rizzini et al., 1978). Mit Ghamr Formation unconformably overlies the El-Wastani Formation and is unconformably overlain by the Bilqas Formation (EGPC, 1994).

METHODOLOGY

Reservoir petrophysical evaluation and environmental correction of well log analysis has been carried out using Techlog (2011.2) software for S10, S20 and S30 reservoir in Taurt field using available logging data for five wells (T-01, T-02, T-03, T-04 and T-05) by density, sonic, gamma ray, neutron, thorium, potassium and resistivity logs.

Lithological evaluation and clay minerals analysis of Mit Ghamr Formation within the studied wells by using cross plots of well logging parameters (dia-porosity as neutron-density, tri-porosity as MN, MID and Th/K cross plots).Vertical petrophysical parameters distribution in each well in the form of litho-saturation cross plots was done. The analysis of MDT reservoir pressure test data for detection horizontal and vertical reservoirs connectivity in the form of pressure depth plots is performed. Iso-parametric maps for the lateral variations in petrophysical parameters are established.

RESERVOIR PETROPHYSICAL EVALUATION

Before starting petrophysical evaluation, reservoir units identification was done from analysis and zonation of well logs, reservoir petrophysical characterisation has been carried out by calculating porosity, fluid saturation, and reservoir thickness.

Shale Volume Determination Methods (V_{sh})

The presence of shale represent a serious problems in reservoir properties determination as saturation, porosity..etc. and estimates of reserves and producibility (Darwin and Julian, 2008). The volume of shale is calculated using GR clay indicator by the Schlumberger (1974) formulas and neutron-density as double curve clay indicator.

In the study area, due to the washout effect on GR logs, shale volume calculation from neutron-density is preferred. Fig. (2A), shows that V_{sh} calculation using neutron/density logs for T-01 well, gas reservoir zones have low percent of V_{sh} which indicate that Mit Ghamr reservoir units are clean formation while high V_{sh} percent at the base of pay zones due to the occurrence of shale.

Determination of Effective Porosity (Φ_e)

The effective porosity is the total porosity less the fraction of the pore space occupied by shale or clay, represents pore space that contains hydrocarbon and non-clay water and depends largely on the degree of connection between the rock pores with each other forming channels, to facilitate the paths of fluids, through the lithologic content.

The effective porosity calculation was done by using density, combination of neutron-density and neutron-sonic logs. The effective porosity calculated from density log is more matching with core porosity data for T-01 well; hence it is the most reliable for effective porosity estimation (Fig.2A).

Evaluation of Water Resistivity (R_W)

The reservoir water resistivity (R_w) is an important parameter since it is required for the calculation of water and hydrocarbon saturations. Practically, there are several ways to estimate the formation water resistivity (R_w) such as the Pickett plot. The Pickett plots showed that R_w value is 0.07 Ω.m for sand reservoir at formation temperature (50^{o}c).

Determination of Fluid Saturation

The fluid saturations determination means the differentiation between the various types of fluid components water and hydrocarbons movable and residual. There are many equations for determining water saturation such as Archie, Dual Water, Indonesia,..etc which depend on the availability of well log data and the type of formation.

In the study area an empirical model called "Indonesia formula" of Poupon and Leveaux (1971) is used for calculating water saturation in uninvaded zone (S_w) and in the flushed zone (S_{xo}). Hydrocarbon saturation is usually determined by the difference between unity and water saturation. The ratio of the uninvaded zone's water saturation (S_w) to the flushed zone's water saturation (S_{xo}) is an index of hydrocarbon moveability. Fig. (2A), represent gas and water saturation for T-01 well, high gas saturation in S10 and S20 reservoir units and high water saturation for shale zones.

LITHOLOGY INTERPRETATION AND CORRELATION

Lithology means the study of physical properties and composition of rocks such as sandstone, limestone, dolomite and shale. The techniques are presented using different crossplots of well logging parameters as follows:

Neutron (NPHI)–Density (RHOB) Crossplot

Neutron-density measurements are affected by porosity, hydrocarbon density, and lithology which include both clay and non-clay minerals. If we know two of these factors, we can solve for the other two (Darwin and Julian, 2008).

Tri-Porosity M-N and MID crossplot

M-N plots was used for minerals identification, depend on the fluid and log parameters, which are incorporated together essentially in the three logs (Δt, ρ_b and $Ø_N$).

From these values, M and N functions are calculated, which are independent of the primary porosity, MID depend on the calculation of the apparent matrix parameters RHOMAA and DTMAA which are given through the computation of ROHM and DTMA (Wyllie, 1963).

Clay Minerals Identification Crossplot

The clay minerals must be identified due to their great effect on the hydrocarbon bearing zone. The clay rocks microstructure is a sensitive indicator of the rock formation environment and various combinations of microstructure features are in strong relation with the rock properties. The clay minerals identification depends on Th/K relationship.

VERTICAL AND LATERAL PETROPHYSICAL PARAMETERS DISTRIBUTION

Petrophysical parameters of the rock fluid constituents, including shale content, formation porosity, fluid saturation forming the rock material of Mit Ghamr Formation are necessary to evaluate the hydrocarbon occurrences in the reservoir as the following:

Litho-Saturation Crossplots

Litho-Saturation crossplots are done to clarify the vertical distribution of petrophysical characterization and gas occurrences in the interested formations, density, neutron and resistivity logs were adopted to evaluate various reservoir intervals.

ISO-PARAMETRIC MAPS

The petrophysical parameters of Mit Ghamr Formation (pay A and pay B zones) extracted from well logging data were averaged and shown in (Table1). Combined iso-parametric contour maps for these parameters were constructed using petrel (2014.2) software to reflect the lateral distribution throughout the Pleistocene Mit Ghamr reservoir. The maps are for two pays; the pay zone A is S10 unit and the pay zone B is connected S20 and S30 units.

EVALUATION OF RESERVOIR PRESSURE SYSTEM

Pressure analysis of Taurt field based on Modular Dynamic Formation Tester (MDT) data represent well test, means that some fluid is produced from the formation, generally to the surface, Flow rates and bottom hole pressures are measured during the test. A plot of formation pressure against depth can give a large amount of valuable information to the reservoir engineer.

Table (1): Reservoir parameters of Mit Ghamr pay zones.

Well Name	FM Name	Pay Zone Name	V_{sh}(%)	PHIE(%)	S_g (%)	Net Pay Thickness (m)	Top TVDSS (m)
T-01	S10	A	3	32	60	32	1088
	S20.1, S20.2 & S20.3	B	2.8	31.5	60.3	139	1184
T-02	S20.3, S30.1& S30.3	B	4.1	30.5	49.4	48.5	1256
T-03	S10	A	0	35	58	25	1105
	S30.1	B	0.5	42.7	85.6	49	1199
T-04	S10	A	0.1	35	64	33.5	1092
	S20.1, S20.2 & S20.3	B	0.5	36.1	78.9	130	1187.5
T-05	S10	A	0.3	40	70	31.5	1087
	S20.1, S20.2 & S20.3	B	3.1	36.2	78.7	134	1184
T-06	S20.3, S30.2 & S30.3	B	5.8	34.9	52.2	27.5	1558
T-07	S20.3, S30.2 & S30.3	B	0.2	35.6	57.2	31	1253

Table (2): The pressure gradient and fluid type of T-01 well.

FM Name	Pay Zone Name	Pressure Gradient (psi/ft)	Pressure Gradient (psi/m)	Density (g/cc)	Fluid Type
S10	Pay Zone A	0.0308	0.1011	0.071	Gas
S20.1, S20.2 and S20.3	Pay Zone B	0.0422	0.1385	0.029	Gas
S30.3	Aquifer	0.4372	1.434	1	Water

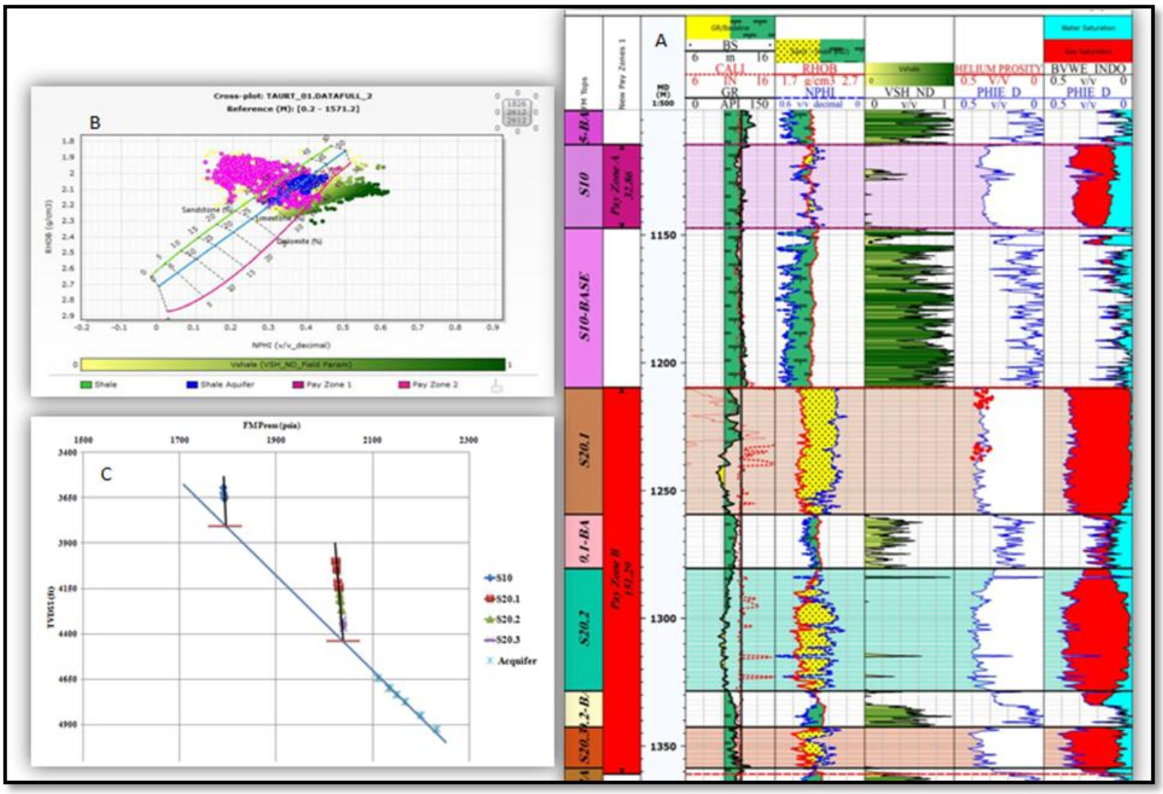

Fig. 2: (A) Petrophysical evaluation, (B) NPHI/RHOB crossplot, (C) Pressure depth plot, T-01 well.

The pressure gradient can be interpreted in terms of formation fluid density using following equation. It gives an indication of the nature of the formation fluid (gas or water) as well as positions of the gas-water contact (GWC).

Fluid density (g/cm3) = Pressure gradient (psi/m)/1.422

Analysis of Mit Ghamr Gas Reservoir

The petrophysical evaluation of S10, S20 and S30 reservoirs and lithology interpretation of it, are illustrated through the lithology identification crossplots, show the vertical distribution of petrophysical parameters using litho-saturation crossplots, S10,S20 and S30 reservoir connectivity using pressure plots and lateral distribution of petrophysical parameters by Iso-parametric maps.

- **Results and Analysis of T-01 well:**
- **Petrophysical evaluation of T-01 well:**

In Fig. (2A), S10 and S20 (S20.1, S20.2 and S20.3) gas reservoir units have low value of $V_{sh}< 10$ % that indicate clean reservoir units, high Φ_e with high gas saturation.

- **Neutron –Density Crossplot of T-01well:**

In Fig. (2B) , The NPHI/RHOB crossplot for T-01well, the main lithology is clean sandstone to shaly sandstone with porosity values ranging from 30% to 40% on clean sandstone line, Shale aquifer points are scattered on limestone line due to the effect of the calcareous materials, dark green points are scattered right downward between dolomite and limestone lines because of the effect of shale lithology. The location of pay zones points are shifted to west upward direction due to the gas effect.

- **Single Pressure-Depth plot of T-01 Well:**

Fig. (2C), shows the MDT analysis for the well and note that lines with different gradient indicating various fluid types. The point of intersection between lines represent changes in mobile phase fluid density (Table 2) from gas to water and thus fluid contacts defined as GWC. There are vertical connection between S20.1, S20.2 and S20.3, There are two pay zones; Pay zone A is S10 unit at GWC is 3800 ft. TVDSS and pay zone B is connected S20 units at GWC is 4500 ft TVDSS.

- **Results and Analysis of T-02 well:**
- **Pickett plot of T-02 well:**

Fig. (3), (A) shows clean water zone in T-02, (B) represent Pickett's plot with shale volume (V_{sh}) bar color which applied on clean water zone where most of points are scattered around S_w=100%, using a=1, m=n=1.8 from cores data analysis, Rw=0.09 Ω.m then corrected it at formation temperature =50 ^{o}c so Rw=0.07 Ω.m that used in formation water saturation determination.

- **Neutron –Density Crossplot of T-02 well:**

In Fig. (4B), The plotted points of pay zones are scattered around sandstone and limestone lines with porosity values ranging from 30% to 35% so pay zones are mainly sandstone with limestone intercalations. Green points are shifted right downward due to the shale effect, This indicates the presence of shale lithology mixed with calcareous sandstone pay zones. The gas effect is observed where some points have moved upwards. Clean aquifer points are scattered between sandstone and limestone line, so clean aquifer rock is limestone rock with sandstone intercalations.

- **M-N and MID crossplot of T-02 well:**

In Fig. (4C), M-N plots for T-02 indicating clean aquifer points located at the quartz and calcite points, mean lithology of aquifer is limestone with sand intercalations, the data points are migrated in right direction indicating gas effect, the data points are shifted in downward direction due to shale effect.

- **Single Pressure-Depth plot of T-02 Well:**

Fig. (4D), represents the MDT analysis for T-02 well where lines with different gradient showing various fluid types. The point of intersection between lines due to changing in mobile phase fluid density (Table 3) from gas to water and thus fluid contacts defined as GWC. There are vertical connection between S20.1, S20.2 and S20.3, There are two pay zones; Pay zone A is S10 unit at GWC is 3800 ft. TVDSS and pay zone B is connected S20 units at GWC is 4500 ft TVDSS.

Table (3): The pressure gradient and fluid type of T-02 well.

FM Name	Pay Zone Name	Pressure Gradient (psi/ft)	Pressure Gradient (psi/m)	Density (g/cc)	Fluid Type
S20.3,S30.1 and S30.3	Pay Zone B	0.0594	0.1951	0.137	Gas
S50	Clean Aquifer	0.4382	1.437	1	Water

- **Litho-Saturation Crossplot of T-02 well:**

Fig. (4A) shows that the litho-saturation cross plot of connected S20 and S30 reservoir units (pay zone B) 1282m. to 1397m. MD with main lithology is sandstone with smectite and mixed-layer illite-smectite shale intercalations where Avg. V_{sh}, Φ_e and S_h are 4.1%, 30.5% and 49.4% respectively. Reservoir sand dominated by rock type 1 and 2 which is medium to fine- grained sandstone, with modest amounts of clay (~5%).

- **Results and Analysis of T-04 well:**
- **Th/K crossplot for T-04:**

In Fig. (5B), Th/K relationship for T-04, explain clay minerals within Mit Ghamr Formation is a mixture of montmorillonite and illite clay type marine environment.

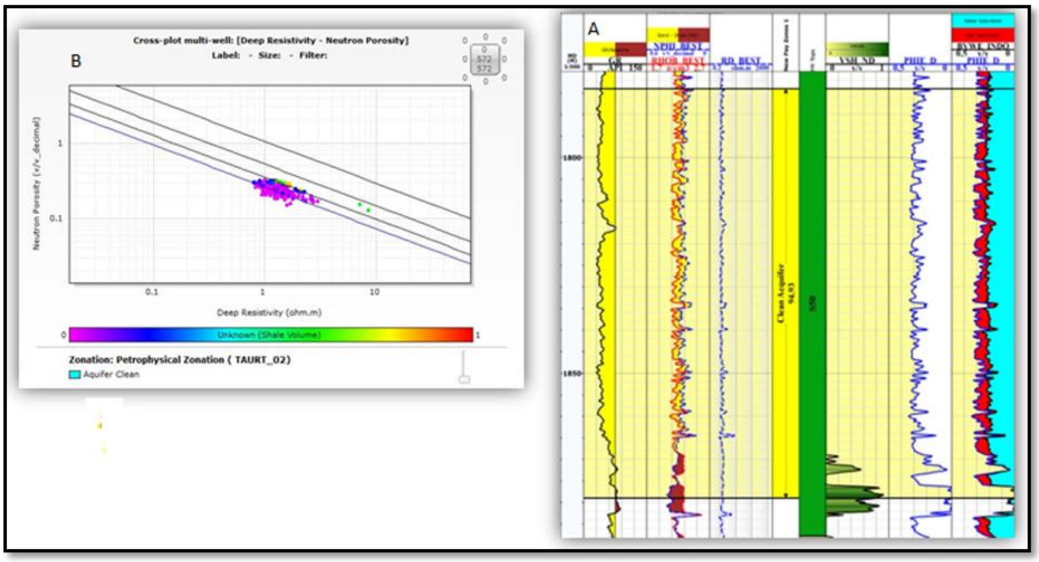

Fig. 3: (A) Clean aquifer formation and (B) Pickett crossplot, T-02 well.

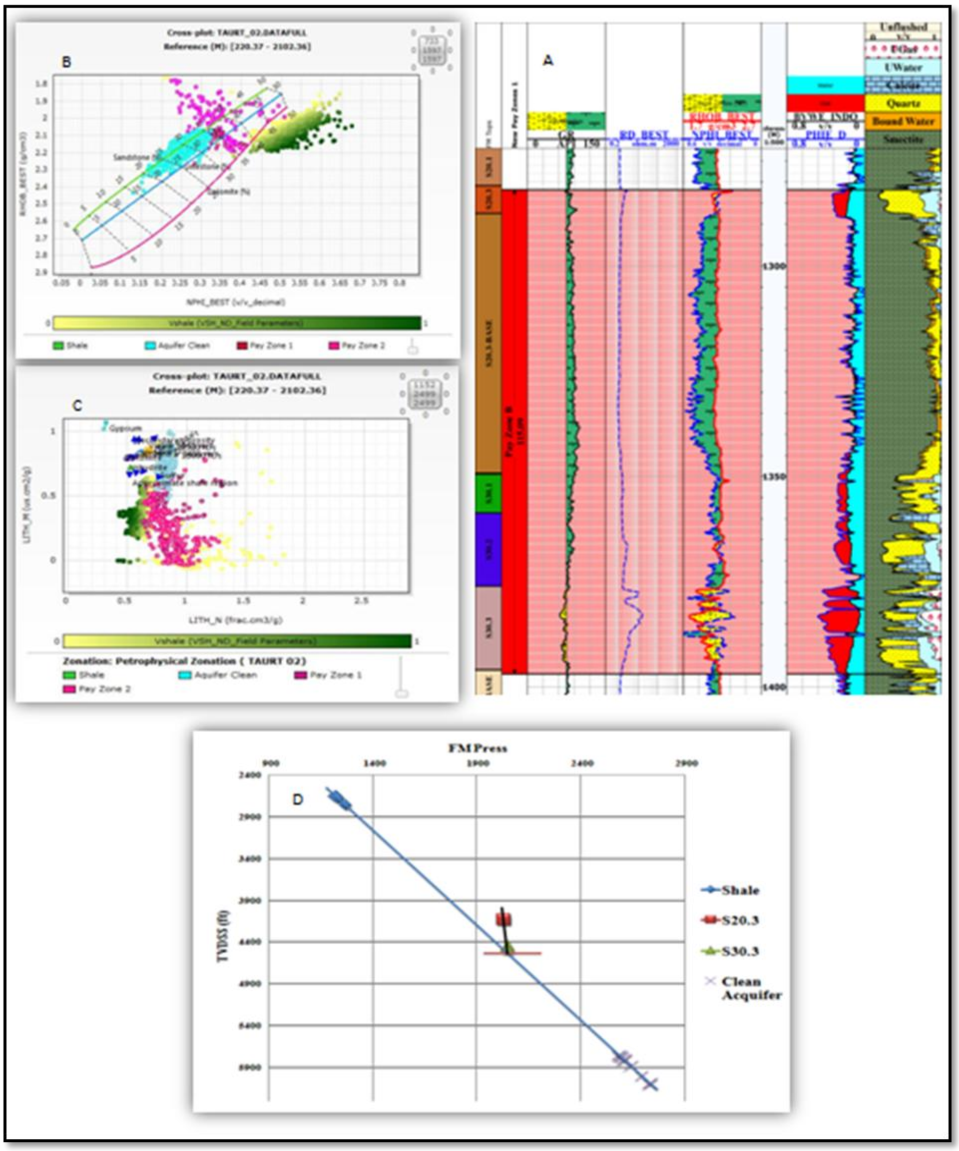

Fig. 4: (A) indicate litho-saturation crossplot, (B) shows NPHI/RHOB crossplot, (C) MID crossplot and (D) pressure depth plot, T-02 well.

➢ Litho-Saturation Crossplot of T-04 well:

In Fig. (5A) the litho-saturation cross plot of T-04 well indicates coarsening upwards cycle due to shallow marine sand bar model for Pleistocene Mit Ghamr Formation. Two main pay zones; pay zone A is S10 unit from 1115 to 1148m. MD with main lithology is sandstone with smectite shale intercalations where Avg. V_{sh}, Φ_e and S_h are 3, 32 and 60% respectively. Pay zone B consists of three connected reservoir units S20.1, S20.2 and S20.3 from 1210 to 1360 m MD with main lithology is sandstone with smectite shale intercalations where Avg. V_{sh}, Φ_e and S_h are 4, 33 and 79% respectively.

➢ Single Pressure-Depth plot of T-04 Well:

Fig. (5C): The MDT analysis for the well and note that lines with different gradient indicating various fluid types (Table 4). There are vertical connection between S20.1, S20.2 and S20.3, There are two pay zones; Pay zone A is S10 unit at GWC is 3880 ft. TVDSS and pay zone B is connected with S20 units at GWC is 4380 ft TVDSS.

➢ Multi Pressure-Depth plots of T-01,T-02, T-03 and T-04 Wells:

In Fig. (6): MDT pressure data analysis for wells indicate horizontal pressure connection between T-01,T-02,T-03 and T-04 wells, vertical connection between units S20.1, S20.2, S20.3, S30.1 and S30.3 units thus Mit Gahmr reservoir is group of connected stacked sand units with similar fluid property, intersecting point between lines represent changes in mobile phase fluid density (Table 5) from gas to water, Mit Ghamr reservoir is defined as two pay zones; pay zone A is S10 with GWC at 4020 ft. TVDSS and pay zone B is connected with S20 and S30 reservoir units with GWC at 4500 ft.

➢ Iso-parametric Maps for Pay Zone A:

Fig. (7), shows lateral distribution of petrophysical parameters, (A) shale volume map illustrates that shale content decreases in NW and SE part of the area at T-03 and T-05 wells, while shale content increase in center of the map. (B) map shows increasing of effective porosity in SE part of the study area (32 to 40%) at T-05 well. (C) map represents gas saturation distribution of S10 that increases in SE part of the area under investigation (58 to70%). (D) net pay thickness distribution map shows the variation in effective thickness values from Min. value in NW of the study area at T-03 well where sand bar reservoir is pinched out and a maximum value in SE of the study area at T-05 well (25 to 34 m). (E) reservoir top depth map distribution of S10 unit illustrates depth decrease towards SE part of the area and thus gas fluids migrated in SE part. The maximum gas saturation (70%) lies in SE part of the interested area.

➢ Iso-parametric Maps for Pay Zone B:

In Fig. (8), the lateral distribution of petrophysical parameters, (A) shale volume map illustrates that shale content increases of S20 and S30 reservoir units in NE part of the area at T-06 (0.2 to 5.8%). (B) map shows that increasing of effective porosity in western part of the study area (30 to 42%). (C) map represent gas saturation distribution which increases in western part

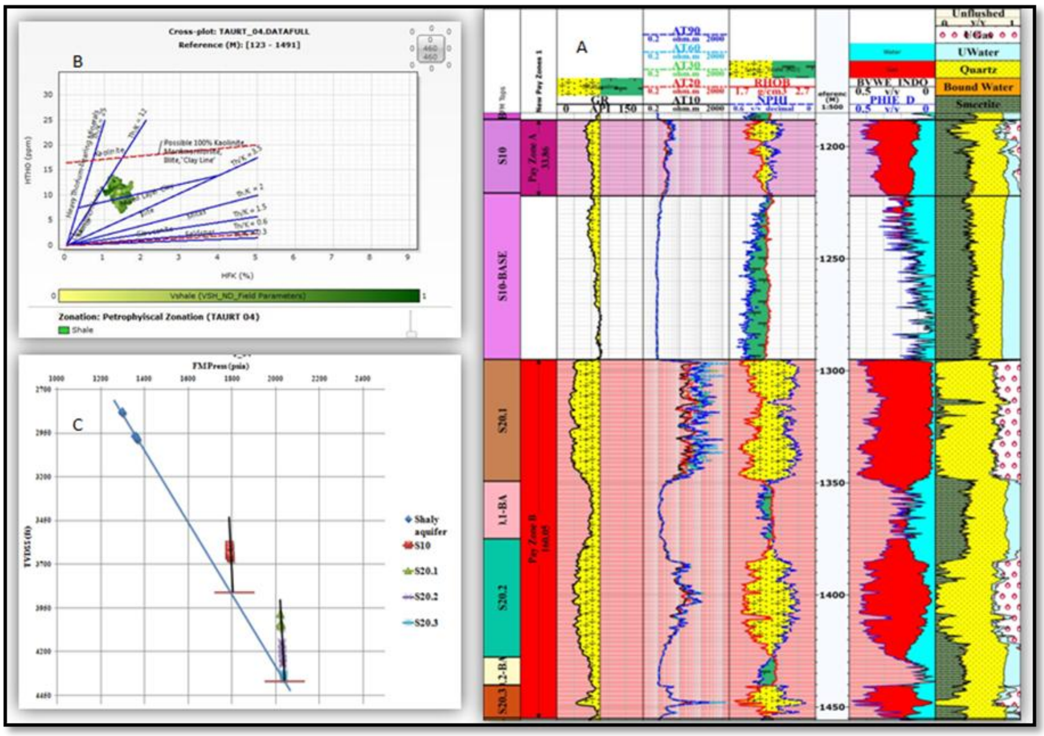

Fig. 5: (A) litho-saturation crossplot, (B) Th/K crossplot and (C) pressure depth plot, T-04 well.

Table (4): The pressure gradient and fluid type of T-04 well.

FM Name	Pay Zone Name	Pressure Gradient (psi/ft)	Pressure Gradient (psi/m)	Density (g/cc)	Fluid Type
S10	Pay Zone A	0.0783	0.2572	0.1808	Gas
S20.1, S20.2 and S20.3	Pay Zone B	0.0428	0.1405	0.0988	Gas
SH-base	Shaly Aquifer	0.4446	1.458	1.025	Water

Table (5): The pressure gradient and fluid type of Taurt field wells.

TVDSS (ft)	Well Name	Formation Name	Pay Zone Name	Press. gradient (psi/m)	Fluid density (g/c.c)	Fluid type	GWC (ft.)
3596:3653.4	T-01	S10	Zone A	0.196	0.138	Gas	4020
3614:3640	T-03						
3591:3668	T-04						
4002:4367	T-01	S20.1, S20.2 and S20.3	Zone B	0.16	0.112	Gas	4500
4124:4185	T-02	S20.3, S30.1 and S30.3					
4496:4570	T-03	S30.1					
3986:4355	T-04	S20.1, S20.2 and S20.3					
5757:6004	T-02	S50	Clean Aquifer	1.43	1.01	Water	

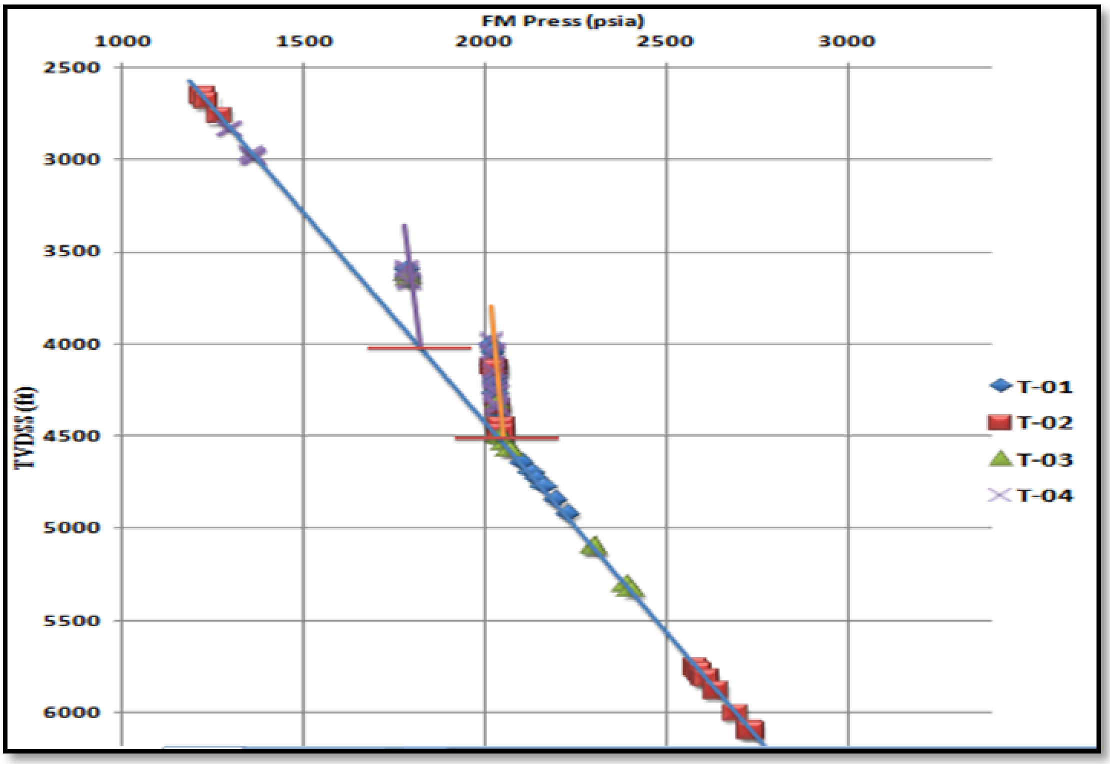

Fig. 6: pressure depth crossplot for T-01, T-02, T-03 and T-04 wells.

of the area under investigation (49 to 85%). (D) net pay thickness distribution map shows the variation in effective thickness values from Min. value in NW of the study area at T-02, T-03, T-06 and T-07 wells where sand bar reservoir is pinched out into marine marls to north and Max. value in SE of the study area at T-05 well (27 to139 m), (E) top depth map distribution of S20 and S30 reservoir units illustrate depth decrease towards SE part of the area and thus gas fluids migrated in southern part so Max. gas saturation (85%) lies in SW part of the interested area.

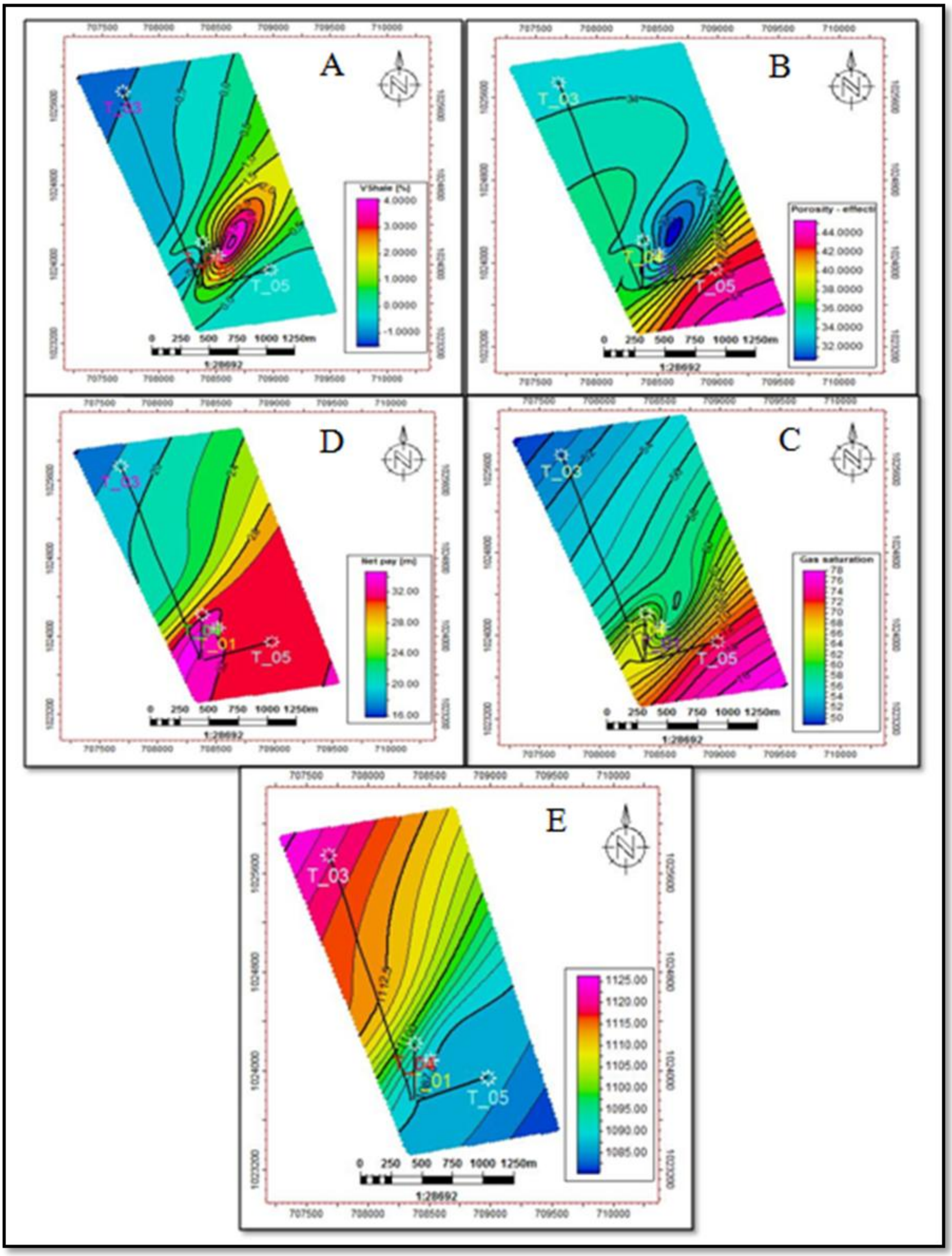

Fig. 7: Combined iso-parameteric maps for pay zone A, (A) shale volume (V_{sh}) map, (B) effective poroity (Φ_e) distribution map, (C) gas saturation (S_g) distribution map, (D) net pay thickness map and (E) top depth (TVDSS) map.

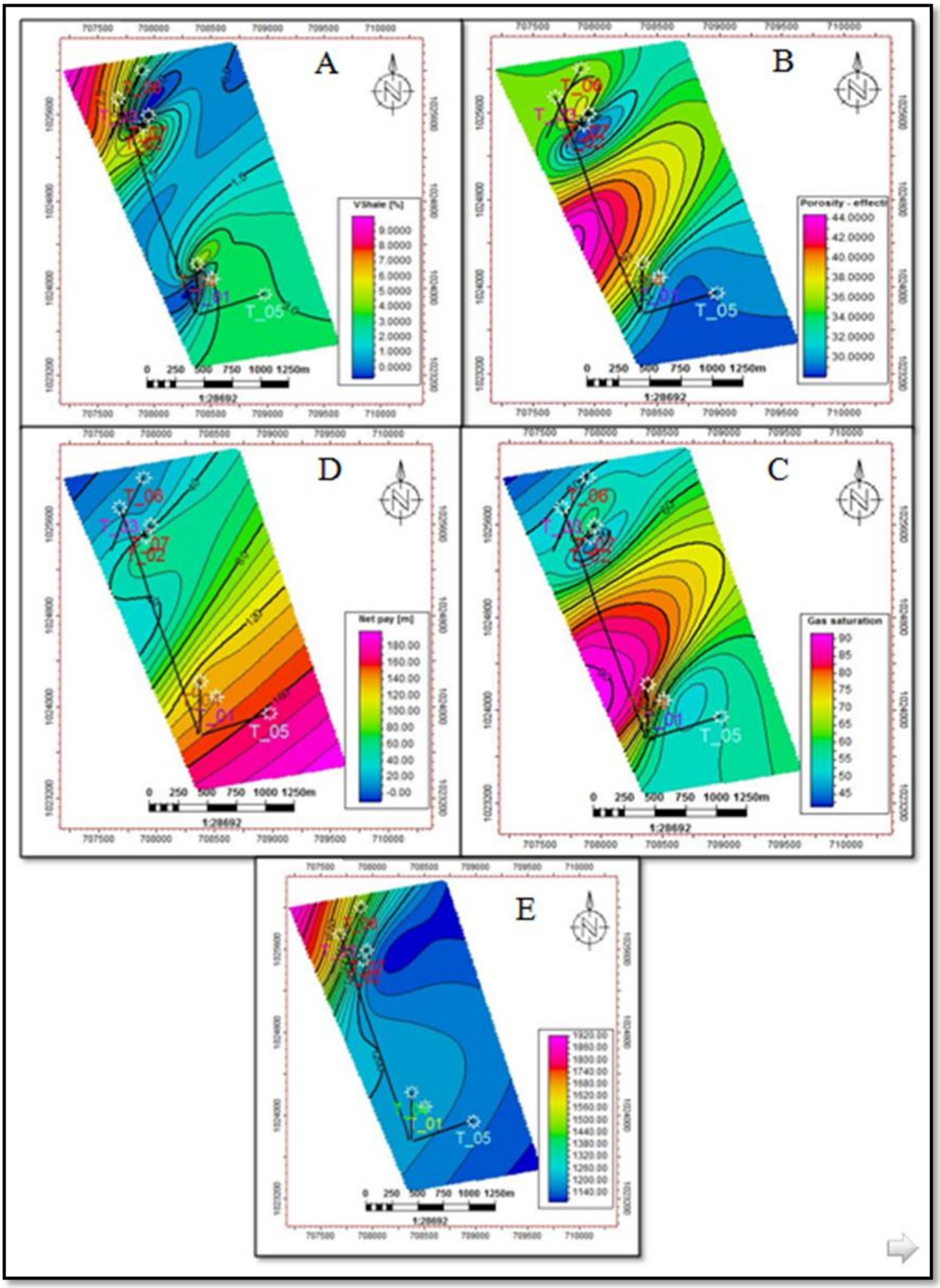

Fig. 8: Combined iso-parameteric maps for pay zone B, (A) shale volume (V_{sh}) map, (B) effective poroity (Φ_e) distribution map, (C) gas saturation (S_g) distribution map, (D) net pay thickness map and (E) top depth (TVDSS) map .

SUMMARY AND CONCLUSIONS

This study aims to petrophysical evaluation analysis of Pleistocene Mit Ghamr Formation in Taurt field, In the offshore Nile Delta of Egypt. This study is a trial to gain a full overview of the stratigraphic and structural setting in the study area, In addition to the petrophyical characteristics of the rock units (S10, S20 and S30) of interest Mit Ghamr Formation, and to evaluate the hydrocarbon potentialities of the studied area. The output results of the petrophysical characteristics of Mit Ghamr Formation are as follows:

Taurt Field is bounded by two major faults running through the north and the south of the field with the main fault trend running northwest to southeast, All Taurt reservoirs are Pleistocene age (ranging from NN19E to NN19A) as supported by well bio-stratigraphic analysis, Mit Ghamr Formation represents stacked sand as S10, S20 and S30 units, The reservoir depositional environment comprises a wave-dominated shore face paralic system developed over the eastern flank of the Nile Delta cone.

The shale volume < 10 % which mean clean reservoir formation and shale content in Mit Ghamr Formation decrease towards southern part with smectite and mixed-layer illite-smectite clay type of marine environment, S20 represents a major influx of sand to the Taurt fault block. .

The gas and shale effect can be observed on the crossplot, where the plotted data tend to shift NW direction from the limestone line due to gas effect and plotted data tend to shift right downward direction due to shale effect.

From MDT pressure analysis, there are vertical connectivity between S20 and S30 reservoir units and horizontal connectivity between T-01, T-02, T-03 and T-04 wells. There are two pay zones; the first one is pay zone A in S10 unit and the second one is pay zone B is connected with S20 and S30 units, Reservoir sand dominated by Rock Type 1 and 2 which is medium to fine- grained sandstone rock unit.

There are increase in effective porosity, gas saturation, net pay thickness and decreasing depth of the stacked sand reservoir units towards South direction. The Net pay thickness of reservoir units increase toward southern part of the area under investigation so reservoir sand units pinches outward the NW direction.

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