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Petrophysical properties of the reservoir unit (1C) for Upper Shale Member from Zubair formation in Luhais field

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Abstract

The research dealt with the reservoir division for Upper Shale Member from Zubair formation in Luhais field, Where it was divided into six units of reservoir and non-reservoir, including the main reservoir unit 1C, which is the subject of research in this study, and studied in terms of thickness and lithology.

The reservoir unit 1C was associated with environmental sediment, which was the environment of the tidal channels, explaining the sedimentation mechanism that helped to form the oil traps and improve the petrophysical characteristics.

The log interpretation was used to determine and calculate the petrophysical characteristics of reservoir unit 1C. The total and effective porosity ratio was calculated with the highest and lowest value, and its porosity was represented by a three-dimensional model representing its distribution in the field, In addition, permeability was calculated through the relationship between porosity and permeability from the pulp where the permeability equation was extracted from the best straight line values containing an unknown value, By compensating for the porosity value of the logs, the permeability could be calculated for the depths of wells that do not contain a core. The permeability of unit 1C is represented by three-dimensional models that are distributed across the field. The oil and water determinations of unit 1C were studied and their existence periods were determined for all wells of the field. The work of three-dimensional models and longitudinal and transverse sections represented the distribution of oil and water polysaccharides in unit 1C. The level of contact of oil - water was determined at a depth of 2753 meters.

Keywords: reservoir, Luhais oil field, Upper shale member, Petrophysical properties.

الخصائص البتروفيزيائية للوحدة المكمنية 1C لعضو السجيل الاعلى لمكمن الزبير في حقل اللحيس

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الخلاصة

تناول البحث التقسيم المكمني لعضو السجيل الاعلى لتكوين الزبير في حقل اللحيس ، حيث قسم الى ستة وحدات مكمنية وغير مكمنية ، ومنها الوحدة المكمنية الرئيسية 1C وهي موضوع البحث في هذه الدراسة ، ودرست من ناحية السماكة والصخارية .

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تم ربط الوحدة المكمنية 1C مع الترسبات البيئية والتي تمثلت ببيئة القنوات المدية ، وشرح الية الترسيب التي ساعدت على تكوين المصائد النفطية وتحسين الخصائص البتروفيزيائية .

تمت الاستعانة بتفسير المجسات لتحديد وحساب الخصائص البتروفيزيائية للوحدة المكمنية 1C اذ تم حساب معدل المسامية الكلية والفعالة مع اعلى واقل قيمة لها ، وتمثيلها (المسامية) بموديل ثلاثي الابعاد يمثل توزيعها في الحقل ، اضافة الى ذلك تم حساب النفاذية من خلال العلاقة بين المسامية والنفاذية المأخوذة من اللباب حيث استخرجت معادلة النفاذية من قيم افضل خط مستقيم والتي تحتوي على قيمة مجهولة ، وبتعويضها في قيمة المسامية المأخوذة من المجسات امكن احتساب النفاذية للأعماق او الابار التي لا تحتوي على لباب .

تم تمثيل النفاذية للوحدة 1C بموديلات ثلاثية الابعاد تبين توزيعها في عموم الحقل ، كما تمت دراسة التشبعات النفطية والمائية للوحدة 1C وتحديد فترات وجودها لجميع ابار الحقل ، وعمل موديلات ثلاثية الابعاد ومقاطع طولية وعرضية تمثل توزيع التشبعات النفطية والمائية في الوحدة 1C ، كما تم تحديد مستوى تماس نفط – ماء بعمق 2753 مترا .

Introduction

Luhais Field is located between longitude (3340 – 3380) and latitude (660 – 690) in the south of Iraq in semi-Arid zone with elevation of 70 m to sea level about 100 km south east Basrah city . The length of the field is about 20 km and width of about 5 km at the northern part of the field and 10 km in the central and southern part of it. Generally , Luhais field is located in unstable shelf of Zubair-Mesopotamian zone can be considered as stable zone according to. It is bounded from south west structure Boleh and Archi and Ratawi Field from the east and sabba field from the north and our structure from the west. It is far about 80 km from Rumaila Field to the north east Figure-1. The Luhais field is structurally a convex fold with a synthetic axes that are oriented towards the general direction north-south.

The majority of the area is covered with a ring of gravel and sand to form the upper Paleocene, while the south-eastern and eastern part is covered with a layer of gravel for the Plastocene-Holocene deposits, which are gradually exposed to the south and west. A layer of sand and gravel, South-West.

The current study deals with upper shale of Zubair formation, which is the reservoir part of Luhais flied [1] . Zubair formation containing large oil reserves, and It is necessary to conduct a study of petrophysical characteristics including the distribution of total and effective porosity, as well as permeability and water and oil saturation. Various types of logs such as radiation, sonic, resistivity and density logs have been used, To determine the reservoir and non-reservoir zones, and different equations were applied to determine the petrophysical results[2-7].

Unit 1C is the main reservoir unit in the Zubair formation. It is formed from the Tidal Channel Environment [8]. It is necessary to connect the reservoir unit to the sediment environment to identify the deposits and their extension or interruption in the field. Knowing the location of the wells and determining the thickness of the reservoir units and knowing the periods of existence of oil impurities are necessary in the accuracy of the results of the three-dimensional model and the longitudinal and transverse sections, Oil saturation are not confined to reservoir unit 1C, but can be found in other reservoir units, but in a smaller. quantity such as units 1B and 1E.

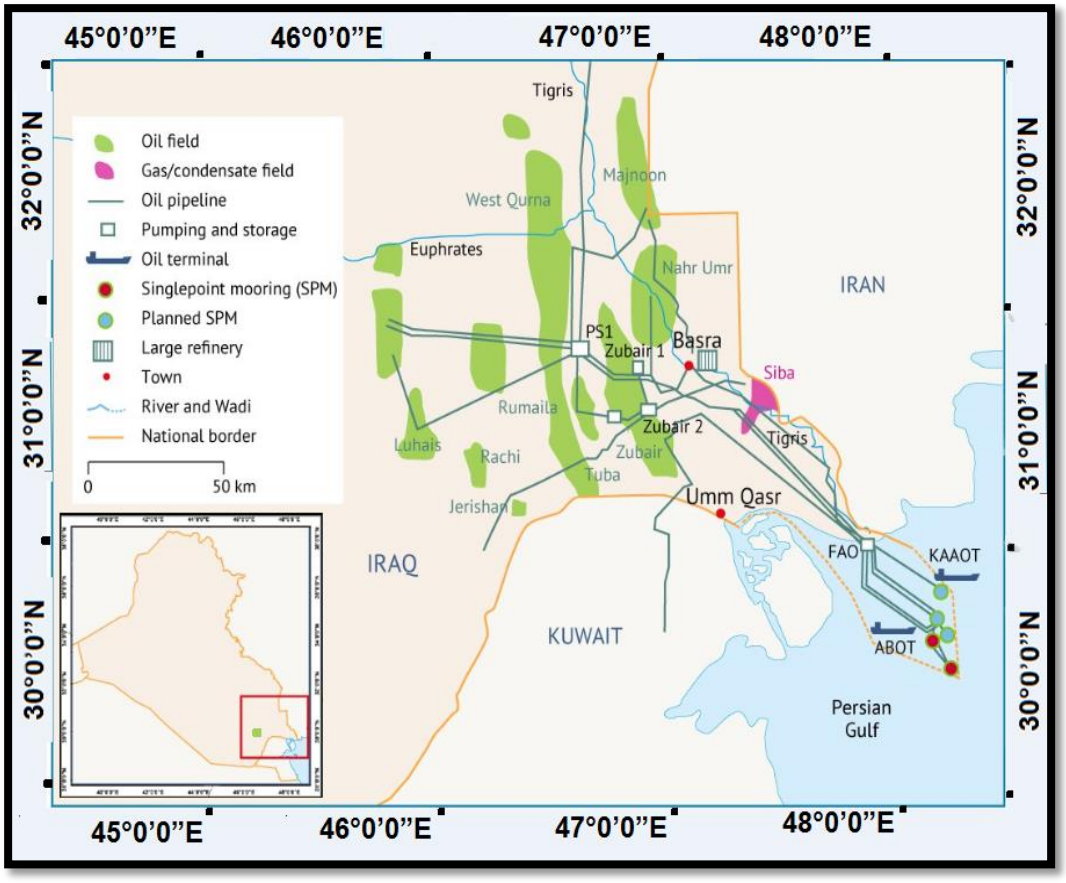

Figure 1-Location map of the Luhais field in southern Iraq (International Energy Agency)
materials and methods

The reservoir and non-reservoir units can be identified using radiation (GR), resistivity (Rt), sonic (DT) and density logs, It was possible to calculate volume of shale, total and effective porosity, as well as the calculation of permeability, water and oil saturation, determination of residual and movable oil. The petrophysical characteristics of unit 1C were investigated as the main reservoir of oil saturation and were shown in 3D models and longitudinal and Crosse section to show their distribution in the field using the Petrel-2015 program. Porosity and permeability were also measured from core of reservoir unit 1C and at different depths.

Division of the reservoir

The Upper Shale Member of the Zubair formation in Luhais field was divided into six units, different in thickness, lithology, hydrocarbon and water saturation (1A, 1B, 1C, 1D, 1E and 1F) [9]. These units were divided according to lithological variability using Gamma ray log, which determines where the presence of sand or shale or silt has varied the proportion of the presence of shale between the units. The main reservoir unit for oil saturation is unit 1C in addition to secondary reservoir units such as (1B, 1D, 1E). The insulating units are (1A, 1F) and the shale layer is extended in unit 1D. The thickness of the reservoir and non-reservoir units is observed through the longitudinal section as shown in Figure-2.

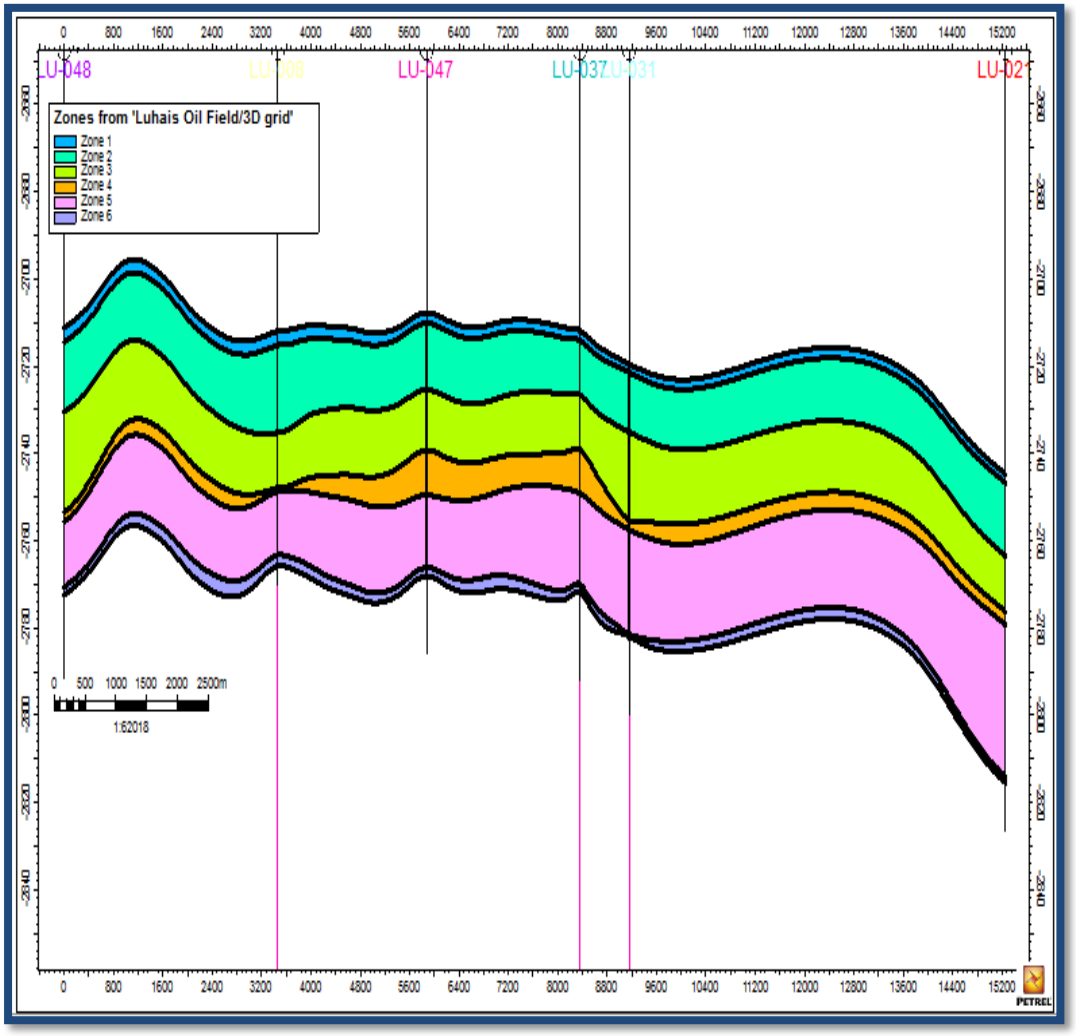

Figure 2-Longitudinal section of the division of units passes through the wells (Lu-21) , (Lu-31), (Lu-9), (Lu-37), (Lu-47), (Lu-8), (Lu-48)

Unit thickness 1C

A table was prepared for the wells of the study Shown in Figure-3, which included the location of the wells and the thickness of the unit 1C, its depth and thickness, and the thickness of upper shale member (Table-1).

The thickness of this unit is (16.27) meters and the minimum is (9.4) meters at the well (Lu-39) at the middle of the field, and the thickness is 29.3 meters at the well (Lu-18) in the middle of the field.

This unit is spread throughout the field and there is no interruption in its extension and bounded from the top Unit 1B and below Unit 1D is a cap rock unit because it consists mainly of shale rocks.

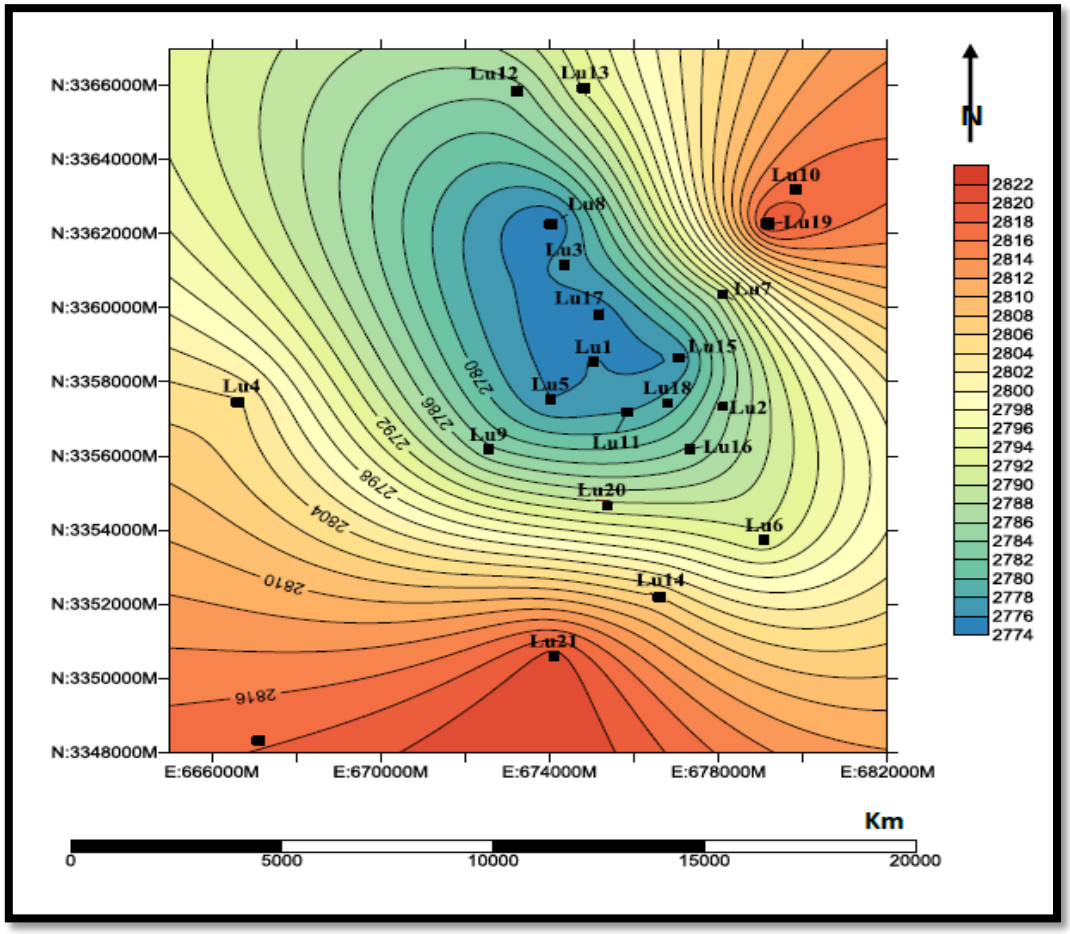

Figure 3-Location map of Luhais field wells

Table 1-Location and thickness of Unit 1C

Well No	X	Y	Unit	DEPTH	RTKB	TH.Un.	TH. Fn
LU-005	673727	3357812	1C	2793.8	64.28	13	67.5
LU-006	678794	3356015	1C	2809	73.1	12	61.5
LU-007	677781	3360641	1C	2804.8	69.75	14.7	53.8
LU-009	672262	3356460	1C	2801.3	60.14	16.7	52.2
LU-011	675548	3357468	1C	2797.3	67.8	15.2	74.5
LU-012	672943	3356620	1C	2799.75	64.86	17.25	66.2
LU-013	674551	3365722	1C	2810	65.38	15	59.5
LU-017	675871	3360098	1C	2796.8	60.78	24.2	74.45
LU-018	676496	3357718	1C	2795.8	64.93	29.3	66.6
LU-020	674942	3354968	1C	2807.5	71.24	16	65.5
LU-021	673812	3350879	1C	2837.5	73.9	12.8	70.7
LU-024	677557	3355662	1C	2793.7	74.6	10.5	40.5
LU-029	679657	3354962	1C	2839.9	80.46	18	67.4
LU-030	674898	3363363	1C	2802.1	70.1	16.8	61.5
LU-035	678257	3356362	1C	2809.8	79.05	15.1	47.2
LU-036	674757	3357762	1C	2801.1	74.17	16	62.6
LU-037	673357	3357762	1C	2795.1	68.51	12.5	60
LU-038	675457	3361962	1C	2785.5	69.32	15.6	62.1
LU-039	676158	3360562	1C	2788.7	72.26	9.6	73.1
LU-041	678237	3355279	1C	2805.3	76.5	26	48
LU-047	673337	3360279	1C	2798.4	70.82	12.7	58.6
LU-048	673662	3366029	1C	2799.6	69.14	23	61.2

The thickness of unit 1C is 16.27 meters and the minimum is 9.4 meters at the well (Lu-39) at the middle of the field, and the thickness is (29.3) meters at the (Lu-18) in the middle of the field. The unit was shown with a three dimensional model as shown in Figure-4, which is the extension and spread throughout the field, and was the work of a Depth map of the of this unit was Figure-5. This unit is the main oil reservoir of the field and characterized by lithology, consisting of pure sand in most of the wells interspersed sometimes with some layers of shale, as well as silt. The reservoir unit 1C contains the sediments of the environment Tidal Channel (Environment) is a retrograde environment and is considered the main reservoir unit of oil deposits in the field where the Streams of rivers are formed and are stratigraphic traps and this explains the difference in the number of reservoir units and their variability in the number and thickness from one well to another, The river has a limited geographical extension, where it fades sideways with deposits of floodplains with high mud content to complement the conditions of stratigraphic fishing.

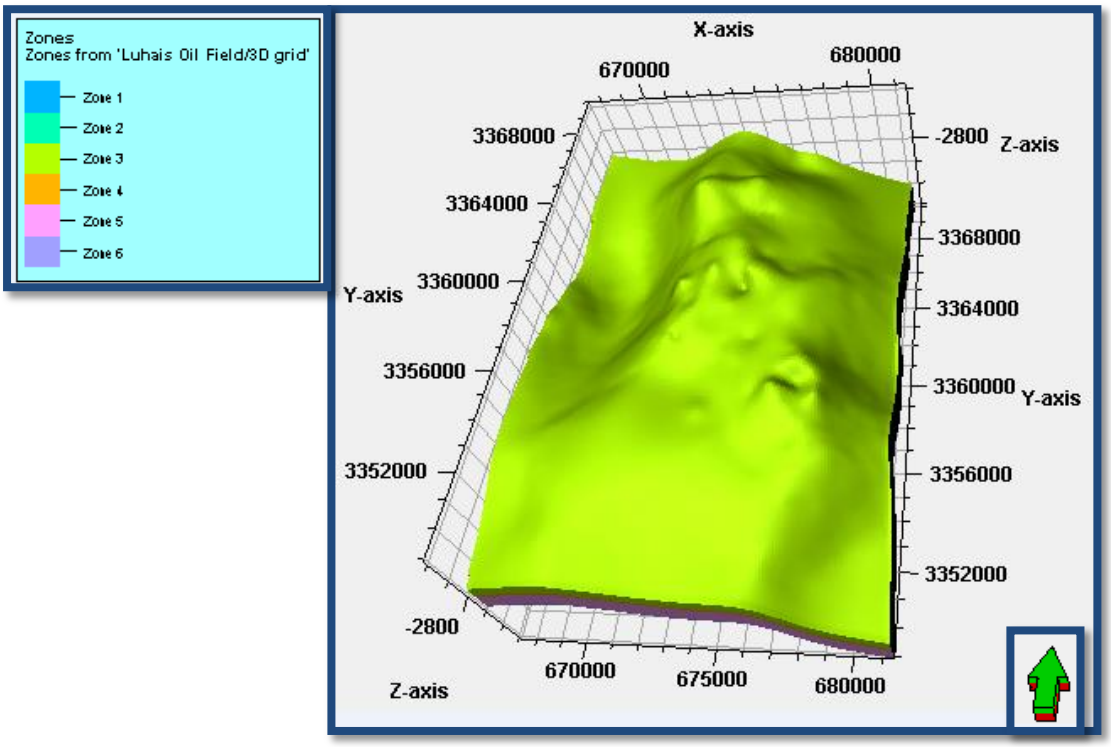

Figure 4-Three-dimensional model of unit 1C

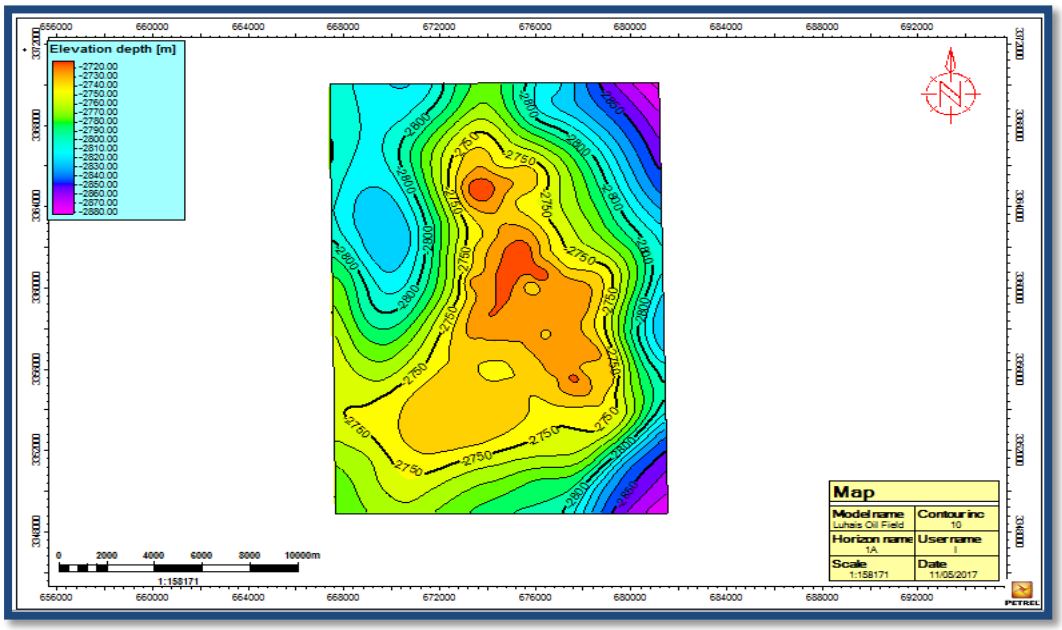

Figure 5-Depth map of unit 1

Total and effective porosity models in unit 1C

The total porosity of this unit is 0.2150 and the highest value is 0.3424 and the lowest value is 0.096 while the effective porosity rate is 0.1684 and the highest value is 0.2560 and the lowest value is 0.01.

The three-dimensional model of total porosity Figure-6 shows that total porosity is distributed relatively moderately and convergent in value except for the area south of the field where porosity is significantly reduced.

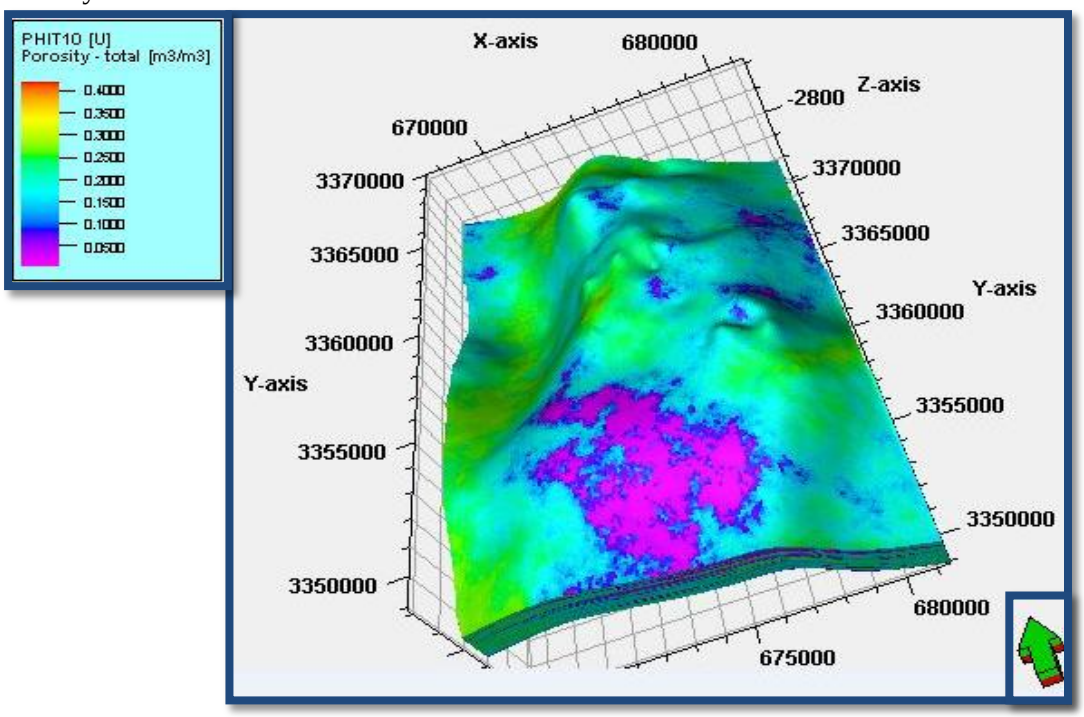

Figure 6-Total porosity distribution in unit 1C

The effective porosity shown in the 3D model Figure-7 shows he increase of porosity in most of the north, center and east of the field, while the southern and western parts of the field are characterized by very low porosity.

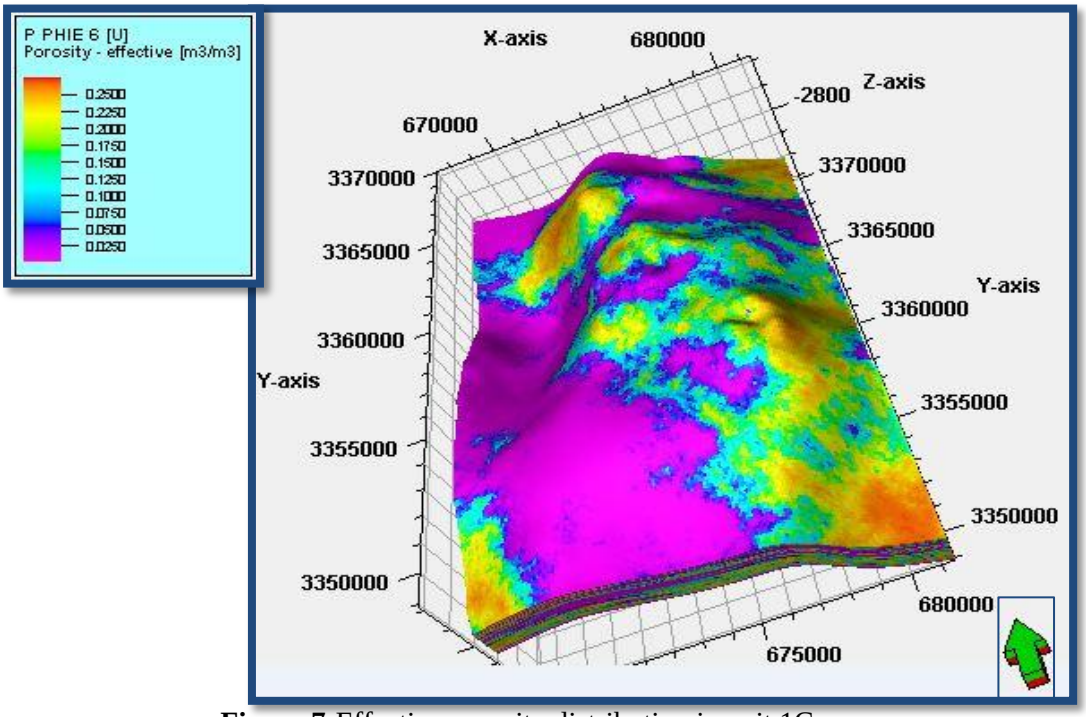

Figure 7-Effective porosity distribution in unit 1C

Model of distribution of permeability in unit 1C

permeability and porosity of core were calculated, in the relationship between porosity and permeability taken from the core[10], the permeability equation was extracted from the values of the best straight line Figure-8. To compensate for the porosity value of the logs, the permeability can be calculated for depths or wells that do not contain core [11] The following equation was used in the calculation of permeability in the 1C zone:

$K=0.8177e^{26.9034x}$

Where x represents the effective porosity calculated from logs.

Note the similarity in the increase and decrease of porosity and permeability in unit 1C due to the lithological similarity.

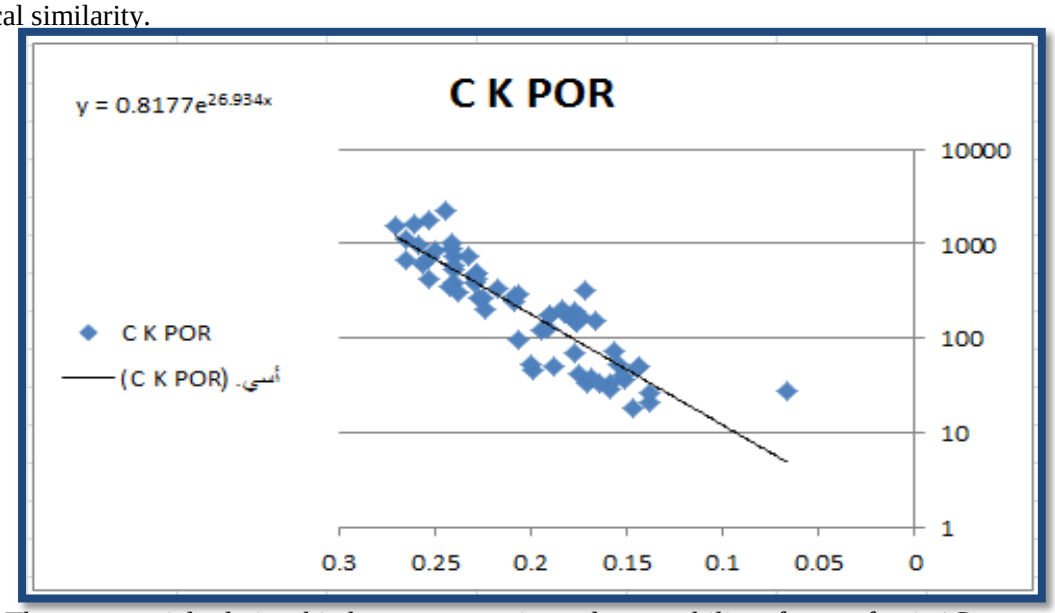

Figure 8-The exponential relationship between porosity and permeability of core of unit 1C

Reservoir unit 1C is the main unit of oil saturation, the permeability rate in this unit is 243.00 m.d. and the highest value is 1346.1312 m.d. , while the minimum value is 0.8199 m.d. and the low permeability value to less than 1 m.d. due to the presence of shale in some areas of this unit, Where sand is abundant. The three-dimensional model, as shown in Figure-9, shows a significant increase in permeability in the northern, eastern and south-eastern regions as well as the center of the field, while the permeability decrease is observed from the western part of the field.

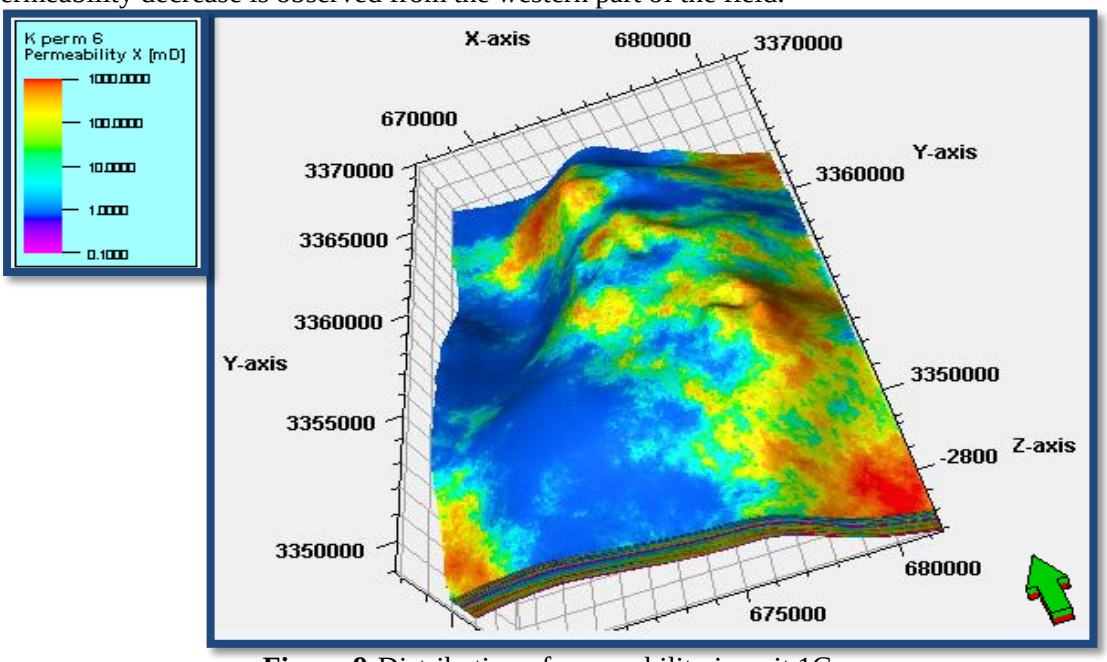

Figure 9-Distribution of permeability in unit 1C

Water and oil saturation models in reservoir unit 1C

The oil and water saturation in reservoir unit 1C were studied by calculating these variations with the special equations adopted and the work of three-dimensional sections and sections of longitudinal and transverse extension of the water and oil of the unit 1C, as well as sections of correlation between the wells indicate the continuation or interruption of these saturation. Figure-10 shows that oil saturation is high throughout the field except for the southern and south-western parts and some parts of the east and west of the field, and very few areas throughout the unit , The level of oil-water contact was determined by electrical logs and also from the production tests. It was noticed that there was a difference in the level of contact between the wells because of its structural location. Some wells reach a level of contact (2731-2733) meters as in the two wells (Lu-33) and (Lu-36), but Most wells have a level of contact of oil - water (2753).

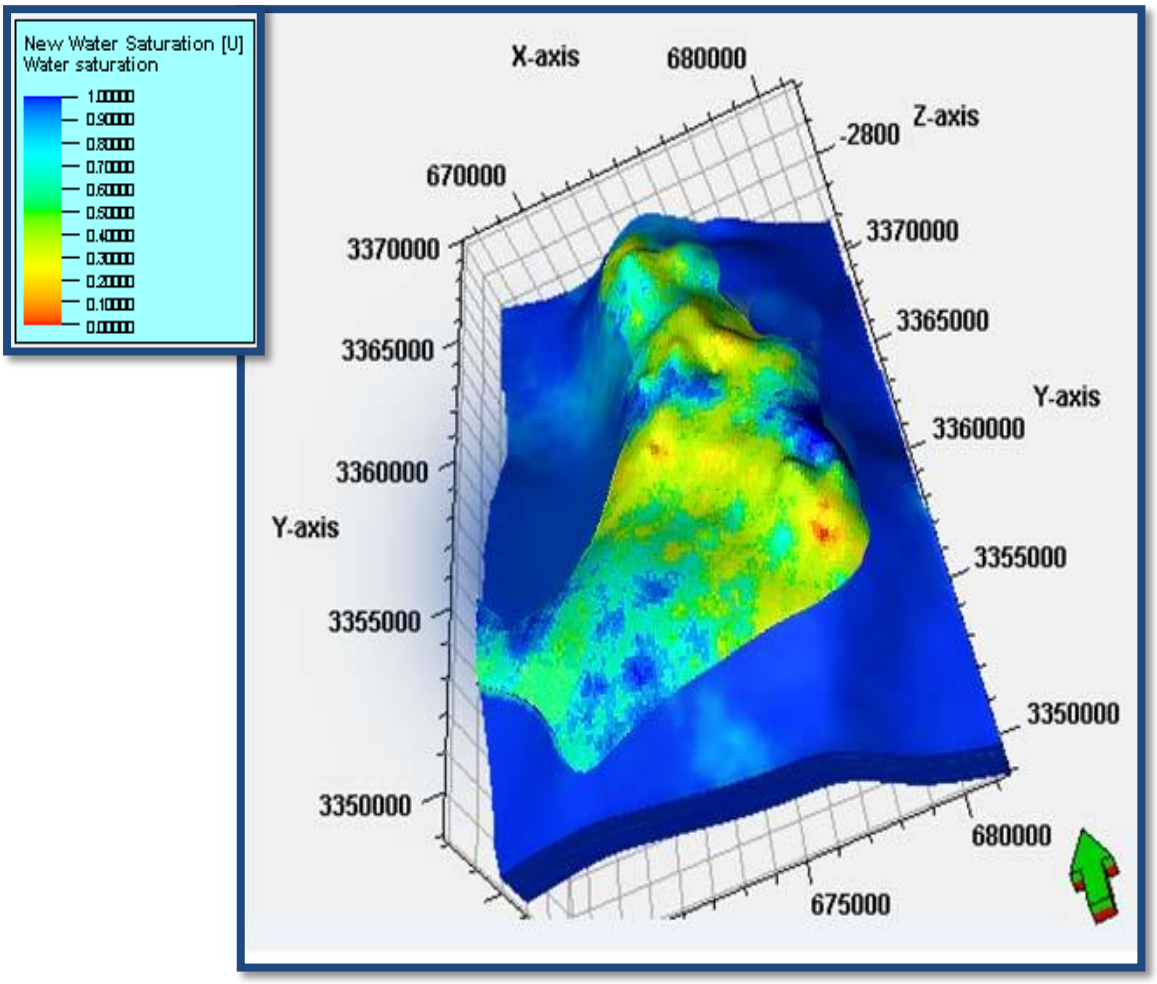

Figure 10-Water and oil saturation in unit

Longitudinal and transverse sections show the continuous high oil invasions of this unit except for thin or intermittent thin layers such as Lu-36 in the middle of the field and well (Lu-9) located in the eastern part of the field, In the cross section as in (Figure-11) section 2) and the well (Lu-21) located in the south of the field and visible in the longitudinal section as in Figure-12.

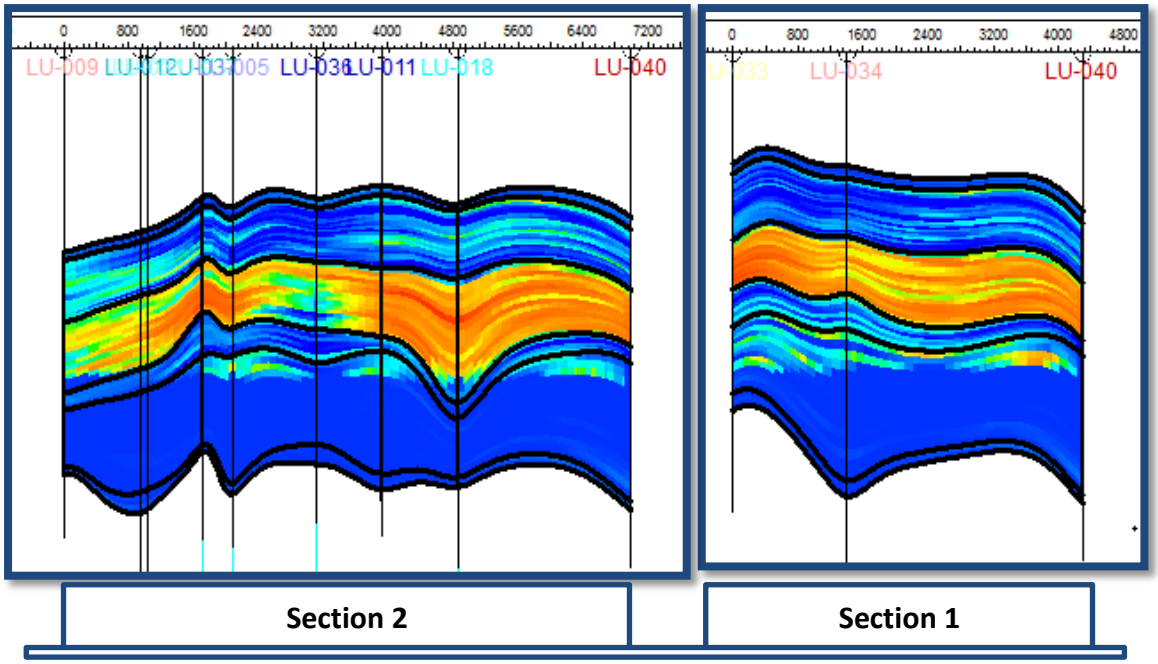

Figure 11-Two cross sections for the distribution of oil and water impurities. Section 1 passes through - (Lu -33) ، (Lu -34) ، (Lu -40)
Section 2 passes through the wells (Lu -40) , (Lu -18) , (Lu -11) , (Lu -36) , (Lu -5) , (Lu -37) , (Lu -12) , (Lu -9)

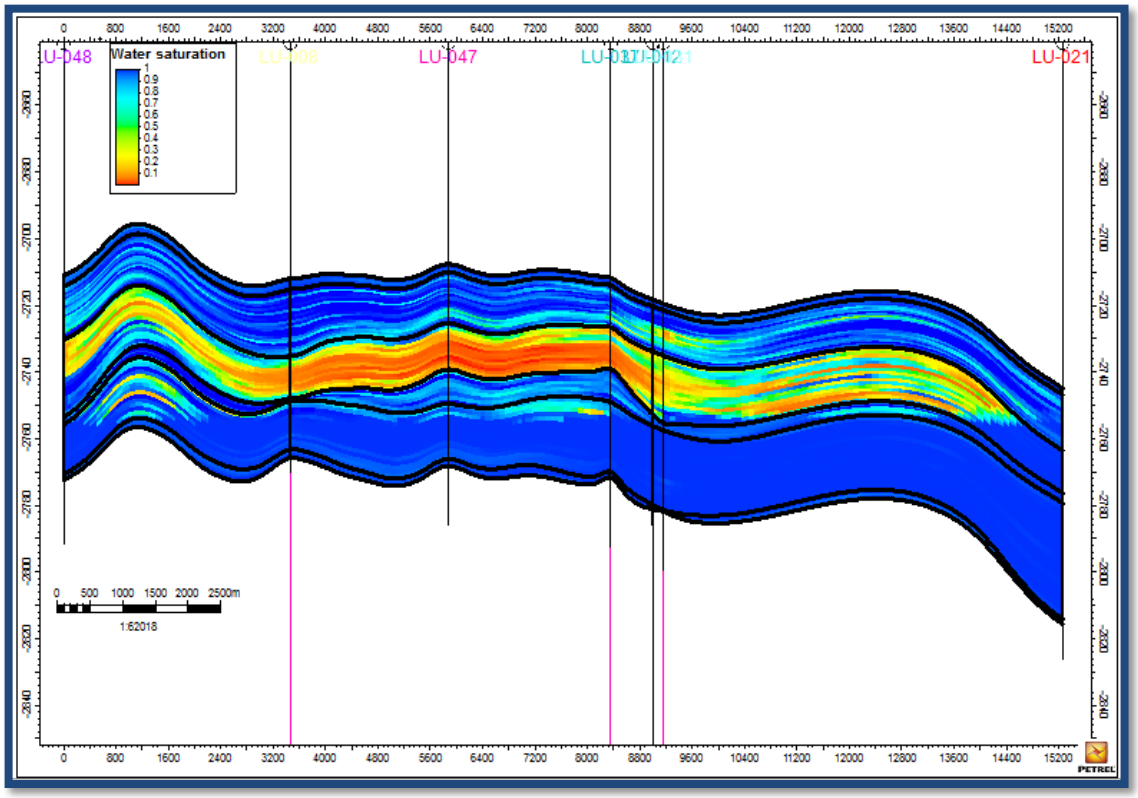

Figure 12-A long section of the distribution of oil and water spills passes through the wells (Lu -21) , (Lu -31) , (Lu- 9),(Lu -37) , (Lu -47) , (Lu -8) ,(Lu-48)

Conclusions and recommendations

Pterophysical models and longitudinal and Crosse sections show that good reservoir characteristics such as permeability, effective porosity and high oil saturation are concentrated along the top of the structure, as well as in the eastern and western sides of the middle of the field, which are suitable for

drilling, while the southern and southwestern parts of the field have poor reservoir characteristics. We also recommend the use of modern logs such as Neutron Magnetic Resonance (NMR), which can be used to identify lithology, determine the volume of interconnected water, free water, estimate permeability, water and oil saturation, know the gas zones, determine the size and distribution of pores, determine oil – water contact, And flow efficiency in the reservoir.

As well as the use of image logs, which is used in the imaging of complex fractures and the identification of fractures and faults and trends and their extension or interruption, and calculate the slope of fractures and identify the sedimentary structures and the distinction of shipments and evaluation of porosity secondary.

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