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Facies and Porosity Model of Jeribe Formation in the Khabbaz Oil Field, Northern Iraq

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Abstract

Jeribe Formation (Middle Miocene) consists mainly of limestone, dolomitic limestone and dolomite, the upper contact of the Formation represents a surface that is unconformable with the Fatha Formation, while the lower contact is conformable with the Dhiban Formation, the present study showed that most parts of the Formation consist of shale content at a rate of less than (20)%, the Formation was divided into three porosity units depends on the variation of shale content and porosity rate and the unit Je3 is one of the best units in all sections of wells (KZ-18,17,14,13) while the unit Je1 comparatively has less petrophysical qualities than the unit Je3 and the unit Je2 In the two wells KZ-14,18 is similar to the properties of the first unit, while in the two wells KZ-13,17 it represents the low porosity units, and the porosity rate in the Formation ranges between (15-4)%. Petrel V.2014: was used to draw the three-dimensional model to show the distribution of the Lithology Formation of each unit within the Khabbaz Oil field, as well as to draw the porosity model for each unit of porosity to show its distribution within the field.

Keywords: Jeribe Formation, Khabbaz Oil field, Lithology, Porosity.

نموذج الوجوه الرسوبية والمسامية لتكوين الجريبي في حقل خباز النفطي، شمالي العراق

الخلاصة

يتالف تكوين الجريبي (Middle Miocene) بشكل رئيسي من الحجر الجيري والحجر الجيري المتدلمت والدولومايت، يمثل الحد الاعلى للتكوين سطح عدم توافق مع تكوين الفتحة اما الحد الاسفل فيكون متوافق مع تكوين الذيبان. تبين من الدراسة الحالية بأن معظم أجزاء التكوين قيد الدراسة تحتوي على محتوى للسجيل بمعدل اقل من %(20)، تم تقسيم التكوين الى ثلاثة وحدات مسامية بالاعتماد على تباين حجم السجيل ومعدل المسامية وتعتبر الوحدة Je3 هي من افضل الوحدات في جميع مقاطع الابار (KZ-18,17,14,3) اما الوحدة Je1 فتمتلك صفات بتروفيزيائية اقل نسبيا من الوحدة Je3 وتكون الوحدة Je2 في البئرين -kz 14,18 مشابها لخواص الوحدة الاولى اما في البئرين kz-13,17 فتمثل اردأ الوحدات المسامية، وان معدل المسامية في التكوين

تتراوح بين %(4-15). استخدمت البرنامج (petrel-2014) لرسم الموديل ثلاثي ابعاد لاظهار توزيع صخارية التكوين لكل وحدة ضمن حقل الخباز، وكذلك رسم موديل المسامية لكل وحدة المسامية لبيان توزيعها ضمن الحقل.

1. Introduction

Jeribe Formation was first described by [2] in its typical section near the village of Jadala located in the Sinjar fold, The Formation is considered a sedimentary beds of the Tertiary period of age (Middle Miocene) and consists of limestone, recrystallized limestone and dolomitic limestone deposited in the environment (Shallow marine) [1,2] The thickness of the Formation in the typical section is about 70 meters of recrystalline limestone and dolomitic limestone containing foraminifera fossils[3] The Formation consists of dolomite, dolomitic limestone and limestone in the Jambour Oil Field [4]. The upper contact of the Formation is unconformable with the Fatha Formation and is conformable from the lower with the Dhiban Formation [5]. The porosity of the Formation ranges (14-21)% and the permeability reaches (1114) MD, The Formation has been divided by [6] In the Hamrin Oil Field to two reservoir units, where it was found that the effective porosity rate reaches in the upper unit to (9.65)%, while in the lower unit it reaches (4.92)%.

The study area is located to the southwest of the Baba Dome and southwest of the city of Kirkuk by about 12 km and represents an asymmetrical subsurface fold whose axis extends in a northwest-southeast direction [7]. The Field is located in the unstable platform area in the Foothill zone according to the divisions of [8].

The present study aims to evaluate the petrophysical properties and variations that occur within the section of Formation vertically and laterally and their importance as rocks stored for oil and is the interpretation of logs response and one of the ways that lead to knowing the properties of the rock and through the current research was the use of logs response (Gamma Ray, Neutron, Density and Sonic logs) where the study area included four sections subsurface in the Khabbaz Oil field within Kirkuk Governorate of consisting of wells (kz-13,14,17,18) and these properties were calculated using Techlog software. Figure (1).

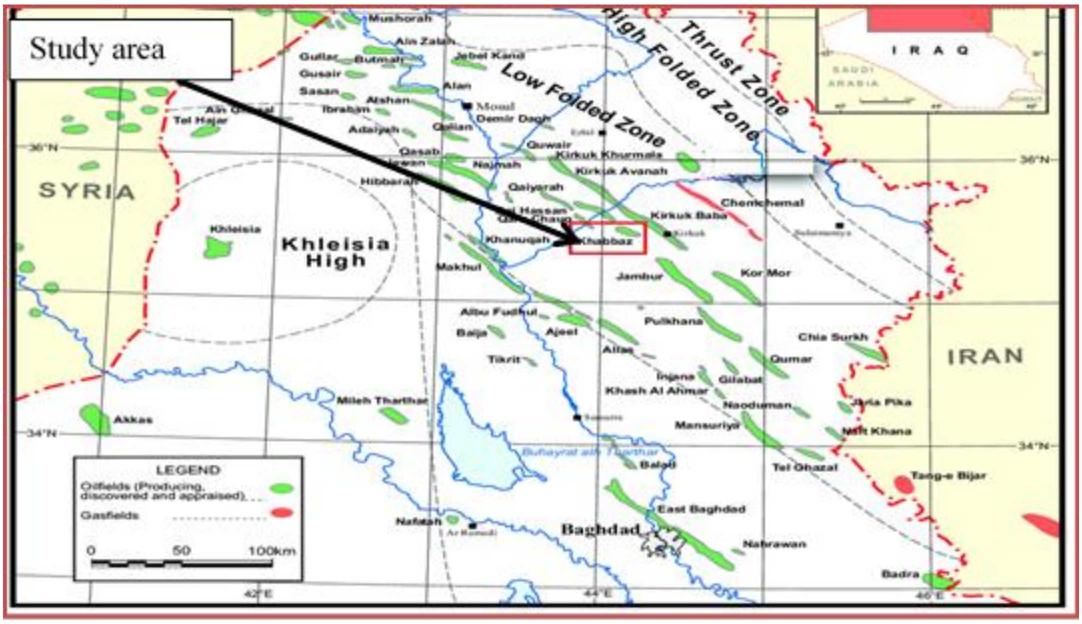

Fig. (1): Location map of the study area showing studied wells

2. Material and Methods

In the present study, the well log (Gamma Ray, Neutron, Density and Sonic logs) were relied on, and using (Neruralog software), the logs were converted to digital data and used in the Techlog software For the purpose of calculating porosity and drawing figures and cross plot between the two (Neutron, Density logs), which is used to know the Lithology, as well as the values of each of (M-N) were calculated and the cross plot between them was drawn to know the Lithology of the Formation, and also the (Petrel-2014 software) used to draw model was depend on the contour map after converting it to digital in the (Neruralog software) in order to make a model to show the distribution of porosity and facie.

2.1. Theory/calculation

2.1.1. Lithology

The Formation Lithology was determined based on porosity log by drawing a cross plot between two log (Neutron, Density logs), it was found that the Formation consists of limestone, dolomitic limestone and dolomite Figure (2) for wells (Kz-13,14,17,18) and based on this scheme the Formation Lithology Figure (3) was drawn as well as (M-N) Which depends on the log response (Neutron, Density and Sonic logs) and it was found through the scheme that the Formation Lithology are close to what was deduced from the previous scheme Figure (4) and this Lithology was compared with what was found using the program (Petrel) Where it was found that there are slight differences between the results as the Formation in the above wells consists in the upper part of dolomite mainly and in the middle consists of limestone and dolomitic limestone while in the lower part it consists of dolomite with a zone of limestone and dolomitic and dolomite is relatively less than the upper part.

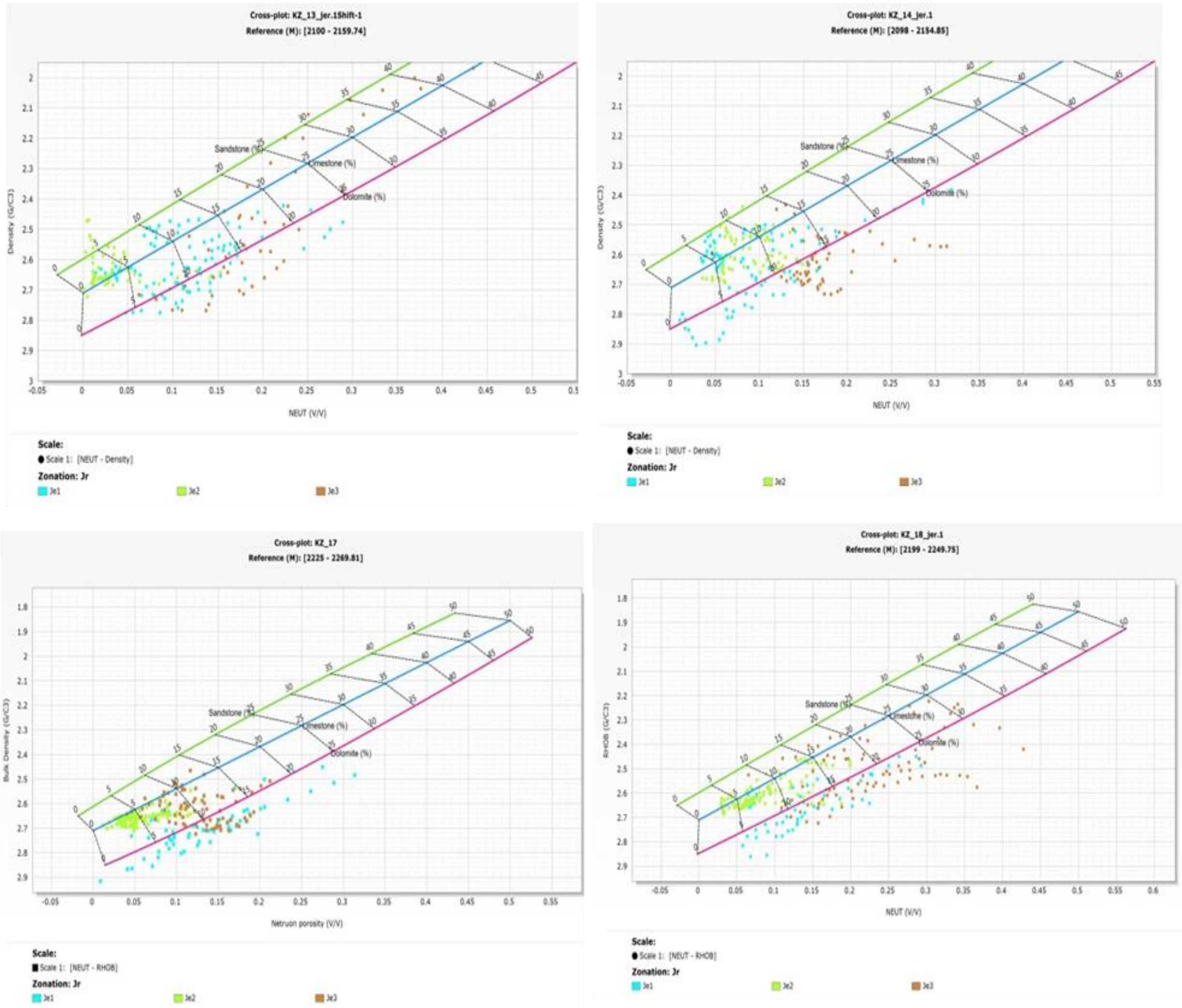

Fig. (2): Cross plot between neutron and Bulk Density for determine Lithology Jeribe Formation in kz-13,14,17,18.

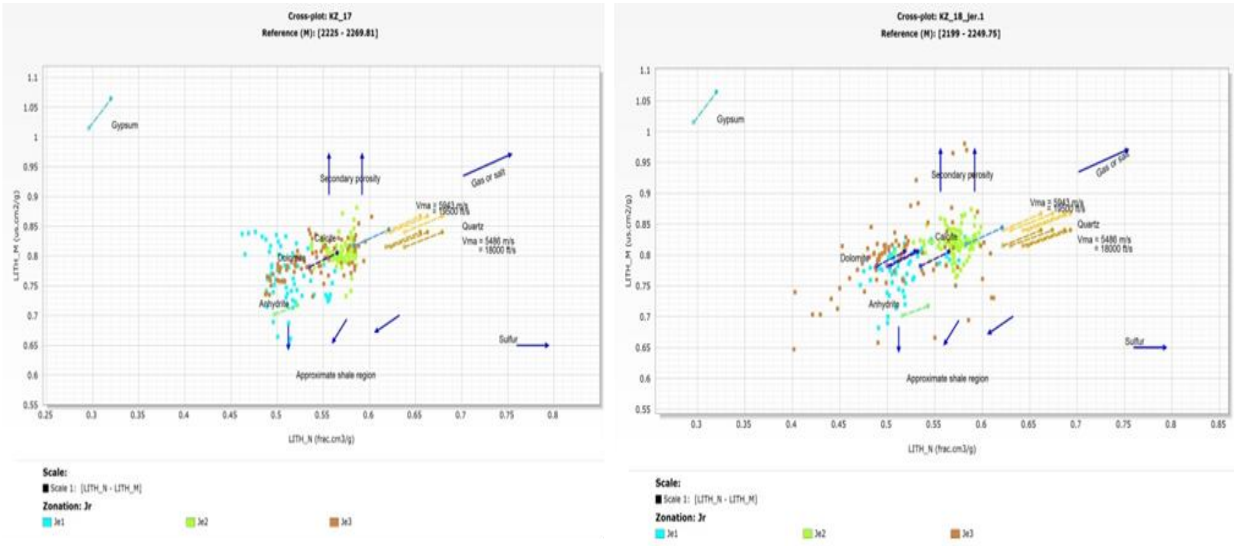

Fig. (3): Cross plot between M and N for determine Lithology Jeribe Formation in kz-17,18.

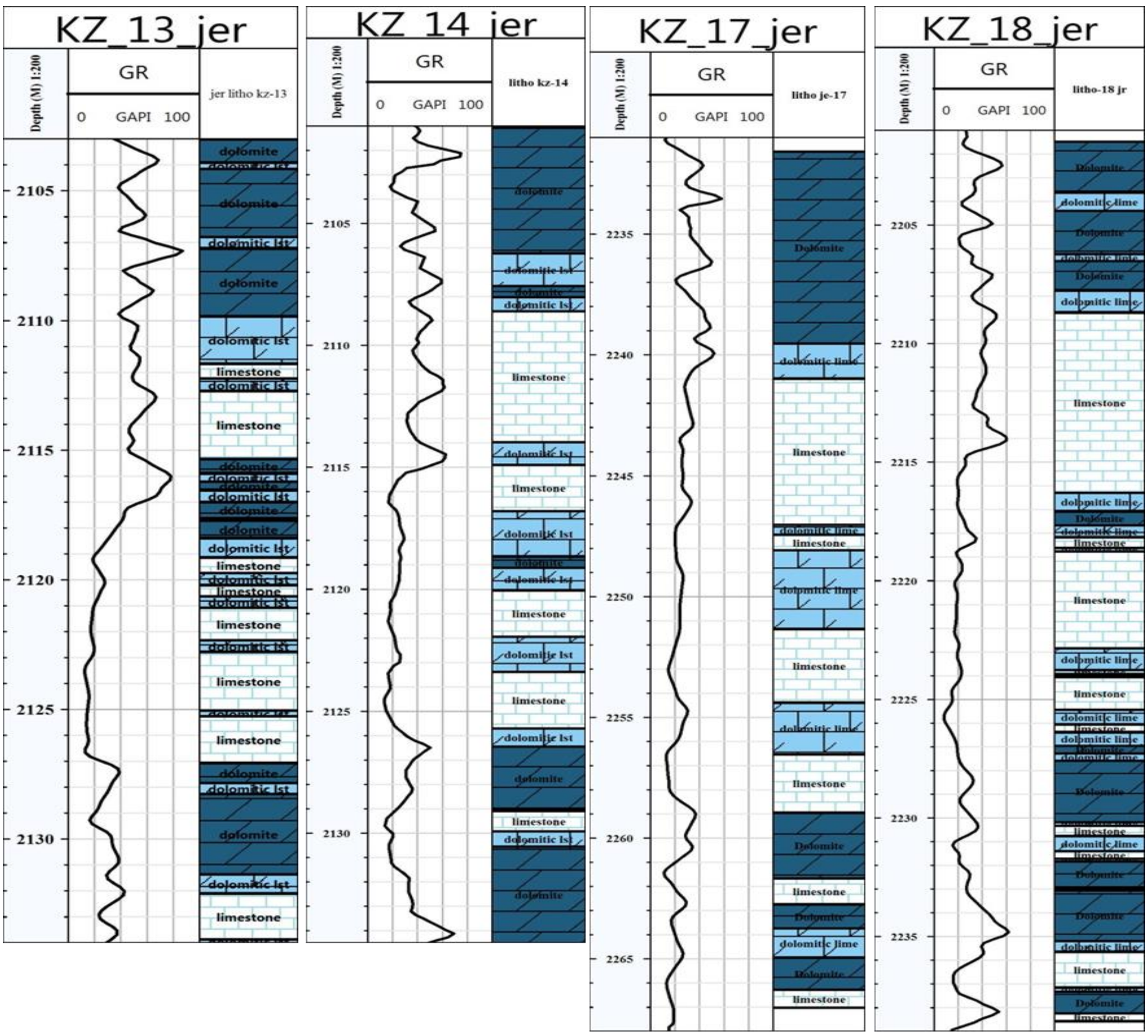

Fig. (4): Coloum Lithology for Jreibe Formation depend on well logs.

2.1.2. Shale content

The shale content is calculated through several sensors, but the Gamma Ray log is one of the best sensors for calculating the content of the shale, and in this study it was depend on the Gamma Ray log, where it was found that the values of the shale content during the Formation sections are less than 40%, except for some thin zones. In order to describe the shale in the Formation, it was based on the classification proposed by [9] Which depends on the basis of the percentage of the content of the shale, as it was considered that the sections that contain the size of the shale are less than 10% of the clean zones, while the zones that indicates the content of the shale between (10-35%) is considered from the Shaly zone and when the value is greater than 35% It is considered one of the Shale zones.

The different proportions of shale in the reservoir effect by giving inaccurate values affects the deduction of porosity derived from (Neutron, Density logs) [10] and it was found through the current study that the presence of the shale content has an affects in reducing the values of porosity, especially in the parts where the shale content increases, so the shale content was calculated using the program (Techlog software). Which depends on the equation [11] Figure (5), Table (1) and it was also found that the porosity is not affected only by the content of the shale, as it was found that some zones where the content of the shale decreases to less than 10% and the porosity do not increase and this indicates the effect of diagenesis processes.

2.1.3. Porosity

Porosity is one of the basic properties of reservoir rocks, which can be defined as the percentage of pore size to the total volume of reservoir rocks [16] There are two types of porosity according to its origin:

Primary porosity: It is the original porosity that is formed during the sedimentation process and remains after sedimentation, the size of the granules, their shape and the sorting process has an effect on the porosity and the porosity decreases with depth and time factor, while the secondary porosity is formed after sedimentation, which is formed as a result of dissolution, recrystallization and, dolomitization which is of great importance in carbonate rocks than in detrital rocks [17].

In the present study the total porosity (primary, secondary) was calculated in several ways through logs, where the total porosity of the sonic log was calculated depending on the equation [12] the porosity calculated from this log represents the primary porosity, while the porosity calculated from the neutron and density logs was based on the equation [11] and from the density log that depends on the equation [12] The effective porosity will be calculated from the sonic log based on the equation [13], while it is calculated using the neutron log based on the equation [14] and from the density log depending on the equation [13] These equations include the shale size that was calculated using the Gamma Ray log to eliminate the shale size effect. The secondary porosity can be calculated based on the equation [15], the secondary porosity of two wells (kz-13.14) is not calculated because the sonic log reading is not available, Figure (6).

Table (1): Average Reservoir properties of Jeribe Formation Units in wells Kz-13,14,17,18

Units	The properties	Kz-13	Kz-14	kz-17	kz-18
je1	Interval	2103-2117	2101-2115	2231.5-2241	2201-2214
	vsh c	0.12	0.14	0.17	0.17
	PHIT_ND	0.09	0.07	0.08	0.09
	PHIE_ND	0.07	0.06	0.06	0.07
	PHIT_D	0.10	0.14	0.06	0.10
	PHIE_D	0.08	0.12	0.05	0.09
	PHIT_S			0.09	0.07
	PHIE_S			0.05	0.05
	PHIT_NS			0.10	0.10
	PHIE_NS			0.08	0.08
	Permeability			1.33	1.23
je2	Interval	2117-2127	2115-2126	2241-2255	2214-2226
	vsh c	0.15	0.18	0.18	0.08
	PHIT_ND	0.04	0.08	0.05	0.08
	PHIE_ND	0.04	0.07	0.04	0.07
	PHIT_D	0.06	0.06	0.03	0.05
	PHIE_D	0.05	0.06	0.02	0.04
	PHIT_S			0.06	0.06
	PHIE_S			0.02	0.05
	PHIT_NS			0.05	0.08
	PHIE_NS			0.05	0.07
	Permeability			0.07	0.97
je3	Interval	2127-2134	2126-2135.5	2255-2267	2226-2238.5
	vsh c	0.20	0.11	0.15	0.12
	PHIT_ND	0.17	0.12	0.09	0.18
	PHIE_ND	0.14	0.09	0.08	0.15
	PHIT_D	0.16	0.06	0.06	0.13
	PHIE_D	0.13	0.05	0.05	0.11
	PHIT_S			0.10	0.12
	PHIE_S			0.03	0.09
	PHIT_NS			0.10	0.17
	PHIE_NS			0.09	0.14
	Permeability			0.72	11.85

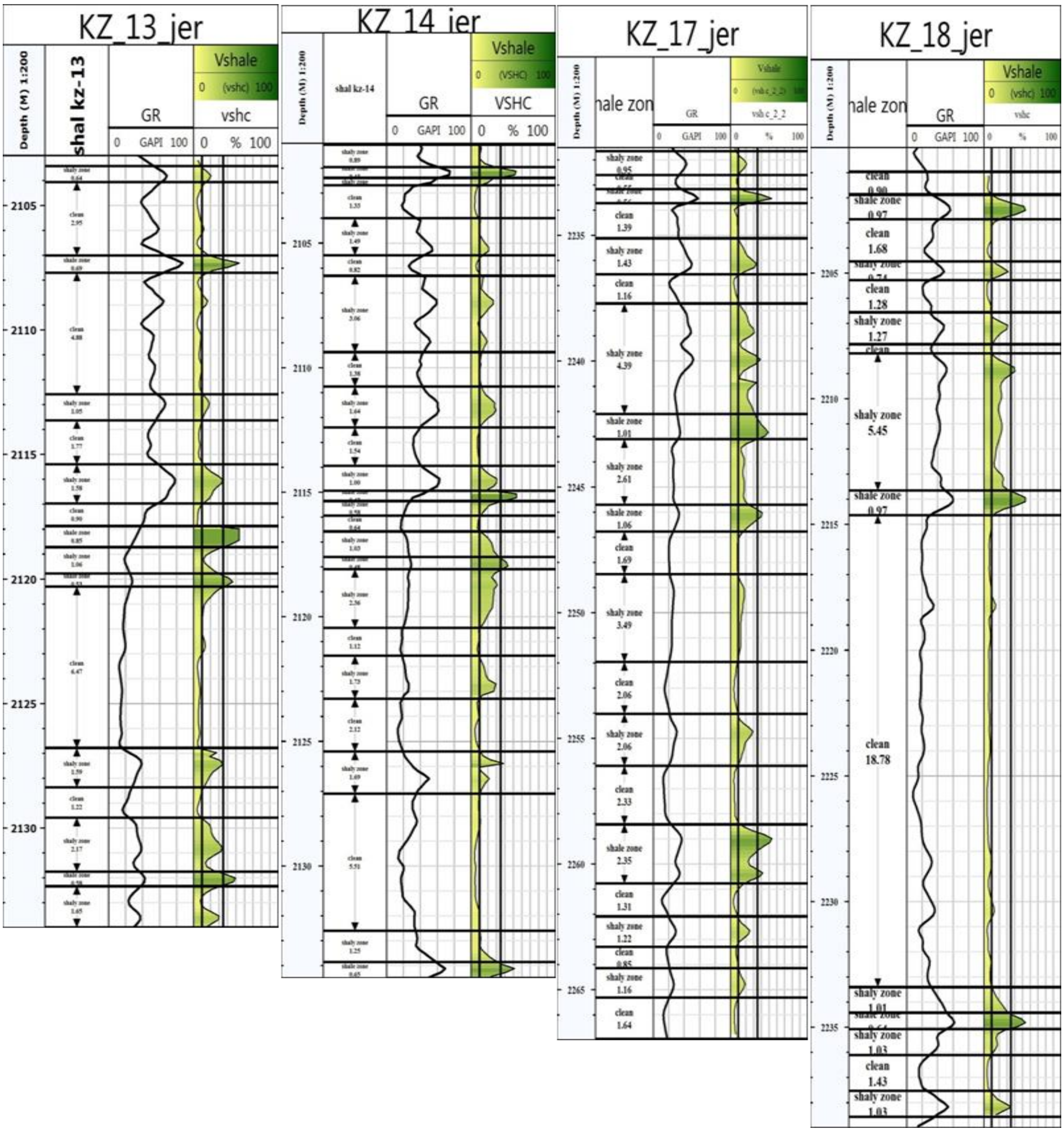

Fig. (5): Content shale correct (vsh c) in wells Kz-13,14,17,18 of Jeribe Formation.

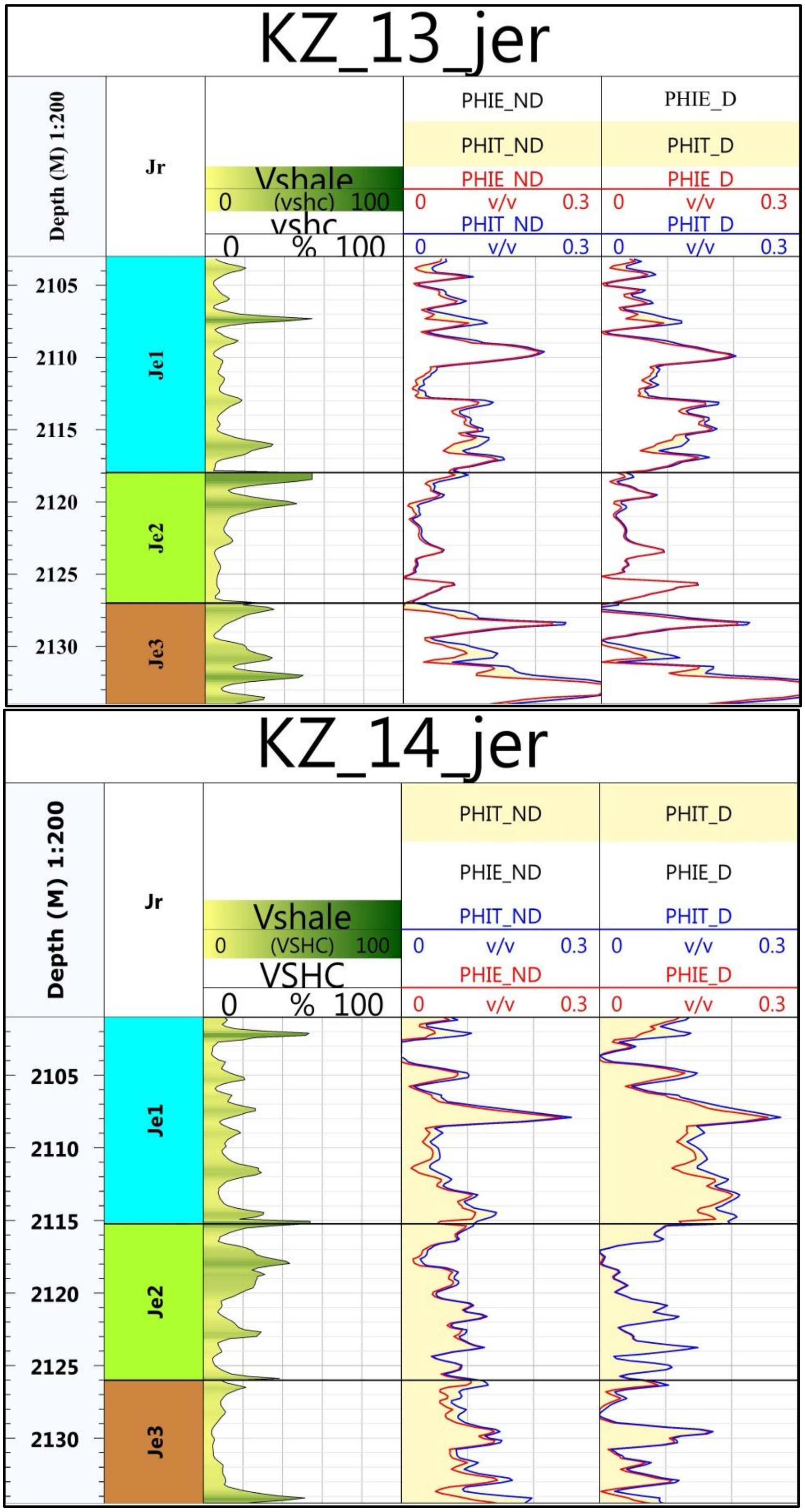

Fig. (6): Content shale (VSH), effect porosity (PHIE), total porosity (PHIT) and in wells Kz-13 & kz-14 of Jeribe Formation.

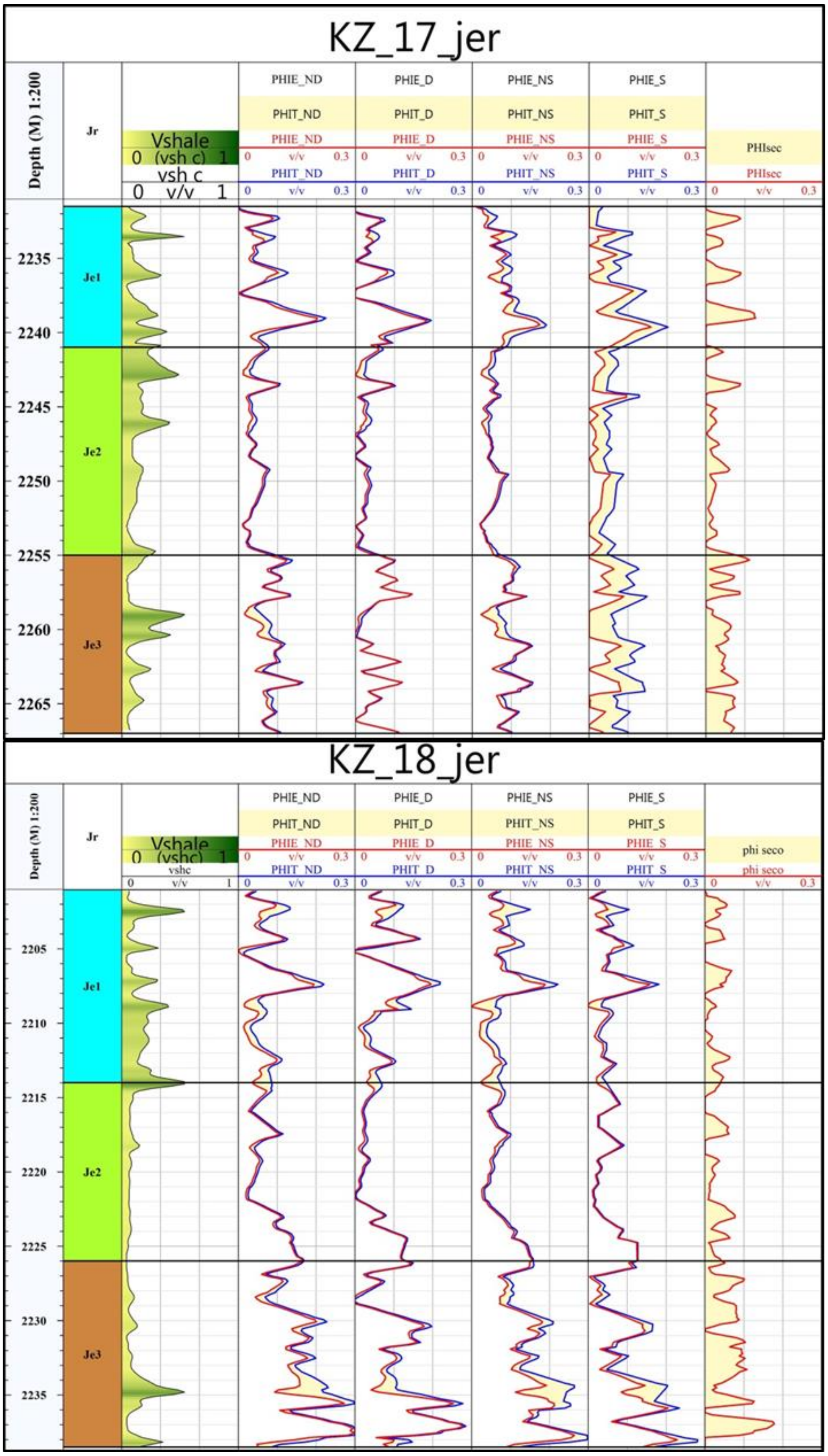

Fig. (7): Content shale (VSH), effect porosity (PHIE), total porosity (PHIT) and Secondary porosity in wells Kz-13,14,17,18 of Jreibe Formation.

3. Results

3.1. Porosity Units

Depending on the effective porosity calculated from the neutron log and the density, the Formation was divided into three main units:

- **Je1:** This unit is located in the upper part of the Formation and consists of a succession of limestone, dolomitic limestone and dolomite in the wells (kz-13,14,18) with a thickness up to (14,14,13) m respectively and a porosity rate in the two wells (kz-13,14) up to 6% and reached (7) % in the well (KZ-13) and the average shale size is 12% in (KZ-14) reached 14%, while in the well KZ-18 reached (17) %, while in the well (KZ-17), the unit consists mainly of dolomite and a little dolomitic limestone with a thickness of about (9.5) m With a porosity rate about 6% and the average size of the shale reached 17%, Figures (6) and (7), Table (1).
- **Je2:** This unit is located in the central part and consists of the succession of limestone with dolomitic limestone and dolomite in all wells under study with a thickness of up to (10) m in the KZ-13 well and a porosity rate of up to 4% and the average size of the shale is 15% either in the well KZ-14 with a thickness about (11) m and a porosity rate of about 7% and the average size of the shale reached 18% and in the well KZ-17 the thickness reaches (14) m and the porosity rate is (4)%, while in the well KZ-18, the thickness has reached (12) m and the average size of the shale is (8) % and the porosity is up to (7)%, Figures (6) and (7), Table (1).
- **Je3:** This unit consists of dolomite mainly and limestone and dolomitic limestone, which is located in the lower part of the Formation in all wells and is thick (7) m and recorded porosity at a rate of 14% and the size of the shale to 20% in the well KZ-13. In KZ-14, its thickness is (9.5) m, with a porosity of (9) %, and a shale size of (11) %, and in the well KZ-17 it was with a thickness of (12) m and a porosity rate of up to (8) % and the average size of the shale was (15) % and a thickness of up to (12.5) m and a porosity rate of (15) % And the size of the shale (12) % in the well KZ-18 and this unit located in the two wells (KZ-13,18) is considered one of the best units with good petrophysical properties, Figures (6) and (7), Table (1).

3.2. Facies Model

The facies model is one of the most important models because it is the basis for the distribution of the rest of the petrophysical properties This process comes after preparing it correctly through the preparation of the general summary of the general theoretical trend of change in lithology in the wells as well as geological processes, and the facies were distributed to the petrophysical zones and the number of three facies.

The following are the most important steps for the work of the facies and petrophysical model, as the program (Petrol-2014) was used to prepare a three-dimensional model for the current study area, as special maps were prepared for the facies and porosity for each unit according to the following procedures.

1- Sectional distribution up scale

Different mathematical methods and the process of distributing petrophysical properties were used, and the goal was to obtain one value suitable for each property in (one cell) for each of these units, knowing that the dimensions of a cell are (300-300)

2- Distribution Properties

The zones of the petrophysical and facies properties was distributed following the mathematical method (sequential Gaussian simulation algorithm) to find the values of those properties between the distances in the wells under study, taking into account the tops of the units, as the model of the facies and porosity was drawn to show the distribution of facies and porosity within the units for the khabbaz field. Figures (8) and (9).

4. Discussion

We note through the facies model of the first unit (JE1) that it consists of limestone, dolomitic limestone and dolomite, where we notice that the dolomitic limestone facies increases in the direction of the well (KZ-13) while the dolomite facies is predominant towards the well (kz-13,17,18) and we also note an increase in dolomite facies In the direction of the southeast and northwest of the field and offset by the increase of the limestone facies dangling in the center of the field and towards the northwest with the presence of limestone facies in the northwest and southeast of the field, while in the second unit (JE2) represented the area of the well (KZ-17) (KZ-14) with a facies. Dolomite Projections showed that the mid-field and north-west areas consisted of a limestone facies in which the KZ-13 well is located, as well as around the KZ-18 well area in the southeastern part. In Unit 3 (JE3), the limestone facies represented the well area (KZ-17). While the dolomitic limestone faucet was representative of the well area (KZ-18), the dolomite facies is located in the wells area KZ-13.14 and speculation showed that this facies extends to the southern part of the field. The porosity model in the first unit showed the lowest porosity ratio in two areas, the first in the southeast where the well KZ-17.18 are located and the other to the south of the well KZ-13, while in the center of the field we observe an increase in the relatively porosity rate in which the two wells KZ-13.14 are located. As for the second unit, we note that the porosity decreases in the center of the field, in which the well KZ-13 is located. The rest of the wells under study are increased. In the third unit, the porosity ratio decreases around the well area (KZ-17) and increases in the rest of the wells to reach (18) % (KZ-18).

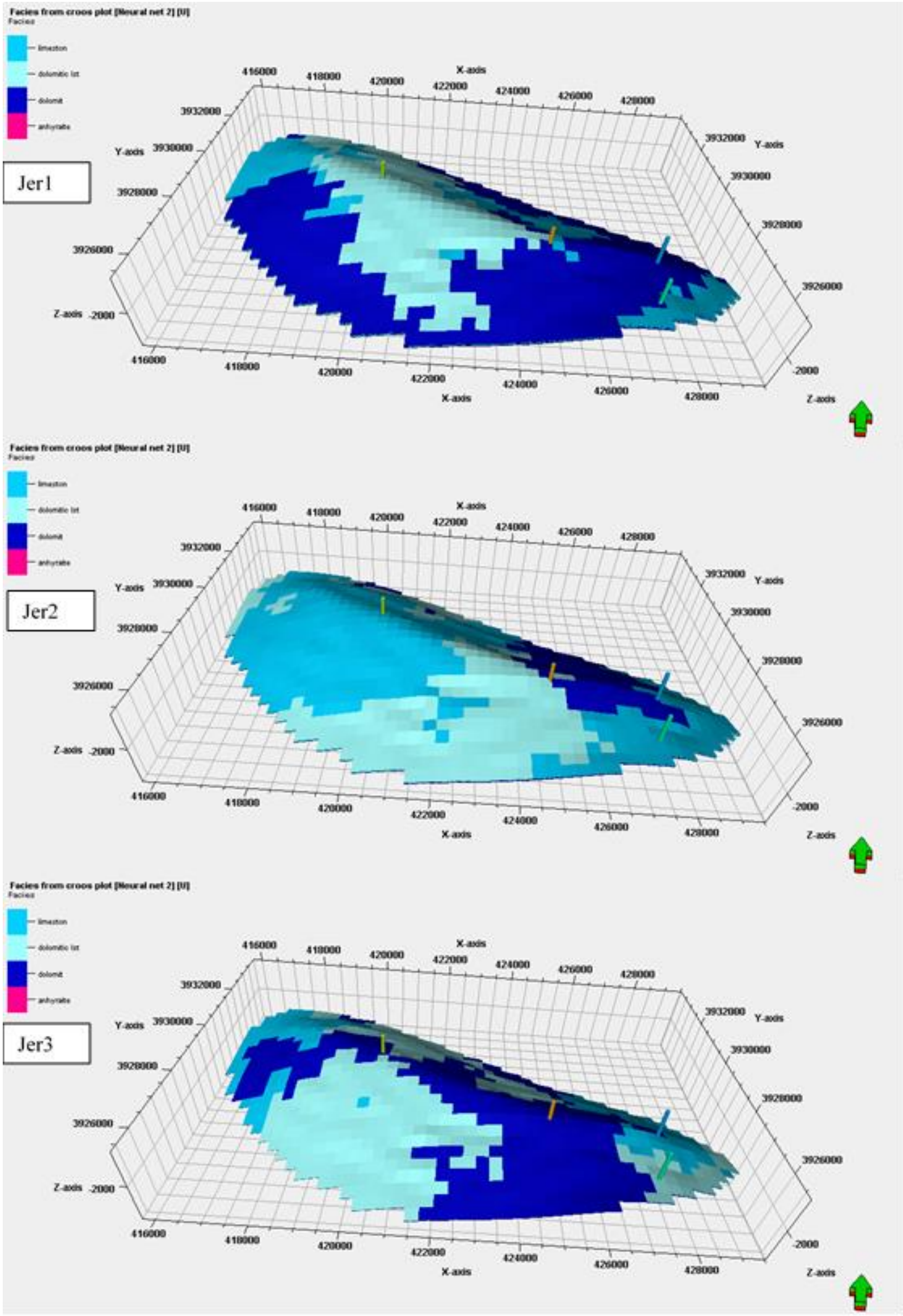

Fig. (8): Distribution of Facies within Jeribe Formation units in khabbaz field.

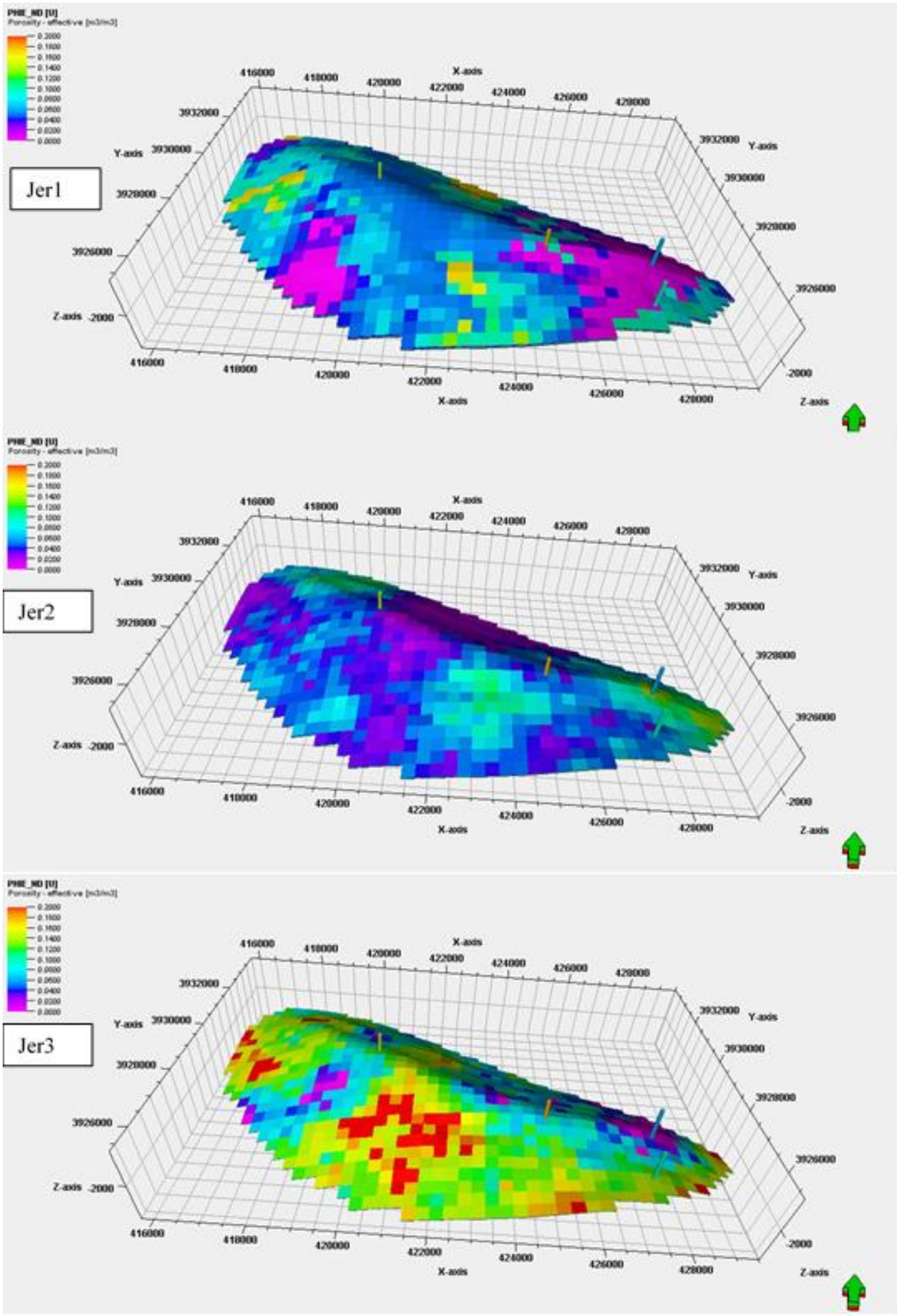

Fig. (9): Distribution of Porosity within Jeribe Formation units in khabbaz field.

5. Conclusions

The Formation consists of three main facies, the first consisting of dolomite and dolomitic limestone in the upper part and in the middle of the Formation of limestone and dolomitic limestone and the lower part consists of limestone, dolomitic limestone and dolomite. Most of the sections of the Formation are within the scope of (shaly zone) and followed by the (clean) area, which is relatively less than it and a very small percentage falls within the (shale zone) in all sections of wells.

The Formation consists of three porous units, the first (JE1) is characterized by an effective porosity rate ranging between (6-7) %, while in the second unit (JE2), the porosity rate ranges between (4-7) %The third unit is considered the best porosity unit, where the porosity rate ranges between (8-15) %.

Porosity is not affected only by the content of the shale, as there are sections in which it is within a clean range and the value of porosity decreases, and this indicates that the Formation was subjected to diagenesis processes that led to a decrease in porosity.

The three-dimensional model shows the distribution of porosity We notice an increase in the porosity of the well KZ-13 in the first unit, while in the second unit, it increases in the direction of the wells (kz-14, 17, 18), while in the third unit, the porosity is good, except for the well (kz-17).

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