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Building a 3D Petrophysical Model for Mishrif Formation in Nasiriyah Oil Field, Southern Iraq

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Abstract

A 3D geological model for Mishrif Reservoir in Nasiriyah oil field had been invented "designed" "built". Twenty Five wells namely have been selected lying in Nasiriyah Governorate in order to build Structural and petrophysical (porosity and water saturation) models represented by a 3D static geological model in three directions .Structural model showed that Nasiriyah oil field represents anticlinal fold its length about 30 km and the width about 10 km, its axis extends toward NW–SE with structural closure about 65 km . After making zones for Mishrif reservoir, which was divided into 5 zones i.e. (MA zone, UmB 1zone,MmB1 zone ,L.mB1 zone and mB2zone) .Layers were built for each zone depending on petrophysical properties. MA(1 layer) ,UmB1(6 layer) ,MmB1 (8 layer) LmB1(6 layer) and mB2(5 layer) Petrophysical models (porosity and water saturation) had been constructed for each zone of Mishrif reservoir using random function simulation algorithm. According to data analyses and the results from modelling, the MB1zone is a good reservoir unit regarding its good petrophysical properties (high porosity and low water saturation) with high presence of oil in economic quantities.

Keywords: Mishrif Reservoir, Nasiriyah oil field, Petrophysical properties.

بناء موديل جيولوجي ثلاثي الأبعاد لمكمن المشرف في حقل الناصرية النفطي / جنوب العراق

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الخلاصة

تضمن هذا البحث بناء موديل جيولوجي ثلاثي الأبعاد لمكمن المشرف في حقل الناصرية النفطي بأستخدام برنامج بتريل الحاسوبي .تم أختيار خمسة وعشرون بئرمن حقل الناصرية النفطي الواقع في محافظة ذي قار لبناء موديل تركيبي وبتروفيزيائي (المسامية والتشبع المائي) والمتمثلة بالموديل الأستاتيكي الجيولوجي الثلاثي الأبعاد.يوضح الموديل التركيبي بأن حقل الناصرية عبارة طية محدبة يبلغ طولها 30 كيلومتر وعرضها 10 كيلومتر ذات محور يمتد باتجاه شمال غرب –جنوب شرق بأنغلاق تركيبي حوالي 65 كيلومتر . بعد بناء الأنطقة في مكمن المشرف والذي قسم الى خمس أنطقة (MA, UmB 1,MmB1, L.mB1 and mB2) .تم بناء عدد من الطبقات ضمن كل نطاق بالأعتماد على الخواص البتروفيزيائية .تم بناء الموديل البتروفيزيائي الذي يشمل المسامية والتشبع المائي لكل نطاق من أنطقة مكمن المشرف بأستخدام طريقة محاكاة الدوال العشوائية اللوغارتمية، وتبين أن نطاق mB1 يتميز بمواصفات بتروفيزيائية جيدة من حيث المسامية المرتفعة والتشبع المائي المنخفض وهذا يعطي دليل لوجود كميات جيدة من النفط الخام في هذا النطاق .

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Introduction

Drilling and different methods for information gathering are regularly costly and limited, Geoscientists subsequently Depending on a great extent on those sophisticated software gain a better understanding of the subsurface by building a realistic, shared earth model, using available information and expertise with lithology fractions and reservoir connectivity that best represent the depositional system[1],Thus the Geological model is high significance to better comprehend structural and stratigraphy aspects from a petroleum field. Recent technology makes conceivable the development of a geological model represented by a three dimensional point of view. To build 3D Petrophysical model of the reservoir, Utlizing Petrel software took after a standard Workfllow: : (i) input data, (ii) structure Modelling, (iii) up scaling, (iv) data analysis, (v) facies modeling, (vi) Petro physical modelling (porosity, permeability and water saturation)[2]**.**

In the recent study, a 3D geological model for Mishrif Formation in Nasiriyah oil field had been built using petrel software. A three dimensional reservoir model is created by using (Petrel, 2014) software for all reservoir unit.

Study Area

Nasiriyah oil field lies east of the River Euphrates, about 38 kilometre northwest of the city of Nasiriyah , it is around 34 km length and 13 km width at Mishrif surface reflection, The Nasiriyah oil field was investigated by the Iraq National Oil Company (INOC) in 1975**.**The field is assembled inside the Gharraf axis, which incorporates the undeveloped Gharraf and Rafidain fields [3] see Figure-1.

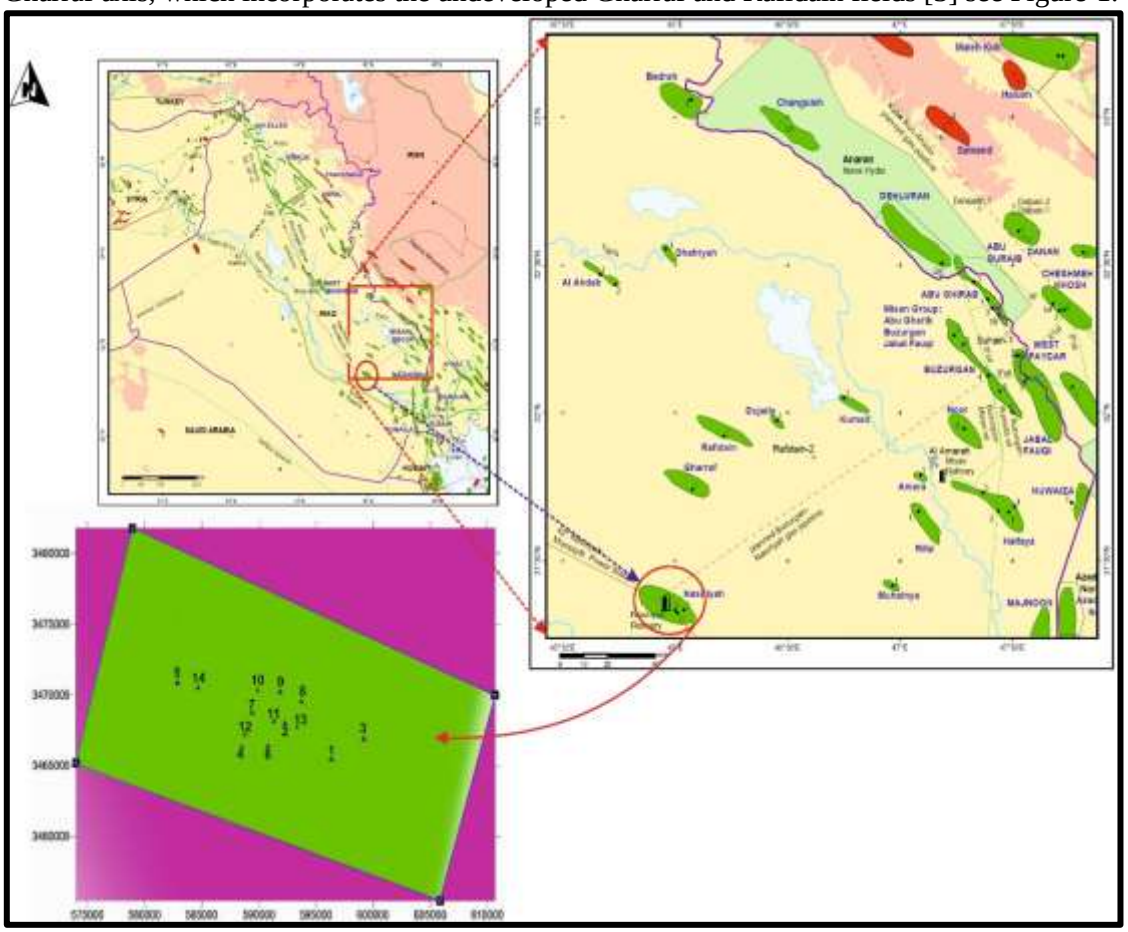


Figure 1- Map of Iraq showing location of the study area (OEC, 1995).

Data Preparation

The basis for geologic model is Data preparation. This geologic model building predominantly applies in the software[4]. Well data are transported in three steps:

1. Well heads:

A well head incorporate the top position of the well path, the measured depth along the path, the well name and optionally a well symbol.

2. Well tops:

Markers representing significant points (well picks) along the well path, regularly an alteration in stratigraphy, the reservoir units of the Mishrif Formation has been imported to Petrel in addition to the total depth for each examined well.

3. Well logs

Well logs (gamma ray, neutron, sonic, density and resistivity) and CPI (porosity and water saturation) for Twenty- five wells of the Nasiriyah Oil field and lithofacies were sent out from IP software and imported to the Petrel software.

Data import:

- Well correlation.
- Structural modeling, which includes:

✓ Pillar gridding.
✓ Layering.

- Property modeling, which includes:

✓ Scale up well logs.
✓ Petrophysical modelling

Well correlation:

Well correlation in Petrel permits the possibility to bring up multiple wells in a well section, make marker picks and bring up new wells to contrast with already correlated wells[5].After data were entered to Petrel software, correlation sections for Nasiriyah wells were made. Two well sections had been made in Nasiriyah Oil Field. Figure-2 shows the direction of correlation between wells, the first direction was from NW to SE direction and the second direction from W to E to N. Figures –(3, 4) showed the differences in reservoirs thickness of the Mishrif units as well as the variation in petrophysical properties (porosity and water saturation). The correlation of well sections shows that the thickness for all examined wells was approximately equal .

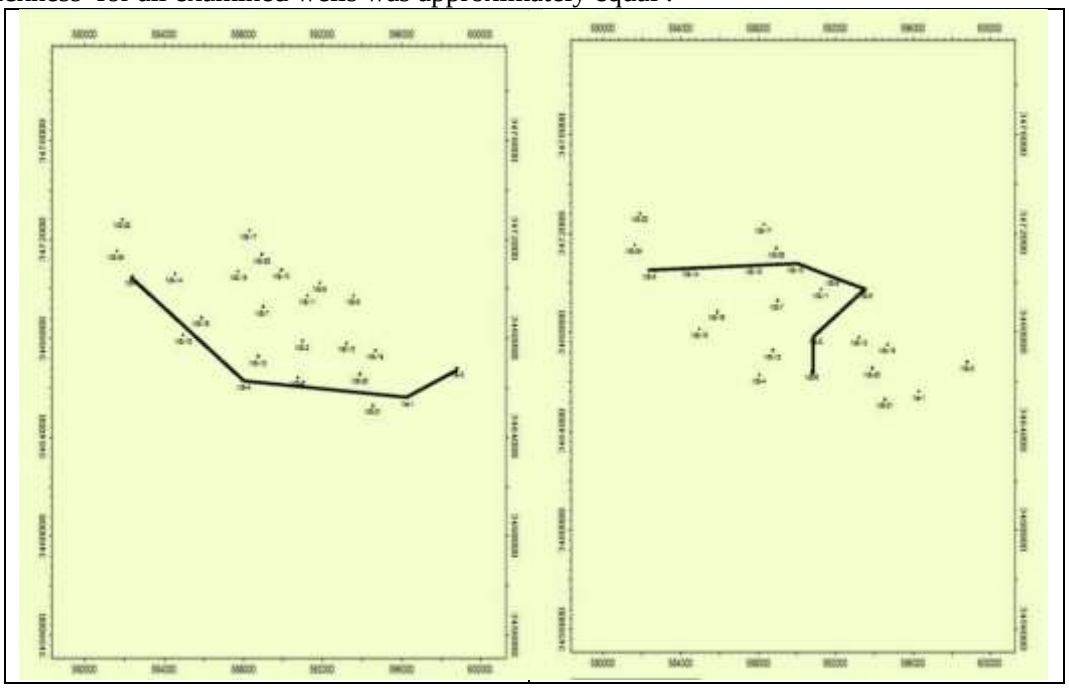


Figure 2- Map view shows the directions of correlation among the Nasiriyah wells

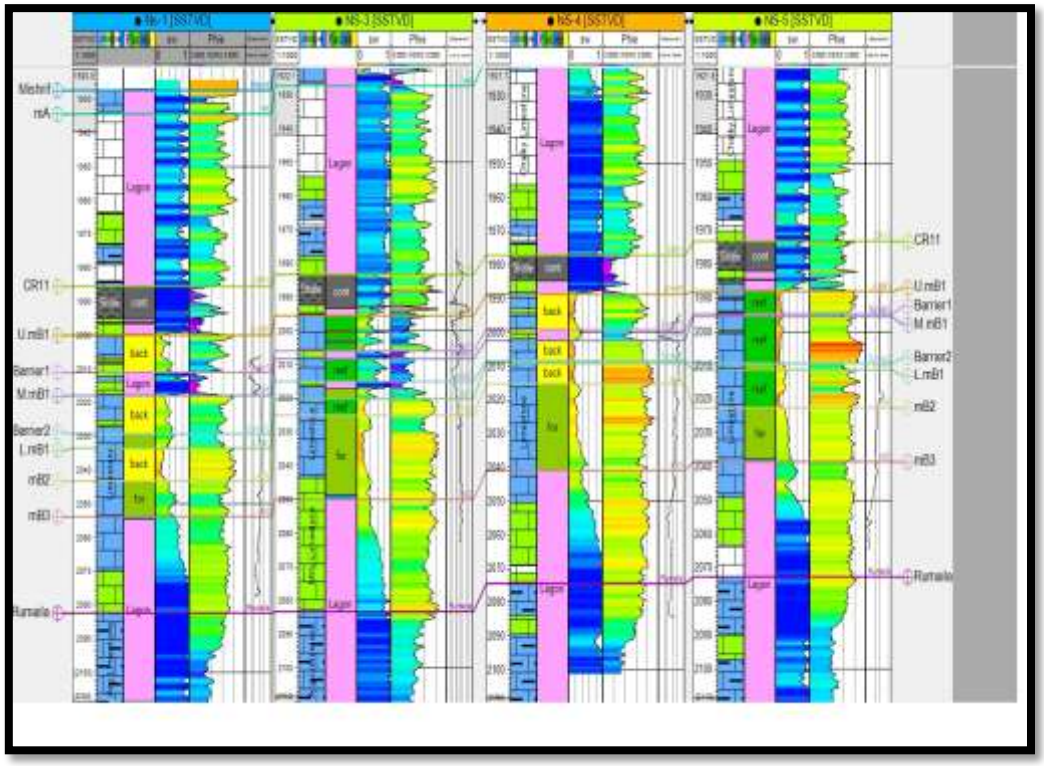


Figure 3- NW-SE Correlated section of Mishrif Formation for wells (NS-1, NS-3, NS-4 and NS-5).

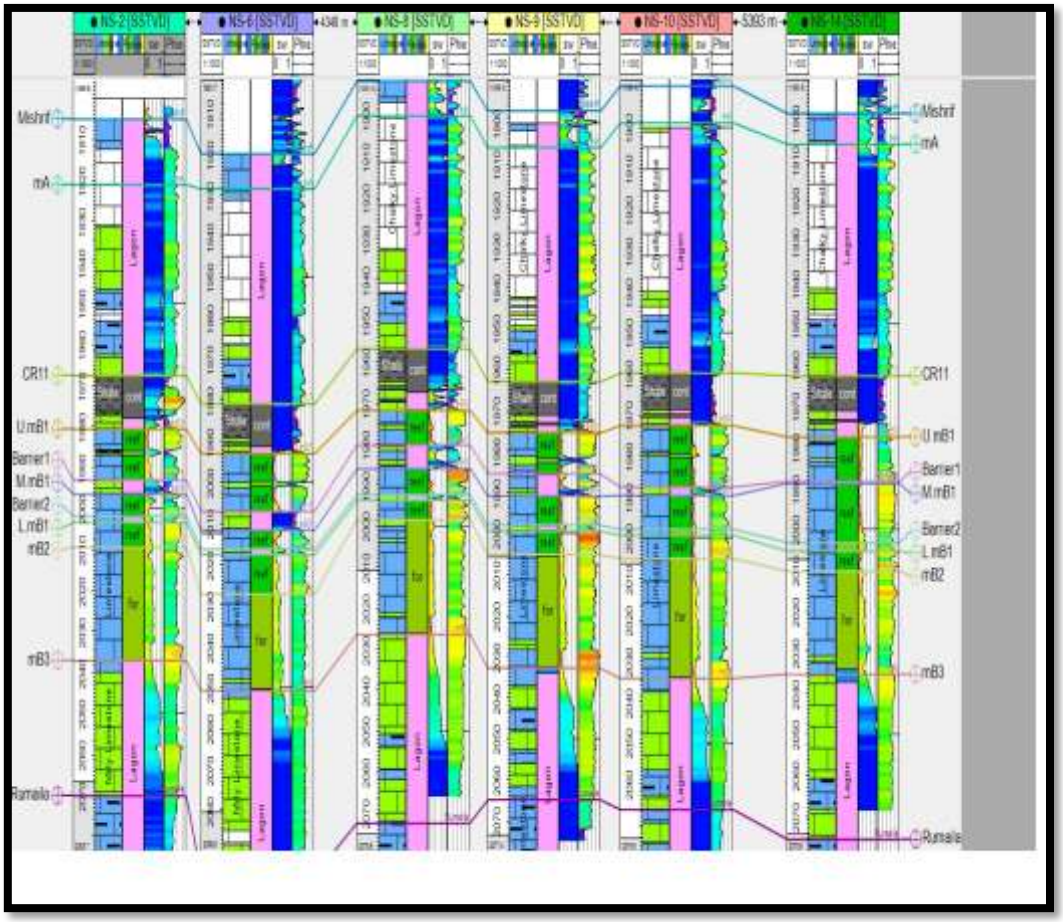
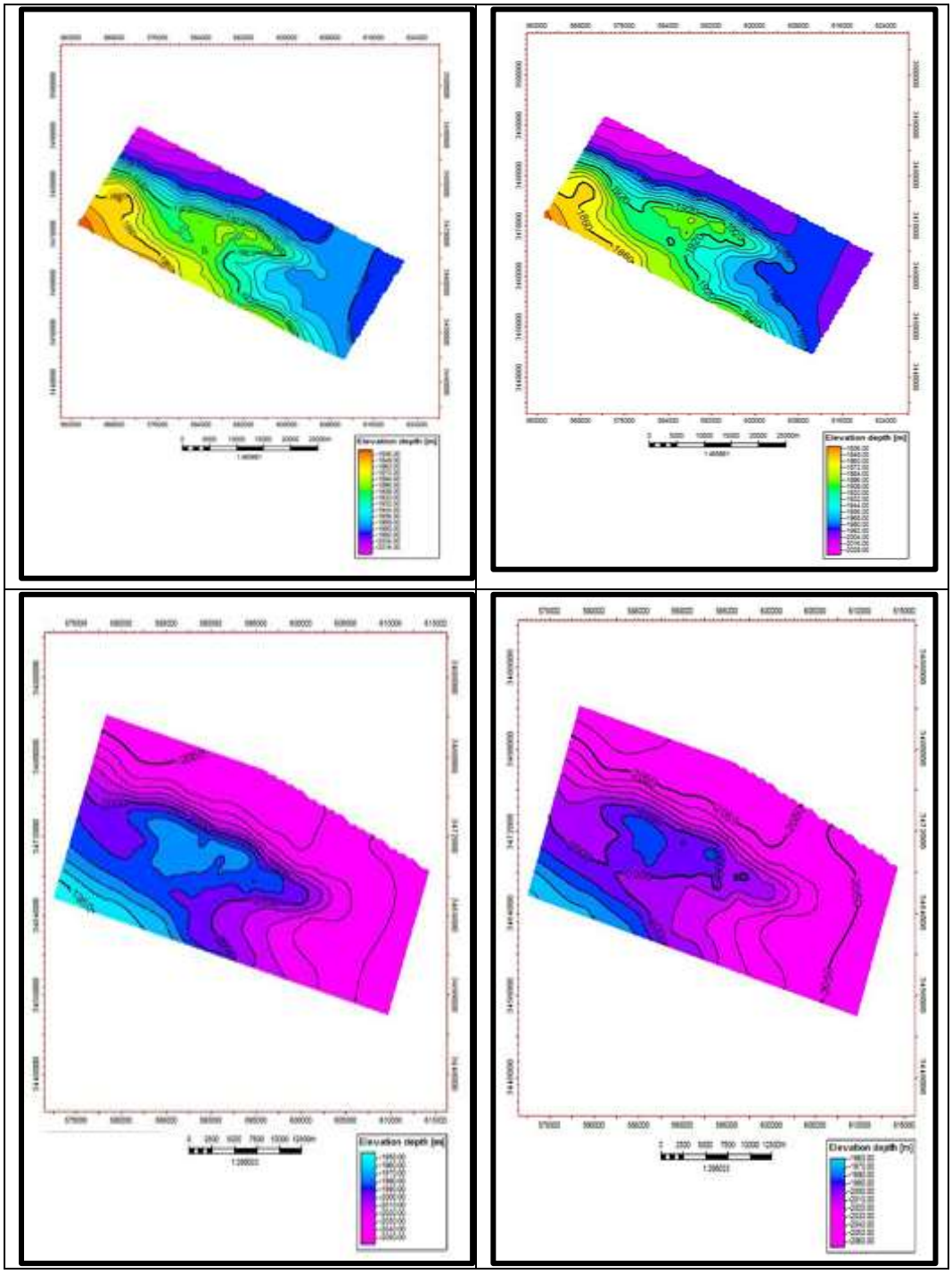


Figure 4- W-E-S Correlated section of Mishrif Formation for wells (NS-2, NS-6, NS-8, NS-9, NS-10 and NS-14).

Structural modelling

This model represents a Geological structure of the study area from which all other models are made [6]. Structural modelling represents building structural contour map for every unit for Mishrif Formation in Nasiriyah oil field . Contour maps can be made by computer from the surface information and connected boreholes [7].Figure -5 represents 2D structural modeling for the Mishrif units. These structural contour maps show that the Mishrif structure in the Nasiriyah oil Field is comprised of anticline fold , its length about 30 km and the width about 10 km , its axis extends toward NW–SE with structural closure about 65 km .



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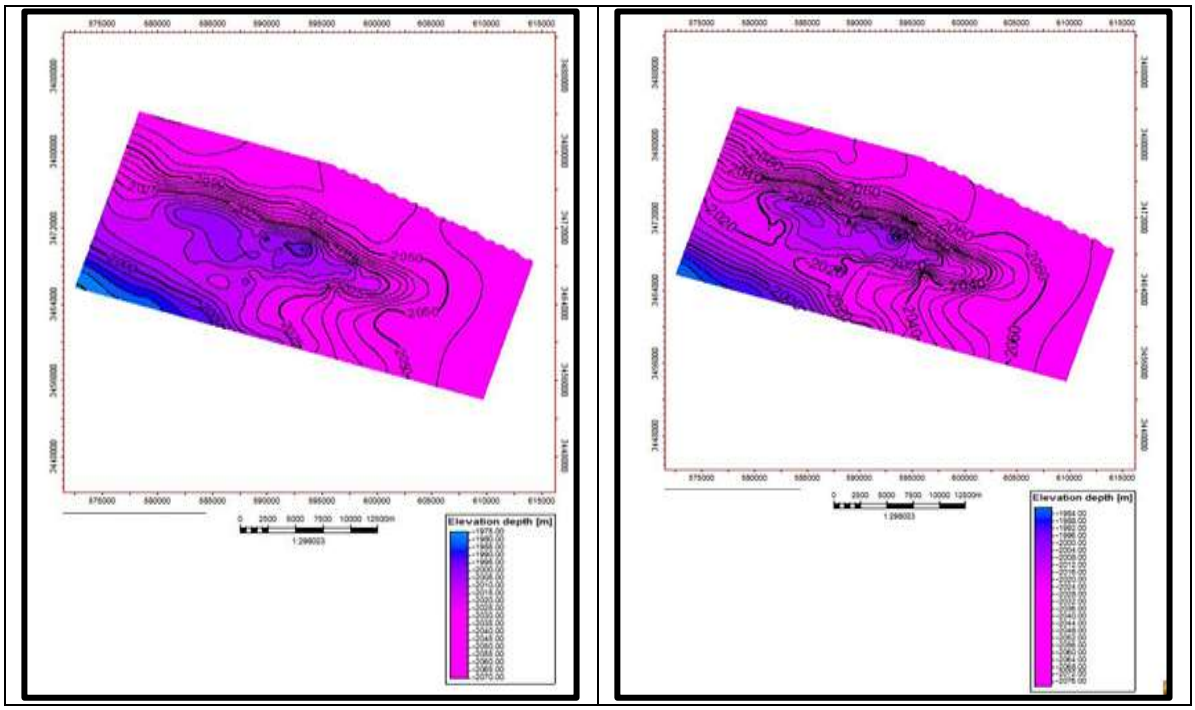


Figure 5- Structural contour map of the of Mishrif Formation units in Nasiriyah oil field.

3D Grid Construction:

A 3D grid construction is the initial step to assemble the 3D model. In an easy terms, a 3D grid divides a model up into boxes. Each box is named a grid cell and will have a single rock type, one value of porosity and water saturation , etc. These are known to as the cell's properties. This is a simplification of the true case, but permits us to generate a representation of reality that can be utilized in calculations, etc. [8].

Pillar Gridding:

It is the process of producing the grid, which represents the base of all modeling. The Skeleton is a grid comprising of Top, Mid and Base skeleton grid [9].

By using the Pillar Gridding, the 3D grid model of Mishrif Formation in Nasiriyah Oil field has been constructed. The result from the Pillar Gridding is the main skeletons on top, mid and base skeletons as seen in the Figure -6. The grid, which used in Mishrif Formation was represented by (100) grid along the x-axis and (100) grid along the y-axis.

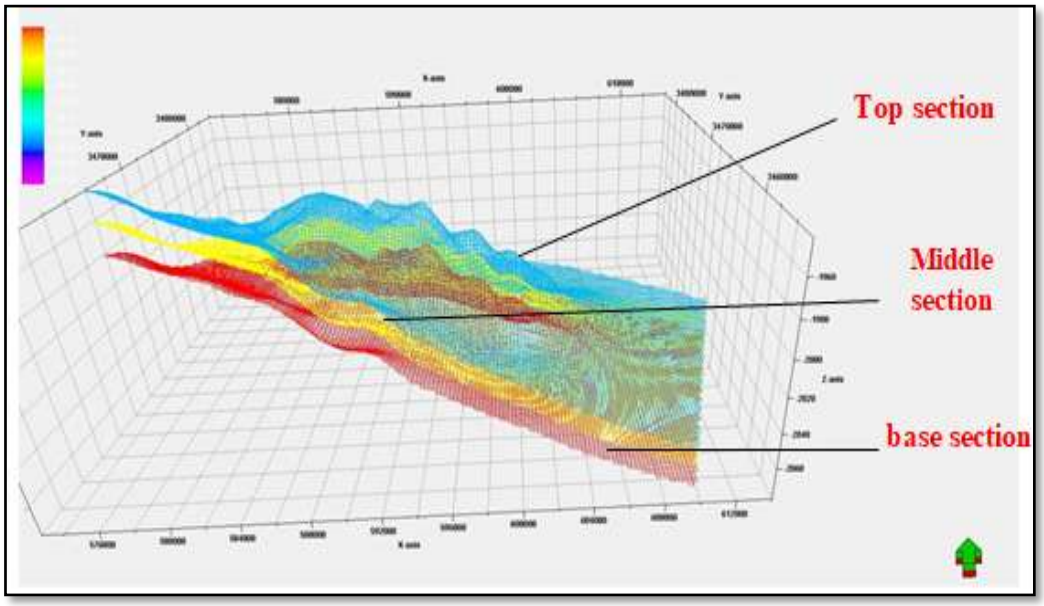


Figure 6- The Structural model of Mishrif Formation in Nasiriyah Oil Field.

Layering

The last step in building the structural framework is to characterize the thickness and orientation of the layers among horizons of the 3D Grid. These layers in conjunction with the pillars characterize the cells of the 3D Grid that are assigned attributes amid property modeling [10]**.** layering, In any case , is characterized as the internal layering mirroring the geological deposition of a specific zone [8]. The reservoir unit of Mishrif Formation in Nasiriyah oil field has been divided into many layers relying upon log behavior and petrophysical properties, the top of Mishrif and other barriers consists of one layer in the uppermost of the Formation. Table -1 illustrates the number of layers for every unit, see Figure -7.

Table 1 - Number of layers for each Zone of Mishrif Formation in Nasiriyah oil field .

Zone	Number of Layers
Top of Mishrif	1
MA	1
Barrier-2	1
U.mB1	6
Barrier-3	1
M.mB1	8
Barrier-4	1
L.mB1	6
Barrier-5	1
mB2	5

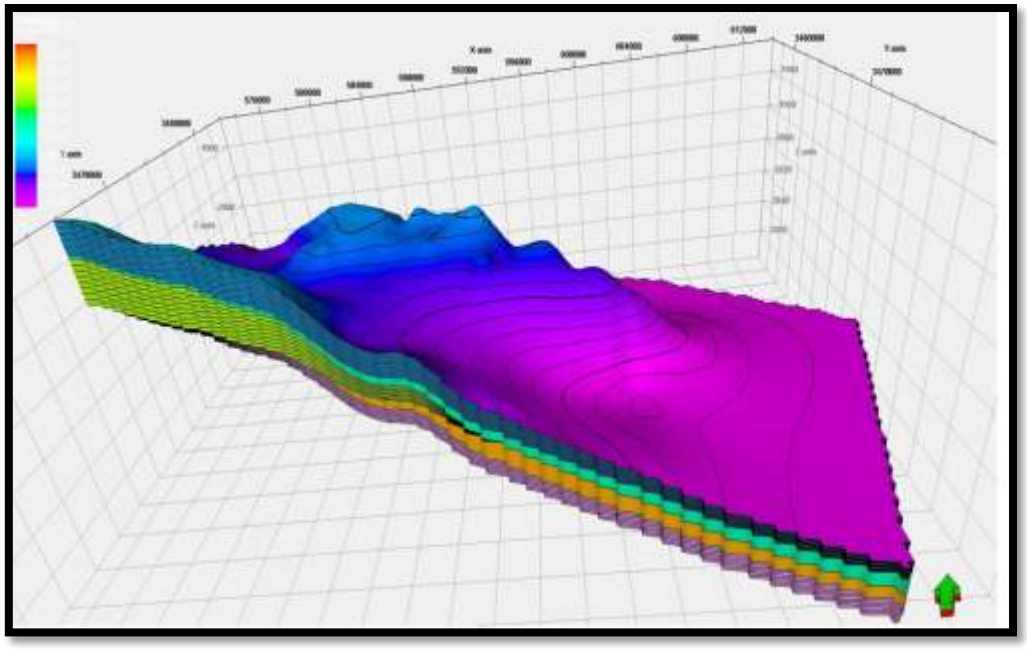


Figure 7- Layers of Nasiriyah oil field model within Mishrif Formation.

Scale up Well logs

This is the procedure of grid coarsening enabled by the computation of successful flow properties utilizing analytical (arithmetic, geometric, and harmonic averages) and numerical simulation. The properties which were incorporated in the scale-up process were permeability, porosity, water

saturation, net-to-gross, and facies type [6].Figures -8 represent the scale up well log setting that was utilized in Nasiriyah Model .

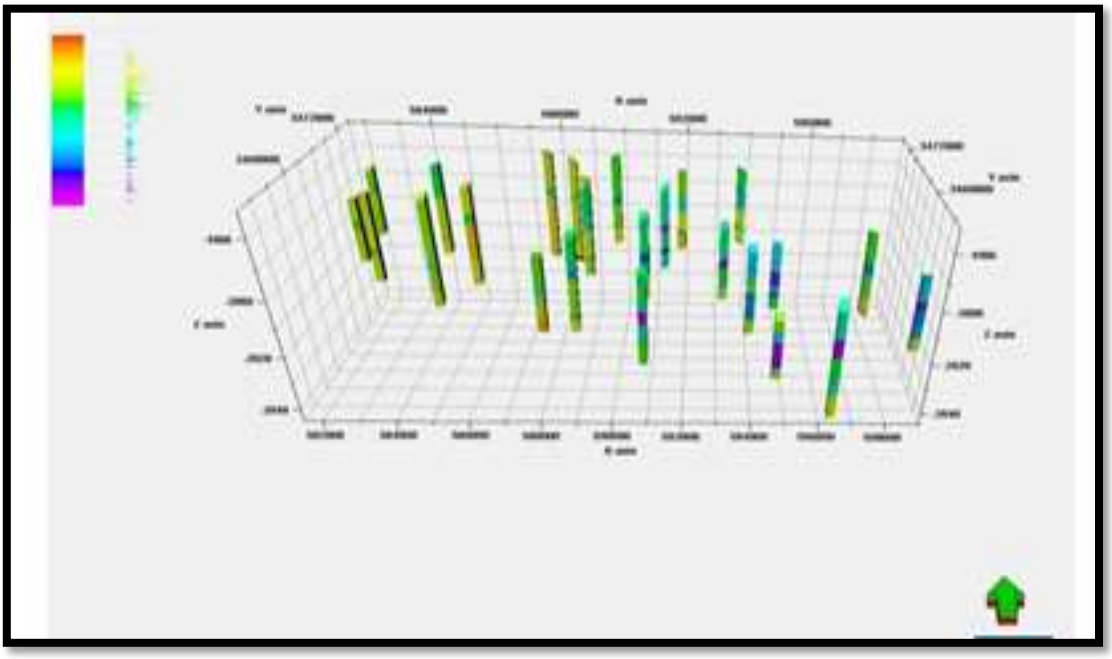


Figure 8- Scale up process of Nasiriyah oil field

Property Modelling

Property modelling utilized for modeling in Petrel is including Petrophysical Modelingthat is an Interpolation of continuous data for example porosity.

The aim of a geological reservoir model is to provide a complete set of continuous reservoir parameters (i.e. porosity, and water saturation) for every cell of the grid [11].

Results and Discussion:

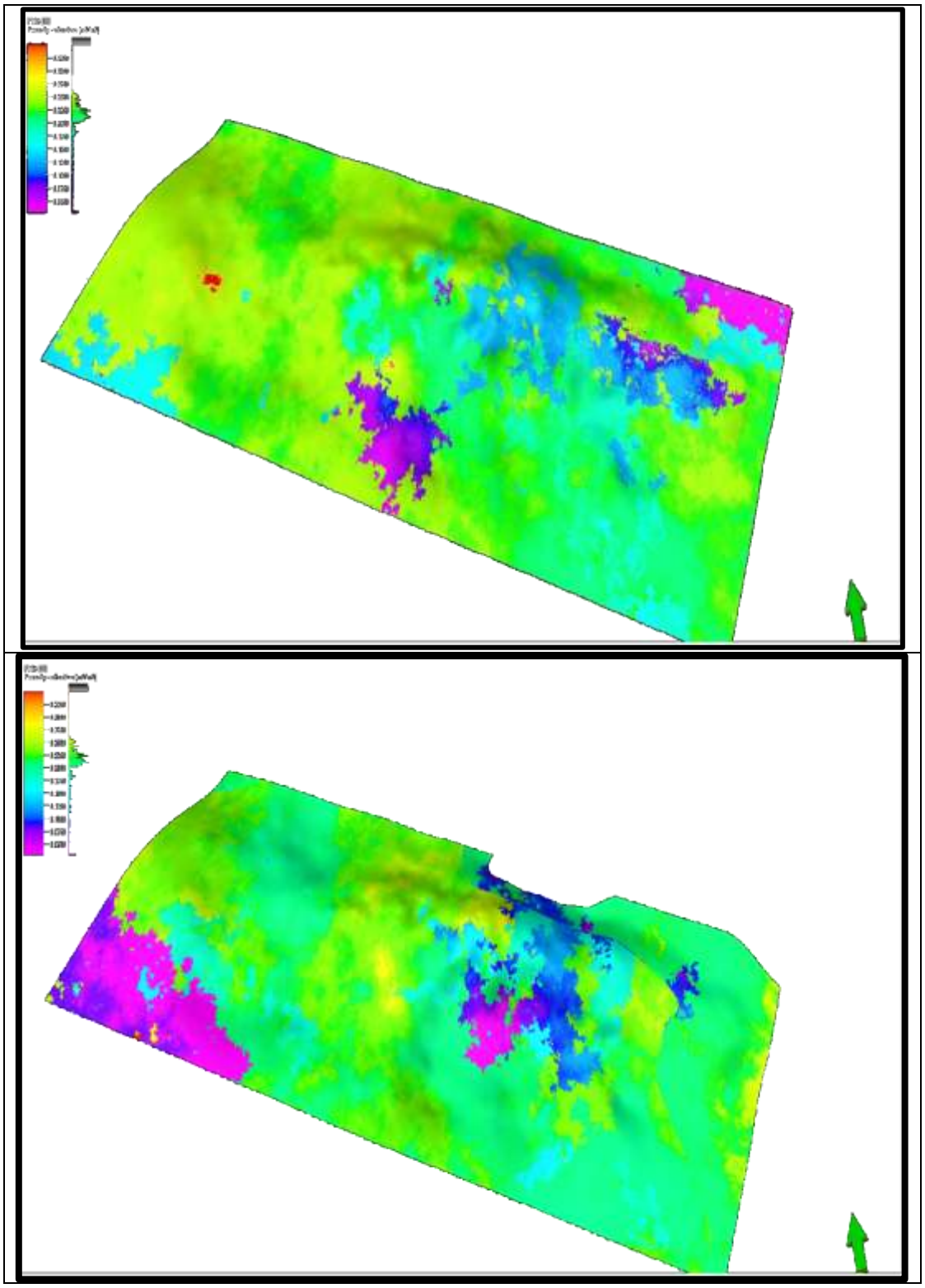
From porosity and water saturation models for each unit of Mishrif Formation, the following points can be shown:

- The porosity of the Mishrif Formation in Nasiriyah oil field were as the following Figure-9:

1. The porosity of the unit UmB1 ranged between 16-32%.
2. The porosity of the unit MmB1 ranged between 15-25% .
3. The porosity of the unit LmB1 ranged between 15-20% .
4. The porosity of the unit MB2 ranged between 10-20% .

- The final water saturation model for Mishrif Formation in Nasiriyah oil field was as the following Figure -10:

1. The value of water saturation of UmB1 ranged between 16-38 %
2. The value of water Saturation of MmB1 ranged between 5-35%
3. The value of water saturation of LmB1 ranged between 5-39%
4. The value of water saturation of MB2 ranged between 10-60%



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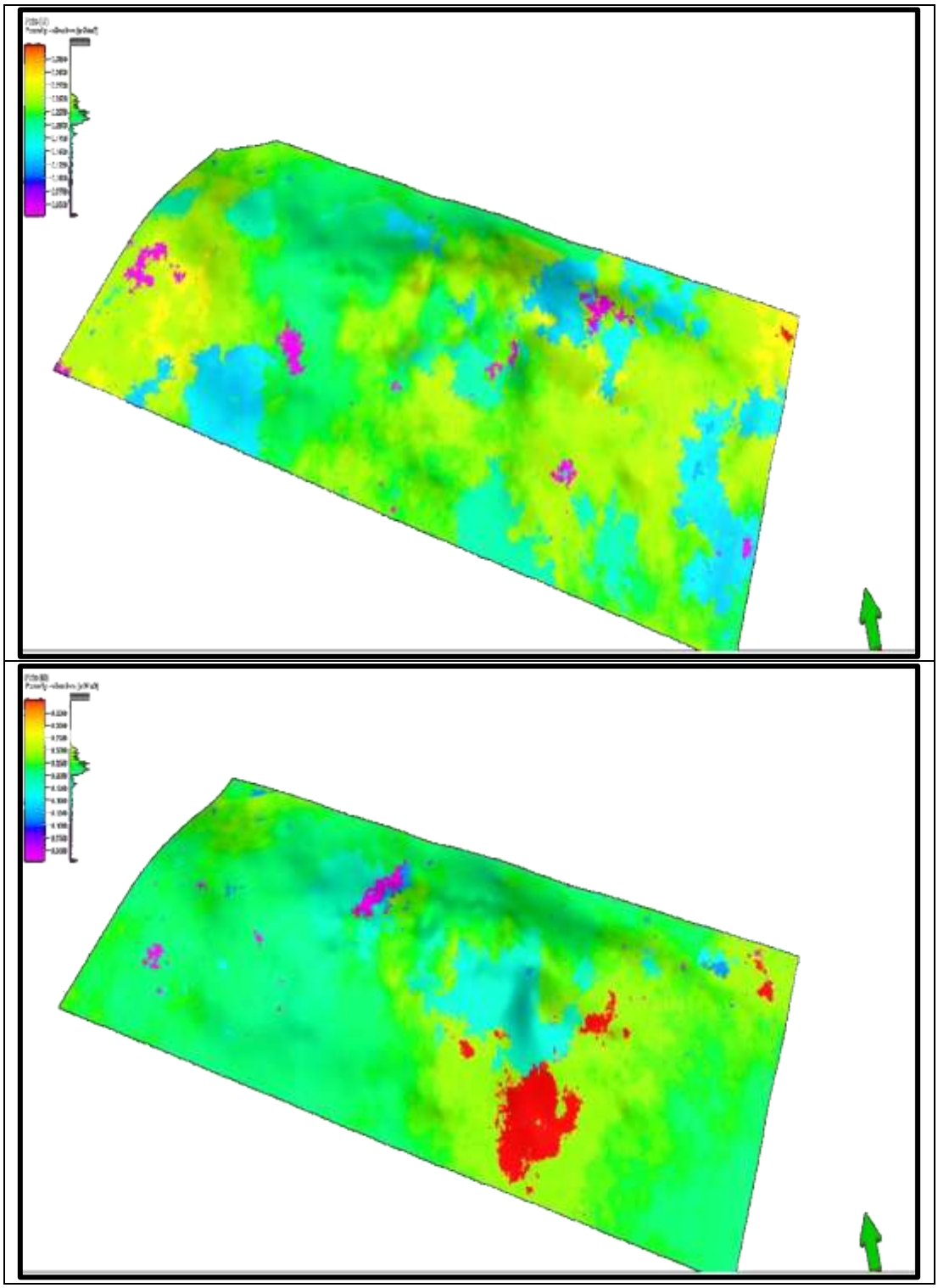

Figure 9- show the porosity model of the Mishrif Formation units in Nasiriyah oil field

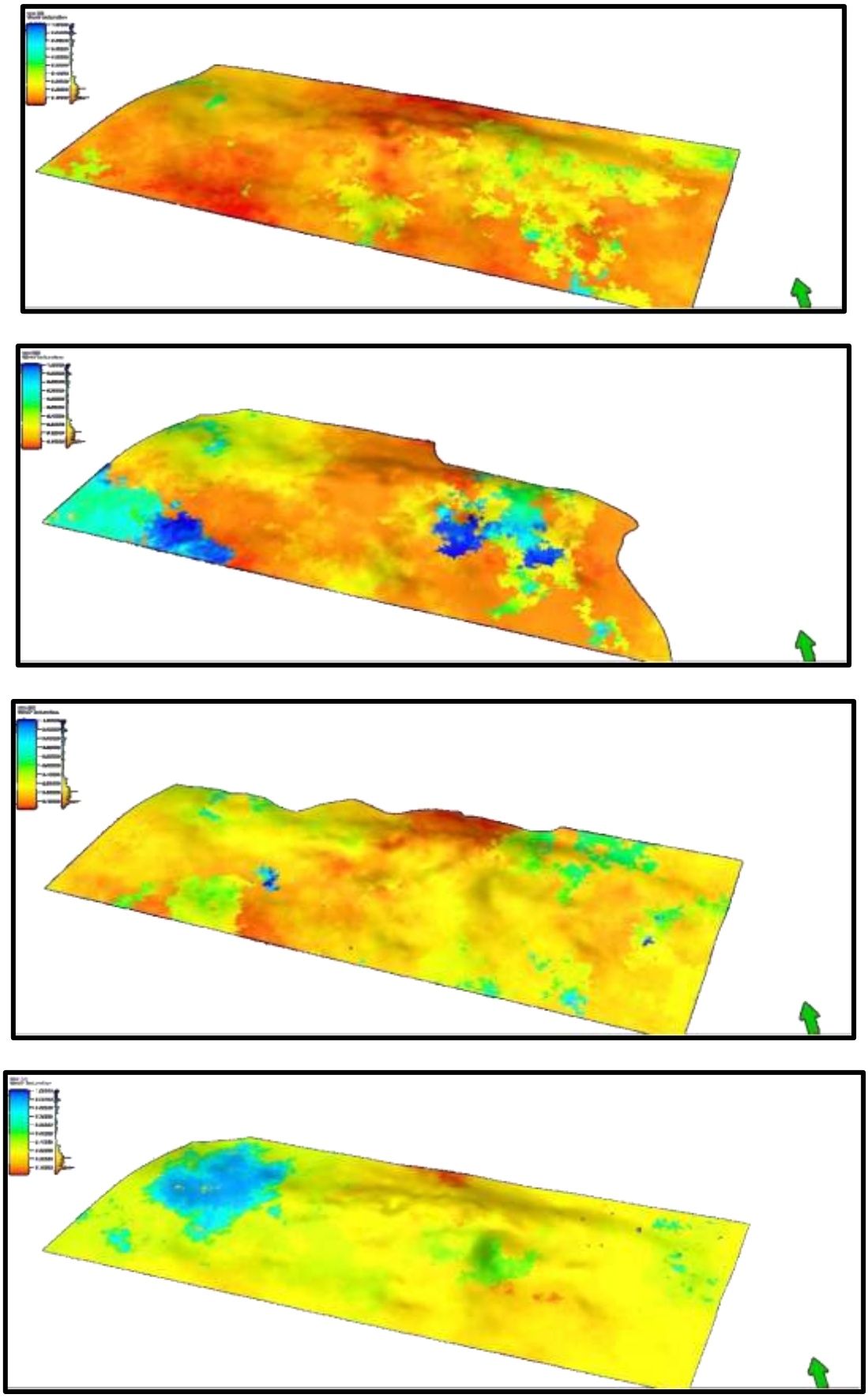

Figure 10-Water Saturation Model of Mishrif Formation units in Nasiriyah oil field.

Conclusions

1. Structural model has been made using petrel software for Mishrif reservoir. This model shows that Nasiriyah oil field represents un anticlinal fold , its length about 30 km and the width about 10 km , its axis extends toward NW–SE with structural closure about 65 km .
2. Horizons were made for Mishrif reservoir, and they are divided into 5 zones (MA zone, UmB 1zone,MmB1 zone ,L.mB1 zone and mB2zone .Layers were built for each zone depending on petrophysical properties. MA(1 layer) ,UmB1(6 layer) ,MmB1 (8 layer) LmB1(6 layer) and mB2(5 layer)
3. The highest values for porosity in MB1 and decreased in MB2 till reach the minimum value in the MA .
4. The minimum value of water saturation in MA unit increased in MB1 till it reaches the maximum value in MB2.

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