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3D Geological Model For Khasib, Tanuma, and Sa'di formations of Halfaya Oil Field in Missan Governorate-Southern Iraq

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Abstract
A geological model is a spatial representation of the distribution of sediments and rocks in the subsurface. Where this study on Halfaya oil field; it is located in Missan governorate, 35 km southeast of the city of Amara. It is one of the main fields in Iraq because it is production high oil. This model contains the structure, and petrophysical properties (porosity, water saturation) in three directions. To build 3D geological models of petroleum reservoirs. Khasib, Tanuma, and Sa'di formations in Halfaya oil field have been divided into many layers depending on petrophysical properties and facies.

Keywords: geological model, Tanuma Formation, petrophysical properties

موديل جيولوجي ثلاثي الابعاد لتكاوين خصيب، تنومه، وسعدي في حقل الحلفاية النفطي في محافظة ميسان_جنوب العراق

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الخلاصة
والنموذج الجيولوجي هو تمثيل مكاني لتوزيع الرواسب والصخور في سطح الأرض. حيث أجريت هذه الدراسة على حقل الحلفاية النفطي. حيث يقع في محافظة ميسان، على بعد 35 كم جنوب شرق مدينة العمارة. وهو واحد من الحقول الرئيسية في العراق لأنها ذات انتاج نفط عالي. يحتوي هذا النموذج على الصفات التركيبية، والخصائص البتروفيزيائية (المسامية، وتشبع المياه) بشكل ثلاثي الابعاد. لبناء نماذج جيولوجية ثلاثية الأبعاد من خزانات النفط قد تم تقسيم تشكيلات الخصيب وتانوما والسعدي في حقل الحلفايه النفطي إلى عدة طبقات اعتمادا على السحنات والخصائص البتروفيزيائية.

Introduction

Upper Turonian - lower Campanian supersequence consists predominantly of deep shelf sediments in Iraq and includes the Khasib, Tanuma and Sa'di Formations. This supersequence consists of a fine-grained, mixed siliciclastic-carbonate middle shelf to sub-basinal depositional system [1], [2]. Halfaya Oil field in Iraq is located on the unstable continental shelf in the northern of the Arabian Gulf Basin. Huge thick sedimentary strata covered the unstable continental shelf [3]. According to [4], the Khasib Formation represents the oldest formation of that subcycle the thickness of the formation in the type section reaches 50 m. The Tanuma Formation is the second formation of the Turonian - Early Campanian Subcycle in the southwestern parts of the shelf area. The thickness of the formation in the type section 'amounts to 30 m. The Sa'di Formation is the highest, thickest, and most widespread

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formation of the tripartite Turonian – Early Campanian subcycle of southern Iraq. The thickness of the formation varies greatly reaches 300 m [5].

Study Area

The Halfaya field is located south of Iraq in Missan province, 35 kilometers southeast Amara city Figure-1. The structure, which is composed of dome runs along a NW-SE direction and gentle elongated anticline about 38km long and 12km wide.

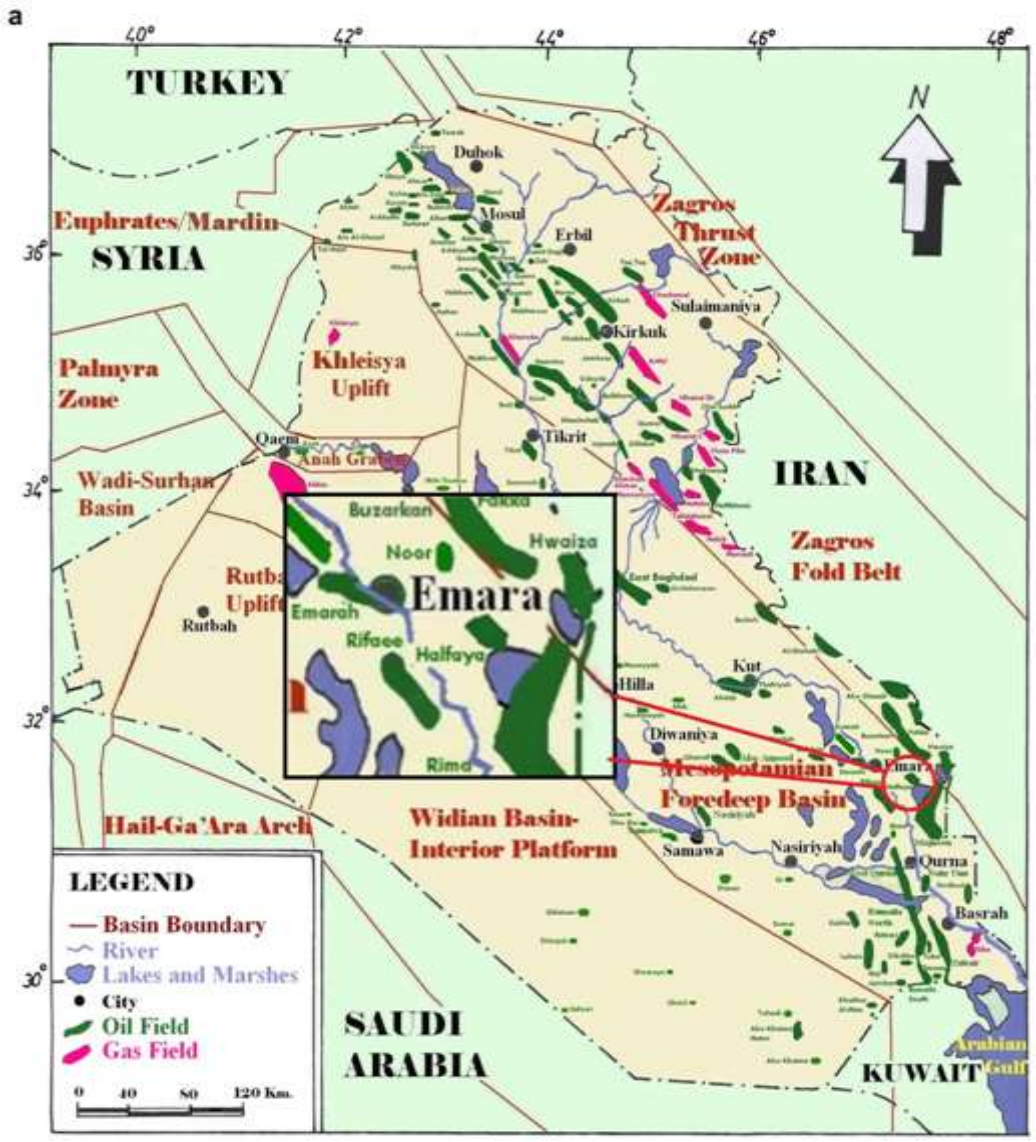

Figure 1-Location map of Halfaya oil field [4].

Methodology

The main purpose of this study to build a 3D integrated model for the Khasib, Tanuma, and Sa'di formations in the Halfaya field. . The software to be used is Petrel 2013, the available logs such as (Spontaneous Potential, Gamma Ray, Density, Sonic, Neutron and Resistivity logs). These logs carried out to Petrel software to construct structural maps and 3D geological models and distributing the petrophysical properties (Facies, Porosity and Water saturation) in the model.

Well Correlation

Well correlation is a relatively easy method to give an idea and allow simple visualization of the changes in the thickness within khasib, Tanuma, and Sa'di units and the change of the petrophysical properties.

Three well sections have been made in Halfaya Oil Field, the Figure-2 shows the direction of correlation between wells, represented by Red line in W-NE direction. And Figure-3 illustrate the variation in reservoirs thickness of the Khasib,Tanuma, and Sa'di units as well as the variation in petrophysical properties (porosity and water saturation).

The correlation well sections show the thickness increasing from the W at HF-2 to NE direction at HF-1 and HF-4. The petrophysical properties good in the crest HF-1 directions and enhancement toward W in HF-2, and became poor in the NE at HF-4.

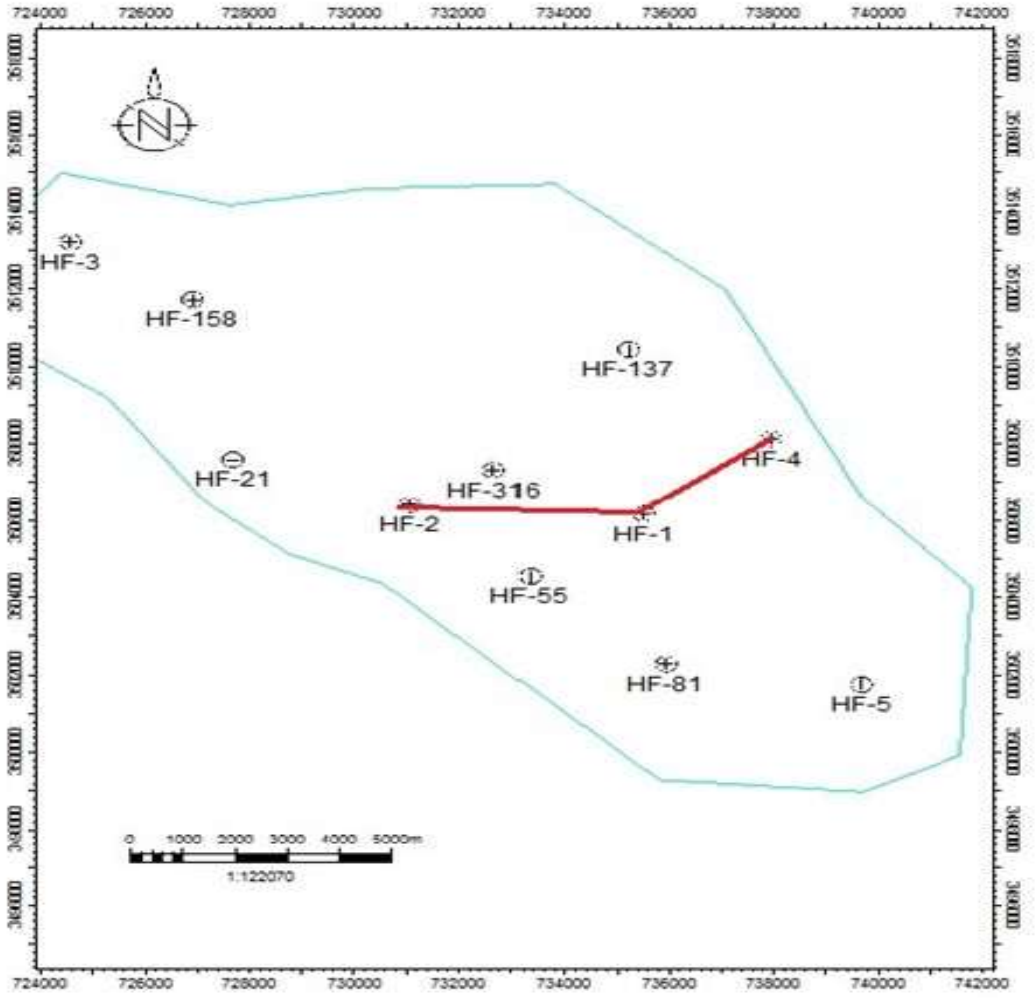

Figure 2-Map view shows the directions of correlation between the wells.

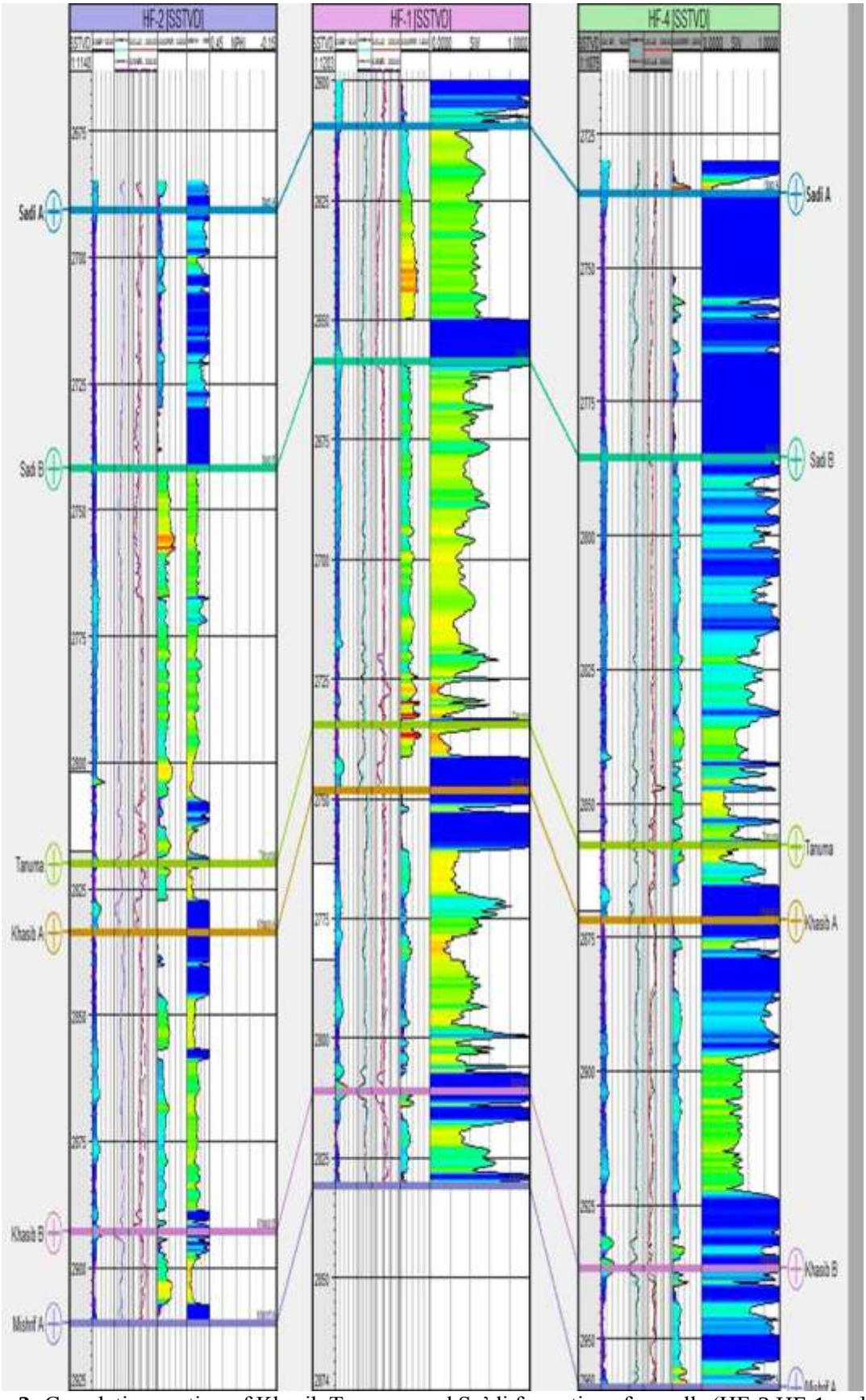

Figure 3- Correlation section of Khasib,Tanuma, and Sa'di formations for wells (HF-2,HF-1 and HF-4).

Structural Contour Maps

It is subdivided into three processes as follows: fault modeling, pillar gridding, and vertical layering. Contour maps can be made by computer from the surface and correlated boreholes [6]. Structural contour maps for top of Khasib, Tanuma, and Sa'di have been made Figures-(4,5,6).

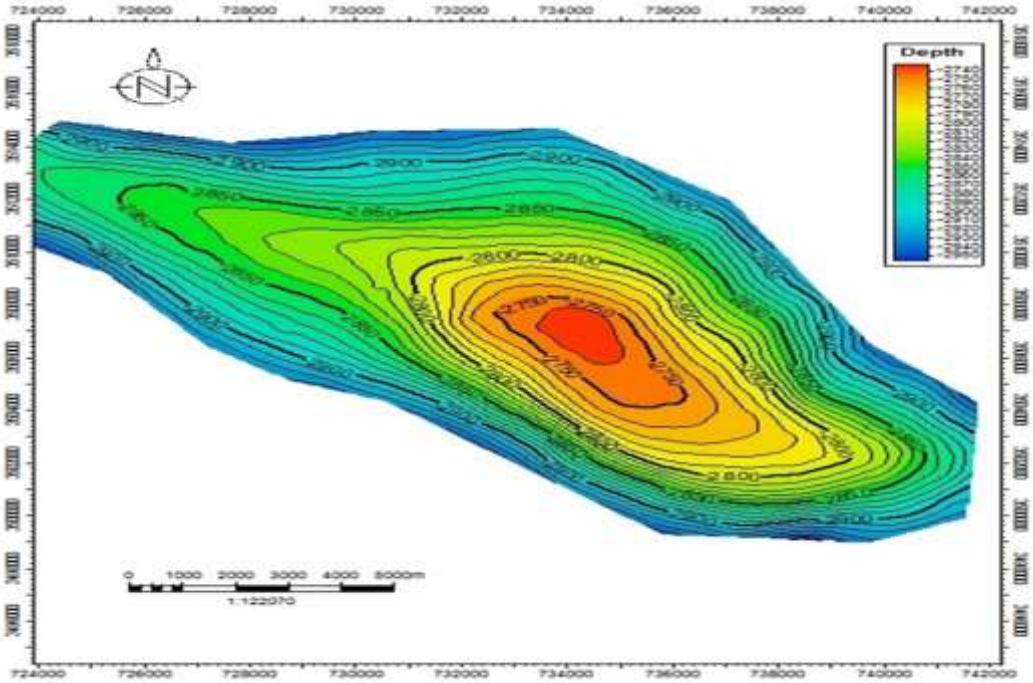

Figure 4-Structural contour map of the top of Khasib Formation.

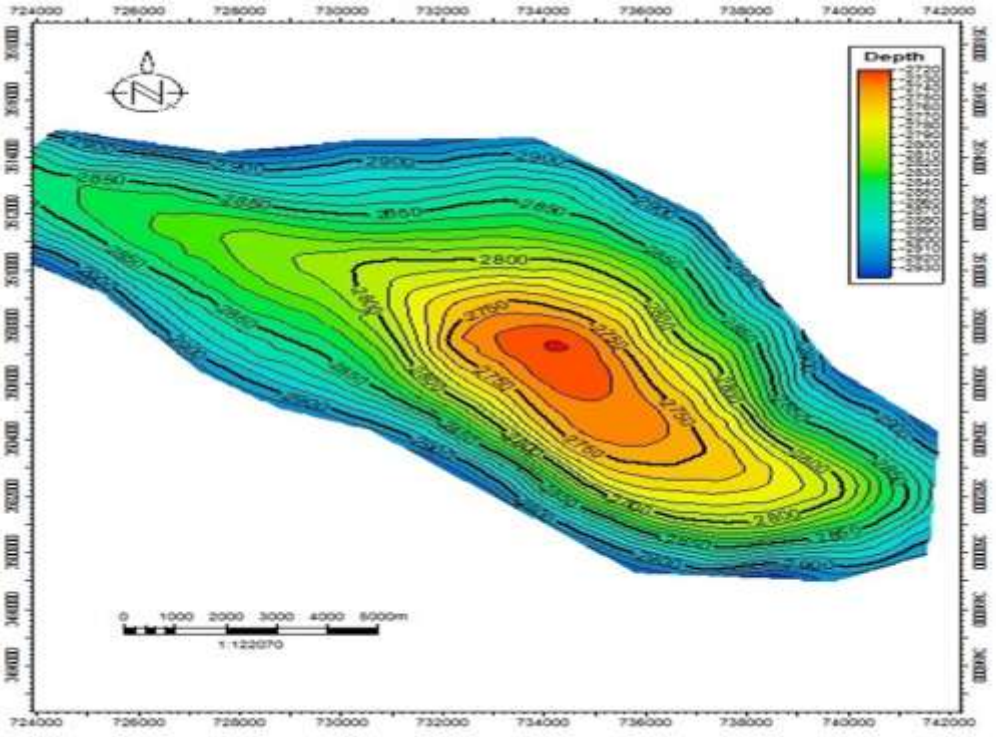

Figure 5-Structural contour map of the top of Tanuma Formation.

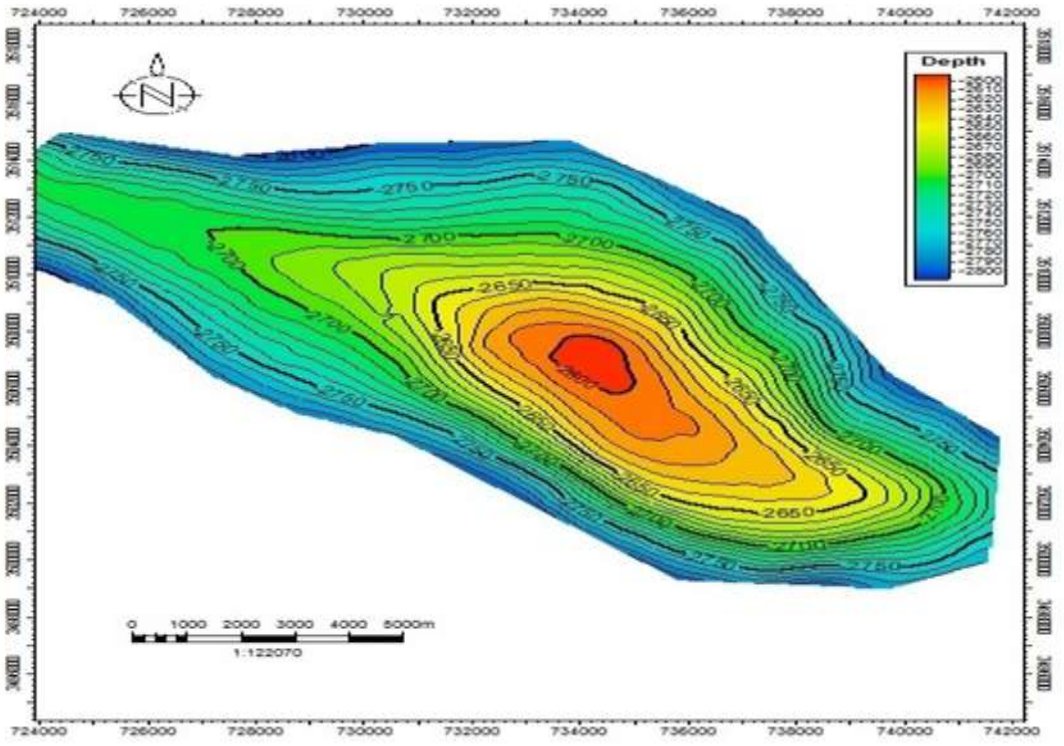

Figure 6- Structural contour map of the top of Sa'di Formation.

Make Horizons

For the surfaces to be incorporated into the 3D grid they needed to be transformed into horizons which was done in the "Make horizons" process. Figure-7 represents horizons of the main units of Khasib, Tanuma, and Sa'di formations.

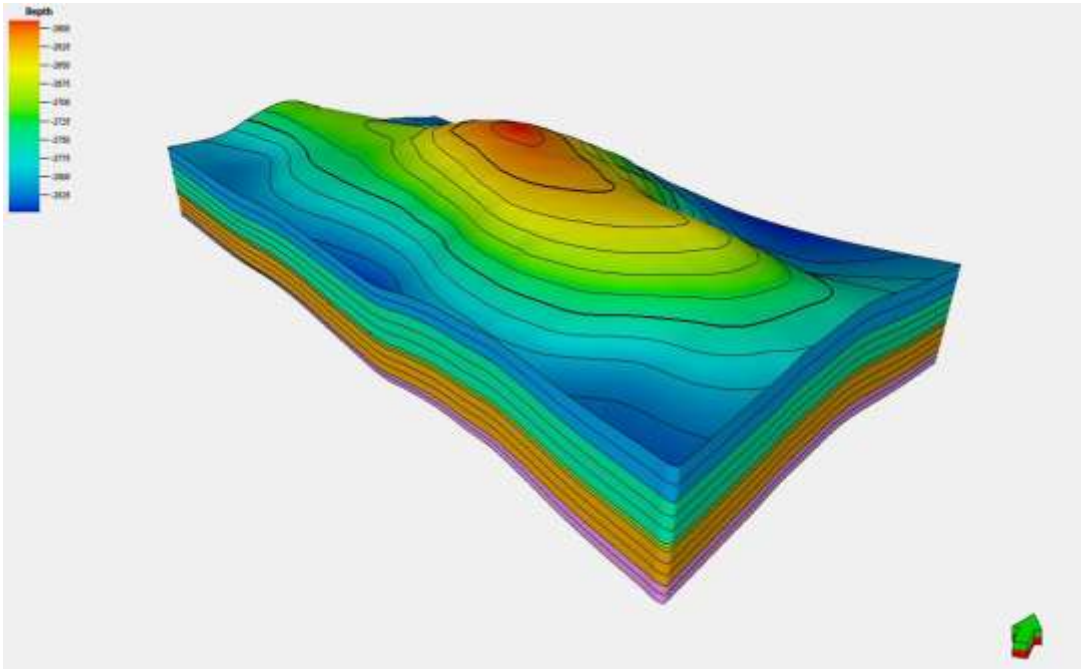

Figure 7- Showing the horizons of three formations in Halfaya oil field.

Property Modeling

The objective of property modeling is to distribute properties between the available wells so it realistically preserves the reservoir heterogeneity and matches the well data; therefore, Property modeling is the process of filling the cells of the grid with discrete (Facies) or continuous (Petrophysics) properties [7].

Petrophysical Model

The purpose of petrophysical property modeling is to create a set of continuous reservoir parameters such as porosity and water saturation for each 3D grid cell [8].

Porosity Model

Porosity model was built depending on the results of porosity logs (density, neutron, and sonic logs). From porosity model the following conclusions can be shown:

- The porosity model for each reservoir unit of Khasib Formation. It was noted that the porosity within reservoir units Khasib units are characterized by relatively lower porosity range from (5%-15%) along the field Figure-8.

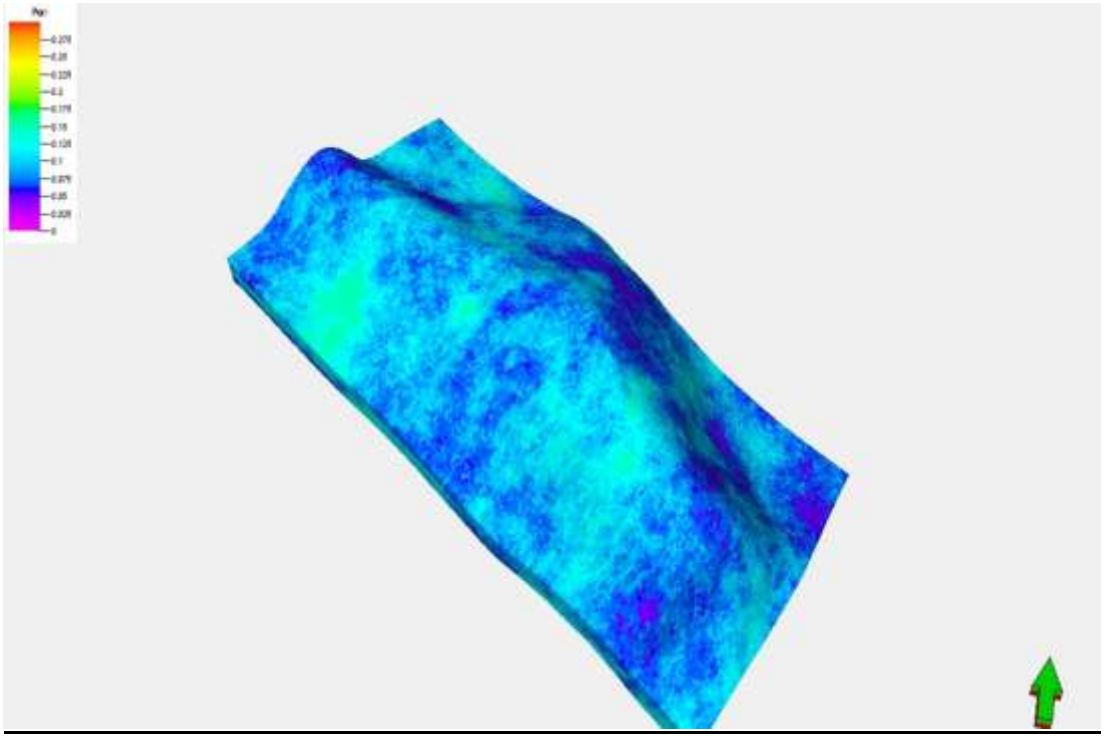

Figure 8-Porosity model of Khaib Formation in Halfaya field.

- The porosity model for reservoir unit of Tanuma Formation. It has nearly higher porosity along the unit reach to 25% Figure-9.

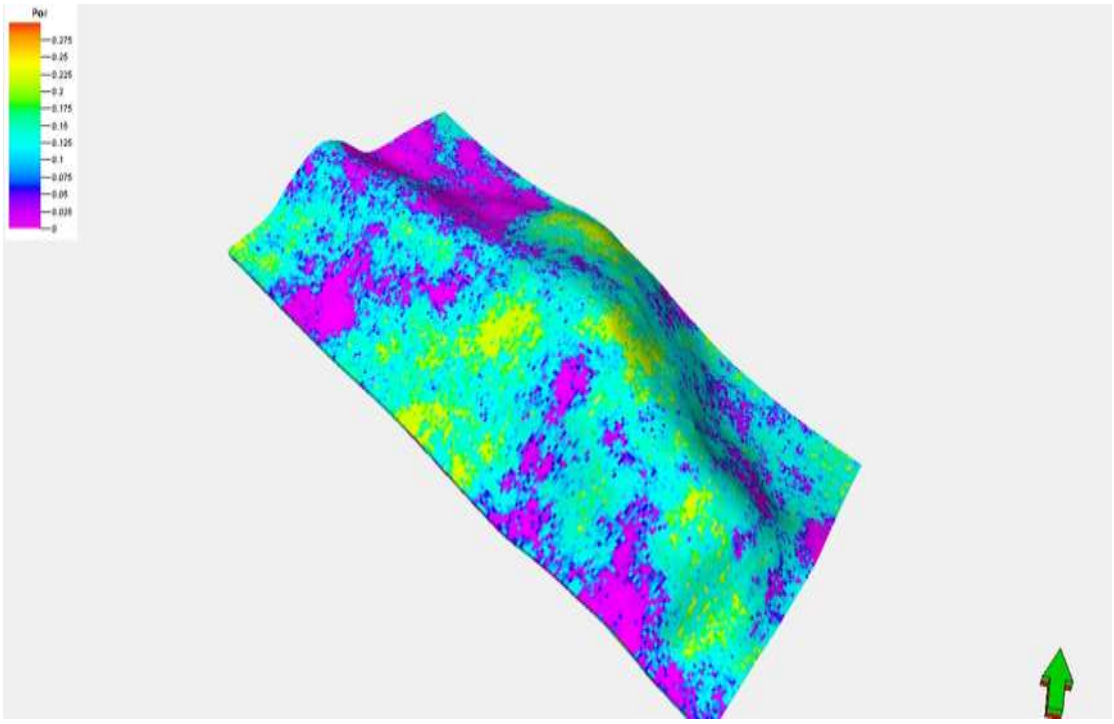

Figure 9-Porosity model of Tanuma Formation in Halfaya field.

- The porosity model for each reservoir unit of Sa'di Formation. It was noted that the porosity within reservoir units Sa'di units. The porosity reaches 23% in well HF-316 at the crest of the first dome. The porosity increased at the west to reach 23% in well HF-3, Hf-21, while the porosity decreased at the east to reach 2% in well HF-5 Figure-10.

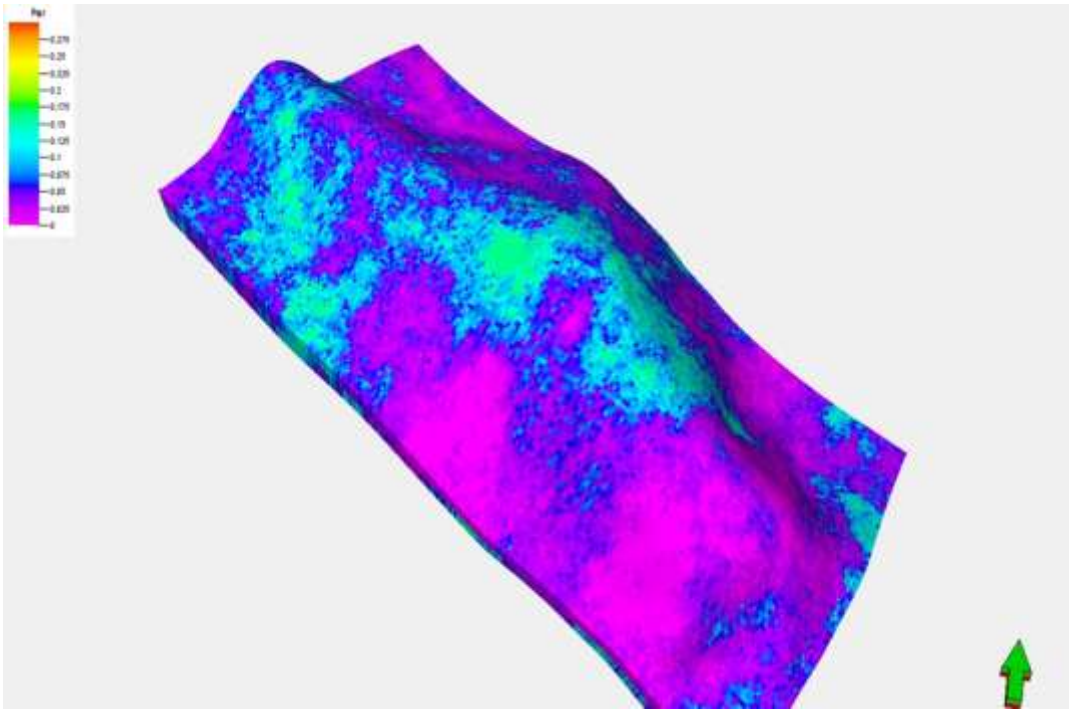

Figure 10-Porosity model of Sa'di Formation in Halfaya field.

Water Saturation Model

The water saturation model was built after the scale up of water saturation that exported from IP software for each reservoir unit of the Khasib, Tanuma, and Sa'di formations. The same geostatistical method was used in the porosity models (Statistical Gaussian Simulation Algorithm) according to the available data. From water saturation model it can be shown:

- The water saturation model for each reservoir unit of Khasib Formation. It was noted that the water saturation within reservoir units Khasib units are characterized by high water saturation reach to 100% north in well Hf-158, while it decreases in the east and west reach to 30% in well Hf-21, Hf-81 Figure-11.

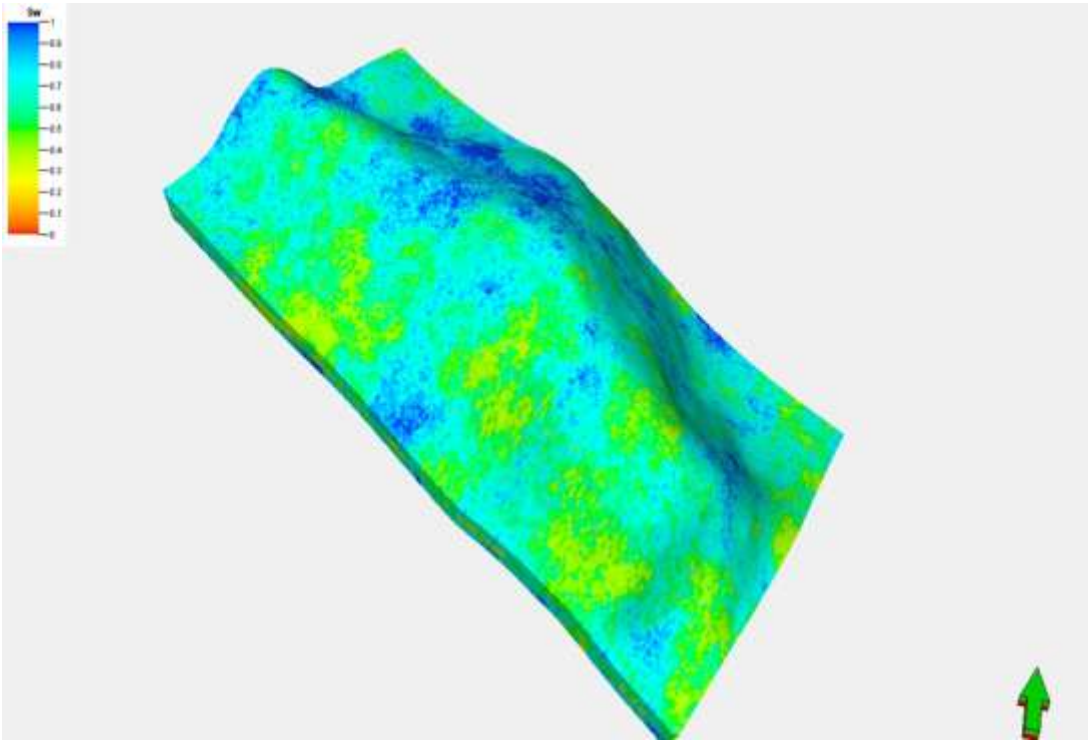

Figure 11- Water saturation model of Khasib Formation in Halfaya field.

- The water saturation model for reservoir unit of the Tanuma Formation. It has nearly higher water saturation in the east and west unit reach to 100% in well Hf-3, HF-4, and Hf-81, and decreased at the crest to reach 25% in well HF-1, Hf-137,and Hf-316 Figure -12.

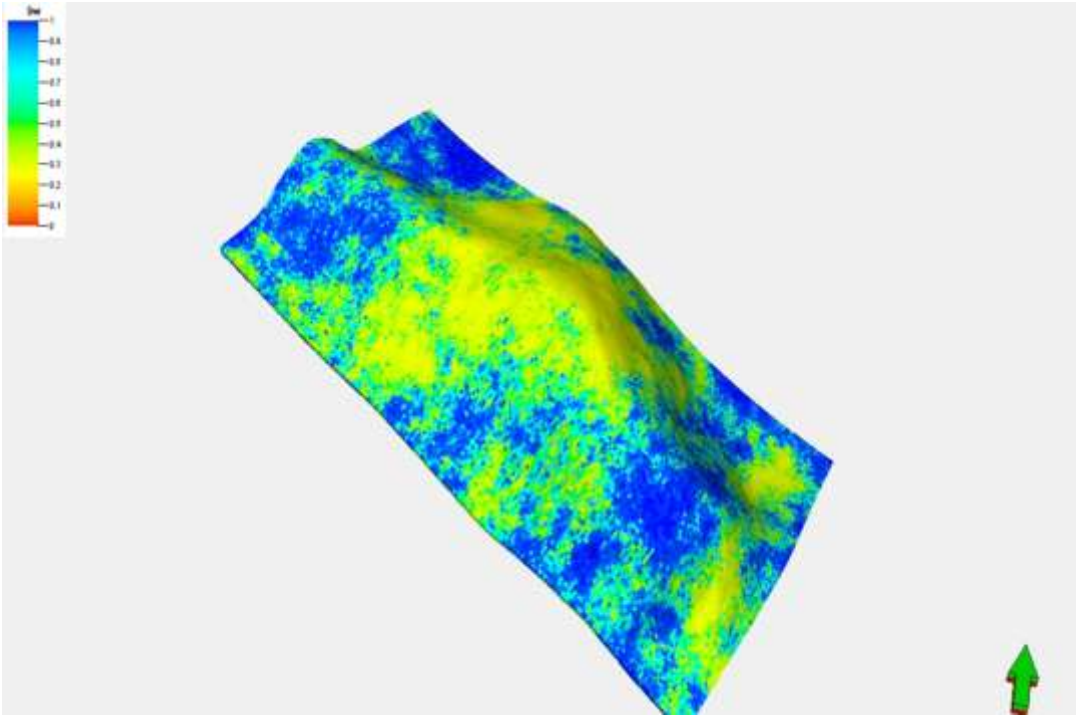

Figure 12-Water saturation model of Tanuma Formation in Halfaya field.

- The water saturation model for each reservoir unit of Sa'di Formation. It was noted that the water saturation within reservoir units Sa'di units. The water saturation reaches 100% along the unit, while it decreased at the crest to reach 50% in well HF-1 Figure -13.

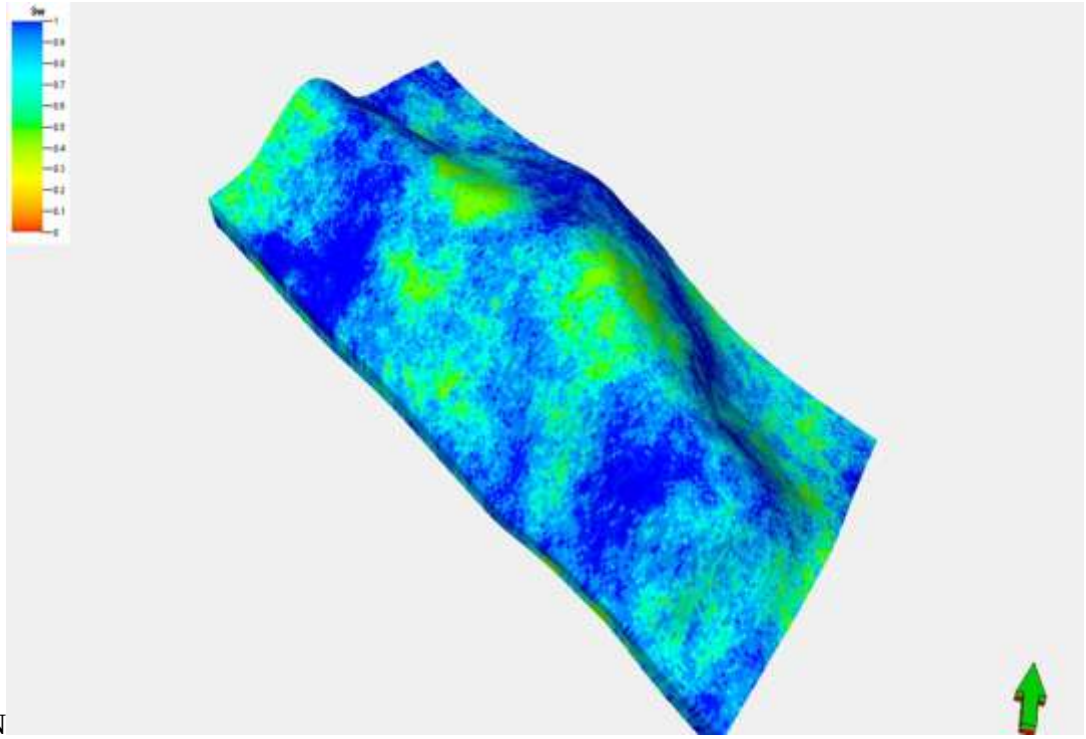

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Figure 13-Water saturation model of Sa'di Formation in Halfaya field.

Conclusions

1- The Halfaya structure, which is composed of dome runs along a NW-SE direction and gentle elongated anticline about 38km long and 12km wide.

2- The correlation well sections show the thickness increasing from the W at HF-2 to NE direction at HF-1 and HF-4, also the petrophysical properties enhancement in the same directions in HF-2, HF-1 and HF-4 respectively.

3- The Structure contour Maps for all units of Khasib, Tanuma, and Sa'di formations have been carried out by Petrel software maps and were shown that maps of these units show that the Halfaya structure is composed of two anticline folds running along a NW-SE direction.

4- Each reservoir unit in Khasib, Tanuma, and Sa'di formations have been divided into many layers depending on petrophysical properties and facies. Khasib-A has been divided into 2 layers, Khasib-B has been divided into 3 layers, Tanuma has been divided into 2 layers, Sa'di-A has been divided into 3 layers, Sa'di-B has been divided into 2 layers.

Recommendations

1- To increase the accuracy of the formation evaluation, new wells should be drilled along the field and penetrate Khasib, Tanuma, and Sa'di formations to cover the area of the field.

2- 2D and 3D seismic data are very important for building advanced geological models.

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