Reservoir characteristics and modeling of Zubair for Subba oil field

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1-Abstract

Geological model is very essential step to distribute reservoir properties. In the present study, a three-dimensional geological model for the Zubair reservoir in Subba oil field was built based on data obtained from sex wells. The 3D grid was built and filled it with petrophysical properties (porosity and water saturation). Structure contour map is prepared for the Zubair Formation using Didger program. The Petrel software 2017 has been used to set-up a 3D model. Simple grid method was used to build the structural framework with 103x149x22 grid cells in the X, Y and Z directions, respectively, with length equal to 150 meters. CPI (computer processed interpretation) for 6 wells contain, (porosity and water saturation) was imported to Petrel 2017 software. The petrophysical properties was distributed using Sequential Gaussian Simulation (SIS)

method. The results shows that petrophysical properties is high and enhanced in the north area of Zubair formation. Porosity model shows

that unit Zubair A have the highest porosity value, while unit Zubair

C have good to medium porosity value. Water saturation model shows that the unit Zubair A have the lowest SW value, which mean this unit is oil bearing zone. The unit Zubair C have low SW

value in the north dome while the south dome has high SW values.

Subba oil field modeling /ptral.(key)

1- Introduction

The geological model represents a static model because it utilizes all known data such as sedimentological, clay mineralogy and petrophysical interpretations (Pápay, 2003). The 3D geological model includes construction of structural and stratigraphic framework, it is also involving property modeling for petrophysical properties by using statistical distribution methods. The petrophysical properties and reservoir characterization are using to generates petrophysical models, the petrophysical model is using for a more precise prediction of future performance and estimate of reserves (Morton et al.,2002). The petrophysical modeling is the using of statistical distribution methods to distribute the petrophysical model for un-drilled reservoir cells, depending on the data obtained from the drilled areas.

The Zubair formation in Subba field is the main hydrocarbon reservoir, which is the subject of our study. The Zubair Formation was introduced by Glynn Jones in 1948 from the Zubair oil field and amended by Nasr and Hudson in 1953. It is the most significant sandstone reservoir in Iraq, composed of fluvio- deltaic, deltaic and marine sandstones. It covers wide areas of the Arabian Plate including northern Saudi Arabia, Kuwait and most of southern and part of Central Iraq. The formation correlates with the Biyadah (Riyadh) Formation in Saudi Arabia.

The upper contact of the formation with the Shuaiba Formation are mostly gradational and conformable. The lower boundary is unconformable with Ratawi Formation (Buday, 1980) and this unconformity described by (Douban and Medhadi, 1999).

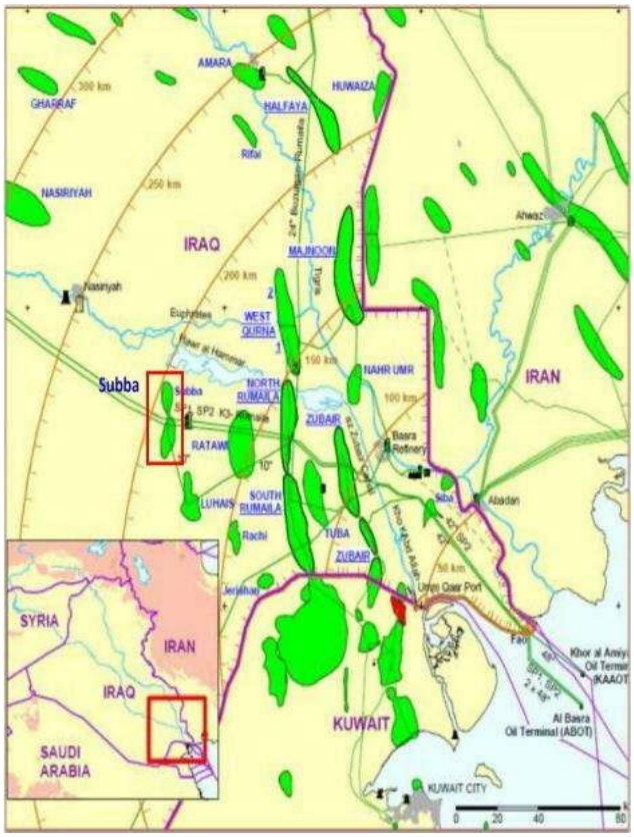
For the purpose of studying the reservoir

properties of the Zubair formation in Subba oil field, a three-dimensional geologic model was built using petrel 2017 software.

2- The study area

The Subba oil field is belonging to the Thi-Qar Oil Company, and it is the third producing field in the company beside Nassiriya and Gharraf oil fields. Subba oil field is situated in the southern of Iraq, about 12 km to Luhais oil field (Fig.1). The dimensions of the field are 7 km and 30 km long. It consists of two domes separated by saddle. The small dome locates in the north while the large dome locates in the south. It is located southeast of the Nasiriyah city. The first well was drilled in 1975. In 1977-1979, three appraisal wells were drilled. In the last of 1980, the operation in Subba oil field was stop due to the wars. after 2003, the Ministry of Oil took upon itself the investment and development of Iraqi fields for the purpose of supporting the national economic artery.

Fig (1) Subba oil field location map (NOC, 1979)



3- AIM OF THE STUDY

The objectives of this study are:

1. Constructing a 3D Geological structural model based on contour map of Zubair formation.

2. Building a 3D Geological model based on geological and petrophysical data, then distribute the petrophysical properties (porosity and water saturation) along the 3D structural grid.

4- Materials and Methods

The data are collected from computer processed interpretation provided by Thi-Qar Oil Company. These data include the following (Well data, CPI (computered processed interpretation of well logs, well tops and structure maps).

The geological model is the main stage in this study. It is a 3D quantitative representation of a volume of rock within a computer. 3D geological model is a very necessary and integrated part of predicting, planning, and it comprises a large amount of geological (Structural data), petrophysical (Porosity, Water saturation, Permeability), and general production data. Petrel 2017 software was used to build the three-dimensional model. Constructing geological model requires the following steps:

5.1 Data Import:

The data prepare for this 3D geological model are well heads, well tops, well logs and depth maps. The well heads manger containing well positions (Northing (y), Easting (x)), true vertical depth TVD, Kelly bushing KB. While the well tops file contain the Zubair units data, these data include the Markers representing significant points (well picks). The results of well logs interpretation (computer processing interpretation (CPI)) (porosity, water saturation and permeability) was imported to Petrel software.

5.2 Well Correlation

After importing well data to the Petrel software, well correlation for the Zubair formation is carried out. Well correlation is applied as an easy method for giving an idea and allowing visualization in properties (water saturation and porosity) and thickness. One longitudinal section of well correlation is chosen to show variation in the thickness of the reservoir. Fig.2 shows the location of well

correlation, Fig.3 show well correlation of lithological units of Zubair Formation.

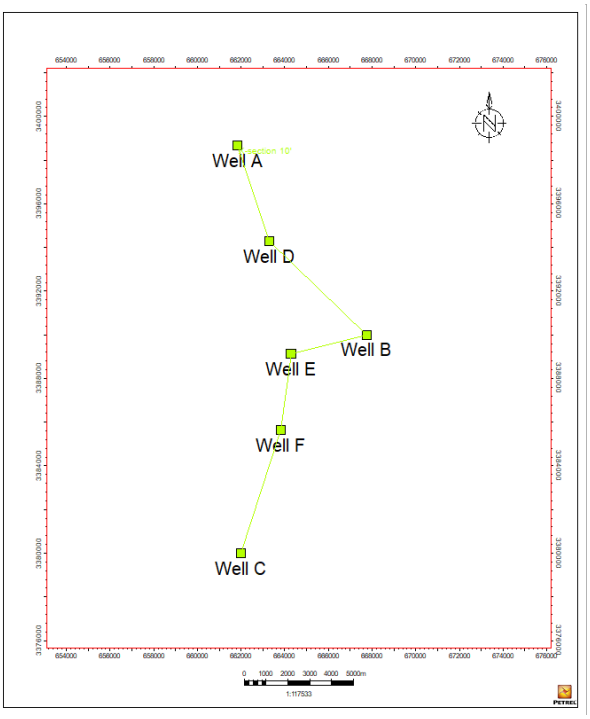


Fig.2 shows the location of well correlation**.**

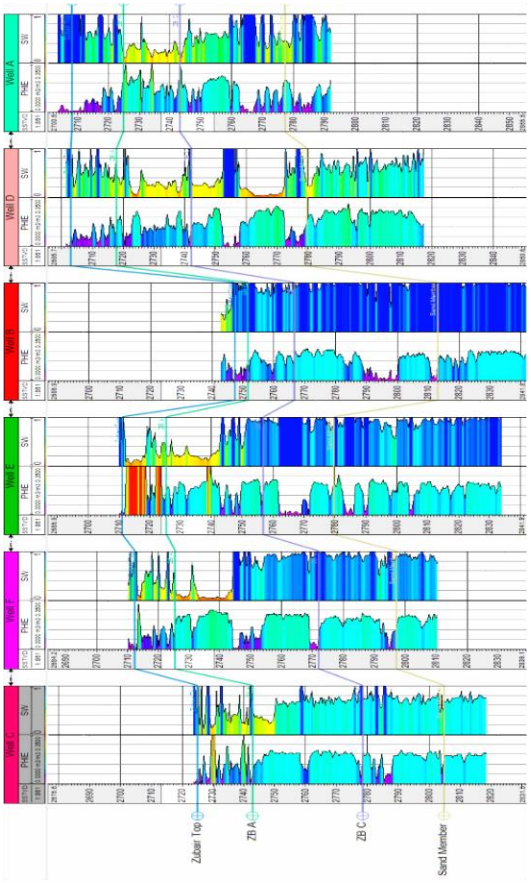


Fig.3 show well correlation of Zubair Formation

5.3 Structural modeling

Structural model represents the first step in construction geological model using contour maps. This map can also be made by computer from the surface and correlated borehole. In this study the structural contour map of the Zubair formation is used to build structural model after digitizing it.

Structural modelling is subdivided into four processes as follows: make edit polygon, make edit surface, make sample grid and vertical layering. All the three operations were performed one after the other to form one single data model. In simple terms, a model was divided into boxes by a 3D grid. Each box will be called a grid cell and will have a single form of rock, one porosity value, one water saturation value

The structural map of top Zubair Formation after digitizing is imported to the Petrel software, and the structural maps of the other units can be constructed depending on information of well tops. Fig. 4 shows structural model of Zubair Formation, which indicates that the structure consists of two domes separated by saddle.

From 103x149x22 grid cells in the X, Y and Z directions, respectively, the three-dimensional grid of the Zubair field was built. The grid was depicted as a square; its side length is equal to 150 meters.

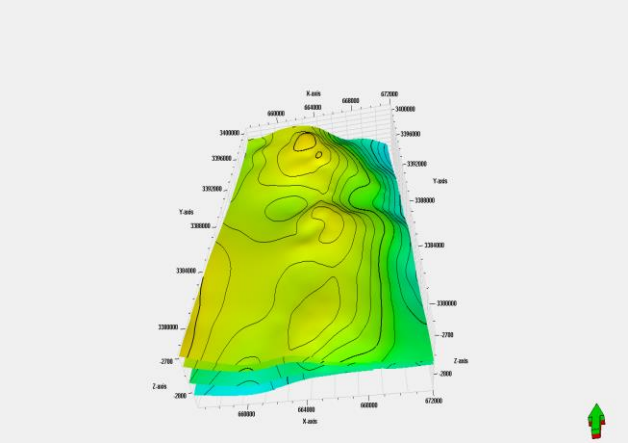


Fig. 4 shows structural model of Zubair Formation

5.3.1 Layering

Layering is additional subdivision of the zone to get better distribution of petrophysical properties (Schlumberger, 2013). Each unit in the Zubair formation is divided into layers depending on petrophysical properties and thickness. Number of layers for each unit Number of layers for each unit are: 10 layers for top of Zubair, 12 layers for unit Zubair A, 8 layers for unit Zubair C. The total of layers is 22.

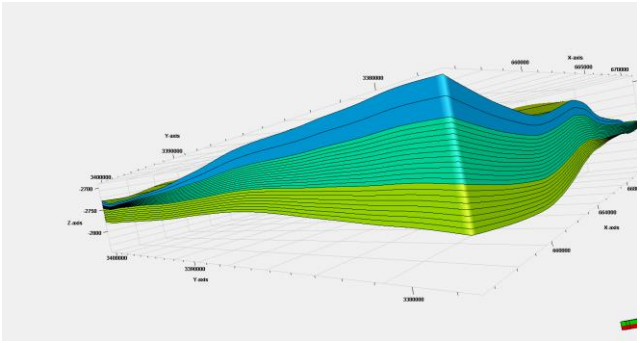


Fig. 5 shows the Layering of Zubair Formation units.

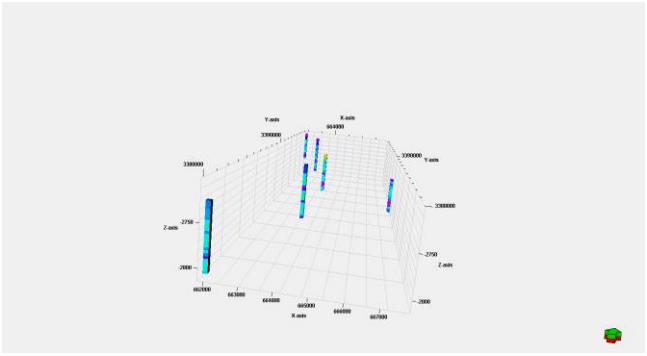


Figure (6) shows the scale-up of porosity.

6 Scale up Well logs

The Scale-up well logs process averages the values to the cells in the 3D grid that are penetrated by the wells. Each cell gets one value per up scaled log. These cells are later used as a starting point for property modelling (Schlumberger, 2010). There are many statistical methods used to scale up such as (arithmetic, harmonic, and geometric method). The porosity and water saturation values in the current model have been scaled up using the (arithmetic average). Figure (6, 7) shows the scale-up of porosity and water saturation.

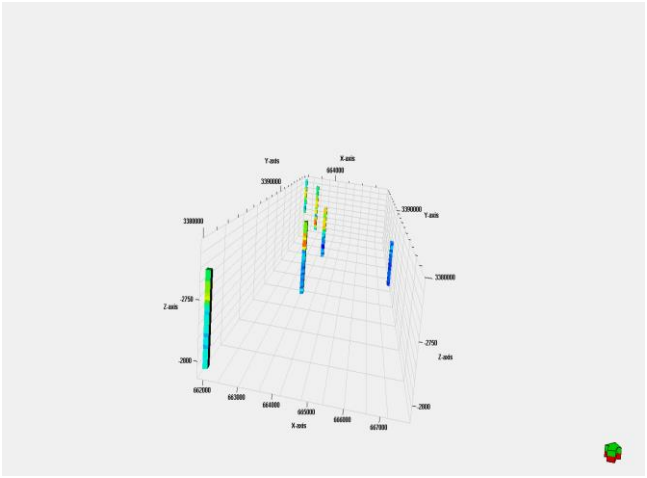


Figure (7) shows the scale-up of water saturation.

7. Petrophysical model

Petrophysical property modelling is the process of assigning petrophysical property values (porosity and water saturation) to each cell of the 3D grid (Schlumberger,2005). Petrel offers several algorithms for modelling the

distribution of petrophysical properties in a reservoir model and correlation well (Schlumberger, 2005). Petrophysics model was built using geostatistical methods The petrophysics models include:

7.1 Porosity distribution

The porosity distribution was carried out by the Sequential Gaussian Simulation (SGS) method according to the analysis of the variogram parameters The current study, porosity model is built depending on the porosity logs (density, neutron, and sonic logs) after making correction and interpretation. The result of porosity model shows that unit Zubair A have the highest porosity value except the well-B which have low porosity value, while unit Zubair C have good to medium porosity value.

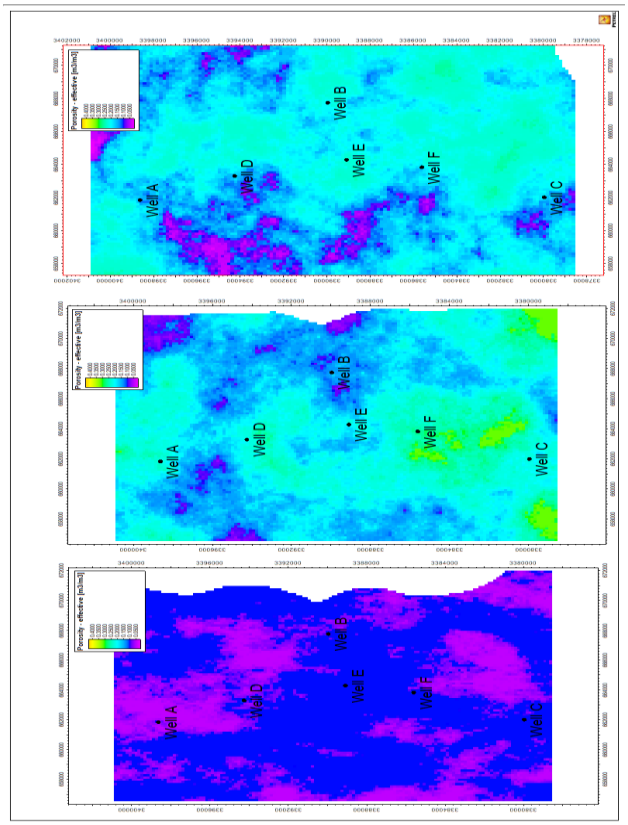


Figure (8) shows the porosity model of Zubair formation in Subba field.

7.2 water saturation distribution

Water saturation represents the percentage of the volume of water-filled voids to the total volume of the rock. It was considered important in the oil reservoirs where it is used to evaluate the productivity in the petroleum range. Either hydrocarbon saturation is the remainder of the volume of blanks not occupied with water. (Serra, 1984)

In this study, the water saturation model was built using the same geostatistical

method was used in the porosity models also used in water saturation model which is (Statistical Gaussian Simulation Algorithm).

Water saturation model show that unit Zubair top have the highest value across the field, while the unit Zubair A have the lowest SW value, which mean this unit is oil bearing zone. The unit Zubair C have low SW value in the north dome while the south dome have high SW values. shape () show SW model of each Zubair reservoir unit.

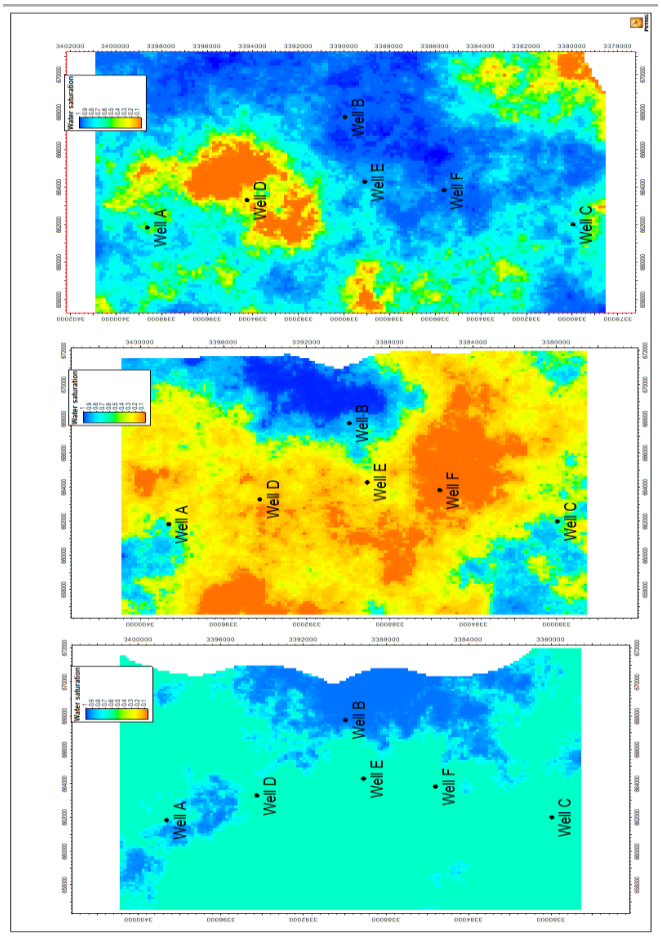


Figure (9) shows the Water saturation model of Zubair formation in Subba field

5- Results and Discussion

Well log data provides precise information for the water saturation and effective porosity that are obtained from computer processing interpretation to construct petrophysical models in this study. Sequential Gaussian Algorithm are used to distribute effective porosity and water saturation. Water saturation and

effective porosity models are shown in Fig.17 to Fig.20.

Effective porosity of unit Zubair top is low in all wells because in these wells, the sand is overlapped with shale. Effective porosity of unit Zubair A increases in north and south dome, while well-B have bad porosity value. A good porosity was observed in unit Zubair C in all wells.

Water saturation of the unit Zubair top is high, so it is not containing oil. Unit Zubair A is considered the main reservoir because it contains the most amount of oil. The units Zubair C are considered reservoir in north dome only, because the south dome is highly saturated with water.

6- Conclusion

The study aimed to build 3D geological model and distribute petrophysical parameters of Zubair formation in Subba oil field using well logs data sets by using Petrel 2017 software. It can be concluded that:

- The Zubair Formation consists of two domes separated by saddle.
- Based on the petrophysical properties distribution the unit Zubair A is the main reservoir of Zubair formation in Subba filed.
- The unit Zubair C is contain oil in north dome only.

REFERENCES

1. PÁPAY, J. 2003. Development of petroleum reservoirs: theory and practice, Akadémiai Kiadó.
2. Morton, R.A, Buster, N. A. and Krohn, M. D, 2002. Subsurface controls on historical subsidence rate and associated wetland loss. Transaction – Gulf coast association of geological societies, vol. 52.
3. Buday, T., the Regional geology of Iraq, VI: Stratigraphy and Paleogeography, state organization for minerals, Mosul, Dar Al-Kutab publication House, 445P, 1980.
4. Douban, A.F. and Medhadi, P., Sequence Cretaceous Megasequences, Kuwait. AAPG Inernational, 1999.
5. Schlumberger,2005. Petrel introduction course . Schlumberger, 44-434p.
6. Schlumberger,2005. Petrel property modeling course . Schlumberger, 10-320p.
7. Schlumberger, 2010 (a). Petrel introduction course. Schlumberger, 13-493p.
8. Serra, O., 1984. Fundamentals of Well-Log Interpretation,Elsevier,.440p