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Static Model of Zubair Reservoir in Luhais Oil Field

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Abstract

Static reservoir modeling is the interacting and analysis of the geological data to visualize the reservoir framework by three-dimensional model and distribute the static reservoir properties. The Petrel E&P software used to incorporate the data. The interpreted log data and core report used in distribution of petrophysical properties of porosity, water saturation and permeability for Zubair reservoir in Luhais oil field.

The reservoir discretized to 274968 cells in increments of 300, 200 and 1 meter in the direction of X, Y, and Z respectively. The geostatistical approach used in the distribution of the properties of porosity and water saturation overall the reservoir units. The permeability has been calculated with classical method depending on the routine core reports data.

The results show the main reservoir unit is 1C where its porosity and permeability are about 20% and 400md respectively. This unit underlaid by barrier unit and rounded by water. The estimated value of oil in place is about $209*10^6$ ScM^3, most of it accumulate at 1C unit and the other at the upper parts of unit 1E.

Keywords: Porosity, Permeability, Water saturation

1- Introduction

Static model includes construction of structural and stratigraphic framework, It is also involves property modeling for petrophysical properties by using statistical distribution methods. The geological model build by the geoscientist and then modified with dynamic data to simulate the model by reservoir engineer. The structural and stratigraphic models are to capture the structure elements such as faults and horizon, also allocate the reservoir units. [1]

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 geostatistics algorithms is the main and modern method use to populate the petrophysical properties overall the reservoir area [2].

There are many modern computer programs used for the purpose of constructing and visualizing the static model. The widely using software is Petrel which provided by Schlumberger. Petrel is a completed program in oil industry from exploration to production.

2- Area of Study

Luhais field is one of the Iraqi oil fields that produces oil with API gravity of about 32^o. It is located in south of Iraq about 100 km north-west of Al-Basra city and 80 km north of Rumaila oil field as shown in Fig. 1).

It is neighboring from east by Ratawy and Raji fields, from north Suba oil field, from west by Oor oil field and from south by Boleih structure.

Zubair formation which is the case of this paper, in general represents one of the main formations that contain hydrocarbon in south of Iraq, which is deposited in the lower cretaceous. Generally, it consists of sequences sandstone, shale and siltstone layers, also has limestome at lower and upper parts of formation. [3]

At Luhais oil field, Zubair formation divided into three members, which are upper shale member, sand member, and lower shale member.

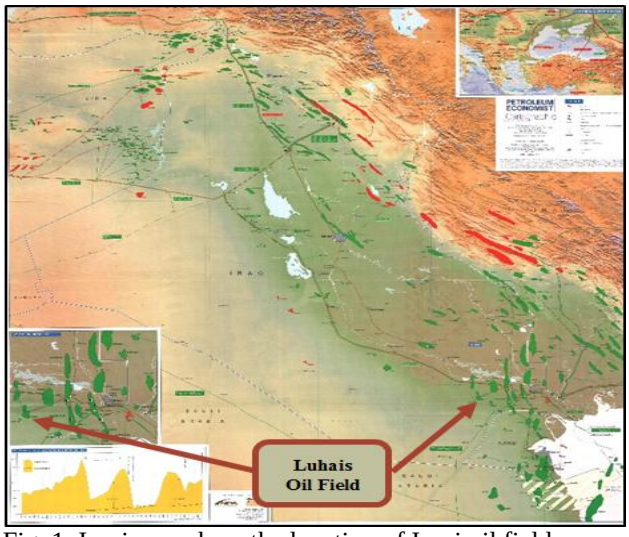

Fig. 1. Iraqi map show the location of Iraqi oil fields

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From log interpretation for Zubair formation, the upper shale member contain oil above water oil contact at depth of 2755m below sea water level, and the other two are water bearing. Therefore, this study will focus on the upper shale member only.

3- Structural and Stratigraphic Models

Structural modeling is the interpretation of geophysical data to define the depth map for top of the reservoir and define the fault pattern if existed in reservoir structure, then use the results of interpretation to define the reservoir geometry and build three-dimensional framework for the reservoir. [4]

The structure of the upper shale member reservoir in Zubair formation is not affect by fault, and the depth contour map of top of reservoir gathered from the seismic study for Luhais oil field [5]. After digitizing this map, it was imported to petrel as digitizing points and resembled by making surface process in petrel software.

The basic aim of stratigraphic model is to allocate the reservoir unit depth and thickness for each well and make a correlation between wells depending on well logs. Then these reservoir units are divide vertically into multilayers to get more accuracy in the definition of reservoir properties.

From the previous studies and geological well reports, the stratigraphy of the upper shale member of Zubair formation in Luhais oil field is divide into six units, according to their origins in lithological correlation, which are (1A, 1B, 1C, 1D, 1E and 1F). These units divided to multilayers according to their thickness as given in Table 1).

Table 1. Division of vertical direction of 3D grid reservoir

Unit	thickness (m)	No .of Layers	Zinc (m)	Top layer
1A	2.70	3	0.9	1
1B	15.00	10	1.5	4
1C	12.60	18	0.7	14
1D	2.610	3	0.87	32
1E	20.00	20	1.0	35
1F	3.00	3	1	55

4- Petrophysical Modeling

Petrophysical modeling is the process of distributing the continuous log properties overall the reservoir by using geostatistics concept.

Geostatistics is "*study of phenomena that vary in space and/or time* " [6]. Also may be define as a statistic algorithm try to estimate property in space depending on the assumption that the property has a degree of continuity. Reservoir engineers use it for the estimation of the properties in area where no well data are available to visualize the reservoir properties. Kriging is the main technique of geostatistics and widely used which provided by D. Krige at 1950. The other modern techniques represent a modifying of it. [7]

Sequential gaussian simulation is the modern algorithm that widely used and recommended to use with continues property in reservoir modeling for its simplicity, flexibility and it is reasonably efficient. [6]

The porosity and water petrophysical model was build depending on CPI reports for eight wells that gathered from [8].

The first step of petrophysical modeling is the upscaling of well log. It means the definition of the property for each cell crossed by the well. This definition done by calculating the average values of well log entire the cell. In other words, if the cell thickness is 0.9 m and log has value every 0.25 m, which mean there are three log values in the cell, so the cell value is the average of these three values. As shown in Fig. 2) at this step of property modeling, the porosity defined for each cell that crossed by well. So to distribute for the reservoir, the geostatistics, which also called spatial distribution, tool used. There are many algorithms of geostatistics provided by petrel.

In this study, the sequential gaussian simulation algorithm used for distribution of porosity.

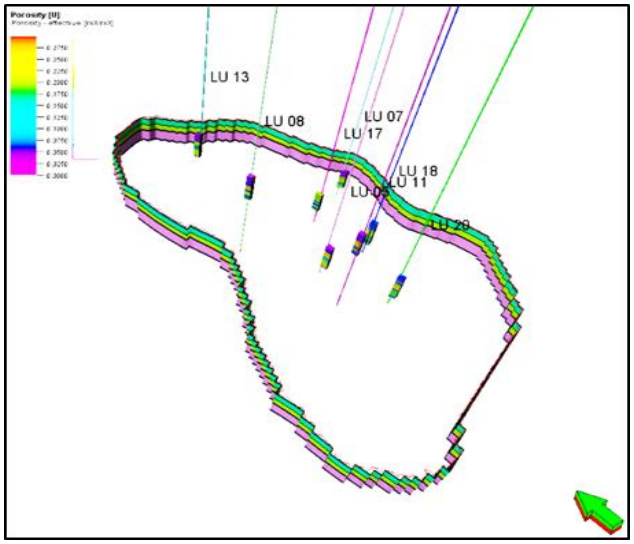

Fig. 2. Scaled up porosity

The permeability property estimated with classical method by make relation between porosity and permeability core data. The report that used were four reports from different wells (Lu 03, Lu 05, Lu 07 and Lu 08). The data scattered for unit 1C separately from the other units because the unit 1C is the main reservoir unit. From the scatter plots as shown in Fig. 3), and Fig. 4) the exponential relationships get from Eq.**Error! Reference source not found.** and Eq. **Error! Reference source not found.**, were obtained with correlation coefficient (R^2) of 0.754 and 0.753 for 1C and the other units respectively.

$$K = 1.6893 * e^{25.608\emptyset} \quad (1)$$

$$K = 0.0652 * e^{35.017\emptyset} \quad (2)$$

Where,

K : Permeability

Ø : Porosity

5- Volumes Calculations

A great portion of the world's oil reserves is contained in reservoirs, which play an important role in oil exploration and makes a large contribution toward oil production worldwide. However, characterization of case study reservoir is very complex as compared to conventional reservoirs. [9]

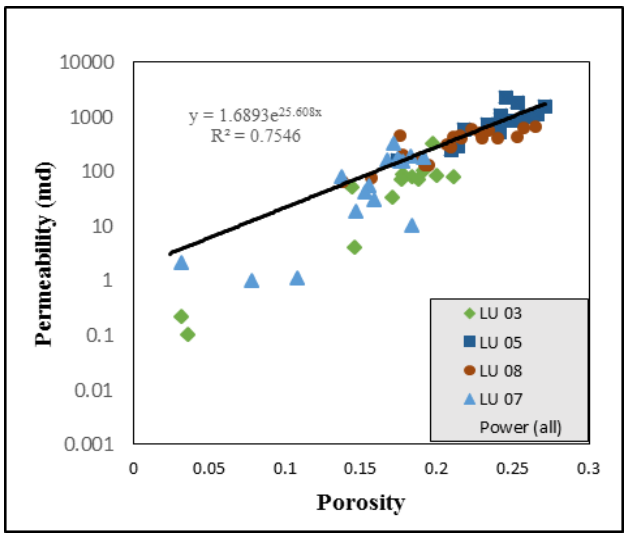

Fig. 3. Scatter plot between core permeability and porosity for 1C unit

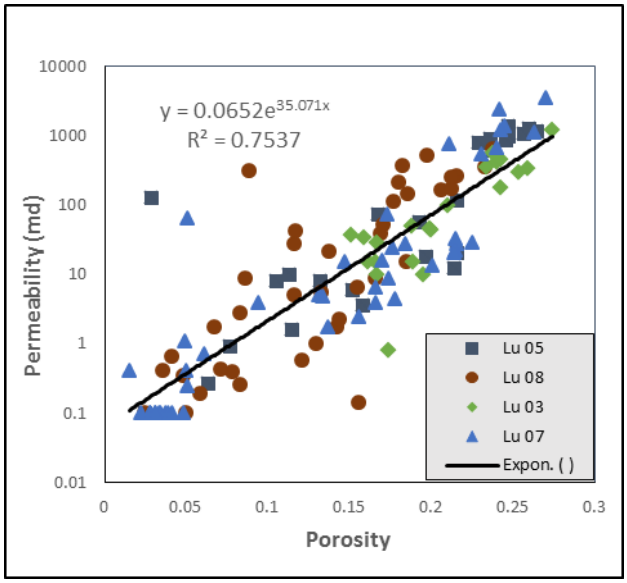

Fig. 4. Scatter plot between core permeability and porosity for all reservoir unit except the 1C unit

Volume calculation means the estimation of pore volume and the stuck tank original oil in place (STOOIP). The general equation for the estimation of pore volume for each grid cell is multiplying the cell volume (bulk volume) by the porosity. The total (STOOIP) is the sum of STOOIP in reservoir grid cells. From the equation Eq. (3) the STOOIP calculated.

$$STOOIP = \frac{V_B * \emptyset * (1 - S_w)}{B_o} \quad (3)$$

Where,

V (B)	:	Bulk volume (cell volume)
Ø	:	Porosity
S_w	:	Water saturation
B_o	:	Oil formation volume factor

Calculation with a static model depend on cell value of porosity and water saturation of the petrophysical model that estimated from well logs and distribute overall the reservoir with geostatistics methods. The B_o used one value of 1.25 bbl/STB.

6- Results and Discussion

The structural contour map of the top of reservoir is shown in Fig. 5). It shows there are many domes found in the reservoir and the reservoir does not affect by fault. The reservoir visualize with framework of 13426.3, 20910.7, and 50 meters in X, Y and Z direction. This framework divided the reservoir into 274968 grid cells with increment of 200, 300, 1 meters of X, Y, and Z direction.

The porosity distribution model shows that the unit 1C and 1E units have good porosity of 0.2 and 0.16. The other units show low porosity values. As shown in Fig. 6), the porosity distribution model horizontally for top of unit 1C and vertically by well section through the wells Lu 45, Lu 43, Lu 11, Lu 05, Lu 08, Lu 23, and Lu 27. The Fig. 6, C) shows the histogram of porosity data of well log, scale up porosity and porosity model.

The water saturation model as shown in Fig. 7), the 1C unit is oil zone and the water rounded it from the sides. The almost thickness of the 1E unit is water earing except the upper parts of it that above water oil contact 2755m.

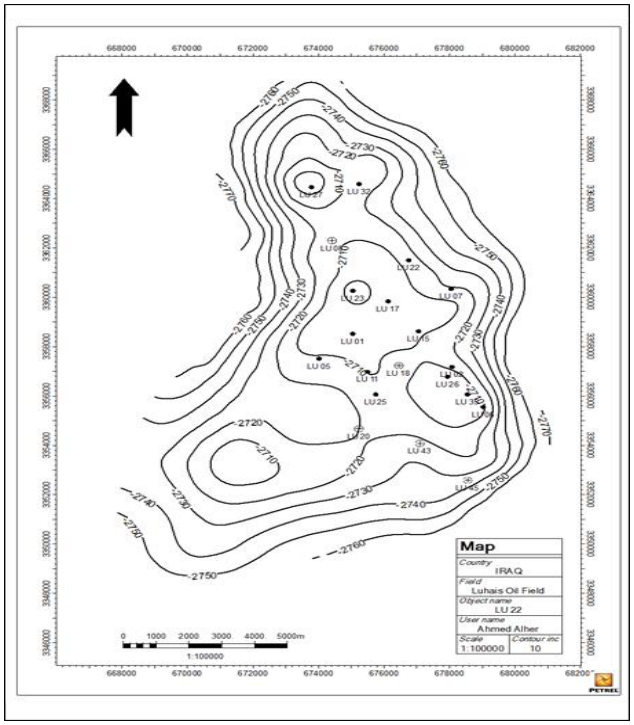

Fig. 5. Depth contour map of top of reservoir

The permeability model shows the units 1A and 1B have very low permeability, this accepted with CPI data that shows these units have a lithology of shale, these two units represent the cap rock of the reservoir. The unit 1C has a good permeability with averaging of 400 md. The unit 1D shows low permeability, so it is a barrier unit between 1C and 1E units, where 1E unit has average permeability of 200 md. The oil in place calculated by the volumetric method and estimated value was 209 million of standard cubic meter.

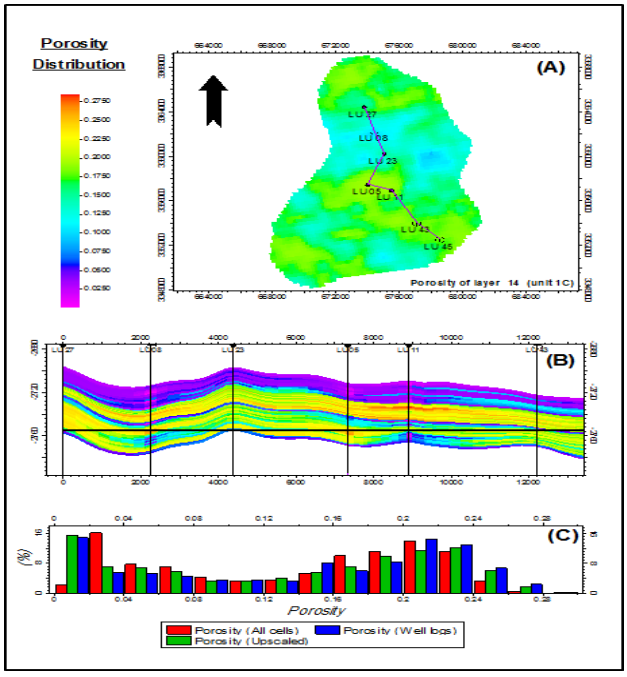

Fig. 6. Porosity distribution

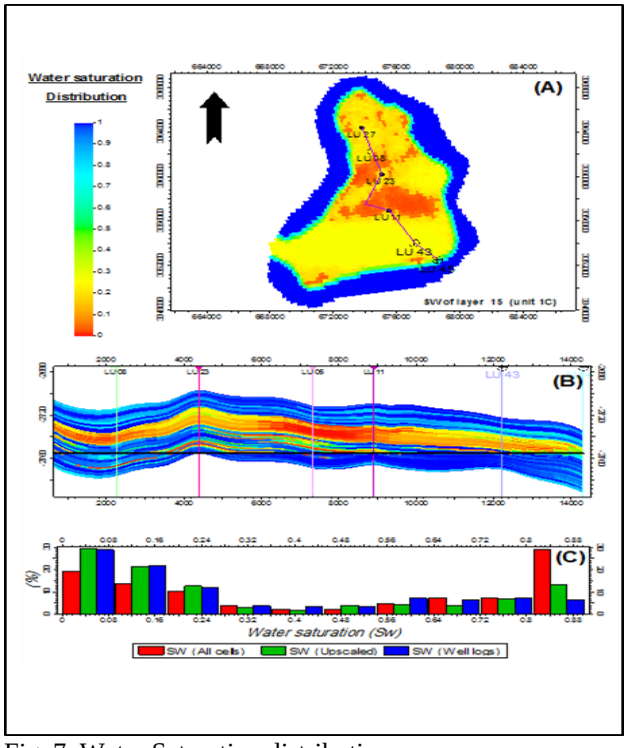

Fig. 7. Water Saturation distribution

7- Conclusions

- Zubair formation in Luhais oil field provides a second main reservoir with Nahr Umar formation. The structure of upper shale member reservoir is very complicated because of the sequences of lithology between shale and sand.
- The main unit in upper shale member reservoir is 1C unit which characteristic with high porosity and permeability
- The oil in place of the Zubair formation in Luhais oil field is about 209 millions of standard cubic meters.

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Nomenclatures

V_(B)	:	Bulk volume (cell volume)
Ø	:	Porosity
S_w	:	Water saturation
B_o	:	Oil formation volume factor
K	:	Permeability

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