Estimation Original Oil in Place (OOIP) In the Selected Well From Small Giant Bai Hassan Oilfield/ Northern Iraq Case Study

Fawzi Al-Beyati[1], Muhammed Ismail[2], Gasham Zeynalov[3]

[1] Kirkuk Technical College, Baghdad street, Kirkuk 3600, Iraq
[2,3]Department of Petroleum Engineering, Khazar University 41 Mehseti street, Baku AZ1096, Azerbaijan

ABSTRACT

The recovery efficiency of reservoir is influenced by its heterogeneities, particularity the distributions of porosity and permeability. Therefore, in order to develop a representative model for thereservoir, should be evaluated porosity, permeability properties, and production potential of fields. The aim of this study is toestimate the original oil in place (OOIP), therefore We first used some basic calculations to identify the mainTertiary reservoir in a small giantBai Hassan oilfield using available information from BH-20 oil wellsuch as, calculation thecut off net pay, gross pay, values for all units. These calculations indicated that the main carbonate reservoir in studied oil well was unit (B) with in Baba formation. The result of volumetric method that used tocalculate theOOIP in the small giant Bai Hassan oilfield from 20 wells was revealed (15.687 MM) STB.

INTRODUCTION

Recently more attention where paid to the small giant Bai Hassan oilfield due to its important in the oil production ,because its characterize by multi pay zones , the study of Sadeq et al. (2015) which deals with the petro physical properties of Cretaceous aged pay zone specially in the target oilfield, with referring to the Early Middle Miocene Jeribe formation pay zone .Also a part of (Al-Sheikhly et al., 2015)study deals with the basin analysis of Tertiary formations, which concluded the effect of tectonic movements on the Paleogene and Neogene formations was more than Cretaceous formations. (Al Jwaini and Gyara, 2016) study were refer to the sediment logical process effect which enhancement the porosity and permeability of Paleogene formations within the Bai Hassan oilfield.

This study deals with calculating the OOIP of the BH-20 and evaluating the main reservoir which contain the trapped hydrocarbon (Early middle Miocene age formations, Kirkuk group formations).The determination of original hydrocarbons in place is generally considered the main stage of the static reservoir study, during this stage the description of the reservoir, in terms of external and internal geometry, and properties of the reservoir rock, which were arequantified through a number expressing the amount of hydrocarbons present within the reservoir at the time of discovery (Lucia and Cosentino, 2001).

Study Area

Bai Hassan small giant oil field is located geographically Northwest of Kirkuk- northern Iraq with in the low folded zone according to (Dunnington, 1958) or zone of Hamren – Makhool according to (Buday and Jassim, 1987, Jassim and Goff, 2006), which it is lay within the Unstable Shelf Zone (Fig.1). Structurally the oil field is asymmetrical elongated anticline extended for 40km in length and 13.5km in width between Kirkuk and Qarachoq anticlines. The well BH-20 from the Kithka Dome the one of two Domes that Bai Hassan oilfield consists of was selected to make the requested calculation to achievement this case study.

Geological and Structural Setting

Bai Hassan oil field is located in the northern east part of Iraq within the Foothill Region of the northwest-southeast trending Zagros Fold and Thrust Belt the field have been mapped previously as northwest-southeast trending doubly plunging anticline manifested as classic four-way structural closures (Dunnington, 1958).

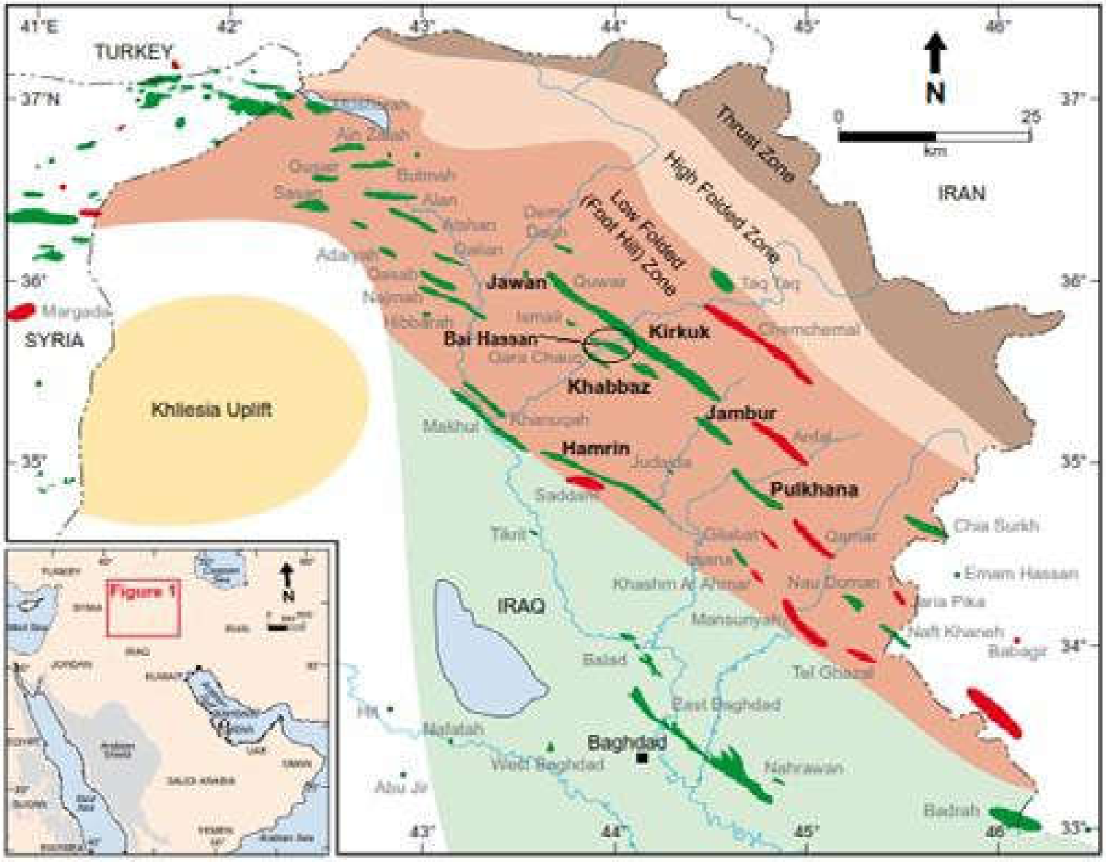

Fig.1: Map of Northern Iraq Showing Location of Bai Hassan Oil Field in Low Folded Zone.

The field consists of two domes with the SE – NW direction, Kithka Dome and Dauod Dome separated by a narrow saddle called Shahal saddle Kithka dome is bigger in size and higher structurally by (335m) than Dauod dome. The number of wells drilled until preparation this study reached to 185 wells (Buday, 1980).

The Baba and Jeribe formations are Tertiary (Paleogene and Neogene respectively) carbonates that's represent the main reservoir within the Bai Hassan oilfield while the Qamchuqa formations represent the main carbonate reservoirs of Cretaceous age (Albian) within the studied oilfield (Al- Shididi et al. 1995Al-Amri et al., 2011). Bai Hassanoilfield has extended previous mapping to include associated fault frameworks consisting of an imbricate front thrust and back thrust fault set within each of the two structures, in additionto northeast-southwest trending tear faults are present within the Bai Hassan structure to accommodate differential fault movement on the separate and loosely coupled lateral thrust sheet segments comprising the front and back thrusts age (Bellen et al., 1959).

Bai Hassan oilfield is one of the several elongated, asymmetrical, doubly plunging anticlines that characterize the Foothills Region of the Unstable Shelf Zone in eastern Iraq. The northwest-southeast trending structure measures 34 km long and 3.8 km wide. Bed dips on the flanks are approximately 40 degrees while the noses plunge at approximately 5 degrees. Dipmeter data acquired on early wells show local dips in excess of 50 degrees that are most likely associated with faults (Buday and Jassim, 1987).

OOIP Estimation by Using Volumetric Method

Volumetric estimation is the only mean available to assess hydrocarbons in place prior to acquiring sufficient pressure and production information to apply material balance techniques. Recoverable hydrocarbons are estimated from the in place estimates and a recovery factor is estimated from analogue pool performance and/or simulation studies. Therefore, volumetric methods areprimarilyused to evaluate the in-place hydrocarbons in a new non-producing wells and pools and new petroleum basins.

But even after pressure and production data exists, volumetric estimates provide a valuable check on the estimates derived from material balance and decline analysis. Volumetric estimation is also known as the “geologist’s method” as it isbased on cores, analysis of wireline logs, and geological maps. Knowledge of the depositional environment, the structural complexities, the trapping mechanism, and any fluid interaction is required to:

- Estimate the volume of subsurface rock that contains hydrocarbons.
- Determine a weighted average effective porosity and water saturation.

With these reservoir rock properties and utilizing the hydrocarbon fluid properties, original oil-in-place or original gas-in-place volumes can be calculated (Lisa Dean, 2007).

For oil reservoir (Anon, 2004) the original oil-in place (OOIP) volumetric calculation is:

$$OOIP = GRV * NTG * \Phi * (1-Sw) * (1/BO) \quad \ldots\ldots\ldots (1)$$

Where:
OOIP= original oil inplace. (m^3) at surface condition or STBstock tank barrel).
GRV= bulk reservoir volume. (m^3, ft^3or barrel).
NTG = Net pay thickness / gross pay thickness. (dimensionless).

Φ= Average weighted porosity (not average arithmetic porosity). [Calculatedusingequation (2) and listed in table (1)].

$$\Phi = \frac{\Sigma(\Phi i * hi)}{\Sigma hi} \quad \ldots\ldots. (2)$$

h= pay thickness.
Sw= Average weighted water saturation. [Calculatedusing the equation (3) and listed in table (1)].

$$Sw = \frac{\Sigma(\Phi i * hi * swi)}{\Sigma(\Phi i * hi)} \quad \ldots\ldots(3)$$

Bo = Formation volume factor, taken equal to 1.3(OEC, 2011).

To calculate hydrocarbon reserve for any reservoir, many parameters such as cut off values, pay net, reservoir volume, and others parameters must be calculated.

Cut-Off Determination

The cut-off concept was used to define the effective petrophysical properties of a given geological unit in the presence of poor reservoir zones. In order to assess the efficiency of reservoir recovery mechanisms, the initial hydrocarbon volume must relate to reservoir rock (Worthington, 2008).

The starting point in determining cut-off is to identify reference parameter that allows us to distinguish between intervals that have reservoir potential and intervals that do not. There is no single universally applicable approach to the identification of cut-off (Worthington, Cosentino, 2005).

To determine porosity cut off, first we must plot core porosity and core permeability on semi log paper, as shown in figure (2). The core porosity cut-off, which was obtained corresponding to the 0.1md permeability value, traditionally, the permeability of 0.1md is generally considered a minimum value for oil production (Jerry Lucia, 2007). From figure (2) the result of core Porosity cut-off is equal to (8%).

Also calculate the log porosity cut-off by plotting the both core and log porosities on linear scale paper, and drawing the best fit line to determine log porosity cut-off, which is corresponding to (0.08) from core porosity cut-off value, the figure (2) reveal thecore porosity cut off value which is equal to (9.7%), while the

Water saturation cut off is obtained by plotting water saturation against porosity values on linear scale paper to determine the water saturation cut-off, which is corresponding to the (0.097) log porosity cut off value figure (3). As depicted in the figure (4) the water saturation cut off value is equal to (58%).

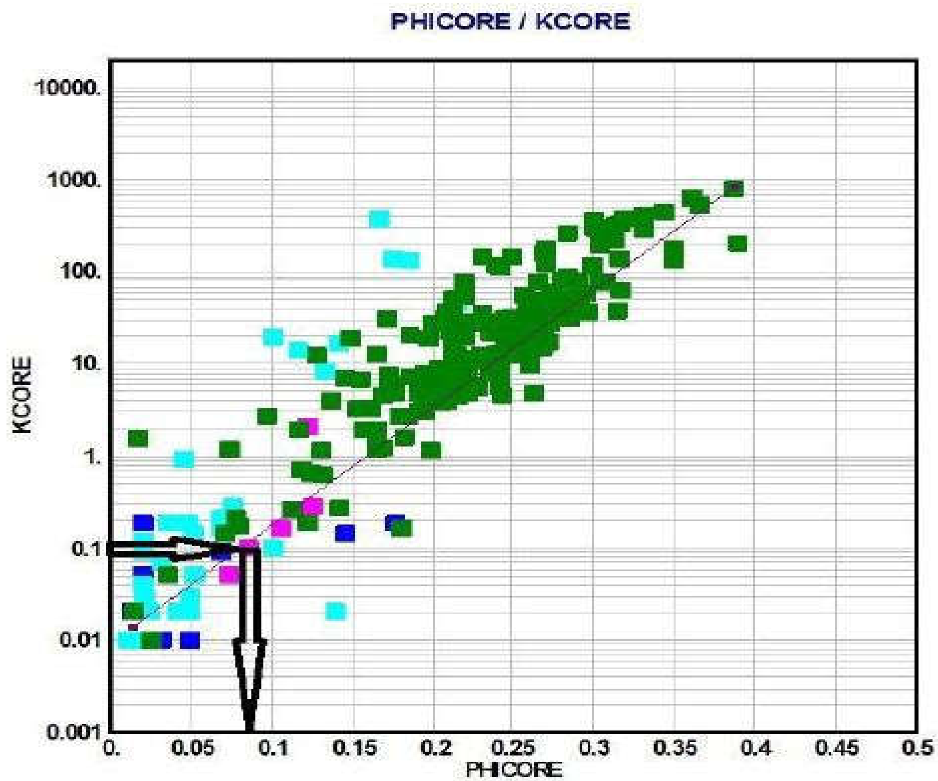

Fig. 2: Core Porosity Cut off Cross plot.

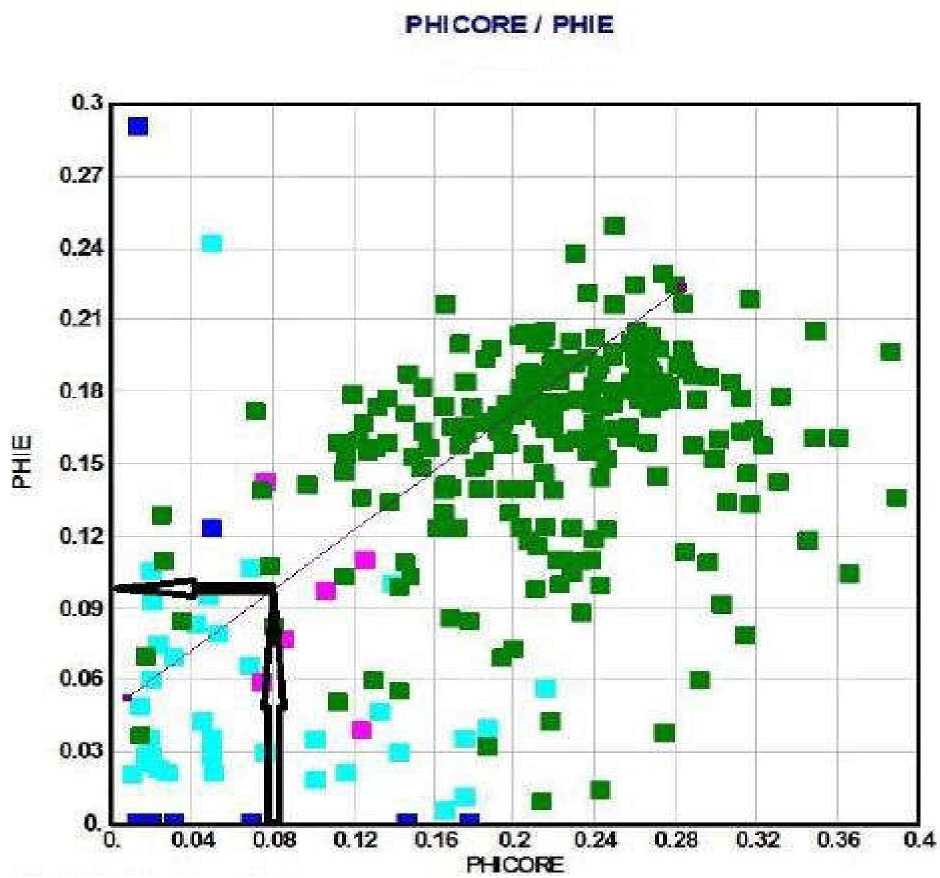

Fig. 3: Log Porosity Cut off Crossplot.

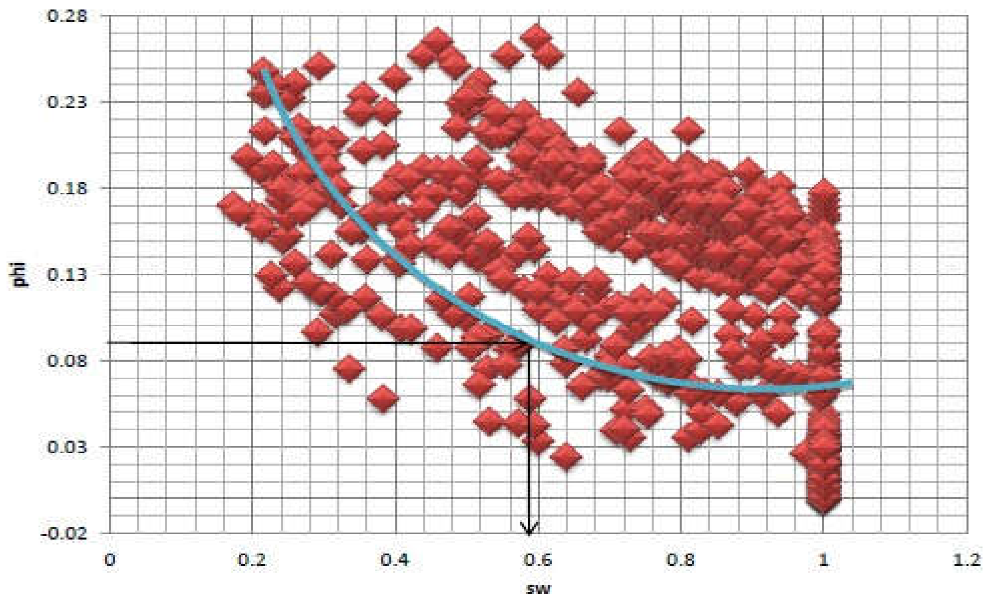

Fig 4: Reveal the Water Saturation Cut off Cross plot.

Determination the Reservoir Net Pay

Net pay is the part of a reservoir from which hydrocarbons can be produced at economic rates, given a specific production method. The gross is regarded as the thickness of the reservoir interval that contains zones of which hydrocarbon can be produced and a zone which does not favors the production of hydrocarbon.Net pay cut-offs are used to identify values below which the reservoir is effectively non-productive. Net pay is used to compute volumetric hydrocarbon in place and to determine the total energy (static and dynamic) of the reservoir which consists of the both moveable and non-moveable hydrocarbons, another uses of net pay is the evaluation of the potential amount from available hydrocarbon for secondary recovery (Cobb, 1998).

The distinction between gross and net pay was made by applying cut-off values in the petrophysical analysis. The cut-off values of porosity is (0.097), and water saturations is equal to (0.58), which were used to identify pay intervals, this intervals with porosity equal to/or greater than 9.7 percent, and water saturation less than 58percent were regarded as net pay intervals. The net to gross ratio is thickness of the net reservoir divided by the gross thickness of the reservoir, this ratio is often used to represent the quality of the reservoir zone and for volumetric hydrocarbon calculations.

Using the cut-off limits, flag curves were created in the database for net reservoir interval (red color) and gross reservoir (green) (see figure 5).

Net reservoir is the thickness of formation that has porosity more than cutoff porosity instead of water saturation value, while net pay takes both porosity and water saturation cutoff in consideration.

The calculated reservoir net pay summary is presented in table (1) using IP software, with the corresponding graphic figure (5).

Table 1: Net and Gross Pay Values for Each Unit in Well BH-20.

Reservoir	Gross(m)	Net (m)	N/G	Avg. Phi	Avg. Sw
Jr	24	5.25	0.219	0.125	0.357
A	18	3.88	0.215	0.161	0.231
A"	17	11.75	0.691	0.180	0.368
B	98	96	0.980	0.176	0.074

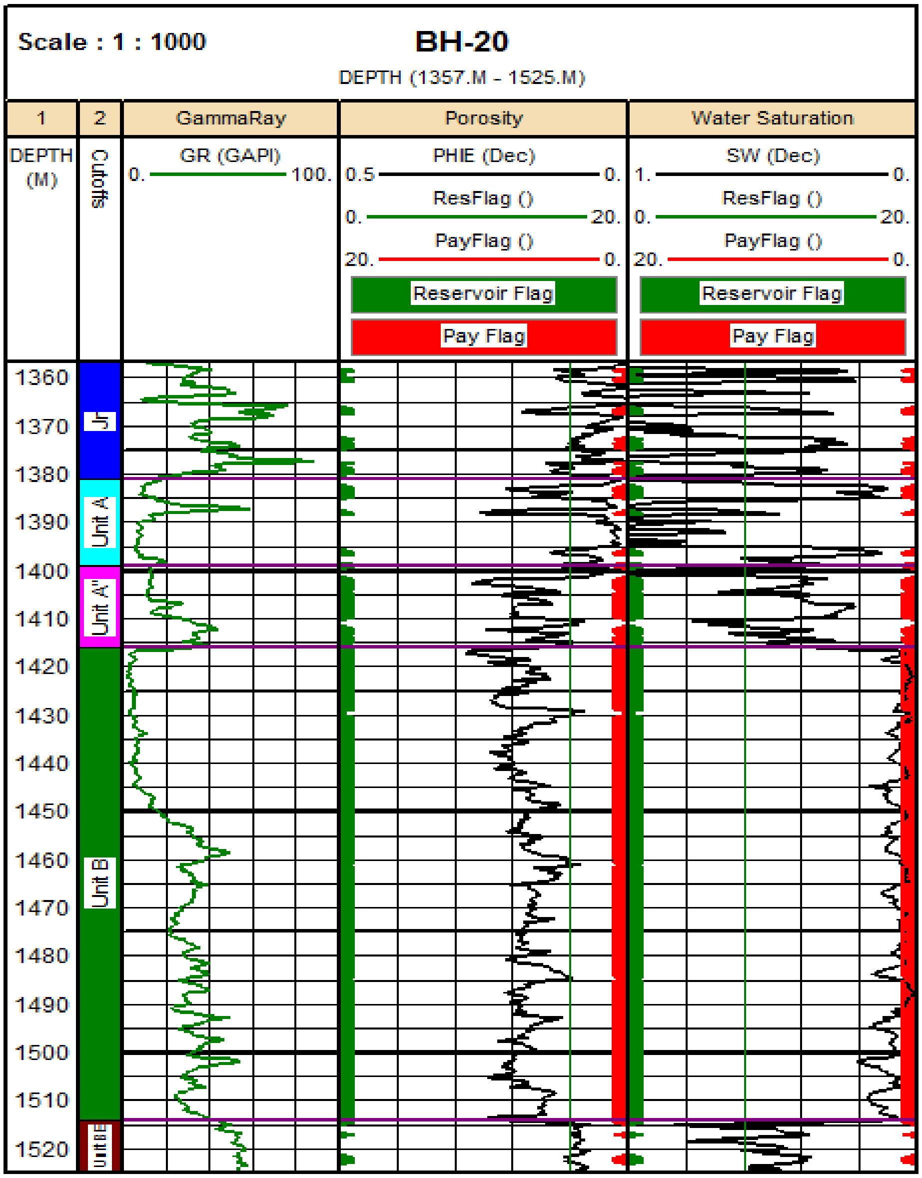

Fig. 5: Net Pay and Gross Pay of Well BH-20.

Reservoir Volume Calculation

Drawing the dimensions of the reservoir in BH-20 oil well encountered many troubles due to the lack of sufficient wells to draw the well boundaries. The oil water contact used to determine the dimensions of the reservoir from the south-east of the field, where the reservoir dimension shave drawn depending on these available information, as shown in figure (6). The reservoir volume is calculated by using PETREL software for each zone depending on the depth from structural map for BH-20 oil well, the results are listed in table (2).

Table 2: OOIP Values for Each Unit in Well BH-20.

Reservoir	Bulk volume [*$10^6$$m^3$]	N/G	Avg. Phi	Avg. Sw	OOIP [*10^6 STB]
Jr	144	0.219	0.125	0.357	1.29
A	105	0.215	0.161	0.231	1.223
A"	117	0.691	0.180	0.368	1.454
B	215	0.980	0.176	0.074	15.687

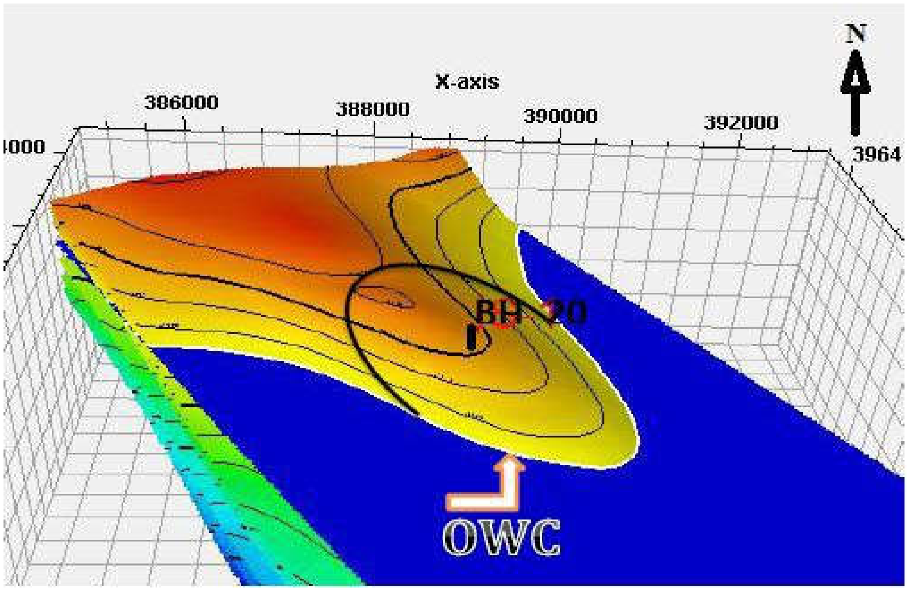

Fig. 6: Reservoir Dimensions of BH-20 oil field

OOIP Estimation in BH-20 Oil Well

Initial or original oil in place in BH-20 oil well is estimated through using volumetric method, by substituting all parameters such as porosity, water saturation, and N/G, as well as reservoir volume in equation (1).

The OOIP results for each zone within the well BH-20 are listed in the table (2) and figure (7) which is represent the contour map for $OOIP_{STB}$ distribution within the BH-20 oil well prepared by using PETREL software. The water saturation and porosity are distributed on each grid.

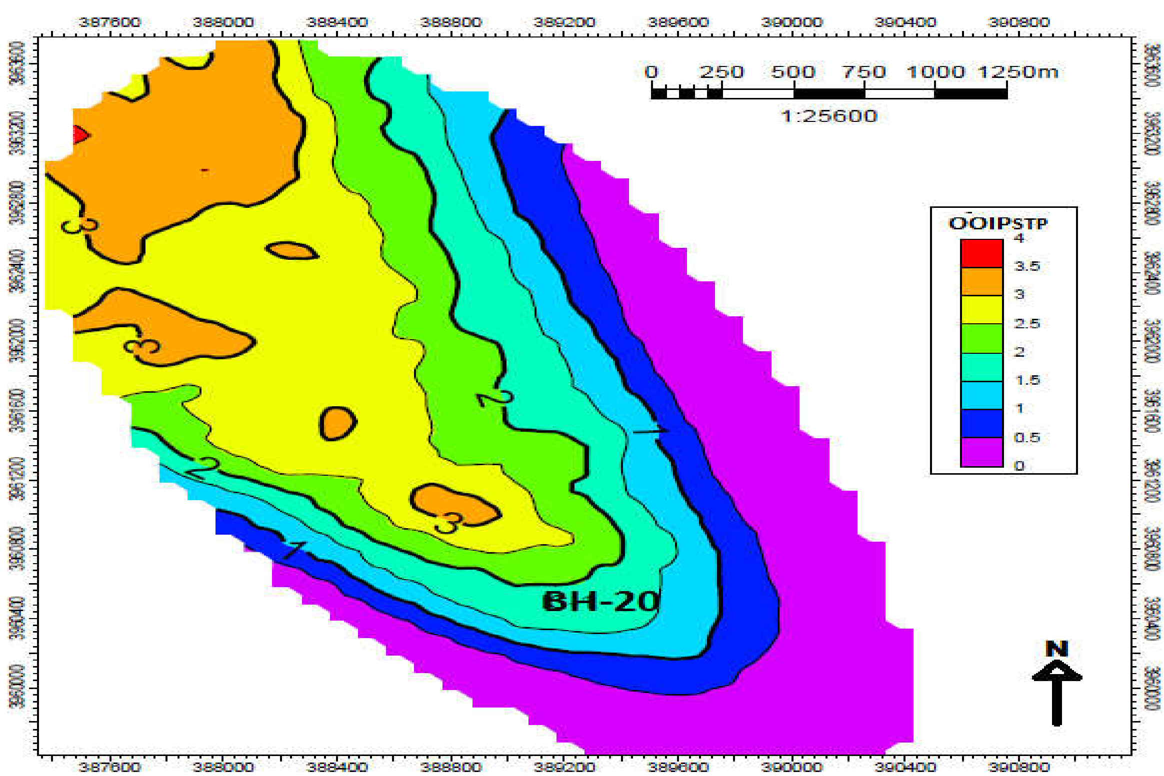

Fig.7: Counter Map for $OOIP_{STP}$ Distribution within the BH-20 Oil well and its nearby

RESULT AND DISCUSSION

The importance of Jeribe formation is coming from its good reservoir properties within the small giant Bai Hassan oil field (Sadeq et al., 2015), therefore this research focused on estimation the original oil in place, which can help to build an idea about the water and oil saturation in addition to obtain their accumulation within the oilfield to build 3D model finally.

The result of estimation revealed water saturation (water accumulation) against oil saturation (small concentration) in the studied well BH-20 table(3), this result is concurring with actual case of the studied oil field, if we take in our mind the three sequence facts about above situation, the first is coming from the effect of tectonic movement on the studied oil field (Al-Sheikhly et al., 2015), (Al-Jwaini et al., 2016), this effect leads to the second fact, which is represented by existence of surface expression (Figure 8) at Kithka dome (Sadiq et al., 2015), also the Kithka dome is high structurally than the Daoud dome.

The third fact is sedimentological facts, which represented by effect of dolomitization process which strongly take place may be due to water migration toward the studied borehole BH-20, also its location may be contributed in the dolomitization of Jeribe formation rocks, while unlike the oil migration which it leads to stop the dolomitization process in large scale

Table 3: Reveal the Summery Result

Parameters	Value
OWC	1200m. MSL 1496m. RTKB
Avg. Phi	0.176
Avg. Sw	0.074
Porosity cut off	0.097
Water saturation cut off	0.58
Net Pay (m)	96
Gross Pay (m)	98
N/G	0.98
Bulk Reservoir Volume ($10^6 m^3$)	215
OOIP (10^6 STB)	15.687

Fig. 8: Reveal Surface Expression of Kithka Dome and Location of Bore Hole BH-20

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