Petrophysical Study Of Zubair Formation at Dhufriya Oil Field Using 3D Seismic Data Middle of Iraq

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الملخص:

تم اكتشاف حقل الضفرية عام ١٩٨٢ بواسطة المسح الزلزالي ثنائي الابعاد و تم تأكيد وجود النفط في تكوين الزبير عند حفر بئر الضفرية-١ و بعد حفر بئر الضفرية-٢ تم تأكيد وجود النفط ايضاً، بعدها تم عمل مسح زلزالي بالابعاد الثلاث و تفسير بياناته حيث تم التقاط ٧ عواكس و دراسة وتفسير عاكس الزبير و اعداد الخارطة الزمنية و خارطة السرعة و العمق و جميعها اثبتت ان الشكل التركيبي للحقل عبارة عن ثلاث دوال تركيبية (A, B, C) الدالة Aعبارة عن انغلاق تركيبي بمساحة ٧.٩ كم^{٢} بين بئري ضفرية ١ و ٢ و الدالة B انغلاق تركيبي بمساحة ١١.٧ كم^{٢} و اتجاه(NW-SE) و الدالة C بأتجاه E-W مفتوحة بأتجاه الغرب. تم عمل المعكوس الزلزالي Seismic inversion أظهرت نتائج تحويل المكعب الزلزالي الى مكعب يمثل الخواص البتروفيزيائية(المسامية والتشبع المائي) أن المسامية لتكوين الزبير تصل الى0.22 و تتحسن المسامية بأتجاه بئر ضفرية-٢أظهرت نتائج الممانعة الصوتية لتكوين الزبير تغاير جانبي وافقي بالاتجاه الشمالي الغربي الجنوبي الشرقي– حيث تعكس تغاير قيم المسامية للمكمن. قدر الخزين النفطي المثبت في الحقل بحوالي 10^{6} *118 bbl باستخدام الطريقة الحجمية

الكلمات المفتاحية : تكوين الزبير ، المسامية ، التشبع المائي ، خزين النفطي ، حقل الظفرية النفطي

Abstract

Al-Dhafriya field was discovered in 1982 by a 2-D seismic survey. The presence of oil was confirmed in Zubair reservoir after drilling Dh-1 and Dh-2 wells. The 3-D seismic data of Dhufriya oil field were processed and interpreted. Seven reflector were picked and Zubair reflector was identified. The depth map of Zubair formation indicates the presence of three structural functions (A, B, C).

A was a structural enclosure by area 7.9 km^2

B was structural enclosure trend (NW-SE) by area 11.7 km^2
C trend E-W opened to the west.
Seismic inversion results showed that porosity of Zubair formation reaches 0.22 and become good toward Dh-2 well while the results of aquastic impedance showed vertical and lateral variance in porosity toward (NW-SE) which reflect changes in porosity values for the formation. Crude oil was calculated about $118*10^6$ bbl from the values of porosity by using volumetric method
Keywords : Zubair Reservoir , Porosity , Water saturation , Crude oil, Dhufriya oil field.

INTRODUCTION

The method of Seismic reflection survey is the most widely used in geophysical technique to reveal the structure of subsurface formations the seismic wave generated in the earth by near surface blast, mechanical impact, or vibration to back to the surface after reflection from interfaces between formations having various physical properties (Lindseth,1979). 3-D seismic data are used to elicit petroleum reservoirs before the operations of drilling, determine the suitable locations for initial drilling for some sites. sites used to develop wells, and reservoirs monitoring (Alder, 1998). The seismic method is more proper in areas where the oil is in structural traps, but it is also helpful for locating and describing certain types of stratigraphic features (Dobrin, 1976). 3D views very useful in understanding a geological feature which characterized by high-amplitude that can be voxel picked (Pendrel, 2006). Zubair formation consists of a number of depositional cycle represents the growth of deltaic lobe (construction phase) followed by hiatus during which the delta margin was subjected to wave and tidal activity (destruction phase) then followed by a shale base and new cycle begins (Nasser, 1989). The Zubair Formation is represented mainly by clastic facies sequences, while limestone is restricted to the upper part of the formation, which represents a

transgressive phase(Jaleel, et, al, 2021).The shale packages become thinner toward the western area of the study while the coarse clastic packages become thinner toward the eastern area (Jassem and Goff, 2006) Dhufriya field was discovered in 1982 based on the results of two-dimensional seismic surveys, which showed that the field is a convex fold of little inclination consisting of two domes the presence of oil was proven in the Zubair reservoir after completing the drilling of first well Dh-1 in 1984. The second well Dh-2 was drill confirmed the presence of oil in zubair reservoir (N. O. C. 1985) .

Dh -1, which is the first exploration well in the northern part of the field and eastern part of Tigris river according to the coordinate system WGS1984 zone 38 N :

N: 3603 973	E: 585 980

Dh-2 was drilled at the top of southern dome of the structure, about (8 km) south east of Dh -1 according to the coordinate system WGS1984 Zone 38 N:

N: 3597 592	E: 591 054

The aim of the study is updating the synthetic image of Zubair formation based on data of 3-D seismic survey and estimating the oil accumulation in the reservoir.

Location of the study area

Al-Dhufriyah field is located in Wasit Governorate, where the field is about 12 km to the north and north-east of the al-Kut city Figure (1-1). The study area is characterized by flat, fertile agricultural land crossed by the Tigris River in the middle.

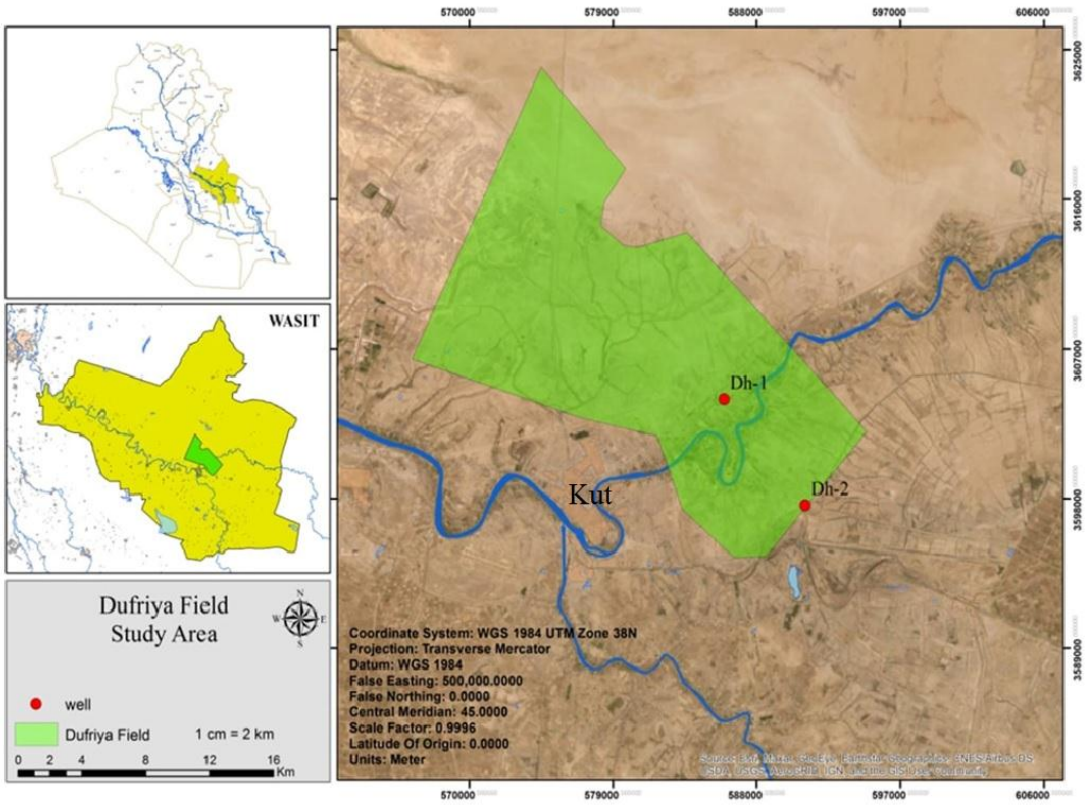


Figure (1) : Location Of Study Area

Generation of Synthetic Seismogram

the synthetic seismogram constructed by the following steps as mentioned by (Al- sinawi, 1981) are :

1- Computing the acoustic impedance = ($\rho \times v$) Where

v: is seismic velocity. ρ: is density measured from log.

2- computing the reflection coefficients of the vertical incident wave on reflector separating two series time intervals such (i) and (i+1) that have values of acoustic impedance (ρi vi) and (ρi+1, vi+1) respectively. According to the following equation

Acoustic Impedance Z=ρv. Where . ρ=density is measured from density log

V=seismic velocity km/s

Where:

the density at two successive layers (i), (i+1)

the velocity at two successive layers (i), (i+1)

The convolution process between the reflection coefficients and the selected wavelet is made to generate the synthetic seismogram. The sonic log data are compared with the well velocity survey which represents the direct method to obtain the geological velocity (average velocity) of geological strata (Barnes, 1998). The synthetic seismogram traces of the Dh-1 and Dh-2 were generated using programs within the IESX (synthetic programs). These have ability to extract the relation between the time and depth functions in the well location. The sonic logs were transformed from the depth to the time domain using the check shots. the synthetics obtained from the computed reflectivity series convolved with a Ricker and extraction wavelet used to match the dominant frequency of reprocessed 2D seismic data (Trappe, and Hellmich, 2000). After that calibration were done on seismic section of the synthetic as shown figure (2), (3).

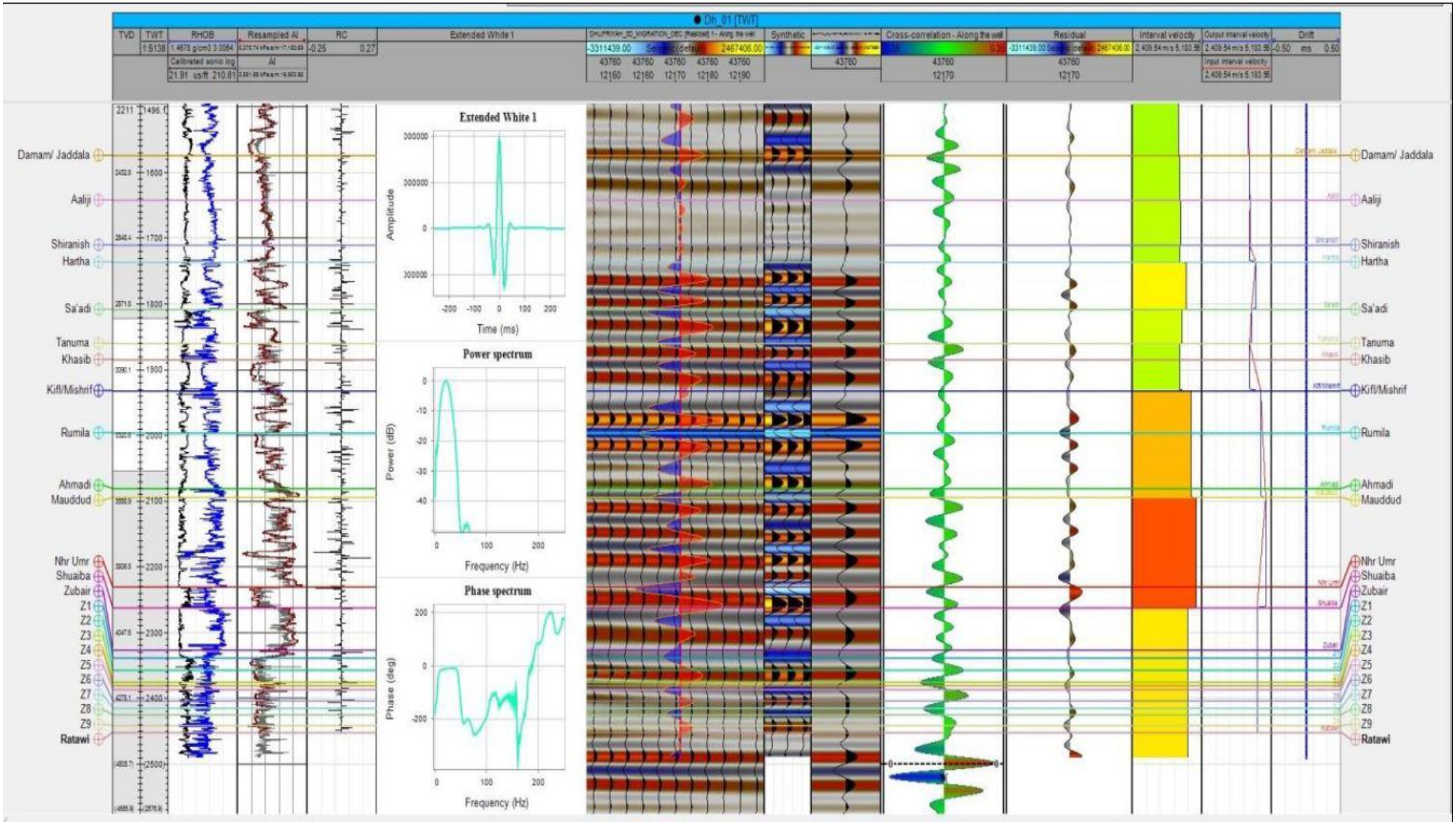


Figure 2. Synthetic seismogram of Dh-1

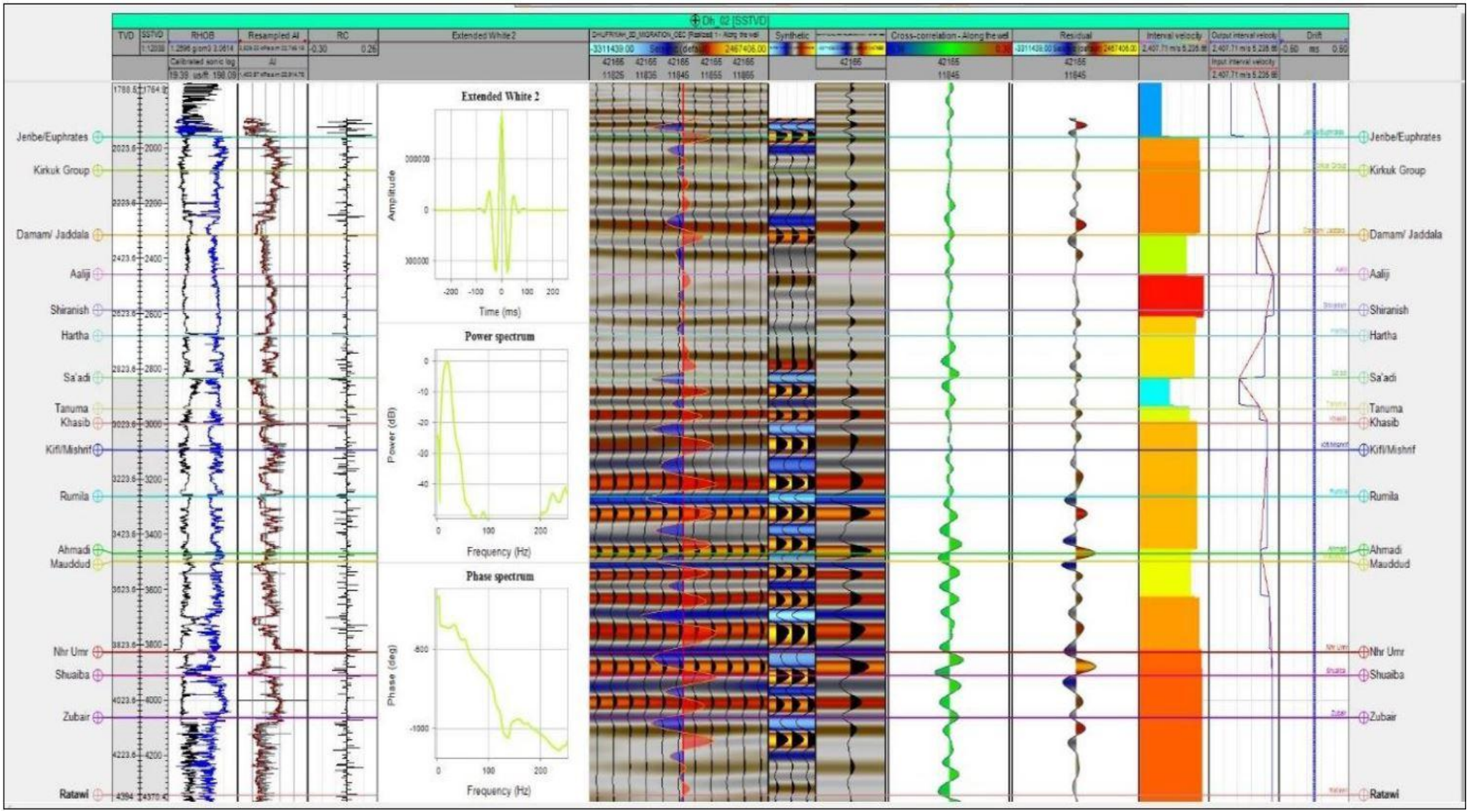


Figure 3. Synthetic seismogram of Dh-2

The match between seismic traces and synthetic traces is very good. Seven reflectors was picked but only the reflector of Zubair formation was picked and identified, The picked reflectors wavelets appeared as peaks on synthetic trace (positive reflection) but in different intensity figure (4).

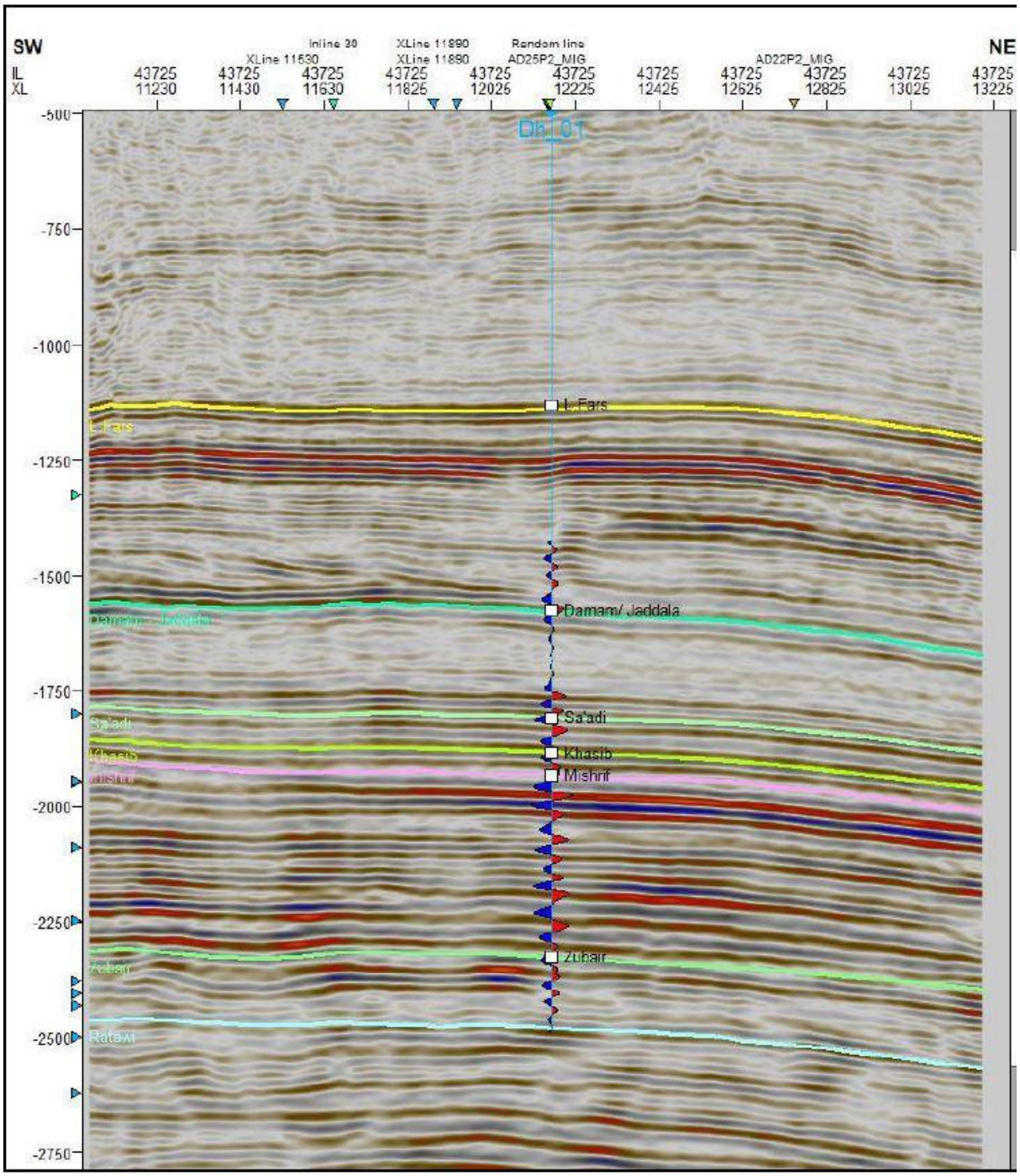
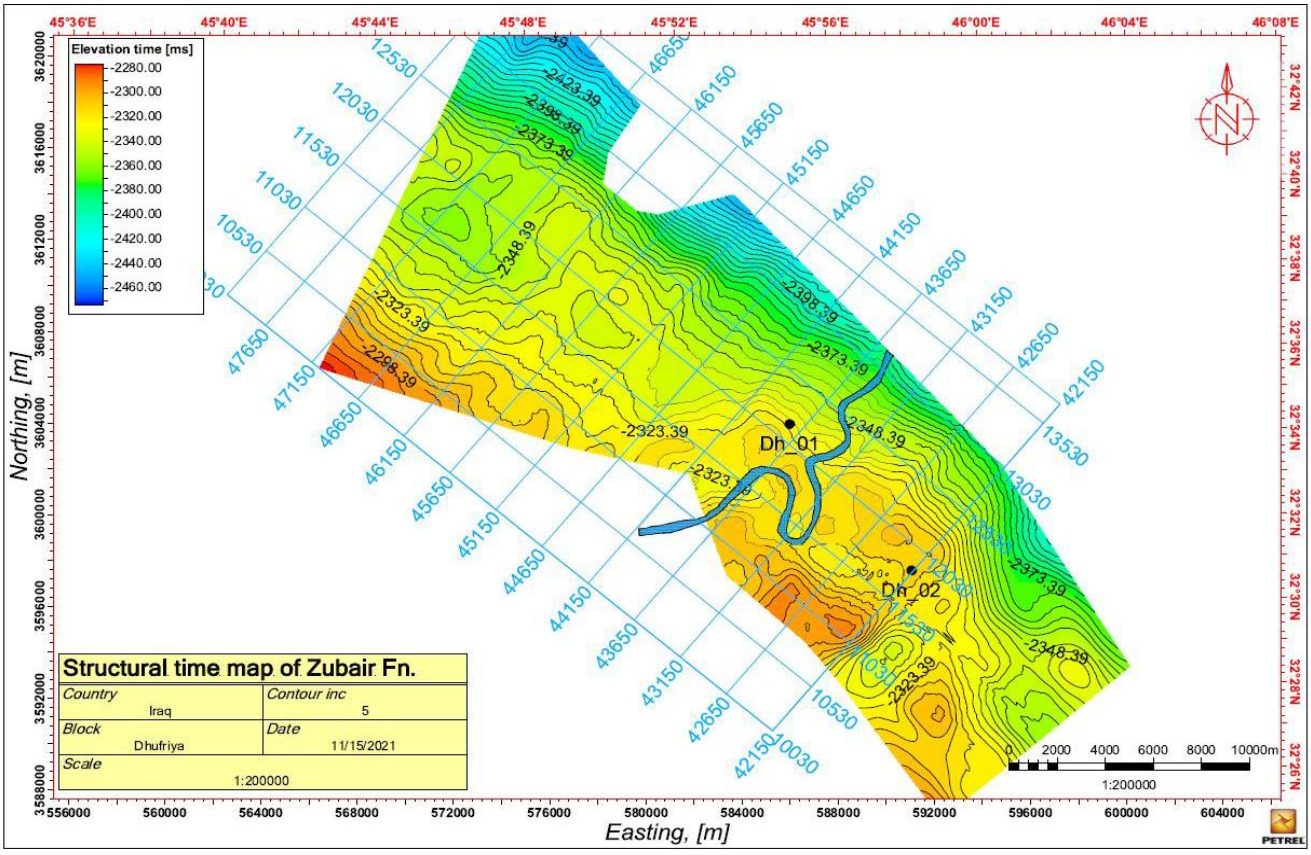


Figure 4. Seismic section (VA) shows the continuity of reflectors passing through well that is matching the synthetic trace very well.

1- Time map

The two way Time (TWT) map of zubair reflector have been prepared and showed that the area was consists of three structural enclosures (A, B, C).

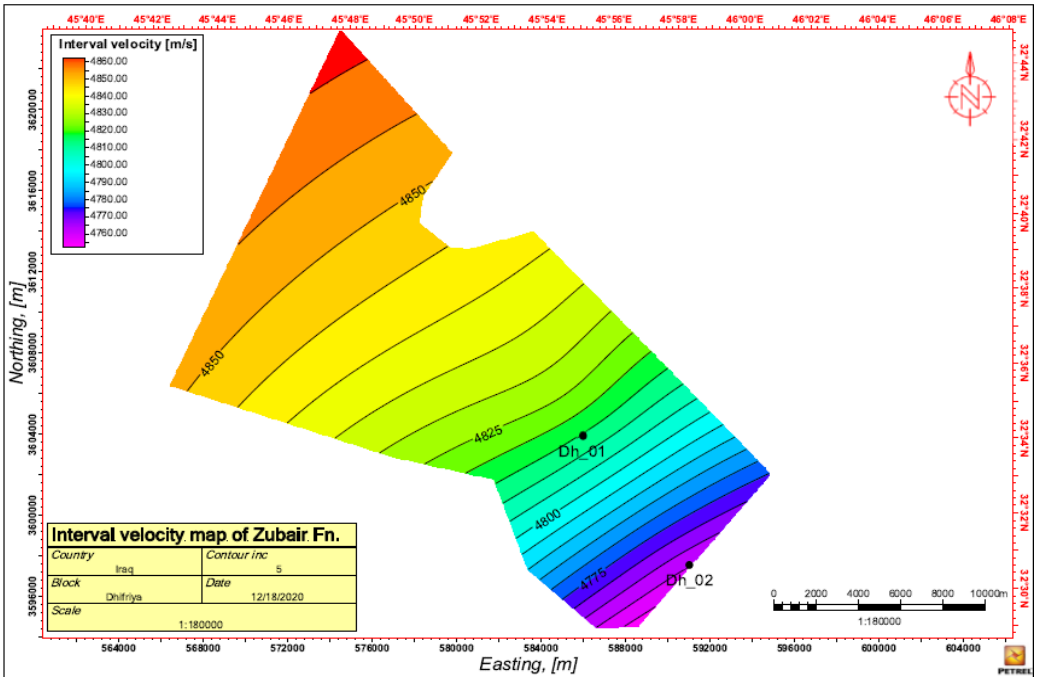
(A) located between Dh-1 and Dh-2 wells of an area about 7.9 km^2 and structural enclose about 10 millisecond, (B) located to the west of Dh-2 trend NW-SE by area 11.7 km^2 and structural enclose 20 millisecond, (C) located to the west of DH-1 trend E-W figure(5).



Figure(5) the time map of bottom Zubair reflector.

2- Velocity Map

Velocity map have been prepared for Zubair formation with scale (1/100000), contour interval of (50) m/sec. and reference surface was sea level. Velocity values decrease toward south east of the study area figure (6).



Figure(6) velocity map of bottom Zubair reflector.

3- Depth map

The data of time map of Zubair formation were multiplied by the velocity data and the depth map were obtained figure(7) this map showing many enclosures of the western part of the study area figure (6).

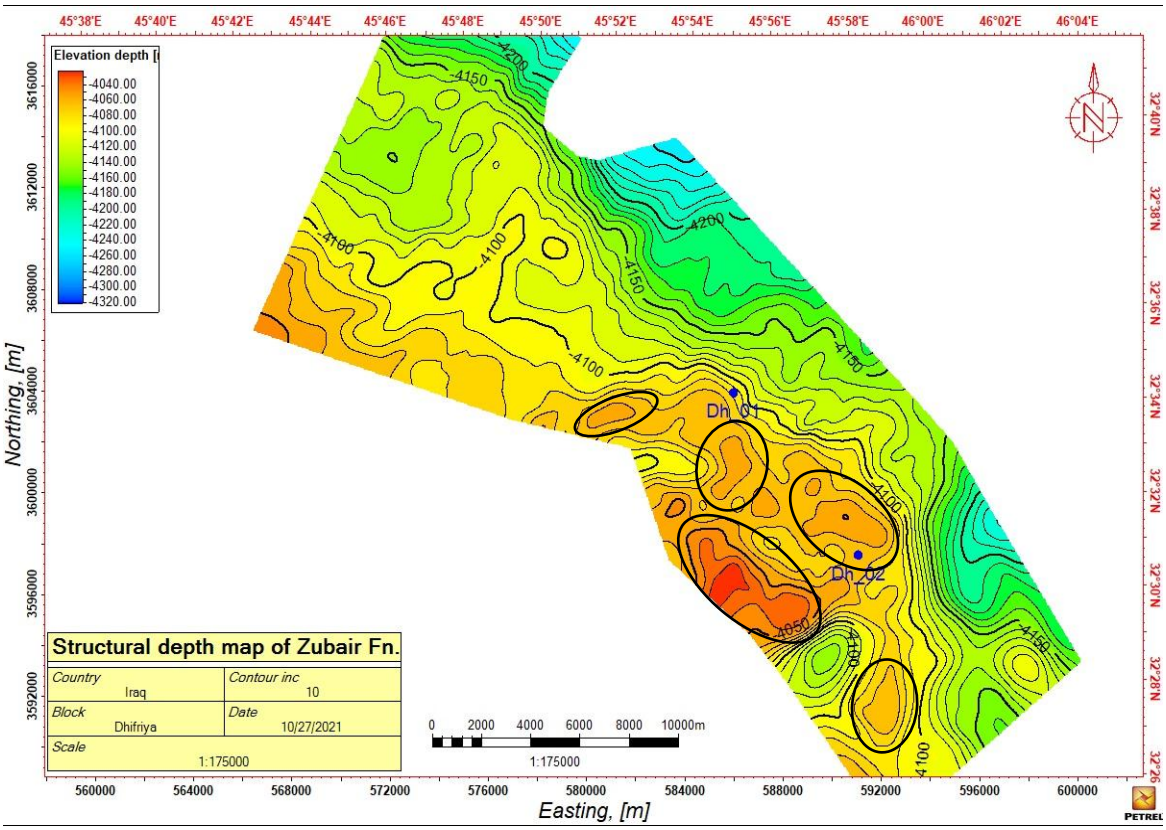
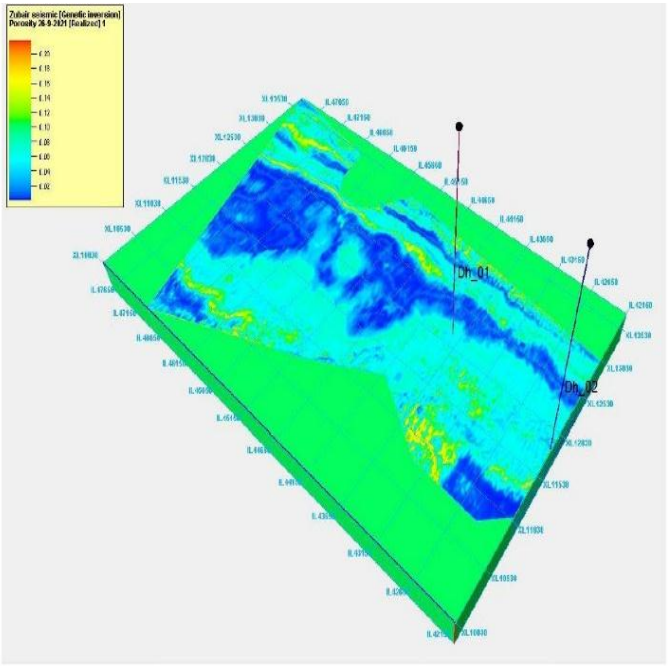
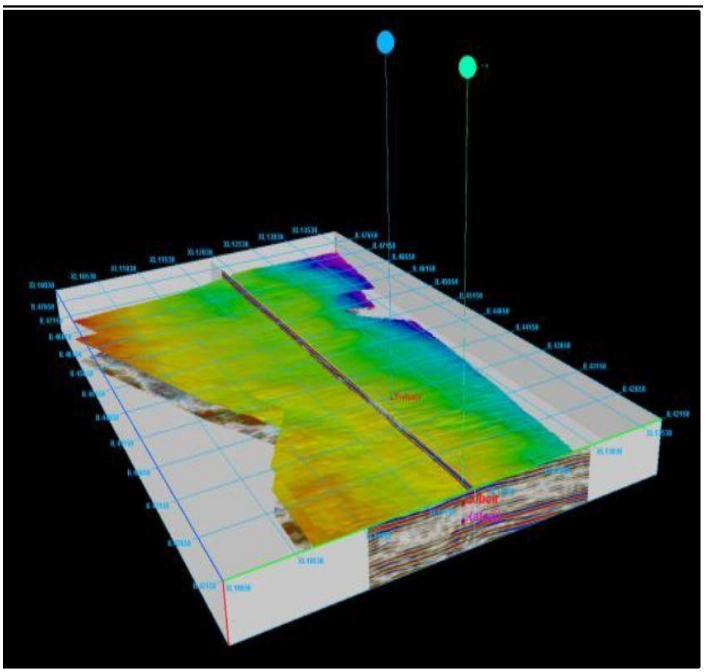


Figure (7) depth map of bottom Zubair reflector.

Seismic Inversion

The purpose of using the seismic inverse is to elicit the petrophysical properties (porosity and water saturation) by converting the seismic cube into a cube of porosity and water saturation, which shows an accurate picture to distribute the properties in the reservoir rock. Because of the lack of wells

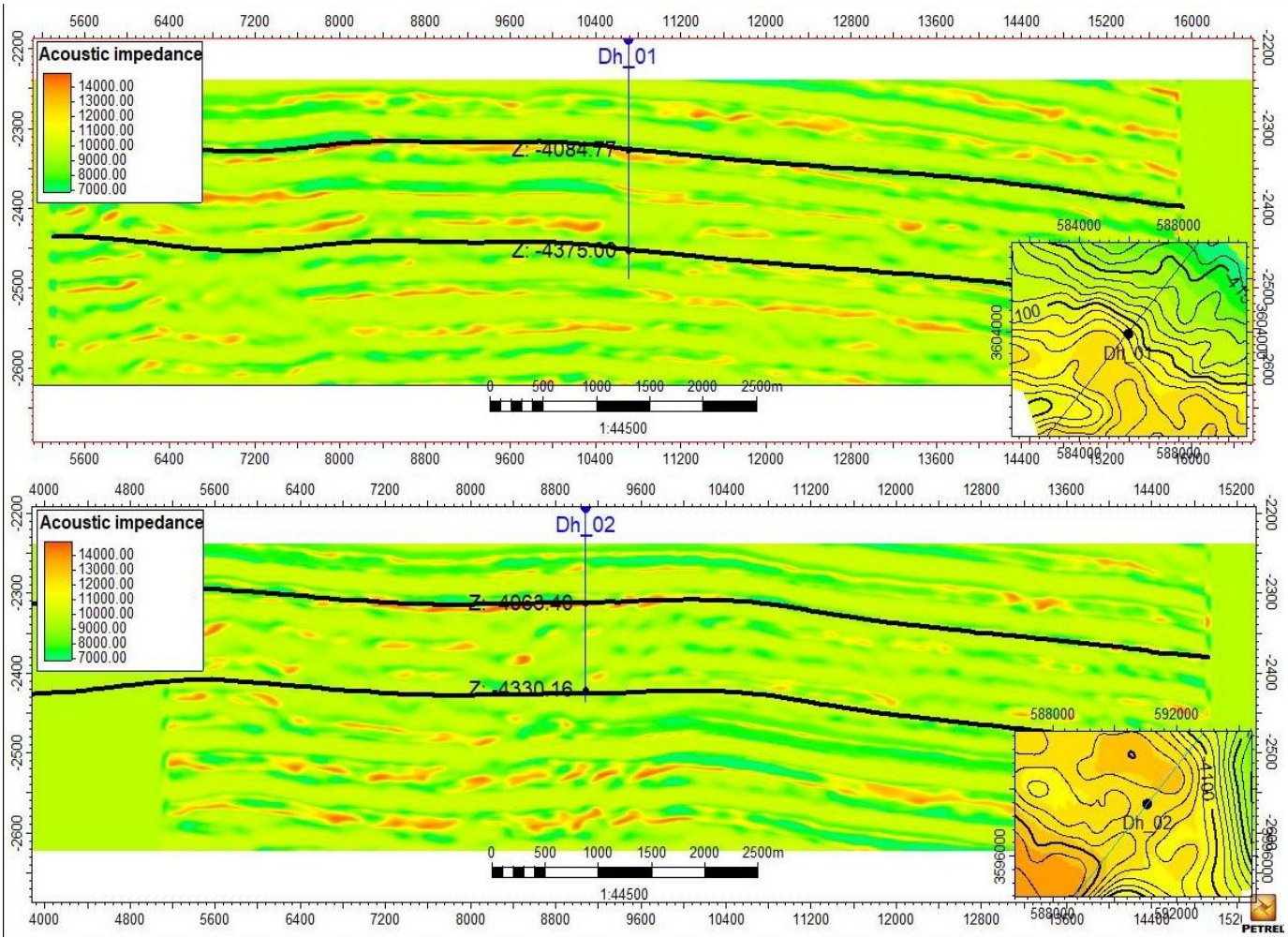




drilled in the field, the reservoir properties were deduced based on calculations of the petro physical properties of the Dh - 1,2 wells and the conversion of the seismic cube to the acoustic impedance cube which reflects the porosity values, as high acoustic impedance values indicate low porosity and vice versa , these values were represented on Zubair Formation Units to find out the lateral, horizontal and vertical variance in the reservoir. The results of converting a seismic cube on the right of figure (8) into a cube of the petrophysical properties (porosity and water saturation) on the left, figure 8 The porosity of Zubair formation reaches 0.22 and toward Dh-2 well. This results confirm the conclusion obtained by (Jaleel, 2021) about increase the porosity of Mishrif, Rumaila, ahmadi and muddud formation (middle cretaceous) in Dh-2 well then Dh-1. It seems that the porosity in Dh-2 well area increase for most formations.

Figure(8) converting the seismic cube on the right into a cube of petrophysical properties on the left.

The results of acoustic impedance shows lateral and horizontal



variance toward NW-SE It reflects the change in the porosity values of the reservoir due to the changes in lithology of Zubair reservoir figure(9).

Figure (9) A cross section show lateral variation of acoustic impedance at Dh-1,2 well.

Calculation of crude oil in Zubair formation

After identification of Zubair formation and calculation of porosity(Ø) and water saturation It remains only to know the volumetric composition coefficient of oil (Bo), whose value was (1.3511 RB/STB) taken from the technical report of the Iraqi National oil company (1985). According to these values crude oil was calculated equal about 118*106 bbl by the equation below (https://www.sciencedirect.com):

$$OOIP = \sum_{i=1}^{i=n} \frac{VBi \times Øi \times \left(\frac{Hnet}{Hgross}\right) i \times (1 - SWi)}{Boi}$$

OIIP: original crude oil.

Ø: porosity < 9 %

VBi: total volume of formation.

Hnet: average thickness of cover rock.

Sw: water saturation > 62 %

Hgross: total average thickness of cover rock.

n : The total number of cells in the geological model above oil-water contact level.

Boi: Volumetric modulus of oil.

Conclusion

According to seismic processing and interpretation of the current research we can list the following conclusions:-

1- Synthetic seismogram was generated from Dh-1,2 well to identify the formations, it showed very good matching between the seismic trace and synthetic traces.

2- Tow way time map was constructed and showed that Dhufriya field consist of three structural enclosure (A, B, C)

(A) between Dh-1 and Dh-2 trend E-W by area 7.9 km^2 (B) to the west of DH-2 trend NW-SE by area 11.7 km^2 (C) to the west of DH-2 area 2.7 km^2 .

3- Average velocity time map constructed from two way time map, showed that Velocity values decrease toward south east of the study area.

4- Depth map constructed from converting time domain to depth domain where all the maps showed a matching with the structural shape in the time domain.

5- Converting the seismic cube into a cube of porosity and water saturation, The results of converting showed that the porosity of Zubair formation reaches 0.22 and become good toward Dh-2 well.

6- the Acoustic impedance shows lateral and horizontal variance toward NW-SE. It reflects the change in the porosity values of the reservoir due to the changes in lithology of Zubair reservoir also the results of the acoustic impedance vary in their values towards the northwest, southeast, which reflects variance in porosity in Zubair formation

7- the Crude oil was calculated and it is found equal $118*10^6$ bbl.

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