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3D Reservoir Study for Yamama Formation in Nasirya Oil field in Southern of Iraq

Salman Z. Khorshid [1], Ghazi H. Al-Sharaa [2], Maha Fadel Mohammed[3]

[1] Department of Geology, College of Science, University of Baghdad, Baghdad, Iraq.
[2] Ministry of petroleum, Oil Exploration Company, Baghdad, Iraq.

Abstract— *Nasriya oil field is located at the Southern part of Iraq, this field is a giant and prolific, so it take a special are from the Oil Exploration Company for development purposes by using 3D seismic reflection.*
The primary objective of this thesis is to obtain reservoir properties and enhance the method of getting precise information about subsurface reservoir characterizations by improving the estimation of petrophysical properties (effective porosity, P-wave, water saturation and poisson's ratio).
There are five wells in the study area penetrated the required reservoirs within Yammam Formation. The Synthetic seismogram of Nasriya wells were created to conduct well tie with seismic data. These well tie was very good matching with seismic section using best average statistical wavelet. Five main horizons were picked from the reflectors by using synthetic seismogram for wells then converted to structural maps in depth domain by using average velocity of five wells.
By using petrel program TWT maps have been constructed from the picked horizons, Average velocity maps calculated from the wells velocities survey data and the sonic log information and Depth maps construction was drawn using Direct time-depth conversion and the general trend of these map was NW-SE. The model of low frequency was created from the low frequency contents from well data and the five main horizons were picked.
The seismic inversion technique was performed on post-stack three dimensions (3D) seismic data in Nasriya oil field.

***Keywords*— Seismic Inversion , Synthetic seismogram, Check Shot correction, The wavelet, Synthetic trace, Structural pictures of the picked horizons, Low frequency model LFM (Initial model), Inversion results.**

I. INTRODUCTION

Nasriya structure was discovered in 1975 through a seismic investigations covered partially the southern part of Iraq by (I.P.C.) groups [1].
Nasriya oil field is located in southern of Iraq within the Dhi Qar governorate about 38 km north-west from the Nasriya city figurer (1)

This research is dedicated to study of the Yamama Formation and study reservoir characterization such as (effective porosity) of Yamama Formation by using software, specifically Hampson- Russell and petrel programs.
Because of the good prospects of the oil in the rocks of Cretaceous generally in Yamama Formation specially in the Nasriya oil field and in view of the economic importance of Yamama Formation, which is considered as important formation that contains hydrocarbon accumulation, this formation is of the one most important oil production reservoirs in southern Iraq.

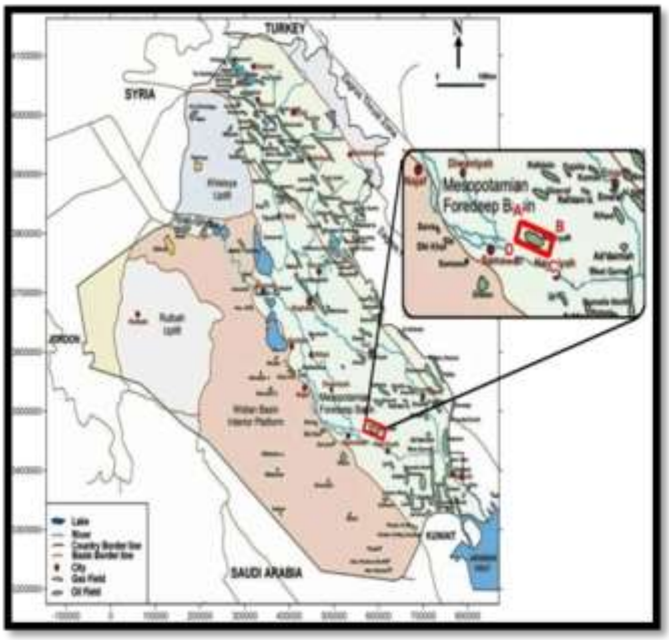

Fig.1: Location map of the study area [2].

II. SEISMIC INVERSION

Seismic inversion is the extracting and calculation process of the earth's structure (underlying geology that gave rise to that seismic) and physical properties from some sets of observed seismic data. The output of the seismic inversion can be P-wave and S-wave velocities, density, Poisson's ratio, acoustic impedance and S-impedance volumes [3],[4],[5]. The flow chart shown in figure (2) to explain the main steps of the work process.

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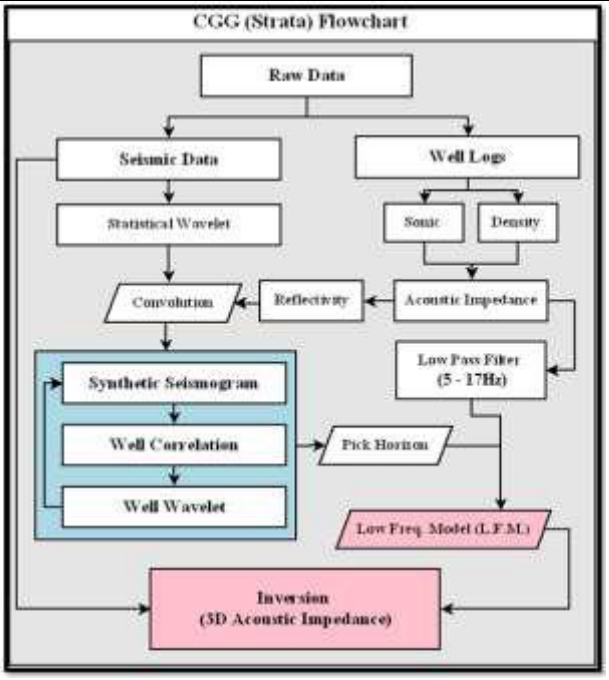

Fig. 2: Flow chart summarized the main steps of inversion process [6].

III. THE WORK FLOW

Inversion is a process of extraction from seismic data that utilized in the post stack and aim of to extract the acoustic impedance volumes, this allows to compute the porosity of fluids and water saturation, seismic inversion is used to transform the seismic effect into acoustic log and density log.

So the inversion helps to delete small wavelets and then contributes the determine of reservoir properties with better dispersion capacity of waves, and that the acoustic impedance requires the integration of the data of the log of the well so the inversion is a step integrated data and the output data connects the wells and also matches the seismic data. The process of description the reservoir regularly using seismic data is not sufficient to simulate the reservoir, and the field seismic data and the processing of these data provide excellent side coverage of the reservoir.

But seismology requires calculating the characteristics of the bottom of the surface by sending controlled seismic energy into the earth and watching the reflected waves at the receiving stations. Synthetic seismogram synthetics allows you to utilize all the well logs, geologic markers, 2D and 3D seismic, check shot data and structural interpretations [7].

3.1 CHEC SHOT CORRECTION

This is basically true for vertical wells, small offset of the source to the well, and little or no formation dip [8]. in the study area all wells are vertical and check shot times measured in these wells are vertical (one way time) OWT.

Figure (3) shows check shot correction have been applied for one wells in study area (Ns-1), in well diagram there are three track, the left track represent relation between true vertical depth (TVD) and TWT which contain two curves, input time in black color and corrected time in red color, middle track represent drift curve and right track represent original velocity from sonic log in black color and corrected velocity in orange color.

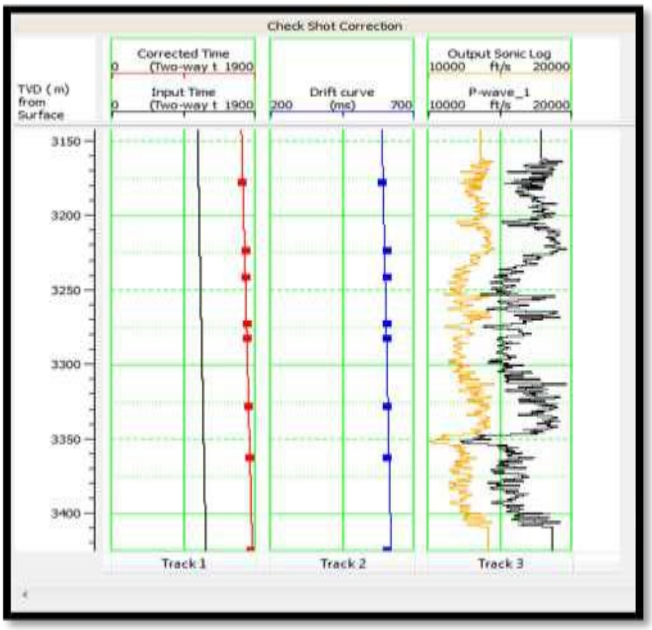

Fig.3: Check shot correction for well Ns-1 in the study area.

3.2 THE WAVELET

The wavelet is a wave pulse approximation for a seismic source which contains many frequencies and is time limited. By correlating reflection events across the wells, an estimated cross-section of the geologic structure can be interpreted [9]. Amplitude spectrum of the wavelet is extracted by analyzing the auto-correlation process of a set of traces over a selected time window [10]. The best average wavelet that match the synthetic trace of the wells of (Ns-1,Ns-2, Ns-3, Ns-4, and Ns-5) figure (4).

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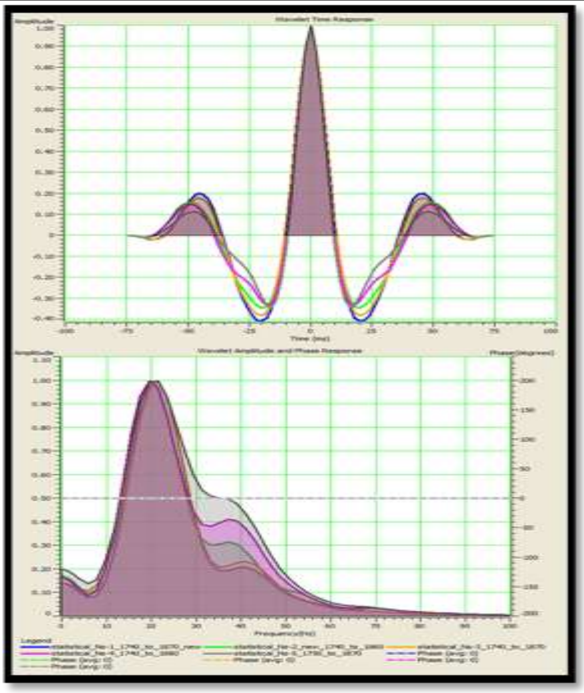

Fig.4: The average statistical wavelet of wells Ns-1, 2, 3, 4, and 5.

3.3 SYNTHETIC TRACE

The synthetic trace in this study is created by convolution process between reflectivity calculated from well data and statistical extracted wavelet in first step, after gate proper correlation between synthetic trace and seismic trace at well location see the figure (5). The corrected synthetic seismogram is displayed in seismic data through wells Ns-1 and Ns-3 with picked main horizons in the study area figure (6).

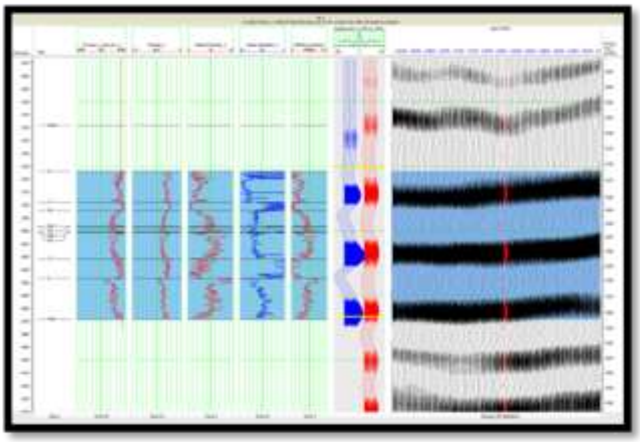

Figure (5): Synthetic seismogram of well Ns-1 with statistical wavelet max. coeff. = 89%.

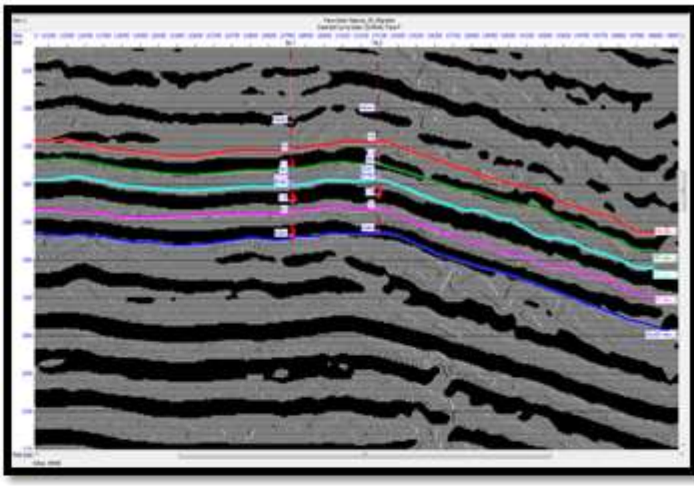

Fig.6: Inline section from 3D seismic data pass through wells Ns-1 and Ns-3 with synthetic seismogram.

IV. STRUCTURAL PICTURES OF THE PICKED HORIZONS

The studied reflectors were defined by using synthetic seismogram for wells (Ns-1,2,3,4 and 5). These reflectors were picked over all seismic cube and mapped to Top of Yamama Formation (YA) , YB1, YB3, YC, and Top of Sulaiy Formation in time domain, then converted to structural maps in depth domain by using average velocity of five wells.

By using petrel program, TWT maps have been constructed from the picked horizons (Yamama) respectively using sea level surface as a datum plane TWT maps shows in general three enclosure domes with a NW-SE axis in the middle of Nasriya Oil field, also show these layers covered all study area with general dip toward NE figure (7) and (8).

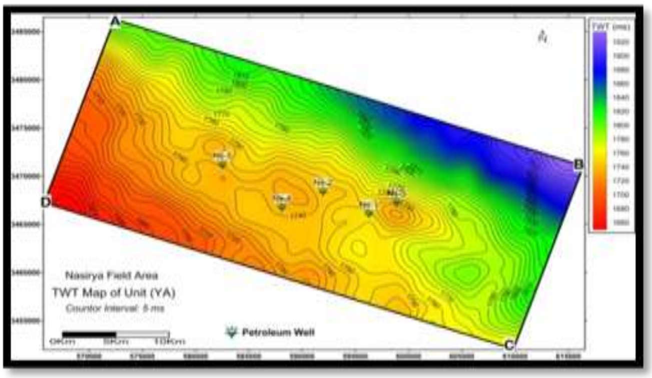

Fig.7: Show TWT map to the top of Yamama Formation (unit YA).

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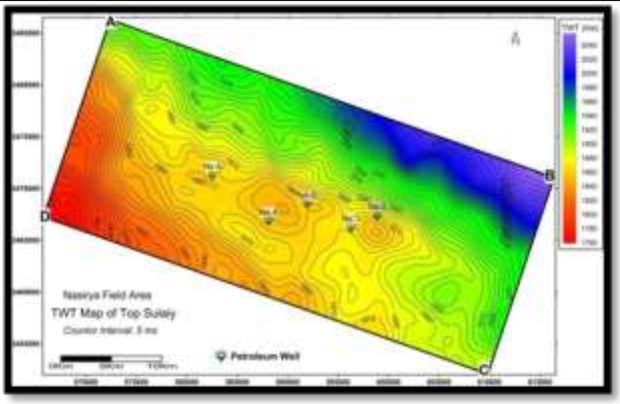

Fig.8: Show TWT map to the top of Sulaiy Formation. (Bottom Yamama Formation).

The average velocity was calculated from the wells velocity survey data for the five previously well of Nasirya oil field and the Sonic Log information through which the cumulative time (TWT) was calculated for the formation after the measurement conversions from (Micro) Second to millisecond and feet to meter and its compatibility with the inverter, thus obtaining the inverter speed from the output of the depth distribution of the configuration on the double-measured time. The RMS was not adopted to convert to the depths because of uneven differences with the values of average velocity of the wells and is so accurate that the correction process is inaccurate

The maps shows generally a gradual increase from the center of the domal shape to the all directions approximately figures (9 and 10). In the Nasirya Oilfield there is a relatively small decrease in the velocity values.

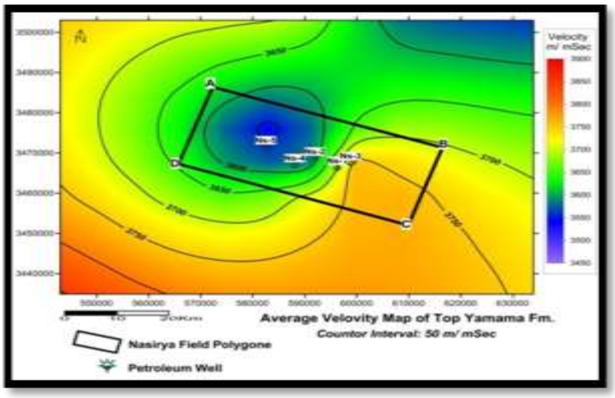

Fig.9:Average velocity map of top of Yamama Formation.

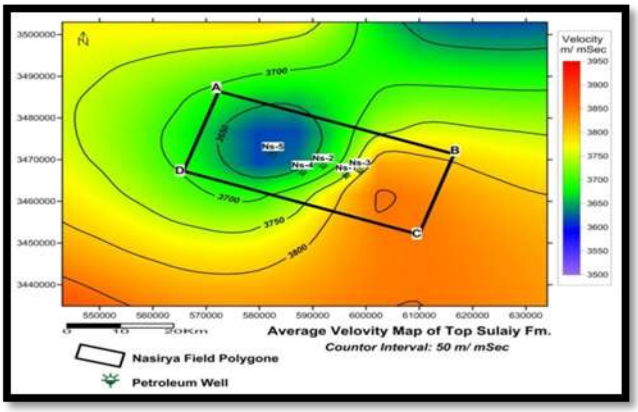

Fig.10: Average velocity map of top of Sulaiy Formation.

Generally, depth estimation can be done wide range of existing methods, but which can be separated into two broad categories [11], In the current study, we have used Direct time-depth conversion by using petrel program In general, the depth maps revealed three major enclosure domes where the first dome is located at the location of the two wells (Ns-1, 3). The second dome is located near the two wells (Ns-2, 4) and the third dome northwest of the well (Ns-5) figure (11 and 12).

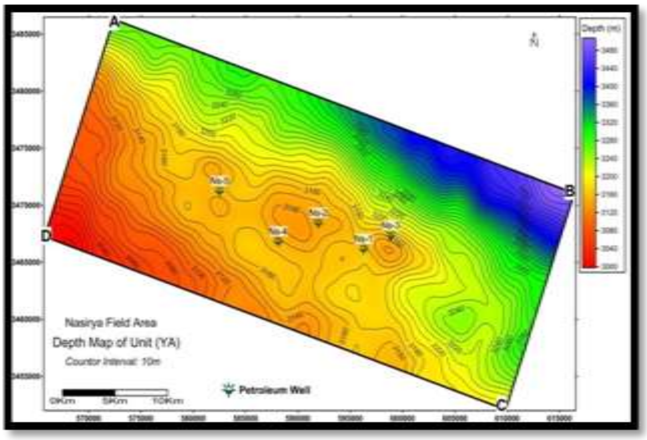

Fig.11: Shows depth map to the top of Yamama Formation (unit YA).

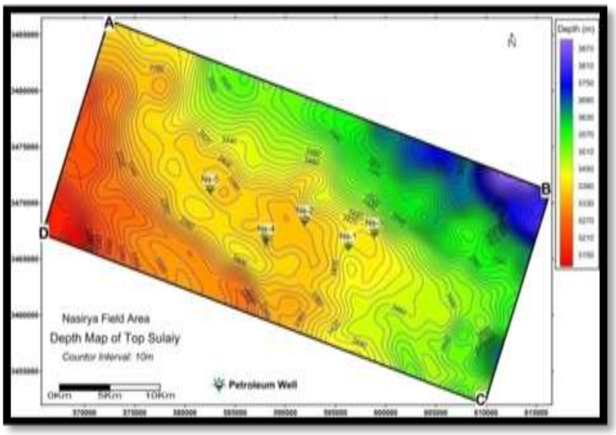

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Fig.12: Show depth map to the top of (Sulaiy Formation) (Bottom of Yamama Formation).

V. CLOW FREQUENCY MODEL LFM (INITIAL MODEL)

In amplitude seismic data, the common occurrence is the absence of low-frequency content, that lost during acquisition and processing of seismic data by the effect of band limited wavelet of seismic sources and applied band-pass filter to eliminate low-frequency ground-roll and coherent high frequency noise [12]. Inversion of seismic data alone leads to band-limited Acoustic Impedance estimation [13], therefore, in seismic inversion process, the low frequency content must be compensated by build 3D geologic model of (AI) from well logs to obtain absolute rather than relative (band-limited) inverted property values [14], [15] figure (13) shows Initial model.

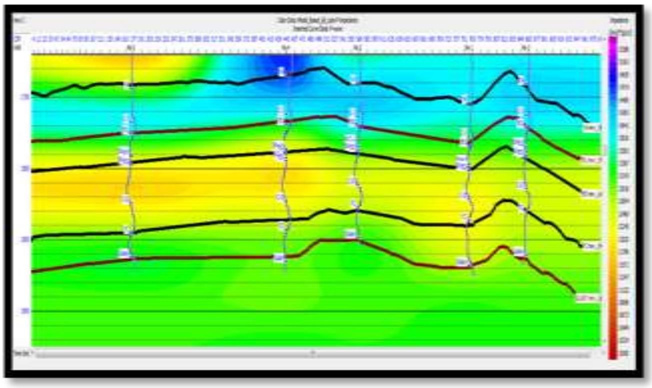

Fig.13: Arbitrary line section passed through 3D volume of low frequency model.

VI. INVERSION RESULTS

The Model Based Inversion (MBI) is a type of post stack inversion to compute acoustic impedance from the seismic datasets. The model based inversion technique is also known as blocky inversion which was used in an attempt to better define stratigraphic features and contacts of interest. The final step of the inversion process is run through all 3D seismic volume to create 3D acoustic impedance between wells and cover all study area figure (14). The final results of acoustic impedance (AI) inversion and used four wells (Ns-1,2,3, and 5) to the inverted seismic data and blind well (Ns-4) to quality control inverted data as shown in figure (15). Acoustic impedance (AI) from wells data were posted on vertical sections passed through wells in the study area which shows very good correlation between original and calculated acoustic impedance (AI), in figures the low acoustic impedance shows the good porosity and promising areas in the oil field.

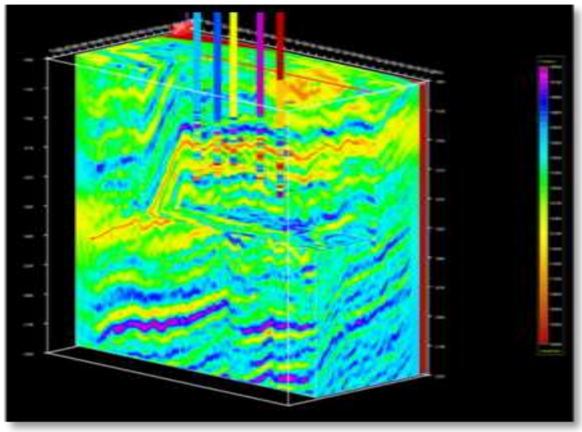

Fig.14: 3D inverted acoustic impedance volume resulted from post stack inversion.

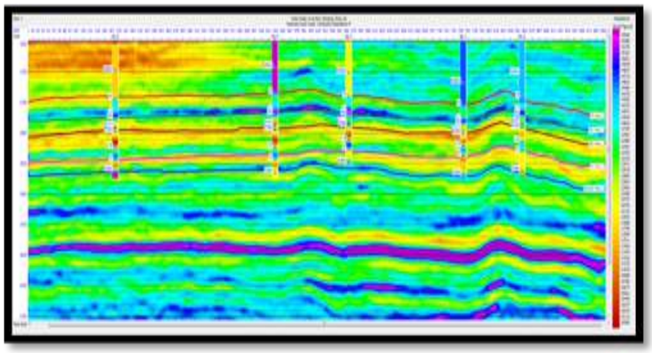

Fig.15: Arbitrary line from 3D all data pass through well locations and shows matching between AI from wells and calculated from seismic data.

The final results of acoustic impedance (AI) inversion, a horizon slices of all units reservoir (Yb1, Yb3, and Yc) centered window beneath Yamama horizon has been out of the (AI) inverted cube indicated a quality reservoir units tend to be enhancement at the crest, NW-SE and eastern sides of the anticline as shown in figure (16) shows the low (AI) in the crest , NW and eastern side of the fold, indicated high porosity. figure (17) shows the low AI in the crest , NW-SE and eastern side of the fold, indicated high porosity. and in figure (18) shows the low (AI) in the crest and NW-SE side of the fold, indicated high porosity.).

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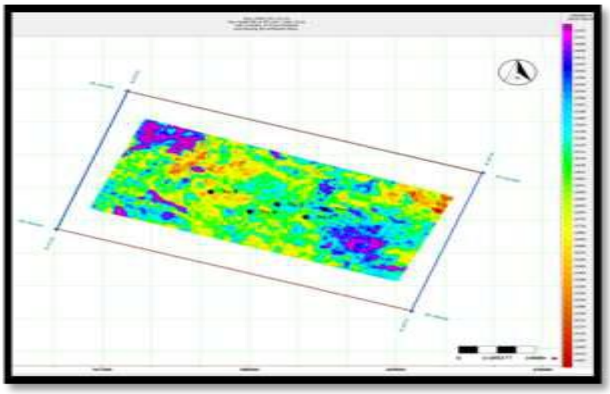

Fig.16: shows the low(AI) horizon slice of unit Yb1

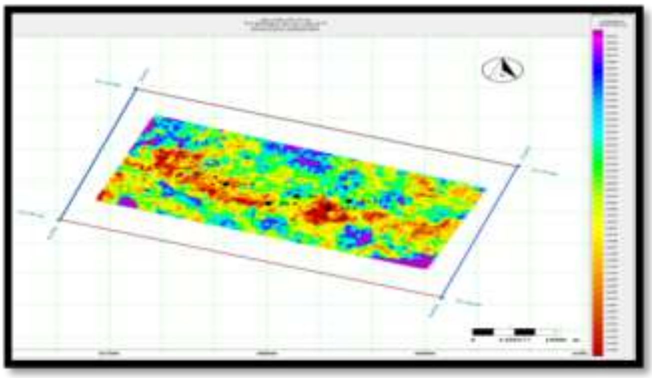

Fig.17: shows (AI) horizon slice of unit Yb.

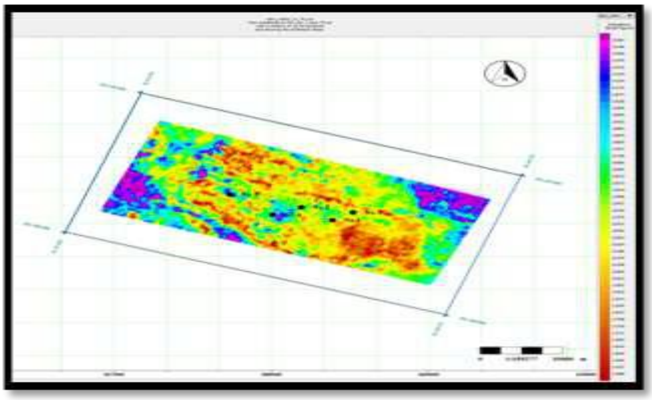

Fig.18: shows (AI) horizon slice of unit Yc in the crest and NW-SE side of the fold.

VII. CONCLUSIONS

1- The Synthetic seismogram of Nasiriya wells were created to conduct well tie with seismic data. These well tie was good matching with seismic section.
2- There is a good match of the average statistical wavelet with the synthetic seismogram of the wells of (Ns-1, Ns-2, Ns-3, Ns-4, and Ns-5).
3- By using petrel program, TWT maps: have been constructed from the picked horizon (tops of Yamama and Sulaiy). The result of study TWT maps appear in general three enclosure domes with a NW-SE axis in the middle of Nasriya Oil field with general dip toward the NE.
4- Average velocity maps calculated from the wells velocity survey data and the sonic log information. The result of maps was generally a gradual increase from the center of the domal shape to the all direction approximately.
5- Depth maps construction in the current study, was drawn using Direct time-depth conversion,

Depth maps were appeared general direction of the study area is NW-SE, and the southwestern side is structurally higher than the northeastern side. In general, the depth maps revealed three major enclosure domes where the first dome is located at two wells (Ns-1and Ns-3). The second dome is located near the two wells (Ns-2 and Ns-4) and the third dome was on the northwest of the well (Ns-5).

6-The seismic inversion technique was performed on post-stack three dimensions (3D) seismic data in Nasriya oil field. The final results of acoustic impedance (AI) inversion were used for four wells (Ns-1,2,3, and 5) to the inverted seismic data and wildcat well (Ns-4) to quality control inverted data. Horizon slices of all units reservoir indicated a quality reservoir units tend to be enhanced at the crest and eastern sides of the NW-SE anticline. The result of inverted slices of Yb1,Yb3 and Yc in directional mentioned later low acoustic impedance indicated to the high effective porosity**.**

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