Seismic Study at Subba Oil Field Applying Seismic Velocity Analysis

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Abstract— *This research is seismic interpretation of two-dimensional seismic data from oil exploration company in Subba oil field. The field data process for the purpose of interpretation, synthetic seismogram was done for the well (Su-7) by using the sonic log and seismic velocity, where the seismic reflectors were picked up (Nhr Umr, Shuaiba, Zubair and Ratawi). Time and depth maps were prepared, showing convex structure with a north-south axis in the center of the study area, with two main dome at northern and southern of the study area. Velocity model from which velocity maps (Average velocity, and interval velocity) were drawn. Seismic inversion technique is used to shows the units within Formations and delineate the increase or decrease of porosity in the Nhr Umr and Zubair Formations.*

Keywords— *Velocity analysis, Seismic attribute, Subba oil field.*

I. INTRODUCTION

The geophysical techniques that most widely employed for exploration are the seismic, gravity, magnetic, electric, and electromagnetic methods. Less common method involves the measurement of radioactivity and temperature at or near the Earth's surface and in the air [1]. The reflection method is depending on the study of the elastic waves reflected from the interface between two geological layers. The reflection method is used exclusively for petroleum prospecting; it is more suitable in areas where the oil is in structural traps, but also it is useful for locating and detailing certain types of stratigraphic features [2], reflection technique measures the arrival time of seismic wave to travel from a source at the Earth's surface down into the ground where it's reflected back to a receiver which is located near the surface. The seismic wave can be generated on the ground by a near-surface explosion of dynamite, weight dropping and vibrate [3]. The studied area is located south Iraq between provinces of Basra, Dhi Qar and Almuthanna, as shown in Figure (1). The aim of this research is using velocity model and maps (vertical and horizontal average velocity slices) to show variation of seismic velocities, acoustic impedance and total porosity for Nahr Umr and Zubair Formations.

Fig.1: Location map of study Area (Subba field)

II. DATA PROCESSING

Geophysical data processing is the use of computers for the analysis of geophysical data. a major task in geophysics is to determine as much as possible about the constitution of the interior of the earth, [4]. we will explain how to obtain the field data used and how to process this data.

Processing steps:

1. Reformat applications: Field data are recorded in a multiplexed mode using a certain type of format [5].
2. Geometry update: is an update of the field records received from seismic teams in the field by sps file containing the information recorded in the field such as the values of (x , y , elevation and location …).
3. Static up date: is a correction of the delayed waves. and eliminates the effect of differences in earth's surface- level elevations.
4. Gain applications: is a time-variant scaling in which the scaling function is based on a desired criterion
5. Noise attenuation: is classified into two categories, random noise and coherent noise [6], as shown in Figure (2).
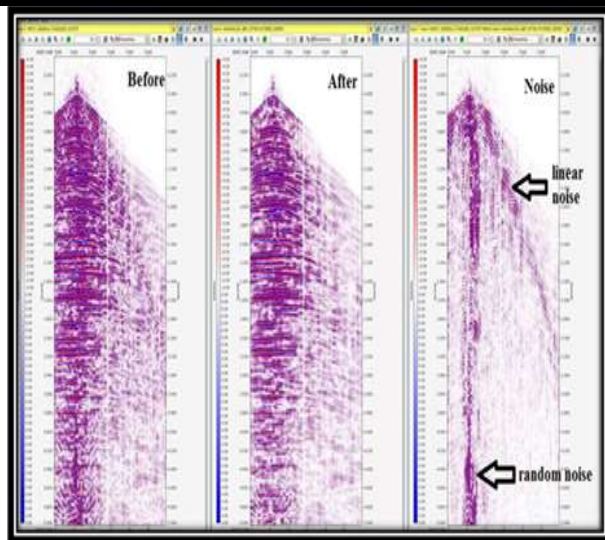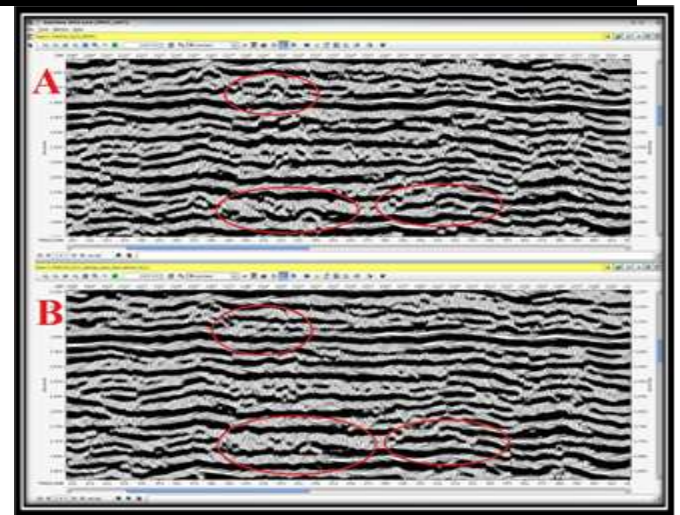
Fig.2: types of noise

Fig.3: seismic section stack, A) old pick, B) new pick, showing the changes in many places

6. Deconvolution: is aimed at improving temporal resolution by compressing the effective source wavelet contained in the seismic trace to a spike (spiking deconvolution).

7. Common - midpoint (CMP) Sorting: is the most important data-processing application in improving data quality. The principles involved have already been discussed along with the field procedures used to acquire the data, [7].

8. Normal-moveout correction: the velocity field is used in normal moveout (NMO) correction of CMP gathers, based on the assumption that, in a CMP gather reflection travel times as a function of offset follow hyperbolic trajectories, the process of NMO correction removes the moveout effect on travel times, [8].

9. Residual statics corrections: is one additional step in conventional processing of land and shallow-water seismic data before stacking [9].

10. Stacking: is one of the most advanced stages in the treatment of seismic data, It aims primarily at improving the quality of these data, Stacking depends heavily on velocity derived from velocity analyzes, It is applied after the procedures of the NMO corrections, for best seismic sections, as shown in Figures (3)

11. Velocity analysis: normal moveout is the basis for determining velocities from seismic data. Computed velocities can in turn be used to correct for NMO so that reflections are aligned in the traces of a CMP gather before stacking, as shown in Figure (5)
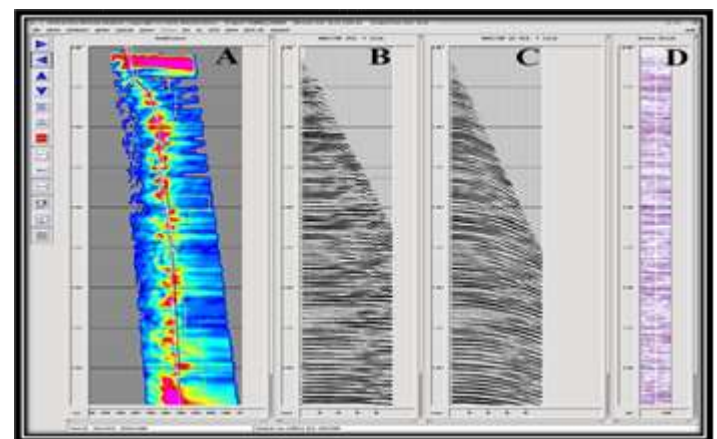

Fig.4: A) Semblance panel, B) NMO-Corrected gather, the wave field is flat, C) Un-corrected gather, D) The area of stack to define the velocity.

III. SYNTHETIC SEISMOGRAM

The subsurface mapping and enhanced by the correlation of seismic data with borehole data using the synthetic seismogram, explain synthetic seismogram for well Su-7 where the density log, sonic log and check shot, as shown in Figure (5)
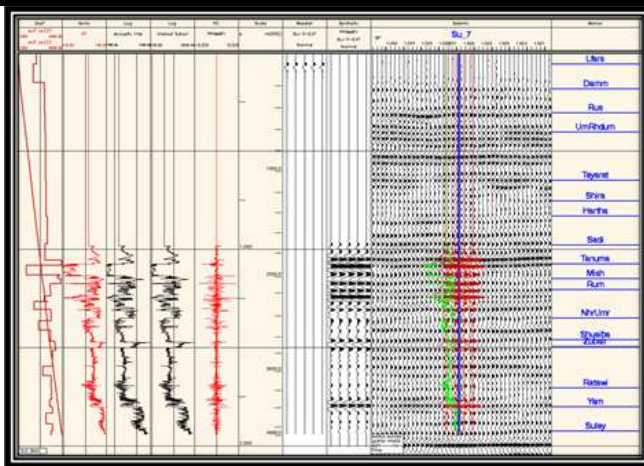
Fig.5: Synthetic seismogram

IV.   TWO WAY TIME (TWT) MAP

(TWT) map have been constructed from the picked horizons Nahr Umr and Zubair Formations with contour interval (20 msec).

The TWT values of Nahr Umr Formation are increasing in the direction of the north-east and decreasing in the south-west. at the south of subba field have small structure at Su-8 well, and Zubair Formation shown structure in the north part of study area, as shown in Figures (6),(7)
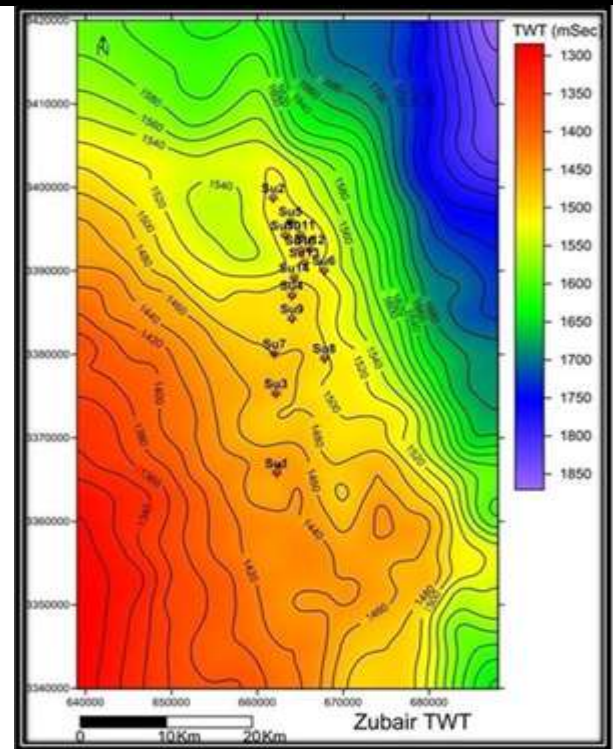

Fig.6: Two way time maps of Nahr Umr formation

Fig.7: Two way time maps of Zubair Formation

V.   VELOCITY MODEL

Velocity models are key components of seismic imaging, and consequently, to reservoir description and geo mechanical analysis.

Velocity model has been created by inserting surfaces which were picked in time domain and well tops of Nahr Umr, and Zubair horizons, the average velocity model explain the change toward the basin, the velocity decrease to north-east and increase to the south-west of the field, as shown in Figure (8).
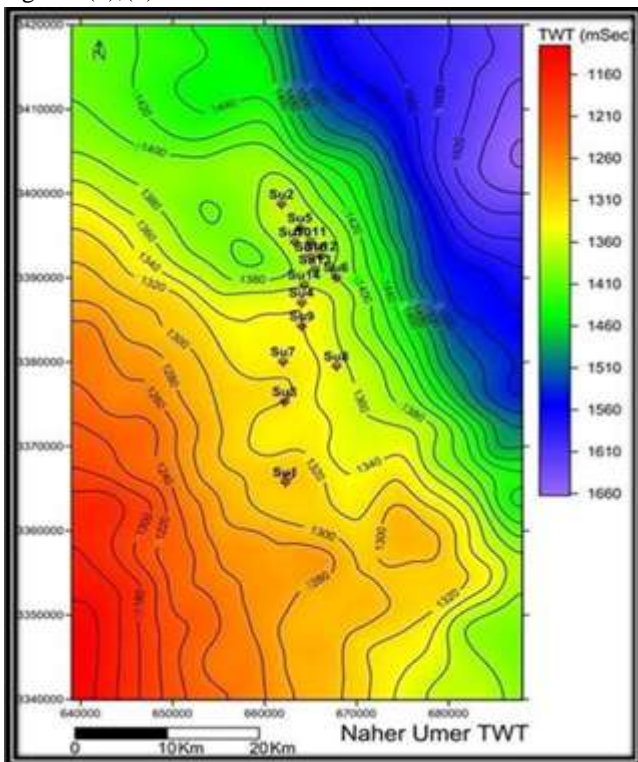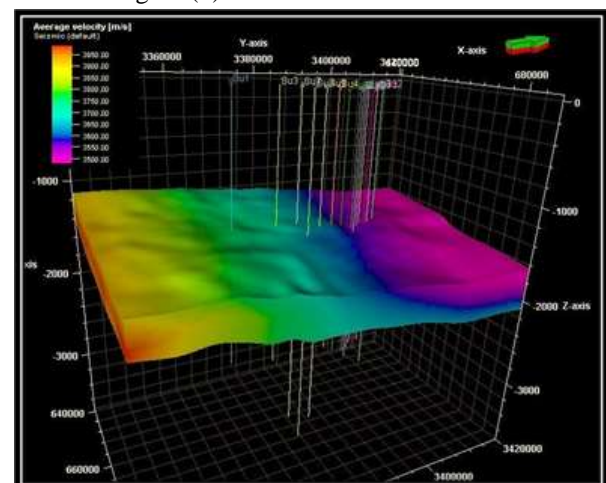

Fig.8: Velocity model of NahrUmr and Zubair Formation

VI.   VERTICAL AVERAGE VELOCITY SLICES

-In line slice:

The average velocity values decrease at the top of the Nahr Umr Formation to the east at well Su-8, and low of the average velocity values in Zubair Formation to the same direction, the increase of values at the bottom of the Ratawi Formation, as shown in Figure (9).
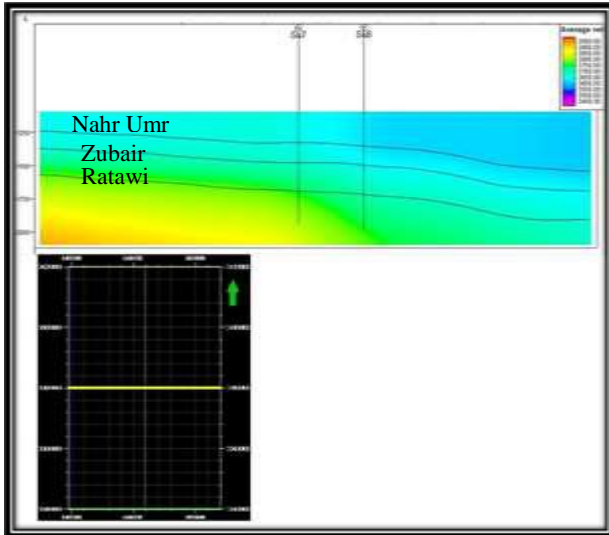

Fig.9: Vertical average velocity slices (In line slice)

-Cross line slice:

The cross line slice explain the lateral changes along of the field shown the average velocity values decrease at the top of the Nahr Umr to the north-east part especially at wells Su-5 and Su-10 and continue low velocity zone in Top Zubair and Ratawi Formation in same direction, as shown in Figure (10).
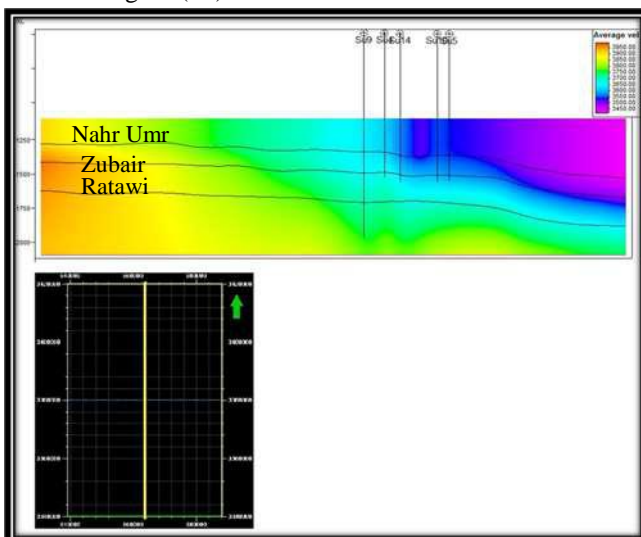

Fig.10: Vertical average velocity slices (Cross line slice)

VII.   Horizontal average velocity slice

Horizontal average velocity slice decrease toward the north-east part of the field, and low average velocity

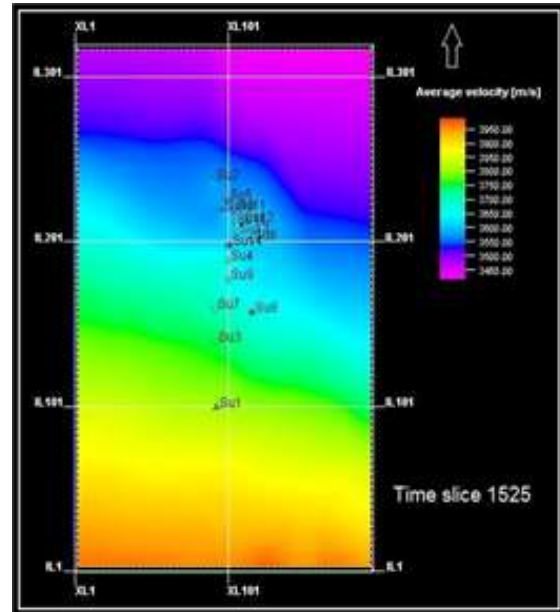appears at boreholes area, and the velocity values increase toward south-west, as shown in Figure (11) .

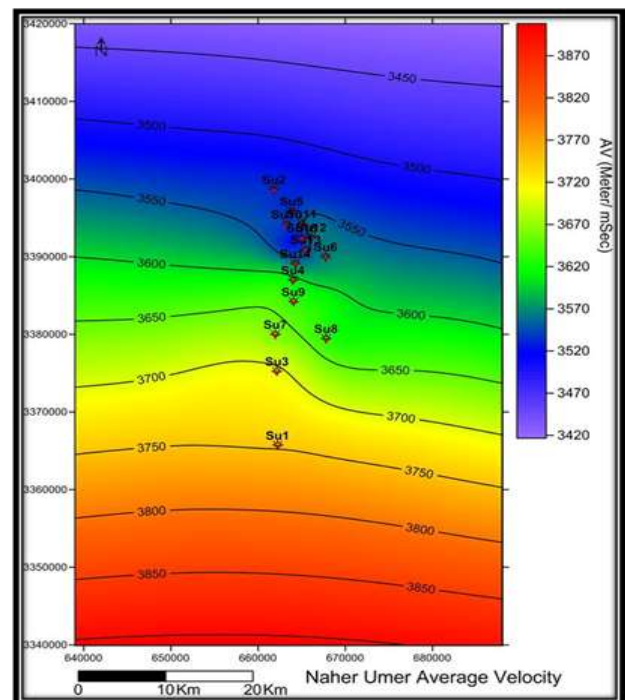*Fig.11: Horizontal average velocity slice*

VIII.   VELOCITY MAPS

Fig. 12: Average velocity map of Nahr Umr Formation

1. Average velocity map:

It's obtained from dividing the total distance travelled by the wave by the time spent in [10]. The average velocity maps of Nahr Umr and Zubair Formations explain the increase and decrease in velocity, of Nahr Umr Formation map the values are ranged from 3420 to 3870 m/s, having closure average velocity in contour value 3550 m/s to the north of field, where most of the oil wells were drilled.

The average velocity increase in velocity values in the southern part and a decrease in the northern part, and Zubair Formation the average velocity values are ranged from 3500 to 3950 m/s, having closure average velocity in contour value 3580 m/s to the north of field, as shown in Figures (12),(13)
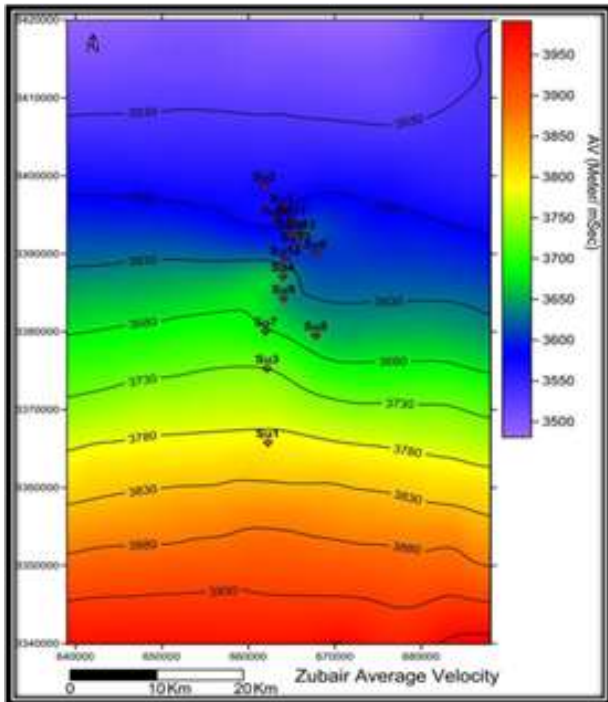

Fig. 13: Average velocity map of Zubair Formation

2. RMS velocity map:

Is defined as the square root of the average, can be calculated from the interval velocity data [10].

The RMS velocity maps extracted from processing data, Nahr Umr Formation map, the values are ranged from 3450 to 4350 m/s, having many closures to the north of the field, between contour values (3400-4000 m/s), when the oil wells were drilled, the velocity values decrease to the north-east part and increase to the south-west part, and Zubair Formation map explain the values range from 3550 to 4350 m/s, shown many closure of cantor interval in center field, between contour values (3500-4100 m/s), and having many smaller closure distributed to the south of field, as shown in Figures (14),(15).
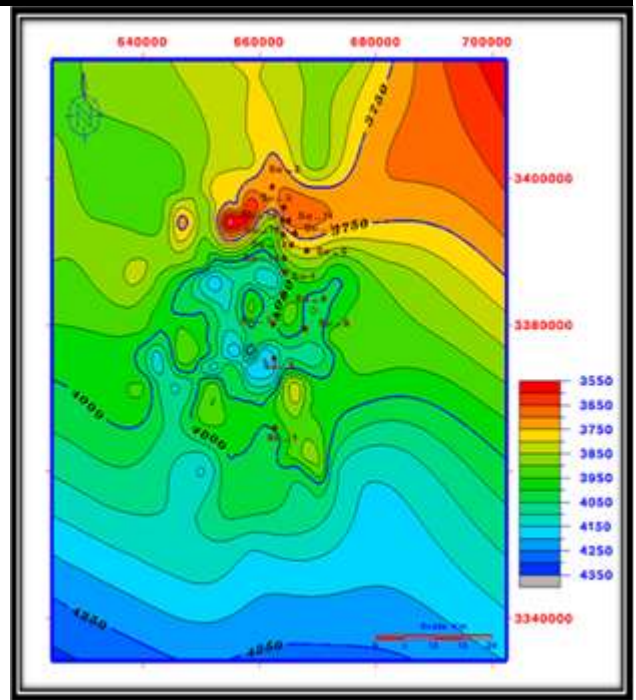

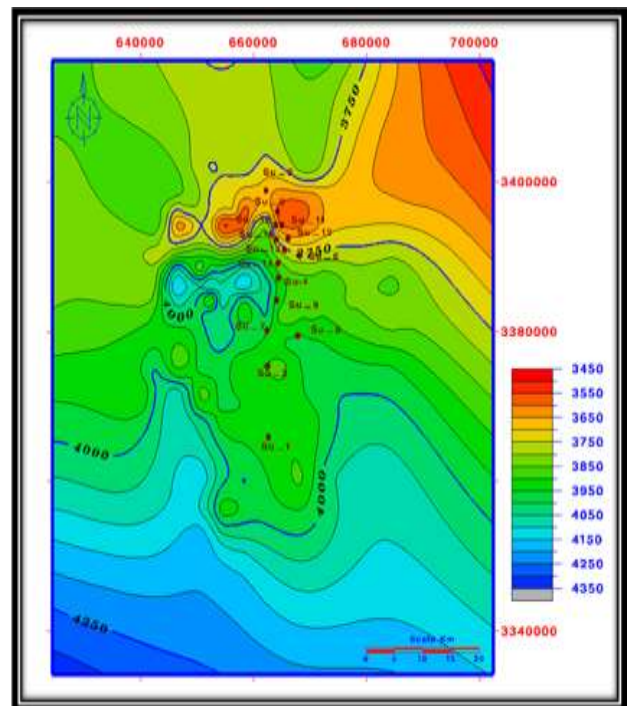*Fig. 14: RMS velocity map of Nahr Umr Formation*

Fig. 15: RMS velocity map of Zubair Formation

IX.   DEPTH MAPS

Depth estimation can be done via a wide range of existing methods, but which can be separated into two broad categories (direct time-depth conversion and velocity modeling for time-depth conversion), [11].
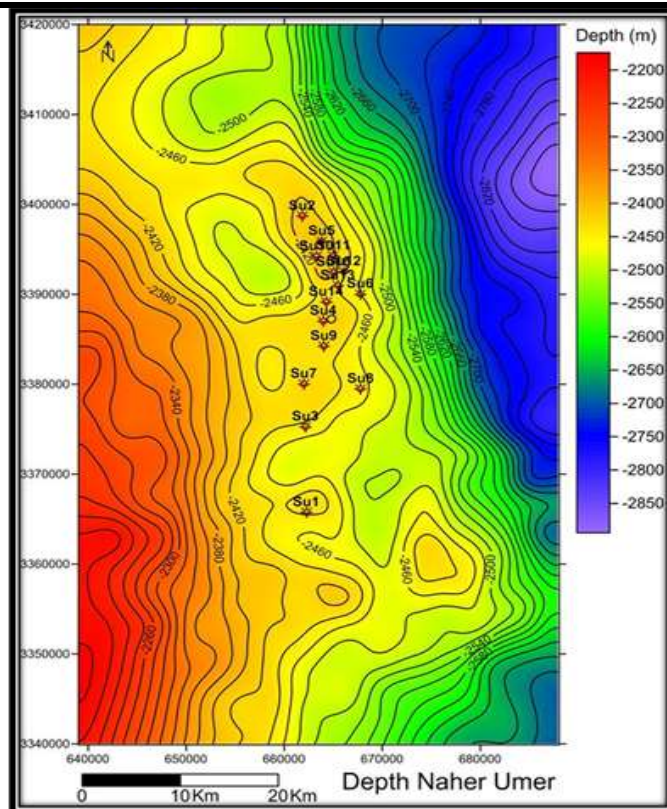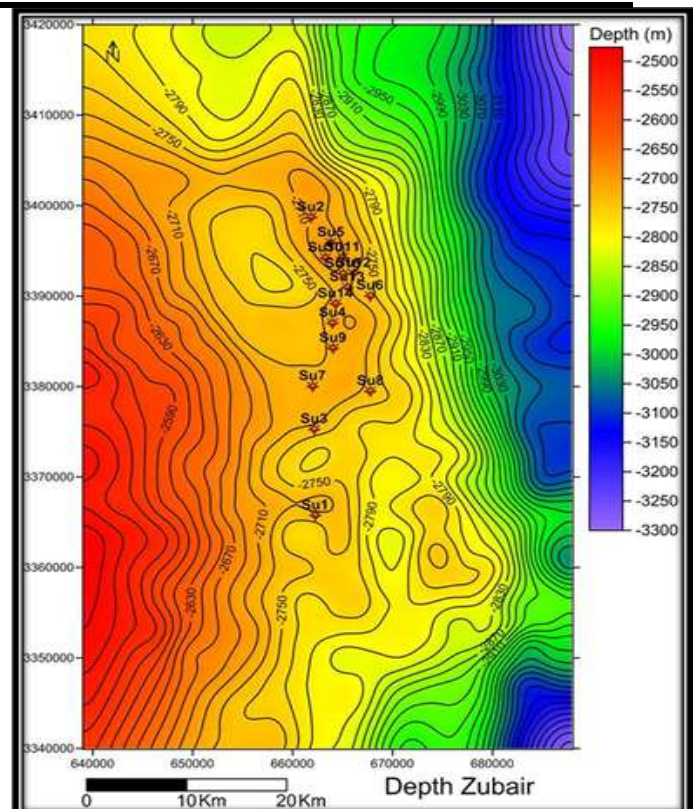
Fig. 16: Depth map of Nahr Umr Formation

Fig. 17: Depth map of Zubair Formation

Nahr Umr Formation map explain the depth increasing to the north-east part a depth of 2850 m, and the depth is reduced toward the crest of the structure reaching a value of 2450m near wells drilling, and depth map of Zubair Formation is Match description to Nahr Umr depth map, where the depth increasing to the north-east part a depth of 3300 m, and the depth decrease toward the south-west reaching to 2500 m, as shown in Figures (16),(17)

X. ISPACH MAP

Isopach maps constructed by subtracting the depth value of two different horizons at each shot point, [12].

Thickness map of Nahr Umr Formation represent the interval limited between top of Nahr Umr and the top of Zubair using a contour interval of 5m. This map shows the increasing in thickness to the south-west, and south part of the area where a maximum thickness of 263m, and the thickness decreases towards the north-east of the area reaching a value of 203m, Thickness map of Zubair Formation is the interval limited between top of Zubair and the top of Ratawi using a contour interval of 10 m. and the thickness decreases to the south of the area reaching a value of 438 m, and the increasing in thickness to the north, where a maximum thickness of 478m to the north, as shown in Figures (18),(19).
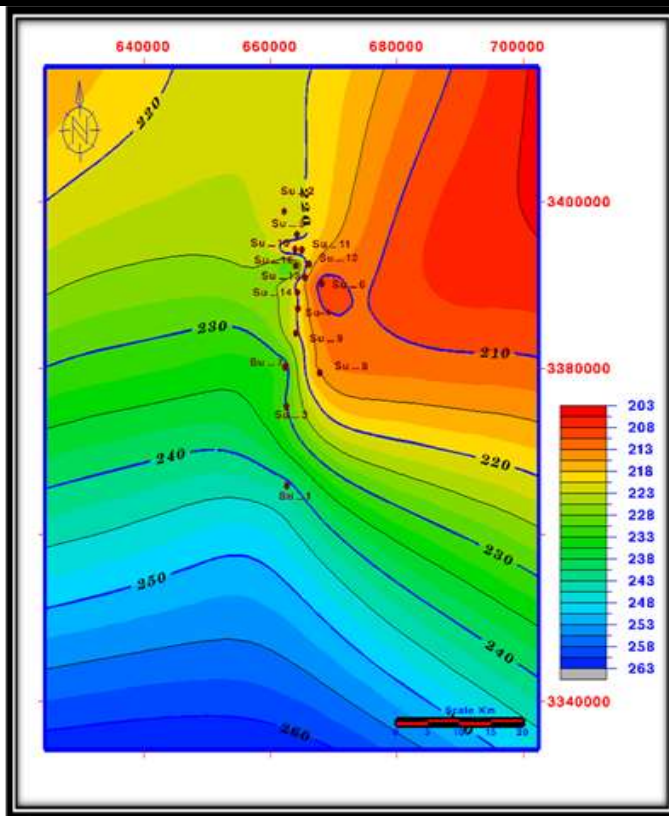
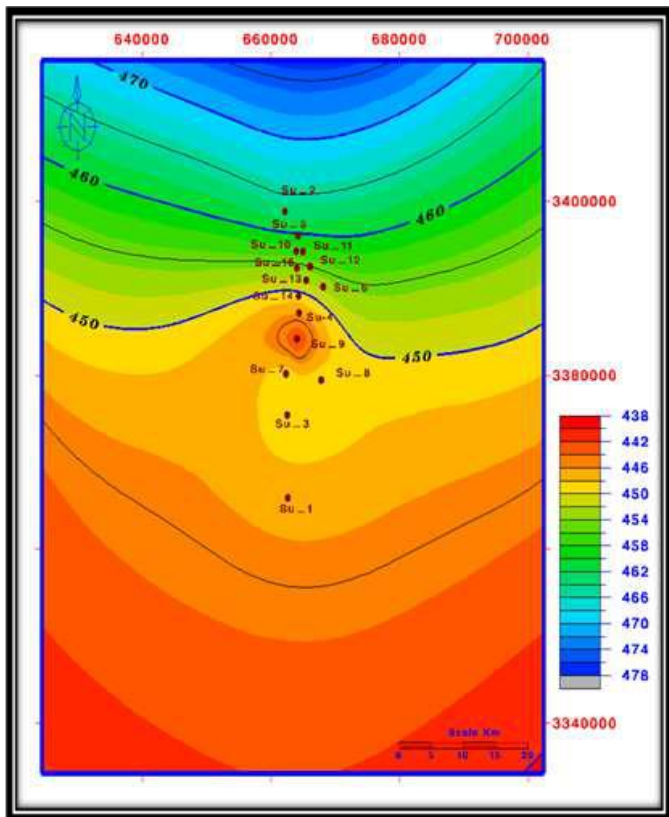*Fig. 18: Thickness map of Nahr Umr Formation*

Fig. 19: Thickness map of Zubair Formation

XI.   SEISMIC INVERSION

The seismic inversion is applied on the line Sl-21 and well Su-7, the result shows the low acoustic impedance in green color show high porosity, and the violet color is high acoustic impedance show low porosity. The inversion section show the Nahr Umr reservoir divided into three units and separate by one cap rock, and Zubair reservoir divided into nine units and separate by four cap rocks, as shown in Figure (20).
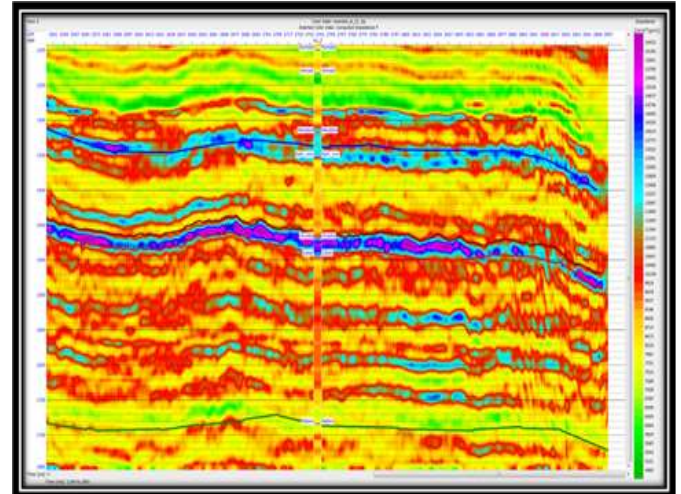

Fig.20: Seismic inversion section

The relationship between acoustic impedance and porosity, as shown in Figure (21), where the increased porosity to the Nahr Umr and Zubair Formations with decreased in acoustic impedance, and the porosity decreased when there is cap rock.
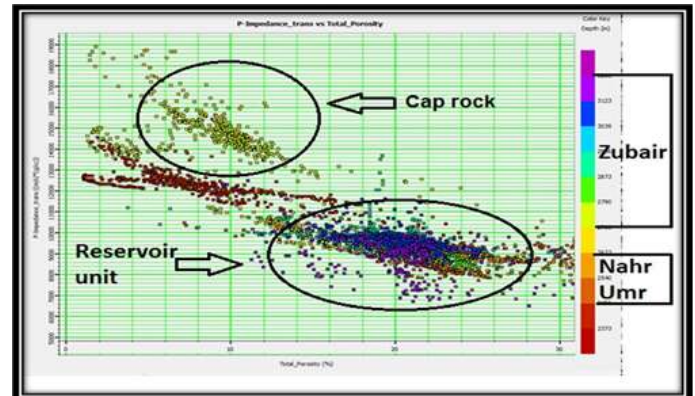

Fig.21: Cross plot show the relationship between acoustic impedance and total porosity

XII.   CONCLUSIONS

1. Seismic information indicates of that the area is not affected by the fault system.
2. Time and depth maps explain the dipping of the horizons to the south of field, and have high structure to the north of field in drilling wells .
3. The average velocity maps of the Nahr Umr and Zubair Formations are provided by using velocity

models. These maps show a decrease of average velocity in the north part which due to the high porosity and increases in the south part direction for Nahr Umr and Formations, The average velocity values affected by thickness and porosity .

4. RMS velocity of Nahr Umr and Zubair Formations contain many closures in the central field.

5. Isopach maps explain Nahr Umr reflector was increase in thickness in the south and decrease in the north, Zubair reflector: Increase in thickness in the north and decrease in the south.

6. Seismic inversion process was used to deduce the reservoir units and total porosity, Nahr Umr reservoir as shown divided to three units, and Zubair reservoir divided into nine units and increasing of the total porosity when the acoustic impedance decreasing.

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