Study the Image of Wasit Subsurface Structure Using 3D Seismic Data – Centre of Iraq

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Abstract

This study is about the seismic reflection structural interpretation of the Fatha Formation in Tertiary and Shiranish and Nahr Umr Formations in Cretaceous of Wasit structure , the 3D seismic data volume have been used in the interpretation process based on synthetic traces ,the tops of the three Reflectors s were determined and picked using an interpretation using specialized computer program . After these formations have been traced overall the area the subsurface structural image can be extracted in order to determined were hydrocarbons could possibly exist , Nahr Umr is expected to be a hydrocarbon reservoir in this research .

Keywords: 3D seismic data structural   interpretations, Folds, Attributes.

دراسة لصورة تركيب واسط باستخدام البيانات الزلزالية ثلاثية الابعاد – وسط العراق

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الخلاصة

تتعلق هذه الدراسة بالطريقة الزلزالية والتفسيرات التركيبية لتكوين الفتحة في العصر الثلاثي وتكويني الشيرانش ونهر عمر المتمثلين بالعصر الطباشيري ضمن تركيب واسط ، ولقد استخدمت البيانات الزلزالية ثلاثية الابعاد في عملية التفسير و بالاستناد الى الاثر الزلزالي المصنع فقد تم التقاط وتتبع اعلى العواكس المدروسة باستخدام برنامج كومبيوتر متخصص . و بعد تتبع هذه العواكس على جميع ارجاء منطقة الدراسةاصبح بالامكان استخراج صورة تركيبية تحت سطحية للتكاوين قيد الدراسة ،حيث يعتقد في هذا ان تكوين نهر عمر هو مكمن هيدروكاربوني .

Introduction

The study area covers (886.16) km² it lies in the eastern part of Iraq within the administrative boundaries of Wasit governorate, and it is about 30-40 km away from northeastern part of Kut city, Figure-1. Around the structure there are fields that oil and gas were discovered. They are Badrah field in the north east and Dhafria in the south west and Ahdab field in the west.

According to the tectonic map issued by The State Establishment Of Geological Survey and mining, the study area lies within the Mesopotamian basin and there is no existence of any structural features that appear on surface that is generally flat [1]. The geological map of Iraq that issued The State Establishment of Geological Survey and mining in 1990 showed that the study area is covered with Holocene and Pliestocene sediments represented by alluvial fans in the northeastern parts, while the southwestern and northwestern part is covered with Chibaiesh Marsh that decreases the survey area to 759,54 km² and the northeastern part is covered with floodplains sediments[2] .

The lithology consists of clay and silt sediments with the existence of some sand and gravel.
 Denoted that the study area of Wasit structure lies within the edge of the Arabian plate where the dip of layers toward the north east [3].
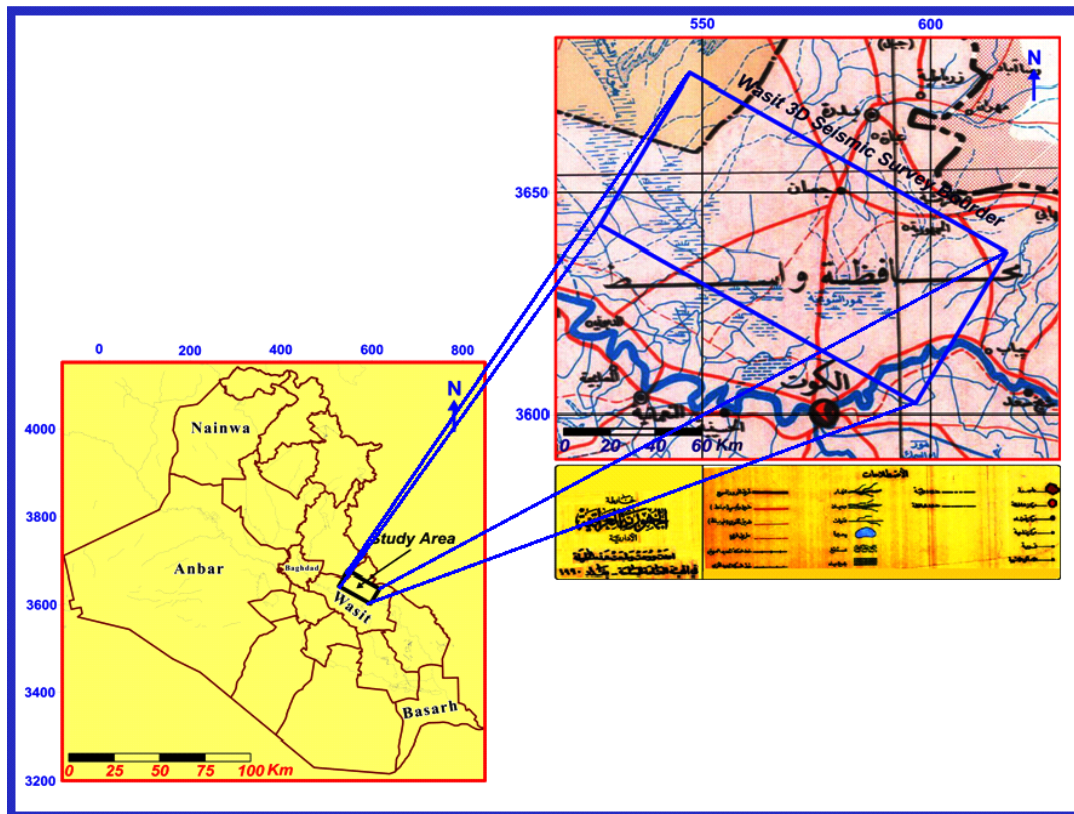
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Figure 1- Location map of the study area after [2]

From the petroleum exploration the point of view the study area is considered to be one of the pristine areas , that no well had been drilled in it, in spite of that it is a promising area where there are fields of oil and gas were found around the structure , they are Badrah field from the North East and Dhafria from the south East and Ahdab from the west . In order to know the lithologic succession in the study area it had been depended on the information of Dhafria well -1- is considered the nearest well to the study area.

Three Reflectors were studied in this study which are:

- Top of Fatha Formation because it represents the beginning of Tertiary.

- Shiranish Formation , it is the boundary between two cycles to inform the structural position of the two cycles .-Nahr Umr Formation that Consists of interfingering layers of gray shale with dark gray shale with little hardness and Brown Shale to Dark brown shale and layers of white sandstone[4] , according to [5] the study of Ahdab field that contains number of oil reservoirs discovered in the area including Nahr Umr Formation , so it is expected to be reservoir in this study .

Data Acquisition

A- Base map preparation

The 3 dimensional data cube was loaded on Geoframe in time domain by seismic interpretation program IESX and in SEG-Y- formula. This process is called (project creation) for achieving the interpretation process on an interactive workstation. After that, the base map of the study area is constructed. This process includes entering the first and last inline numbers, the first and last cross line numbers, the separated distance between bin size along inline direction and cross line direction , Figure-2.
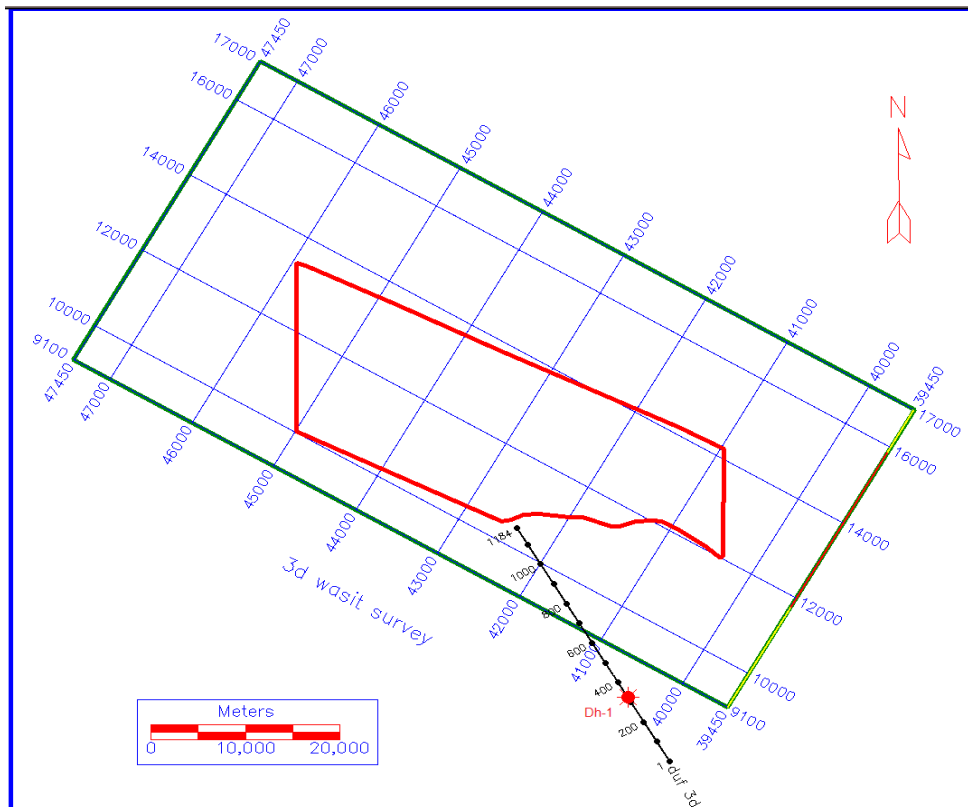
Figure 2 - The base map for the 3D seismic survey for Wasit structure the numbers and the direction of dip and axial lines are denoted on it.

B- Synthetic seismogram

[6] Referred to the main steps for generation of the synthetic seismogram which they are:

1. Computing the acoustic impedance.
2. Computing the reflection coefficients of the vertical incident wave on reflector separating two time series intervals.
3. Convolution process between the reflection coefficients and experimentally selected wavelet is made to obtain 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. These have ability to extract the relation between the time and depth functions in the well location, Figure-3.
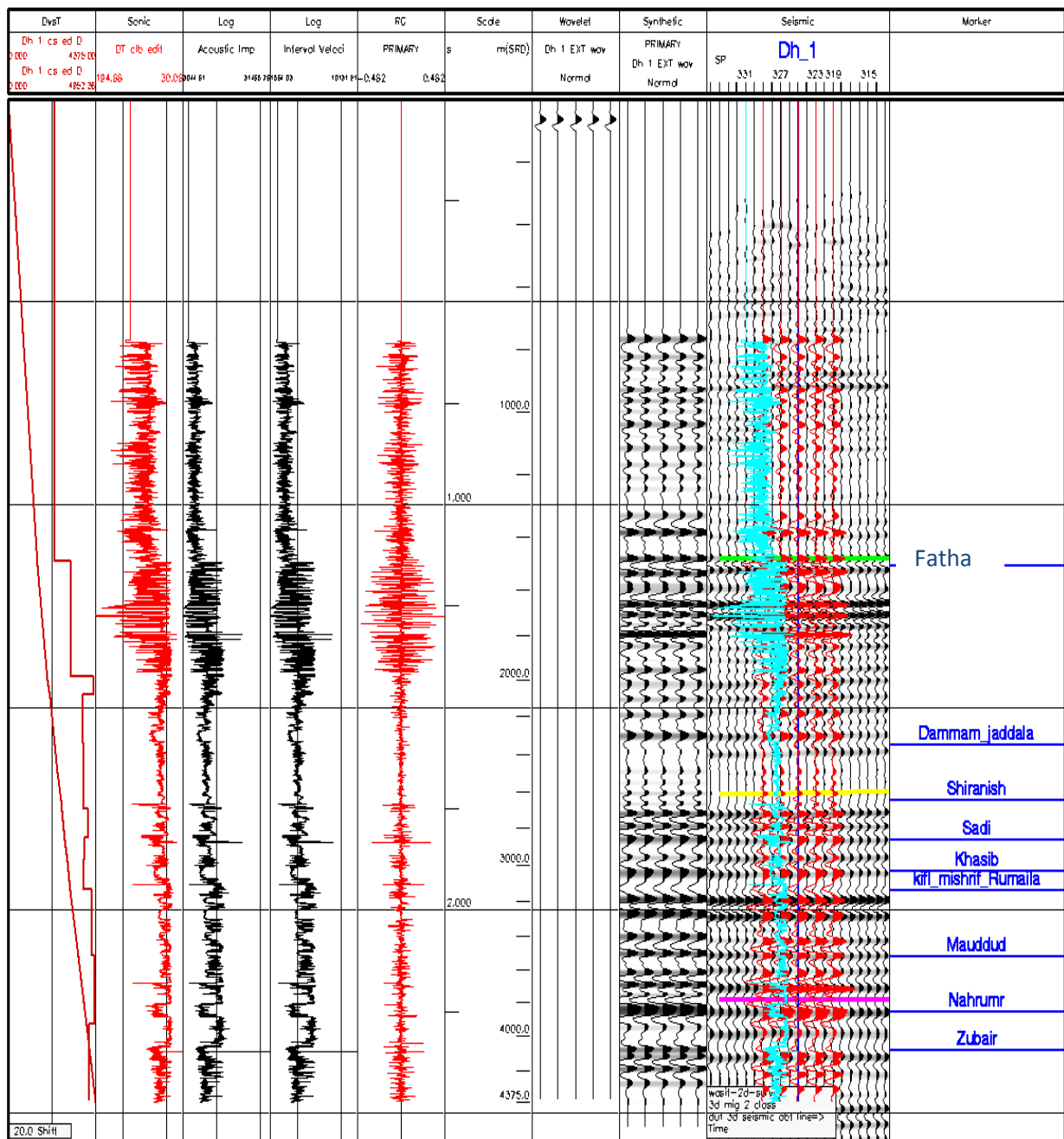
Figure 3- Synthetic Seismogram for Dhafria well -1-

Seismic Interpretations

For seismic interpretations an interactive computer system is used that has colored screen, the 3D seismic data can be displayed in vertical and horizontal section form, the system enables the interpreter to pick and track the studied horizons in the seismic section that helps to identify structures .Many previous studies were performed by oil exploration company that deal with the interpretations of Wasit structure [7].

The interpretations of Wasit structure was made by using Geoframe Software which is available in oil exploration Company to get the subsurface structural images by using:

A. TWT made to show the main structures on the studied Reflectors.

B. Using seismic attributes like instantaneous Amplitude section and Horizental time slices to get primary picture of the existing structures .

C. Using 3D Chair view model for further visualization of the structures on the studied reflectors .

A-Time maps
1. The map of Top Fatha Formations shows the axes of the structural Convexity consist of three structural anomalies.
   - Main southern dome that has elongate oval shape and concentrate in the middle of the study area.
   - A central dome that has elongate narrow shape lies northeast from the main dome.
   - Northern dome that has elongated narrow shape opened in the northwestern direction because it is out of the survey area.
   - The northern dome is separated from the eastern dome by a saddle while its axis deviate from the main southern dome which is separated from a dome that represents an opened dome to the south had not been completely covered by the 3D survey, Figure-4.
2. The TWT map of Shiranish Formation shows that the structural convexity axes consists of two structural anomalies, the first represent a main structural nose and the second represents a small ovoid dome lies to the northeast of the structural nose, Figure-5.
3. The TWT of Nahr Umr Formation shows that the structural convexity axis consists of main southern dome that has elongate wide dome at the middle of the study area separated from another dome by structural nose that lies to the northeast from the main dome, Figure-6.
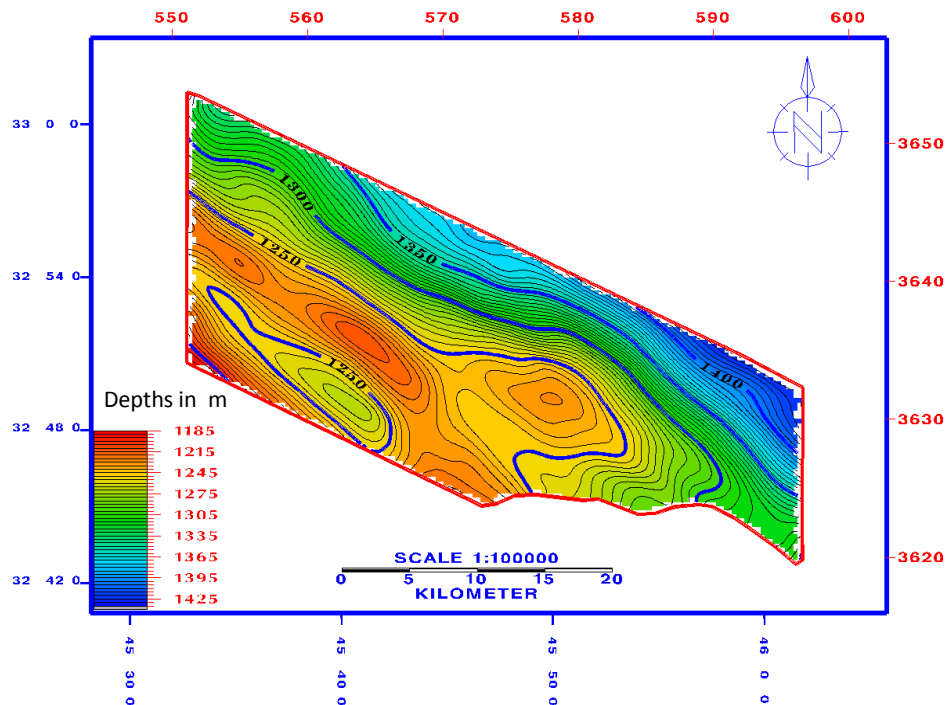

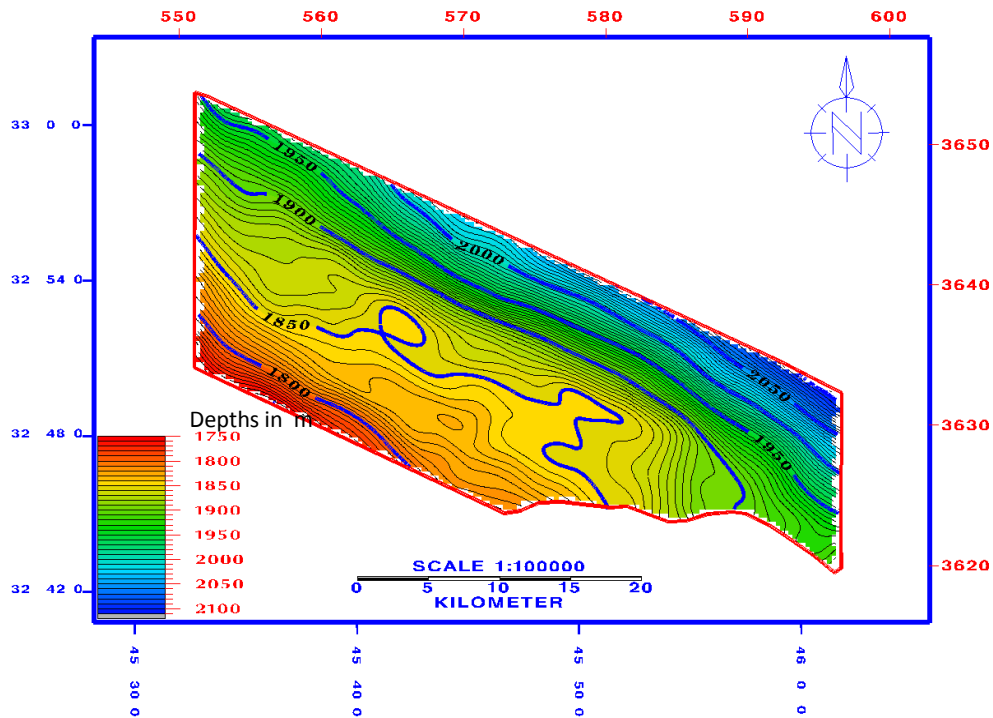**Figure 4-** Represents the TWT map of Fatha Formation

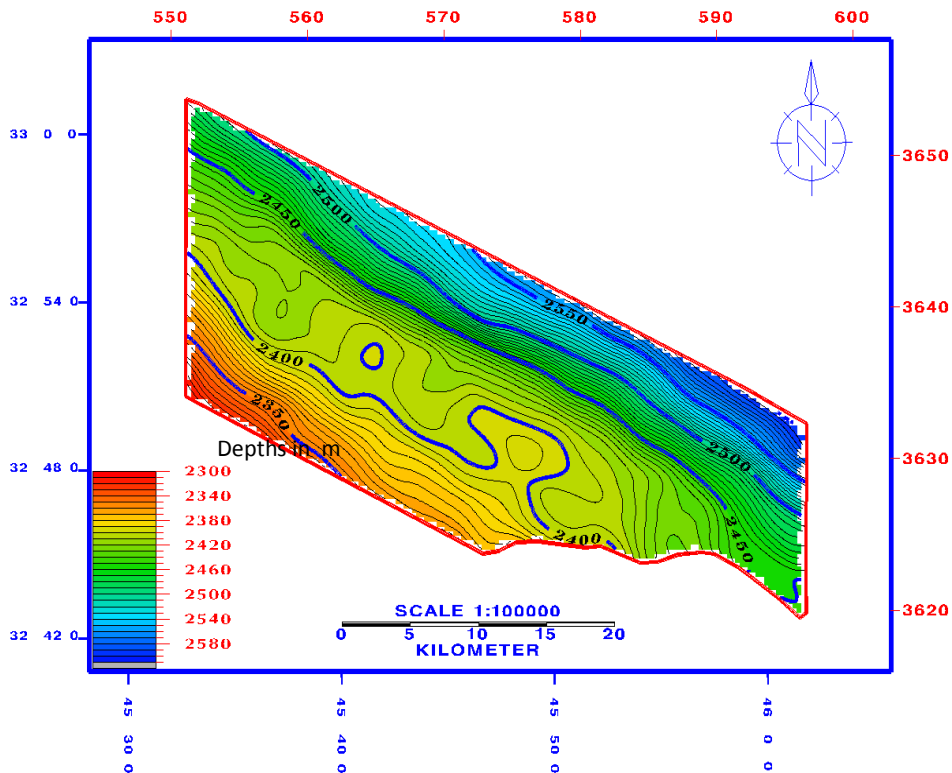**Figure 5-** Represents the TWT map of Shiranish Formation.

Figure 6- Represents TWT map of Nahr Umr Formation.

B- Seismic Attributes

A seismic attribute is any measure of seismic data that helps us visually enhance or quantify features of interpretation interest , a good seismic attribute is either directly sensitive to the desired geologic feature or reservoir property of interest , or allows to define the structural or depositional environment and thereby enables us to infer some properties or features of interest [8]. A number of seismic attributes were applied on Wasit 3D volume which is instantaneous Amplitude, horizontal time slices.

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Instantaneous Amplitude

A seismic reflection is strong or weak depending on difference in velocities between the rock layers above the reflection. And the one below it. The greater the difference the stronger the reflection. A strong reflection is on which trace swings far to the side . The strength or distance the trace swings, is the amplitude of the reflection. When the lithology varies , the velocity contrast varies using different in reflection amplitude . Amplitude is useful in seismic interpretations in several ways , the strength of reflection is an aid in correlation and reflector tracking[9] , in Figure-7 the black events are positive (peaks) and the white events are negative troughs .
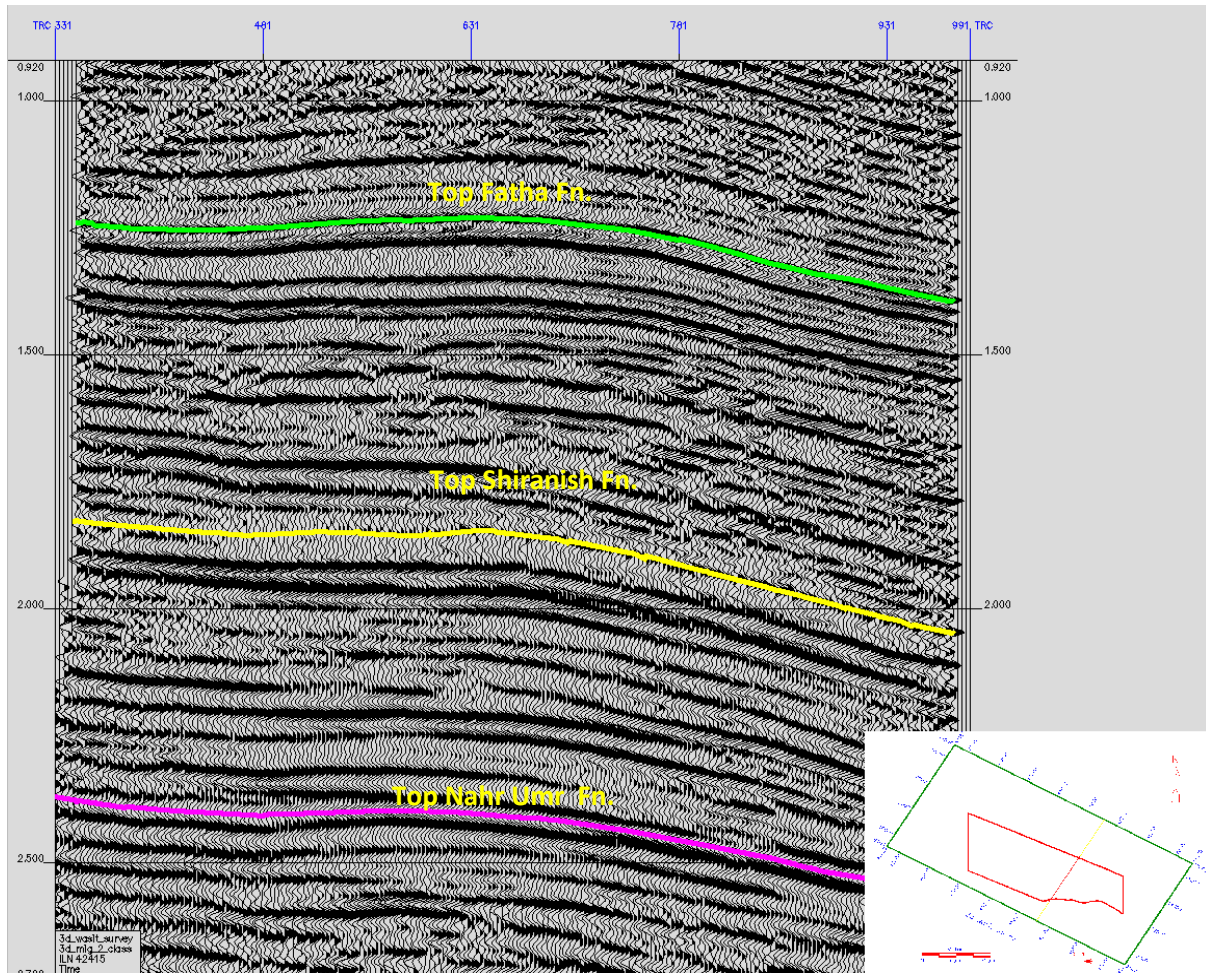

Figure 7- Instantaneous Seismic Attribute section of the studied Formations.

Horizontal time slices

The display of horizontal time slices that give primary idea about the subsurface structural anomalies specially the areas of convexity and concavity and their extension and the direction of their axis ,the 3D seismic volume was processed and converted from signal in time domain to time slice attribute view, Figures-8, 9 and 10.
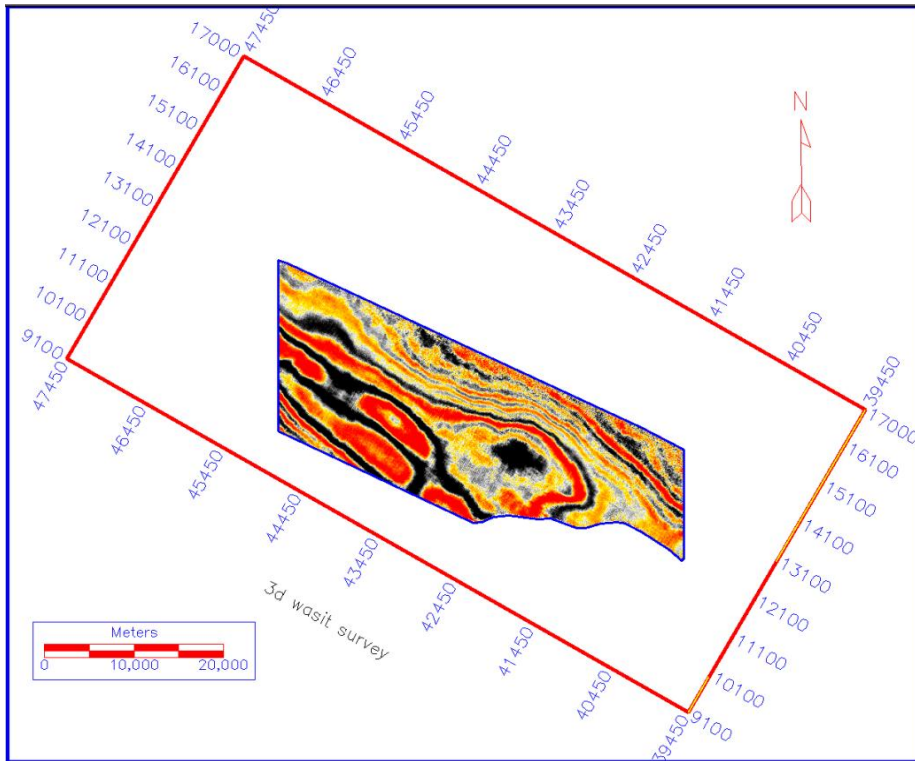
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Figure 8- The time slice that shows the structural anomalies at Top Fatha Formation at level 1260ms in time domain.
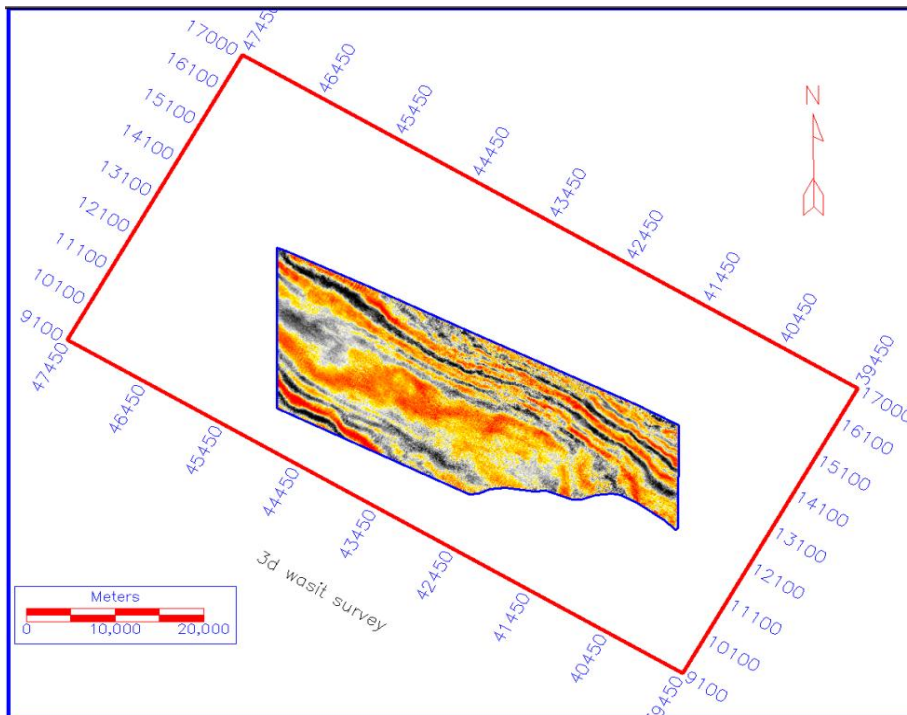

Figure 9- The time slice that shows the structural anomalies at Shiranish Formation at level 1850ms in time domain.
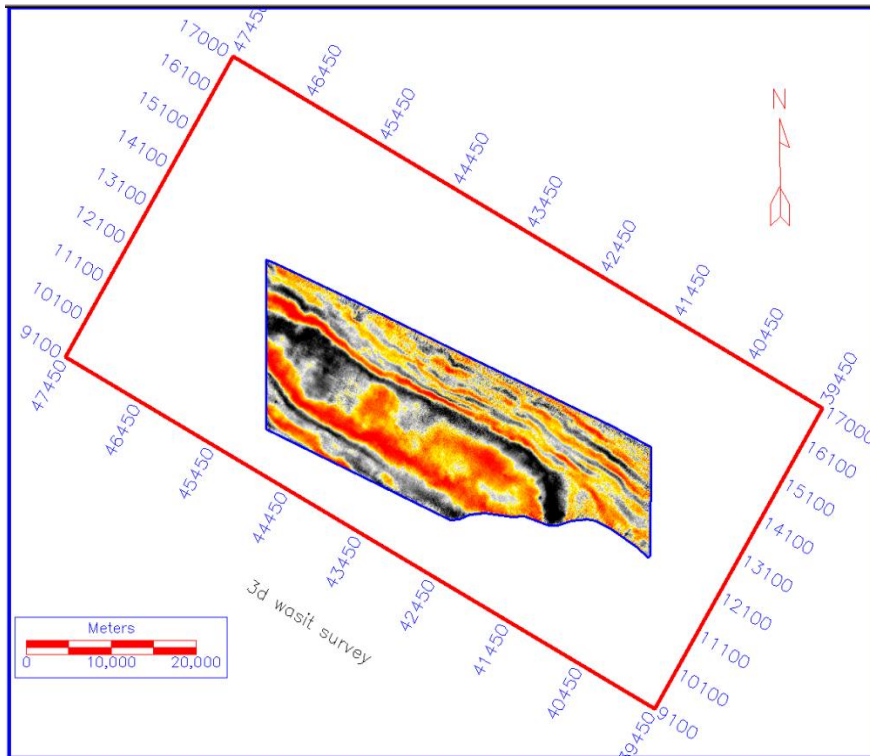
Figure 10- The time slice that shows the structural anomalies at Nahr Umr Formation at level 2420ms in time domain.

C-Chair View Model

Geophysical models of Wasit structure were constructed based on interpretations of 3D Wasit structure Data for determination of structural framework. The picked horizons maps of Tops of reflectors were constructed on the geophysical chair view model in Figure-11, and TWT maps of the studied reflectors were constructed on the 3D Chair View model. This gives a 3D picture for the structures in the study area which shows the distributions of the folds on the Reflectors Figure-12.
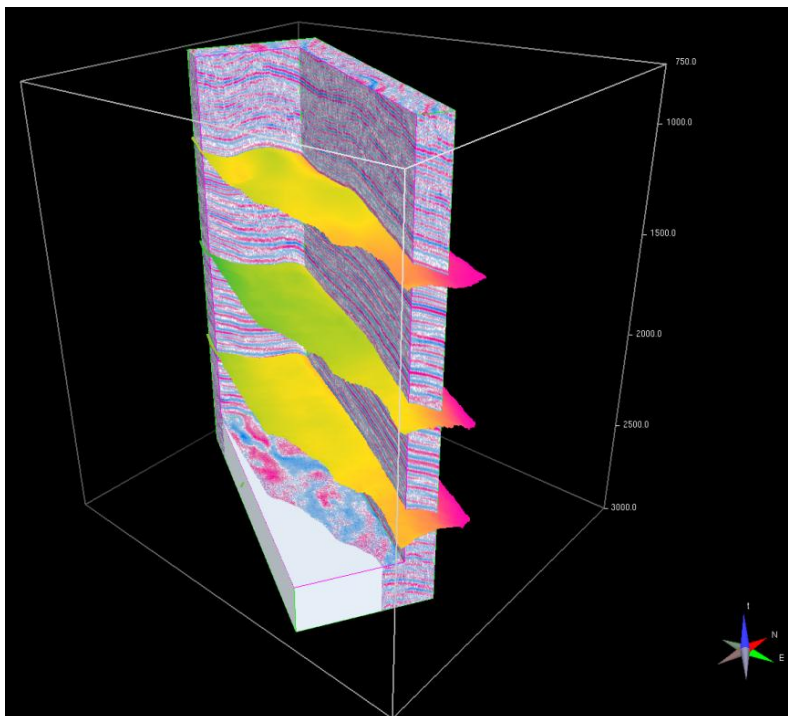

Figure 11- 3D seismic chair view model shows the accuracy of picking of the reflectors in E-W direction.
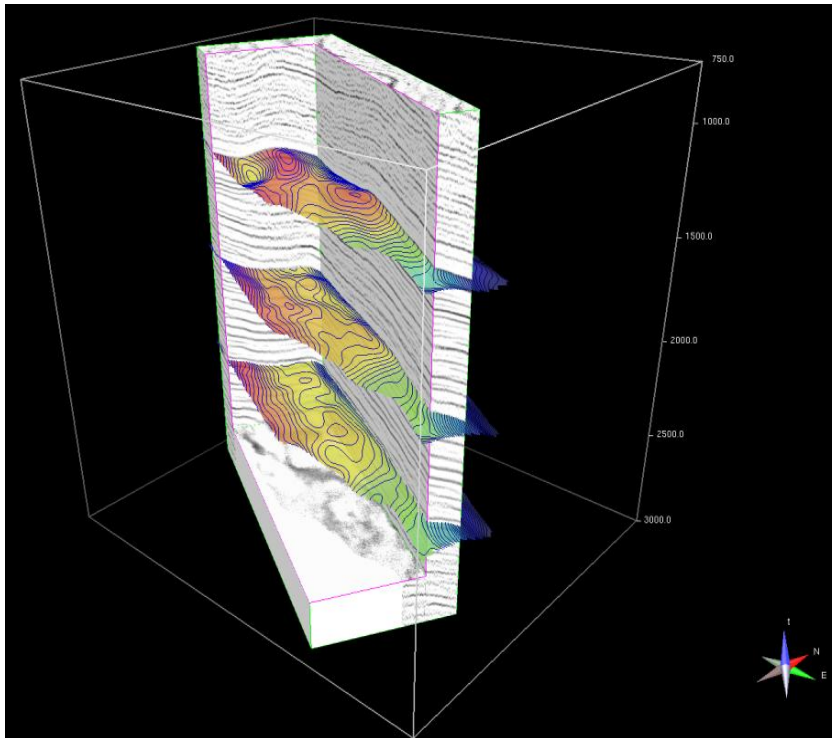
Figure 12- Three dimensional seismic chair view model in time domain with the TWT maps of the tops of the studied Formations.

Conclusions and Recommendations

According to the results given in the study area using 3D seismic interpretation technique, the following conclusions may be listed:

1. Three depth maps were drawn for Fatha , Shiranish and Nahr Umr Formations , The map of Fatha Formation showed main southern dome that has elongate oval shape and concentrate in the middle of the study area , a central dome that has elongate narrow shape lies northeast from the main dome, and Northern dome that has elongate narrow shape opened in the northwestern direction because it is out of the survey area .The northern dome is separated from the eastern dome by a saddle while it axis deviates from the main southern dome until is separated from a dome which represents an opened dome that represents an opened dome to the south which had not been completely covered by the 3D survey .The TWT map of Shiranish Formation shows that the structural convexity axes consists of two structural anomalies , the first represent a main structural nose and the second represents a small ovoid dome lies to the northeast of the structural nose .The TWT of Nahr Umr Formation shows that the structural convexity axes consists of main southern dome that has elongate wide dome at the middle of the study area separated from an other dome by structural nose that lies to the northeast from the main dome.

2. Seismic attributes is a helpful tool to visualize the subsurface structures , Amplitude is useful in seismic interpretations in several ways . The strength of reflection is an aid in correlation and reflector tracking, and the horizontal slices is useful in giving a primary idea about the structure.

3. The chair view model used to show the subsurface structures in 3D display and to show the accuracy of picking.

4. After the interpretations of the subsurface images of the studied formations ,Nahr Umr Formation is expected to be a hydrocarbon reservoir because,

- In the surrounding fields the hydrocarbons were found.
- It includes a sandstone layer (hydrocarbon bearing rock) which was showed in the Amplitude section and the TWT map of Nahr Umr Formation showed that there is a dome, and so the reservoir formation conditions are available.

After showing the structural images using TWT maps and seismic attributes it is recommended to:

1. Drill an exploration well that penetrates the dome of Nahr Umr Formation .

2. Because there is an opened structure in Fatha Formation which represents a fold that in covered completely by the survey because the Water marsh , so it is recommended to continue the survey in the rest of the area , and start an amphibious seismic survey.

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