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Seismic Interpretation for Hydrocarbon Traps Detection of Warka-Zakura Area South of Iraq

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Abstract

This research represents a reflection seismic study (structural and stratigraphic) for a (852) km^2 area located in the south of Iraq within the administrative border of the province of Al-Muthanna and Qadisiyah province ,by using 2-D seismic data from Oil Exploration company three main seismic reflectors are picked, these are (Zubair and Yamama) Formations which they deposited during the Cretaceous age , and (Gotnia) Formation which deposited during Jurassic age .Structural maps of Formations are prepared to obtain the location and direction of the sedimentary basin and shoreline ,time, velocity and depth maps are drawn depending on the structural interpretation of the picked reflectors and show several structural feature as nose structure . Seismic interpretation of the area approves the presence of some stratigraphic features in the studied Formations. Some distributary mound, flatspot , and channel were observed within the area .The study of seismic facies of the picked reflectors distinct two type of seismic facies the first is parallel seismic facies represented by Zubair Formation and second is progressive seismic facies characterized by Yamama and Gotnia Formations .Using seismic attribute techniques including instantaneous frequency showed low frequency in areas of hydrocarbon accumulations. Instantaneous phase attribute detected seismic sequence boundaries, sedimentary layer patterns and regions of onlap and downlap patterns. Amplitude attribute showed low amplitude flat spots.

Key word: Nose structure , Seismic facies , Seismic attributes

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التفسير الزلزالي لتحديد المصائد النفطية في منطقة وركاء-زقوره جنوب العراق

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الخلاصة

يمثل هذا البحث دراسة زلزالية انعكاسية (تركيبية وطباقية) لمنطقة ذات مساحة 852 كم2 واقعه في جنوب العراق ضمن الحدود الادارية لمحافظتي المثنى والقادسية ، بأستخدام المعلومات الزلزالية ثنائية الأبعاد المتوفرة في شركة الاستكشافات النفطية. تم التقاط ثلاث عواكس وهي تكويني الزبير واليمامه اللذان ترسبا خلال العصر الطباشيري وتكوين القطنية الذي ترسب خلال عصر الجوراسي .أعدت خرائط تركيبية للحصول على موقع واتجاه الحوض الرسوبي وتحديد خط الساحل . الخرائط الزمنية , السرعية والعمقية رُسمت بالاعتماد على تفسير العواكس المدروسة وأوضحت وجود عدة ظواهر تركيبية بهيئة خشوم .اثبتت التفاسير الزلزالية للمنطقة وجود ظواهر طباقية في التكاوين المدروسة بهيئة تقبب متراكم وبقعة مسطحة وكذلك وجود قنوات.وتم دراسة السحنات الزلزالية للعواكس الملتقطة وتم تمييز سحنتين هما سحنة زلزالية متوازية parallel تمثلت بتكوين الزبير والسحنة الثانية هي سحنة تقدمية Progradation facies تمثلت بتكويني اليمامه والقطنية .

استخدمت تقنيات الملامح الزالزالية منها التردد الاني (Instantaneous Frequency) فقد لوحظ وجود تطابق بين مناطق الترددات الواطئة ومناطق التجمعات الهيدروكاربونية,وكذلك استخدم (instantaneous phase) وهو مهم في تحديد حدود التتابع وطبيعة الترسيب ونوع التلاشي onlap و downlap وذلك لتحديد التجمعات الهيدركاربونية في المقاطع الزالزالية , وأوضحت ملامح السعة (amplitude attributes) نقصان في السعة (flat spot).

Introduction

The geophysical techniques which are most widely employed for exploration work include seismic , gravity , magnetic , electric , and electromagnetic methods. Some of these are used almost entirely in the search for oil and gas [1]. The Seismic reflection gives more direct and detailed picture of the subsurface geological structures. It is more suitable in areas where the oil is in structural traps, but it is also useful for locating and detailing certain types of stratigraphic features [2] .The seismic reflection exploration method passed through numerous development stages from mid of the last century to a present time including the field survey, data processing & interpretation .The recording developed from analog to a digital, multiple coverage appeared and used digital recording which helped to expand the role of electronic computers in seismic workshop, a Common Depth Point (CDP) technique is also used [3].

Seismic method is by far the most important geophysical technique in term of expenditure and number of geophysicist involved .Its predominance is due to high accuracy, high resolution, and great penetration. The widespread use of seismic methods is principally in exploring for petroleum . The locations for exploratory wells are rarely made without seismic information [4]. Seismic methods are the most effective, and the most expensive, of all the geophysical techniques used to investigate layered media [5].

Location of the study area

The studied area (Warka-Zakura) is located in the south of Iraq within the administrative border of Al-Muthanna and Qadisiyah province as shown in Figure -1. Study area is 48 km to the east of Nasiriyah well, and 42 km from Diwan well, to the south of the study area

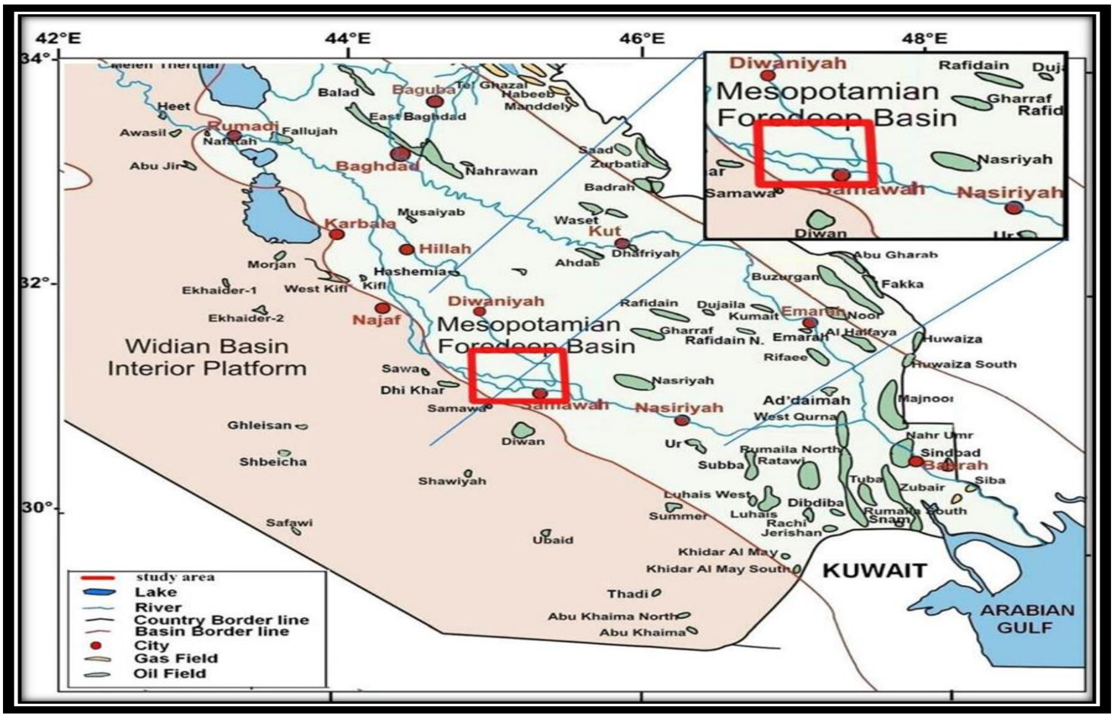

Figure 1- Location map of the study area [6].

Base Map Preparation

The current re-interpretation of (852) km^2, covering an area of (2422) km^2, includes number of seismic lines executed in a survey Rumaitha – Babel area (RB), lines of survey east of Samawa (SE) , number of lines of survey Nasiriya area(NN), which lies east of the study area for the purpose of connecting with the well Nasirya-1, which is 48 km from the current study area , lines of the survey area (Samawa-UR)(SU), lines of survey area (Baseya-Ubaid) (BU), and number of lines (Samawa- Shawiya) (SS) for the purpose of connecting with the well Diwan -1, which is 42 km from the study area. A processed 2D seismic data were loaded in (GeoFrame 4.5) workstation , where seismic lines coordinates are loaded and seismic information in SEG-Y format Figure-2.

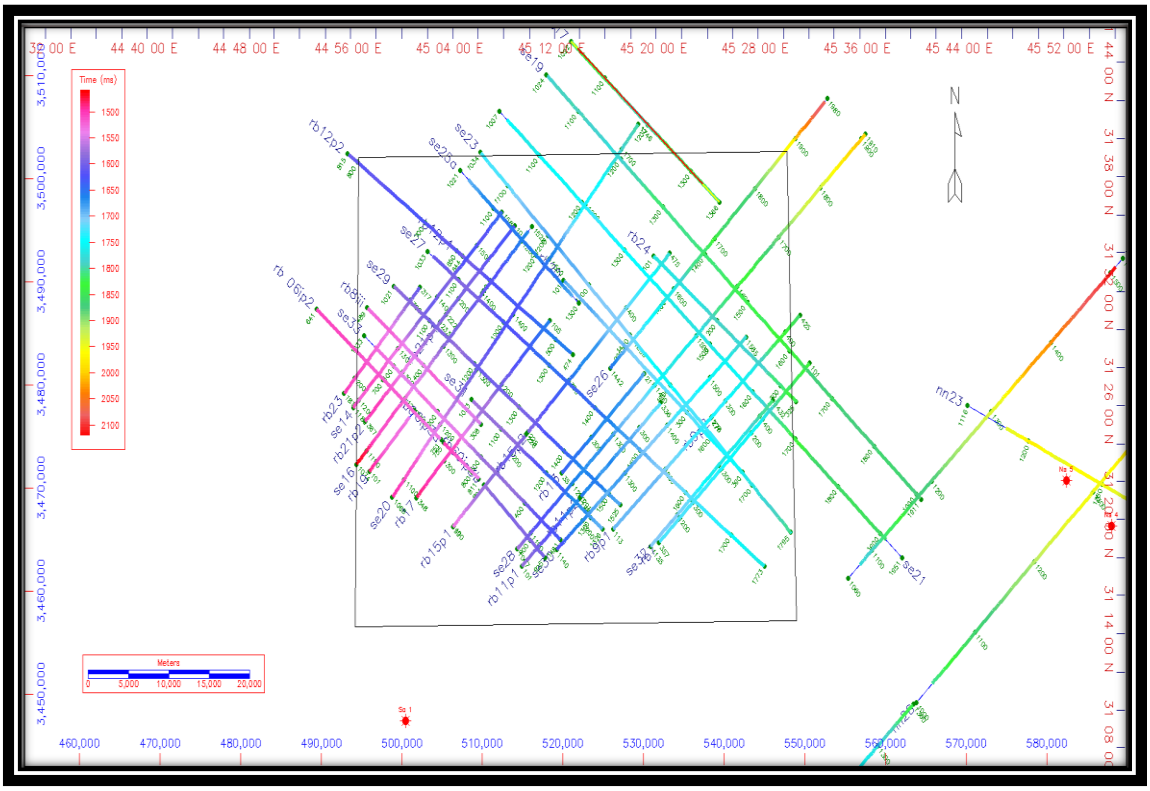

Figure 2-Illustrates a base map of the study area(2D survey).

Generation of synthetic Seismograms

The process of interpretation of seismic section requires the identification of reflectors that represent certain Formations . This is done by a comparison between the times of reflection Two Way Time (TWT) on the seismic section and between the synthetic seismogrsms obtained by sonic log and velocities survey in the wells.

The main steps for generation of the synthetic seismogram[7] are :

1- Acoustic impedance calculation (Z = ρ × v)where:

v: is velocity measured from velocities survey in wells or from sonic log.

ρ: density measured from information of core analysis or from density log.

2- Computing the reflection coefficients as following :

$$\text{Rci} = \frac{(\rho i+1)(vi+1)+\rho ivi}{(\rho i+1)(vi+1)+\rho ivi}$$

Where :

$(\rho i\ , \rho i + 1)$ the density at the interval (i), (i+1)

$(vi\ , vi + 1)$ the velocity at the interval (i), (i+1)

3- Convolution process between the reflection coefficient and experimentally selected wavelet is made to obtain on the synthetic seismogram .The sonic log data are compared with 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.

Figures -3 and 4 represent the seismic sections passing through the well locations and synthetic traces of reflectors are displayed. The match between seismic traces and synthetic traces is fair to good . The picked reflectors wavelets appeared as peaks on synthetic trace (positive reflection) but in different intensity. The Yamama and Gotnia correspond to a peak while Zubair correspond to a trough. This is very reasonable because the rocks over Zubair are sandstone. The sandstone is characterized by high porosity; therefore, the density of limestone is more than that of sandstone under the natural conditions. For this reason, any interface separating two media, the first contains limestone such (Shuaiba Formation) and the second contains, sandstone such (Zubair), the reflection coefficient of this interface is positive (peak) and under it a trough. Yamama reflector appeared as a peak on the synthetic trace (positive reflection) because the rock which overlain Yamama (Ratawi Formation) is of lower density.

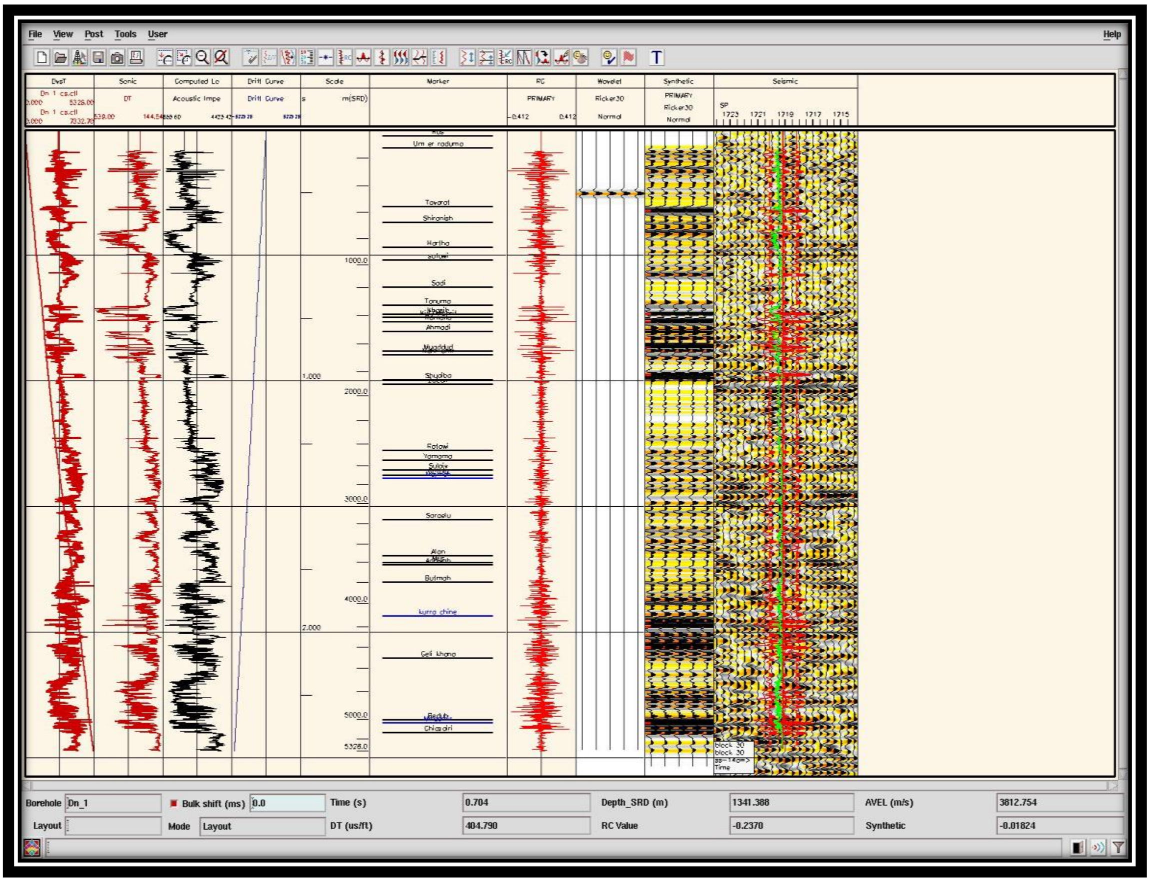

Figure 3- Illustrates the seismic synthetic seismogram of dn-1 well

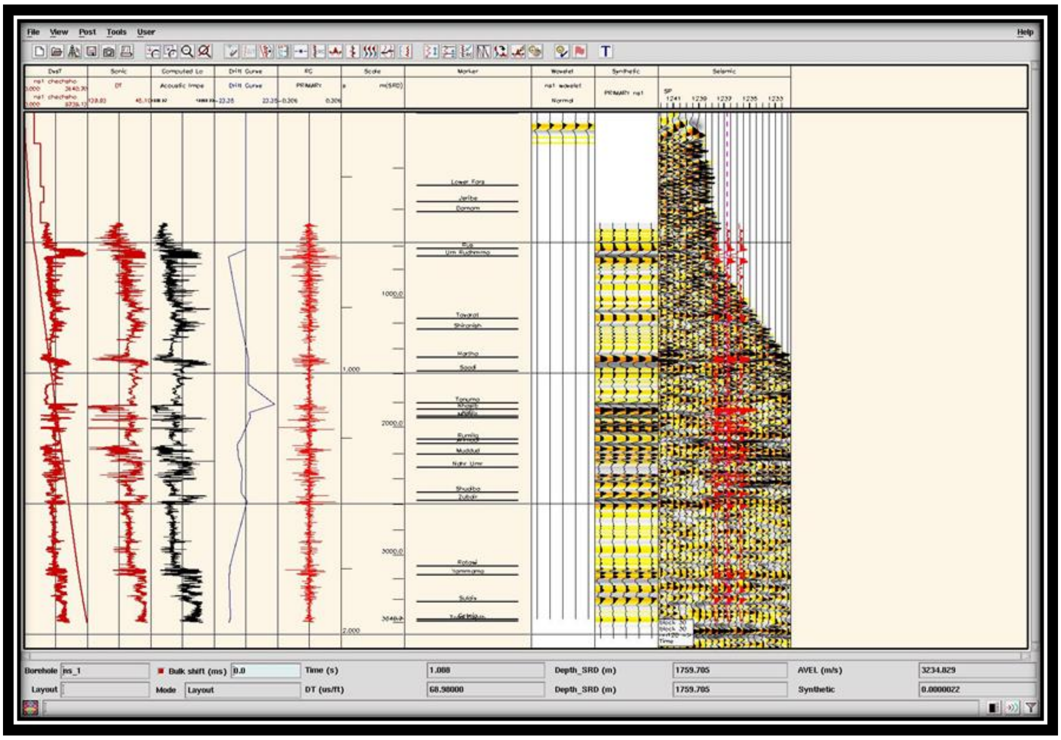

Figure 4- Illustrates the seismic synthetic seismogram of Ns-1 well

Structural picture of picked horizon

Time Maps

TWT Maps of the study area show in general ,several structures phenomena , such as nose structure .TWT of the reflectors were increase toward the north east direction and decrease toward the south west direction , in the study area TWT maps are represent several nose dominated by NE-SW trending , and seismic sections did not indicate the presence of normal faults within the boundaries of the study area. Figures- 5,6 and 7 shows the TWT map for the formations Zubair , Yamama and Gotnia respectively .

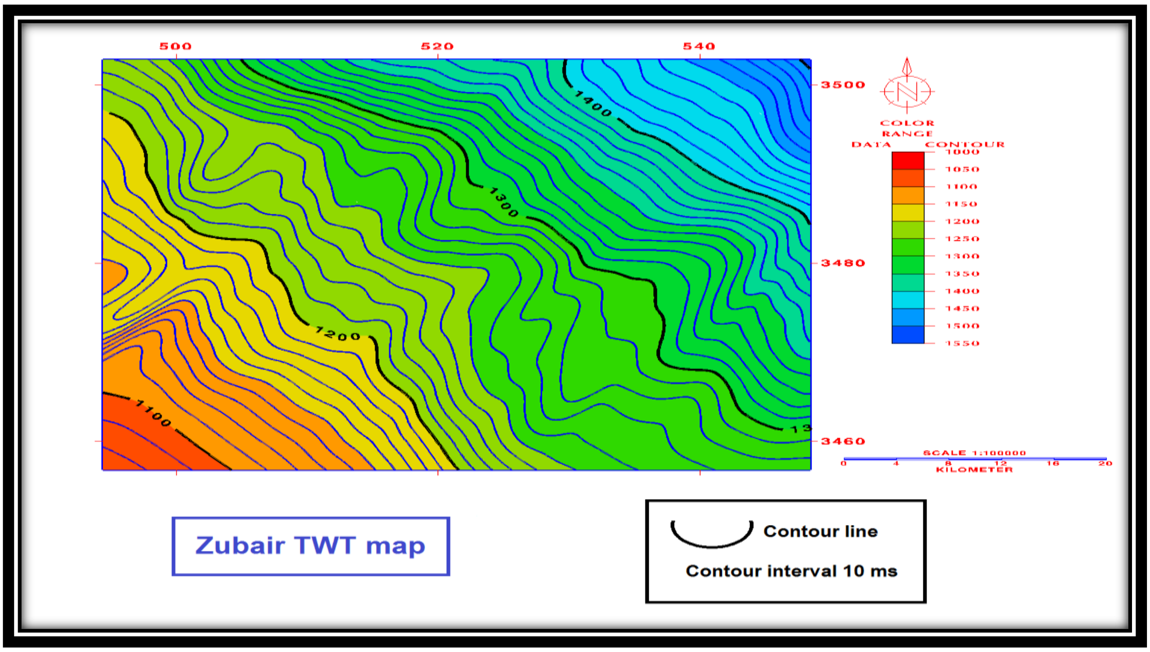

Figure 5- Shows Zubair two way time map

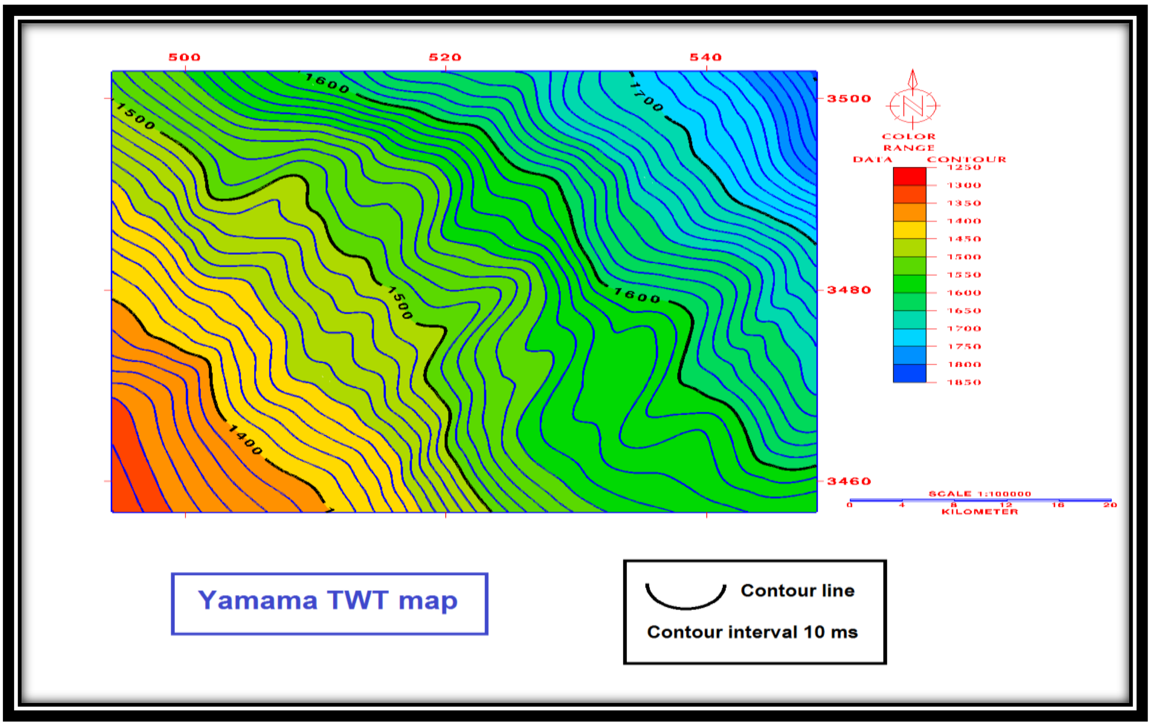

Figure 6- Shows Yamama two way time map

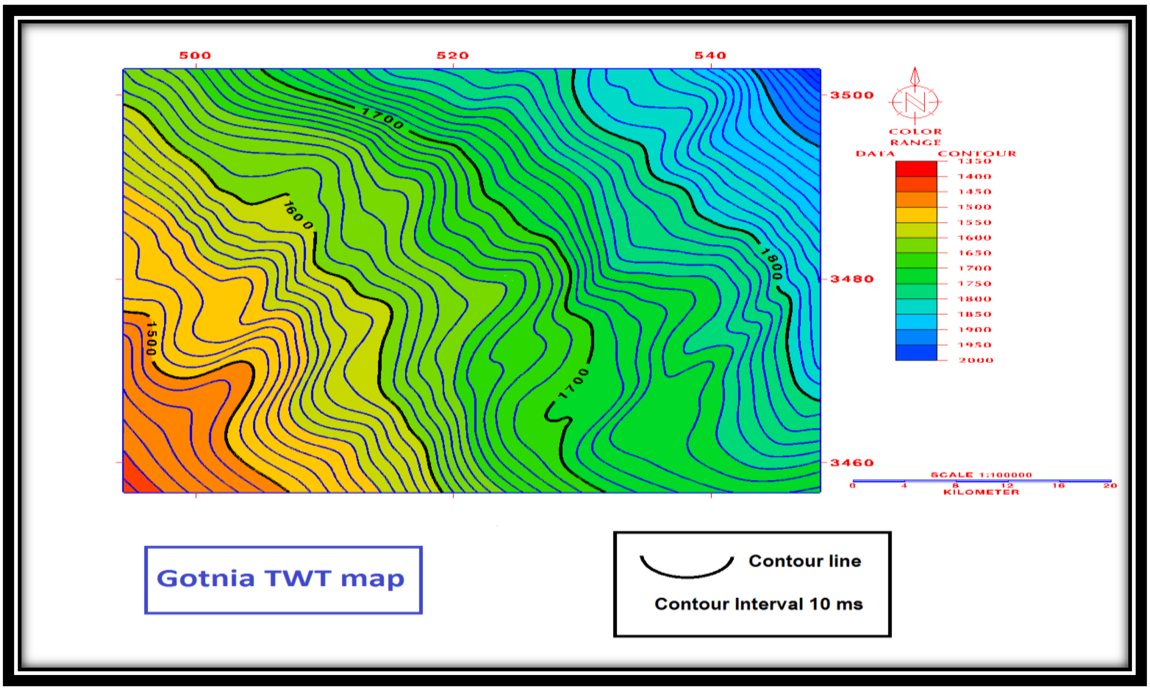

Figure7- Shows Gotnia two way time map

Velocity Maps

Velocity maps are prepared by using contour interval (10m/sec) from sea level , the average velocities map showed that the velocity increases in general with depth increasing irregularly because of the heterogeneity of sedimentary layers as a result of differing in facies and depositional environment **.** The velocity value for each reflector increases toward the south east direction and decrease toward the north east direction . Figures -8,9 and10 shows the velocity maps for the Zubair , Yamama and Gotnia Formations respectively .

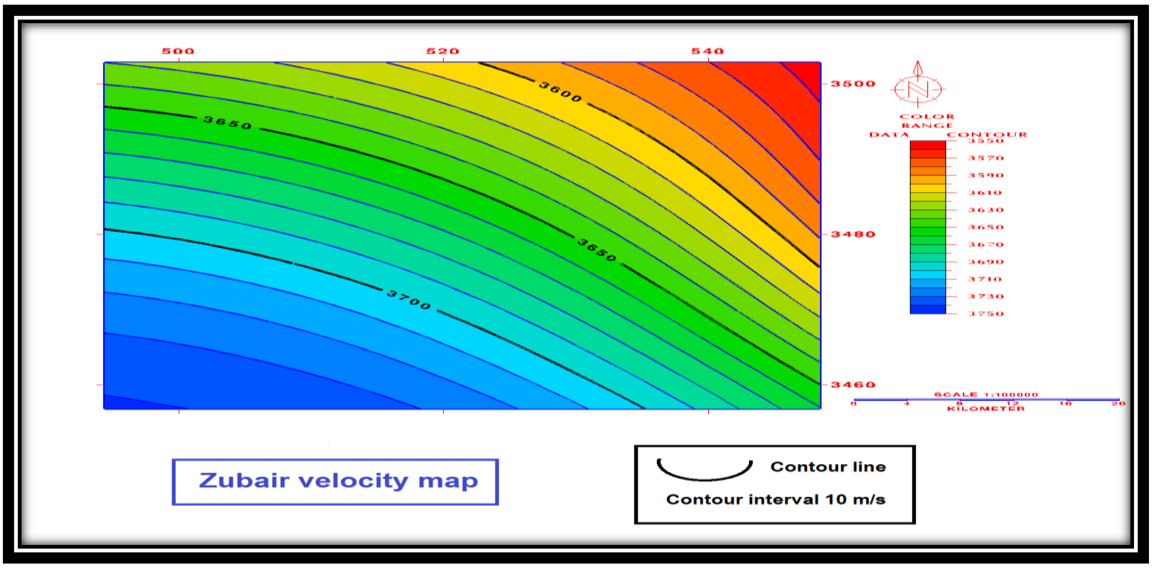

Figure 8- Shows Zubair velocity map

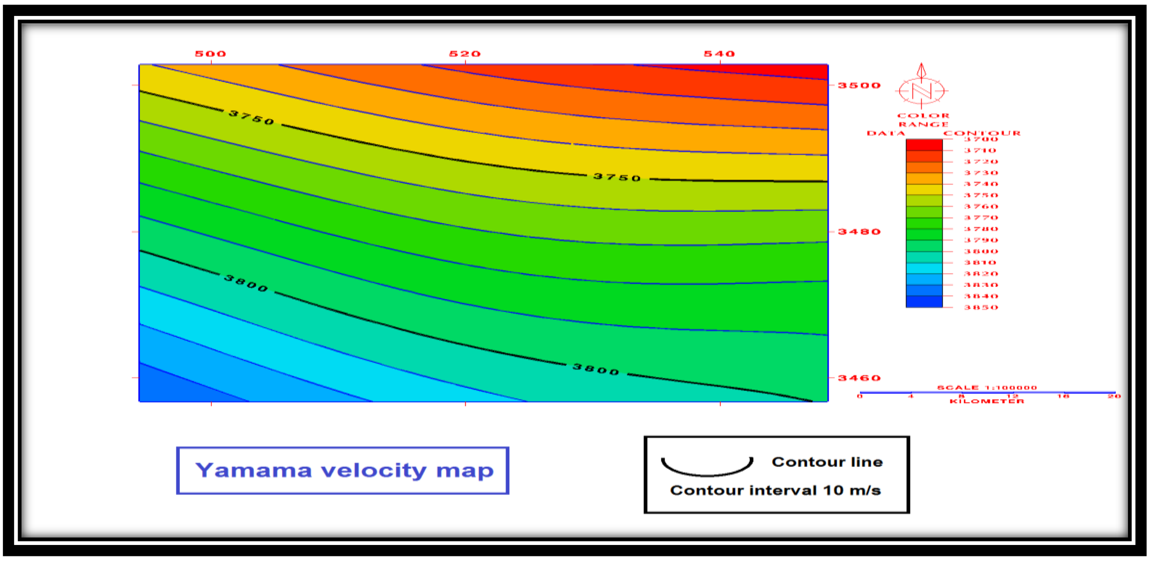

Figure- 9 Shows Yamama velocity map

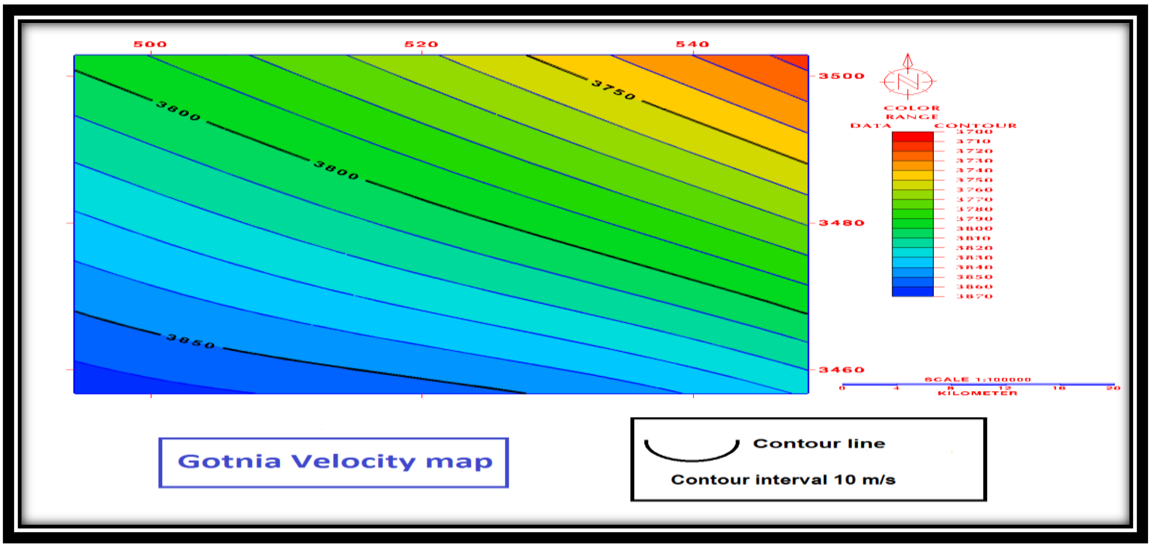

Figure 10- Shows Gotnia velocity map

Depth Maps

By using (CPS3) program within Geoframe system , three depth maps were prepared for the three studied reflectors (Zubair , Yamama , and Gotnia). Depth maps show increase toward northeast direction and decrease toward southwest direction within the study area . Figures -11,12 and 13 shows the depth maps for Zubair , Yamama and Gotnia Formations respectively .

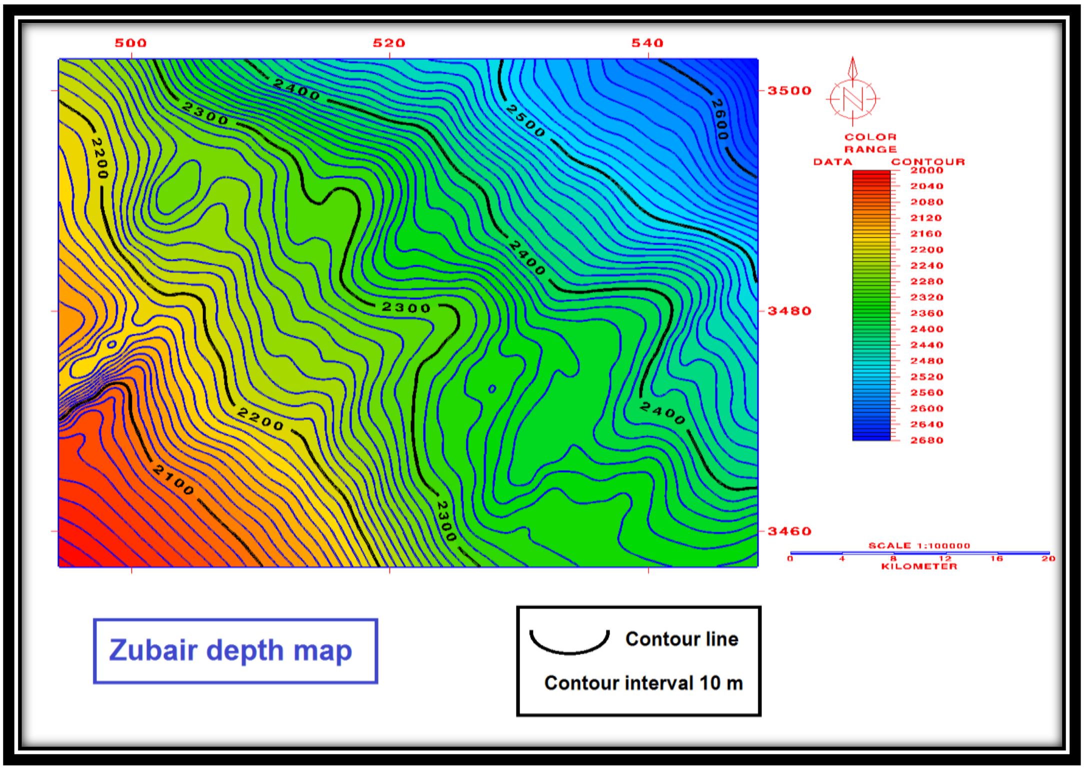

Figure 11- shows Zubair depth map

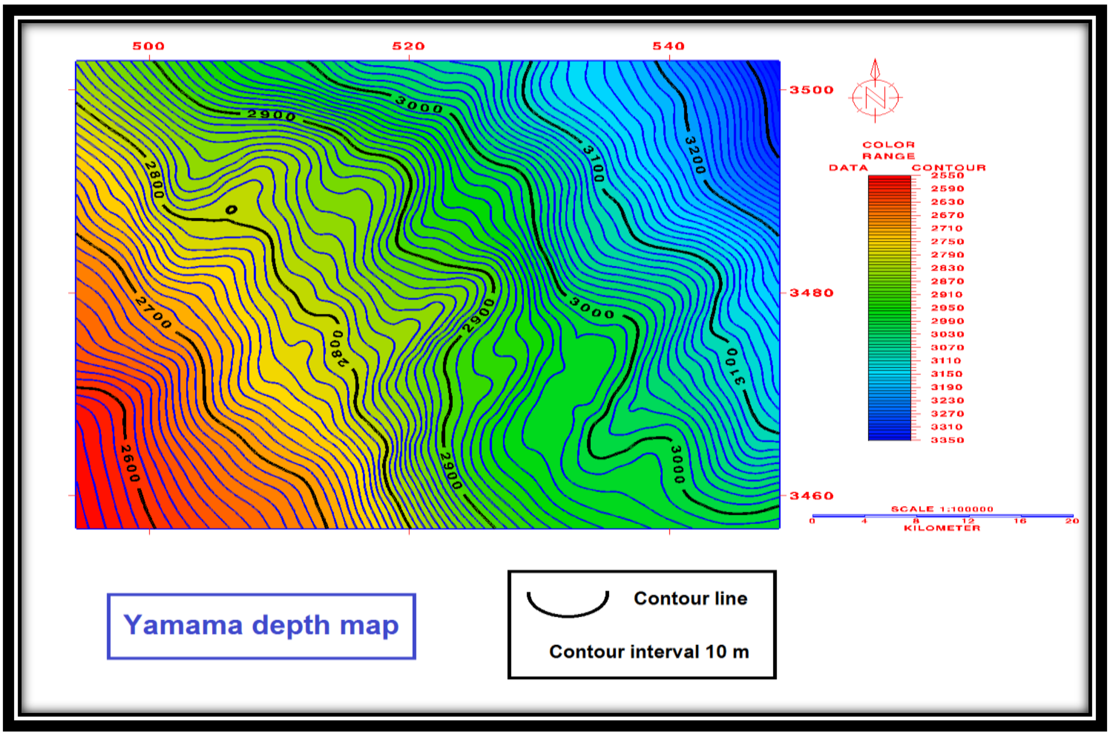

Figure 12- Shows Yamama depth map

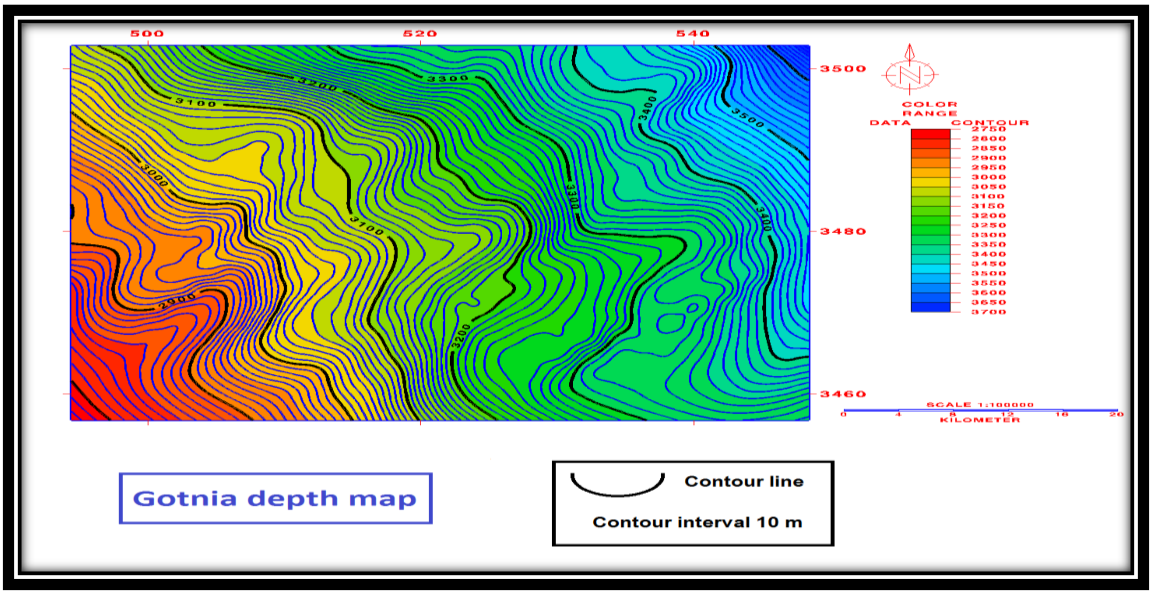

Figure 13- Shows Gotnia depth map

Stratigraphic Interpretation

Seismic stratigraphy is a technique for interpreting stratigraphic information deduced from seismic data. Basically, changes in rock type produce changes in the reflectivity, which affect the wave shape seen in seismic data , Inferring stratigraphic changes and their occurrence which is based on characteristics of seismic data is an objective of seismic stratigraphy [8]

In many areas; seismic stratigraphy can add important geological information and enhance the understanding of the depositional environments, which may help in the understanding the origin, accumulation, and trapping mechanisms of the hydrocarbon deposits. The seismic traces are trying to tell us the details of the subsurface [9]. Based on seismic character and reflections patterns seven distinct intervals were observed and distinguished Figure- 14. These intervals are:

1- An upper interval of parallel reflections comprising the (Zubair to Yamama) Formations

2- A basal interval of parallel folding reflections comprising the (Yamama to Gotnia) Formations.

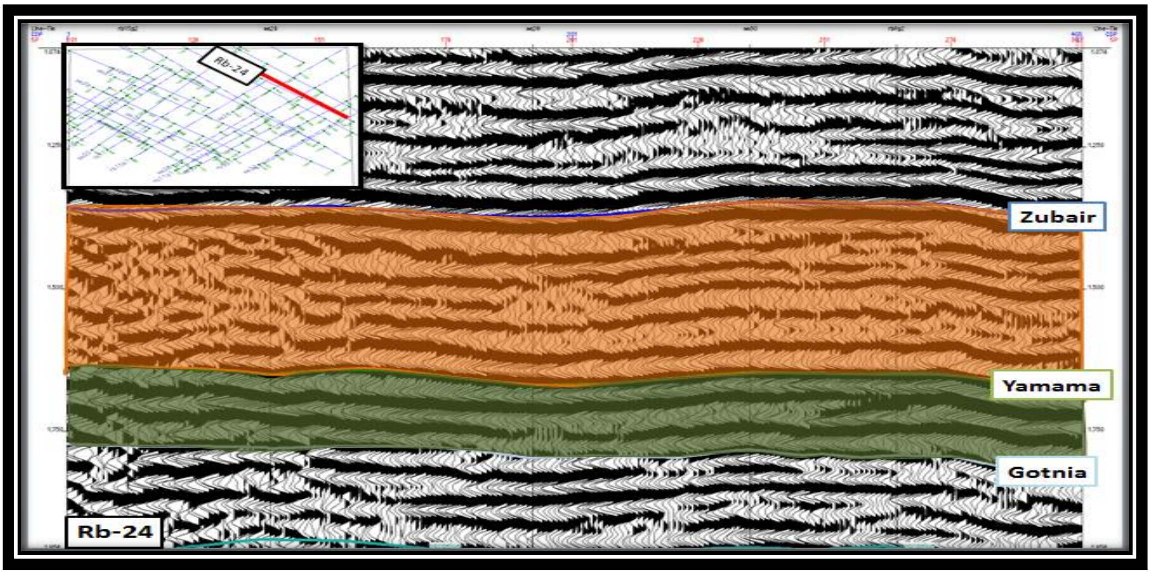

Figure 14- Illustrates the seismic divisions of the study area

Seismic Reflection Configuration

Basically, configuration of reflections provides the best guide to interpret carbonate seismic facies.In this study (Zubair , Yamama ,and Gotnia) have two main types of seismic reflection configuration which are observed , first parallel configuration of Zubair reflectors, and second progradational configuration of Yamama and Gotnia.

Reflection configurations of Zubair indicate wide, relatively uniform lateral extent in sedimentary basin. This means that Zubair facies are deposited on delta platform.Figure-15.

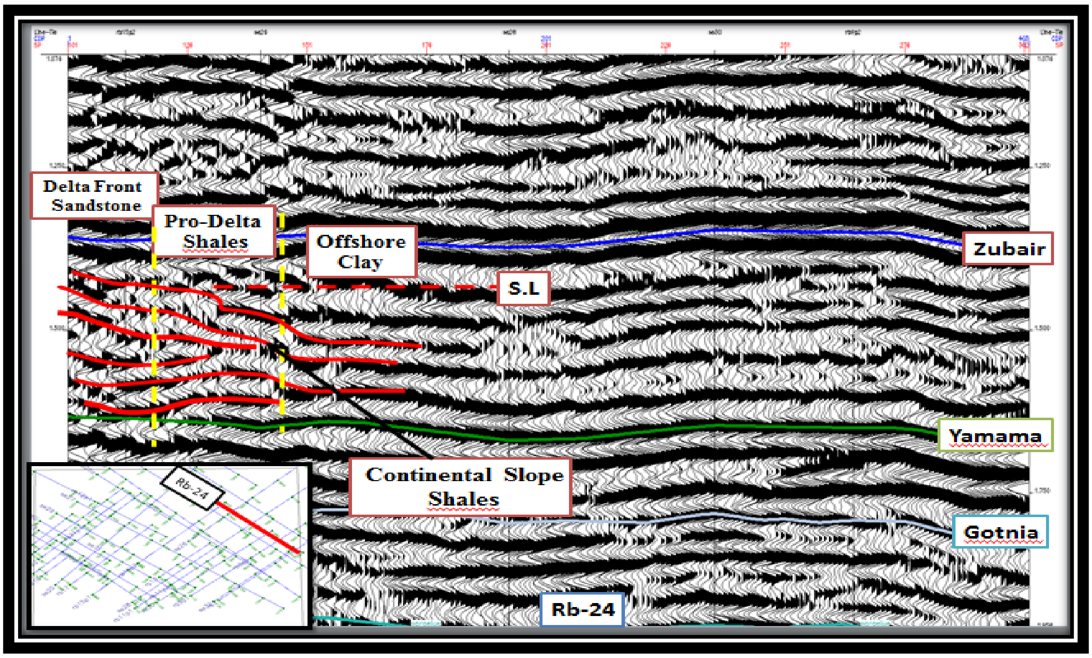

Figure 15- Shows a section display Zubair parallel configuration with delta system

The second type of reflection configuration in the studied package which includes Yamama and Gotnia reflectors is progradational configuration, with two fundamental types of progradational configuration are observed (sigmoid and mound)Figure-16 and 17 .

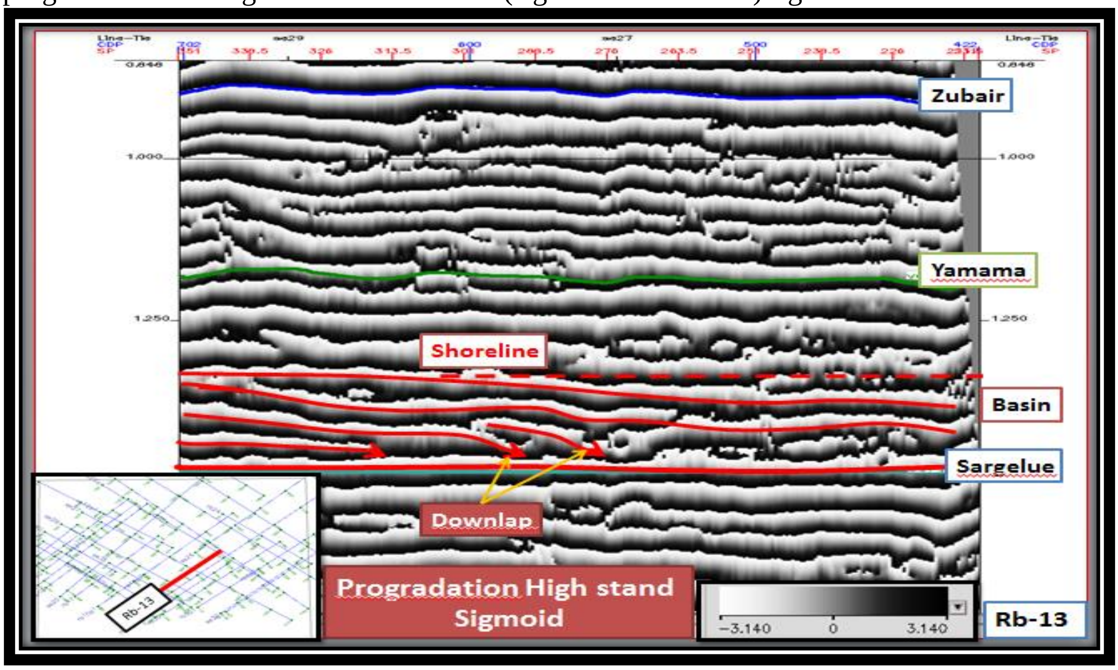

Figure 16- Shows section display progradation high stand Sigmoid seismic reflection configuration

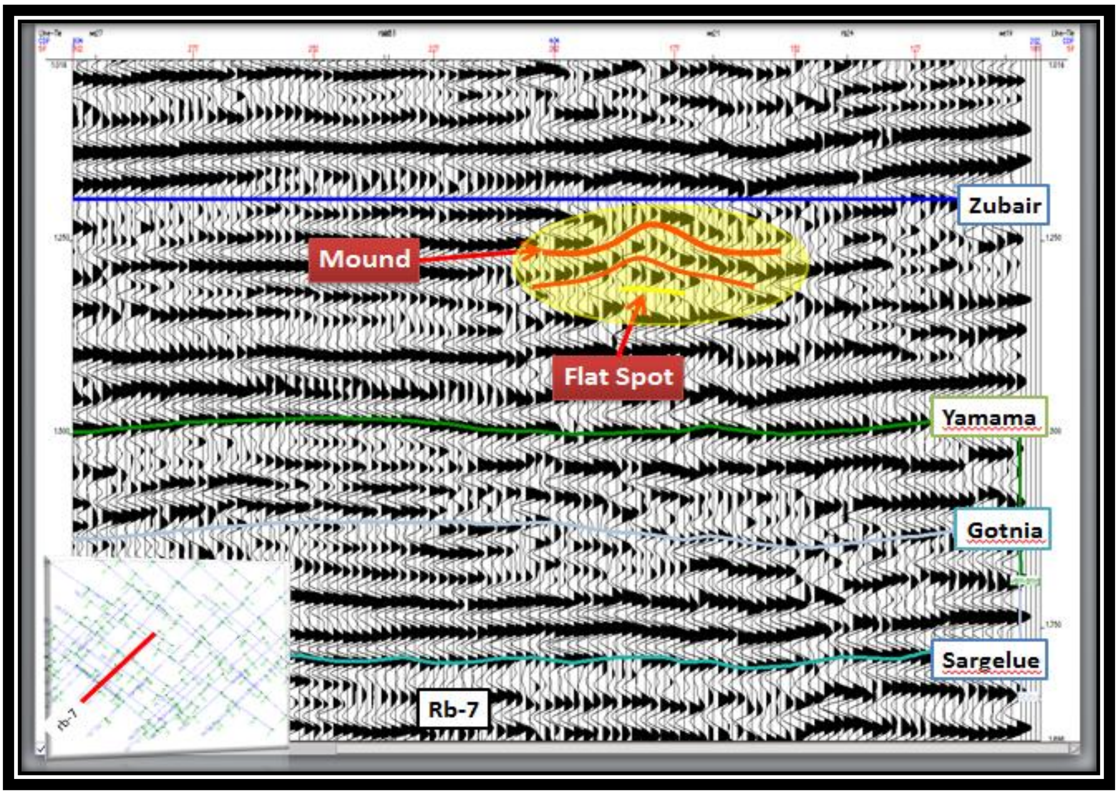

Figure 17- Shows a section display mound seismic reflection configuration .

Seismic attributes sections

1- Instantaneous Phase

Instantaneous phase display the continuity of seismic event. It is very important to study the faults, discontinuity of reflectors, angular unconformity, pinchout and onlap [10], and the information of instantaneous phase is very important in showing and distinguishing the ends of continuity of reflective surfaces [11] Instantaneous phase section of Figure -18 represent stratigraphic feature such as mound and flat spot

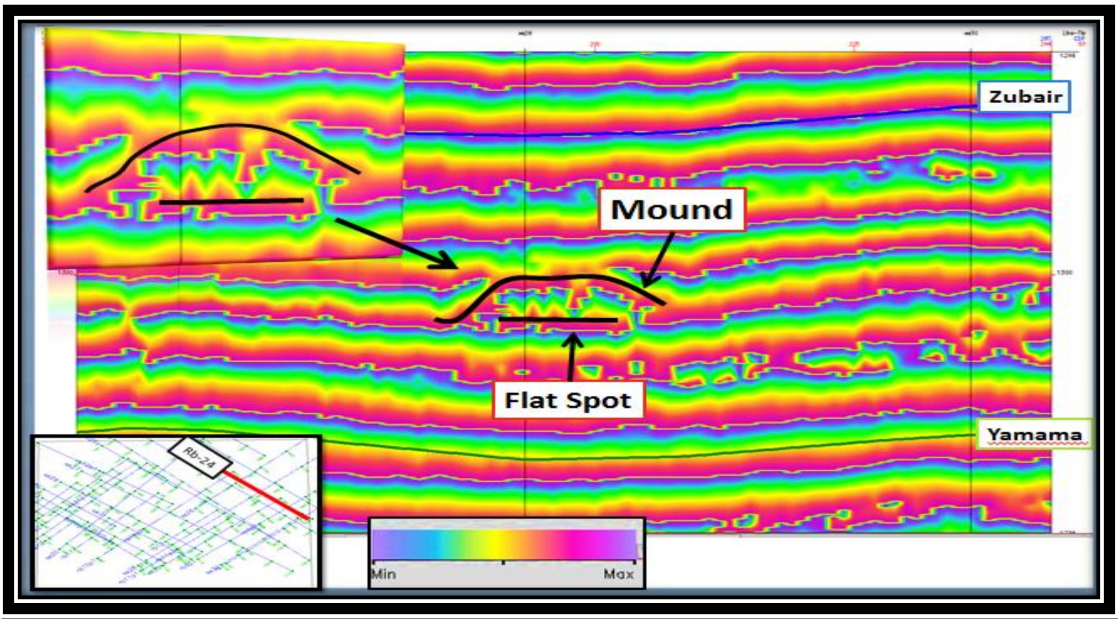

Figure 18- Shows seismic section display the variation in instantaneous phase of studied reflectors.

2-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 [12] . This attribute which measured in time is primarily used to visualize regional characteristics such as structure, sequence boundaries, thickness and lithology variations.. Low amplitude values are observed in study area , which are probably the area of hydrocarbon reservoirs. Figure -19.

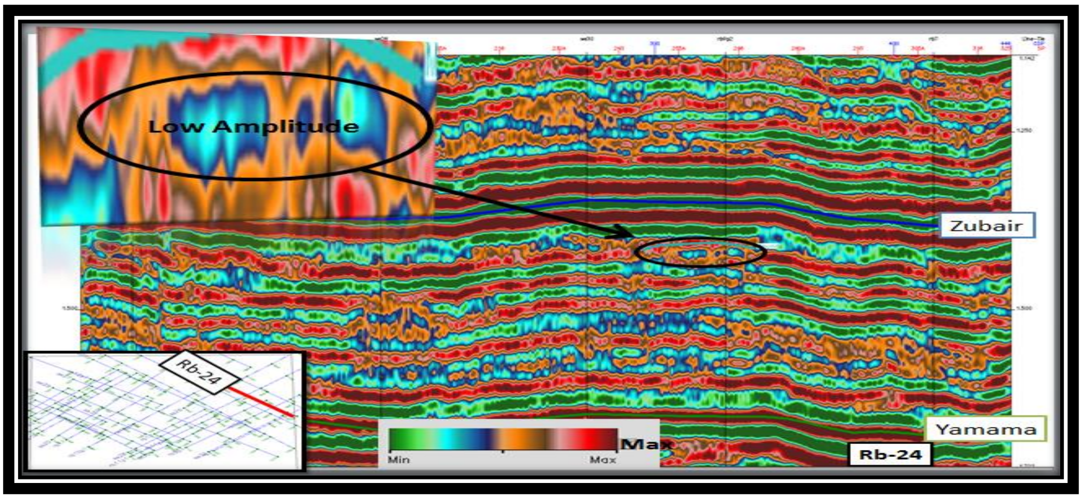

Figure 19- Shows seismic section display the variation in instantaneous amplitude of studied reflectors.

3-Instantaneous Frequency

When tracking regional sequence boundaries, jumping to onlap, downlap or toplap seismic reflectors is a common problem. Sequence boundaries may be distinguished from reflectors that terminate onto them by the lack of high frequency tuning away from the area of contact.

The results of the application of attribute assist to determine sites changes Instantaneous frequency and their relationship to changes in petro-physical qualities, is linked frequencies of low-lying areas to zones communities of hydrocarbon [13].

Low frequency signals were noticed within this section which indicate hydrocarbon accumulation , high frequency which indicate weak probability of hydrocarbon accumulation Figure-20.

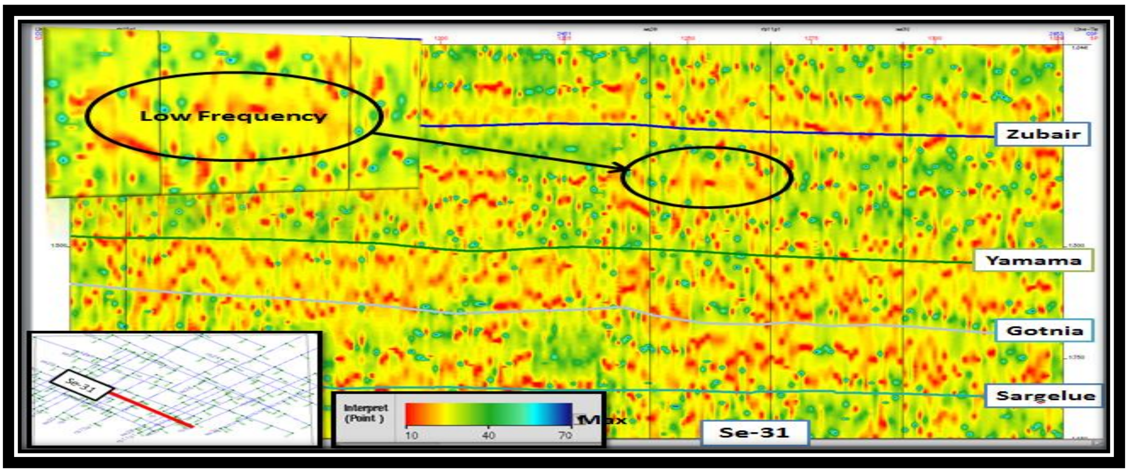

Figure 20- Shows seismic section display the variation in instantaneous frequency of studied reflectors.

stratigraphic model

Facies model has a general summary of a particular depositional system, involving many individual examples from recent sediments and ancient rocks. Facies are controlled by sedimentary processes that operate in particular areas of the depositional environments . Hence, the observation of facies helps with the interpretation of syn-depositional processes. The understanding of facies associations is a critical element for the reconstruction of paleo-depositional environments [14].

Through the seismic sections display it was observed that there may be stratigraphic traps on the top of Sargelue Formation, and the probably of proposing the well in this region . But this formation doesn't include within the studied reflectors and this trap probably can be useful in the future , Figure -21.

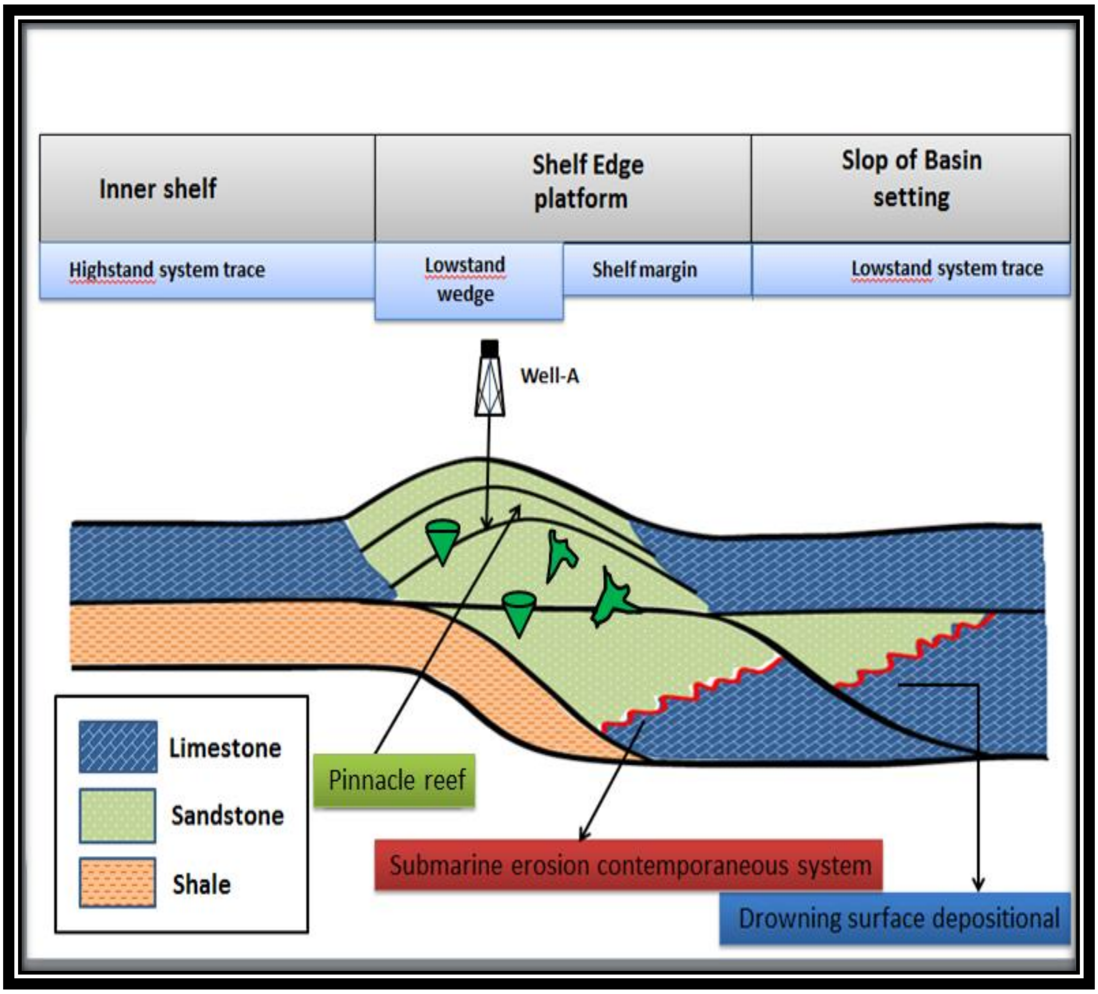

Figure 21- Illustrates the stratigraphic model proposed for Sargelue Formation .

Figure -22 represents base map of the study area that illustrates the properly traps and stratigraphic phenomena that determined from seismic attributes and seismic reflection configuration .

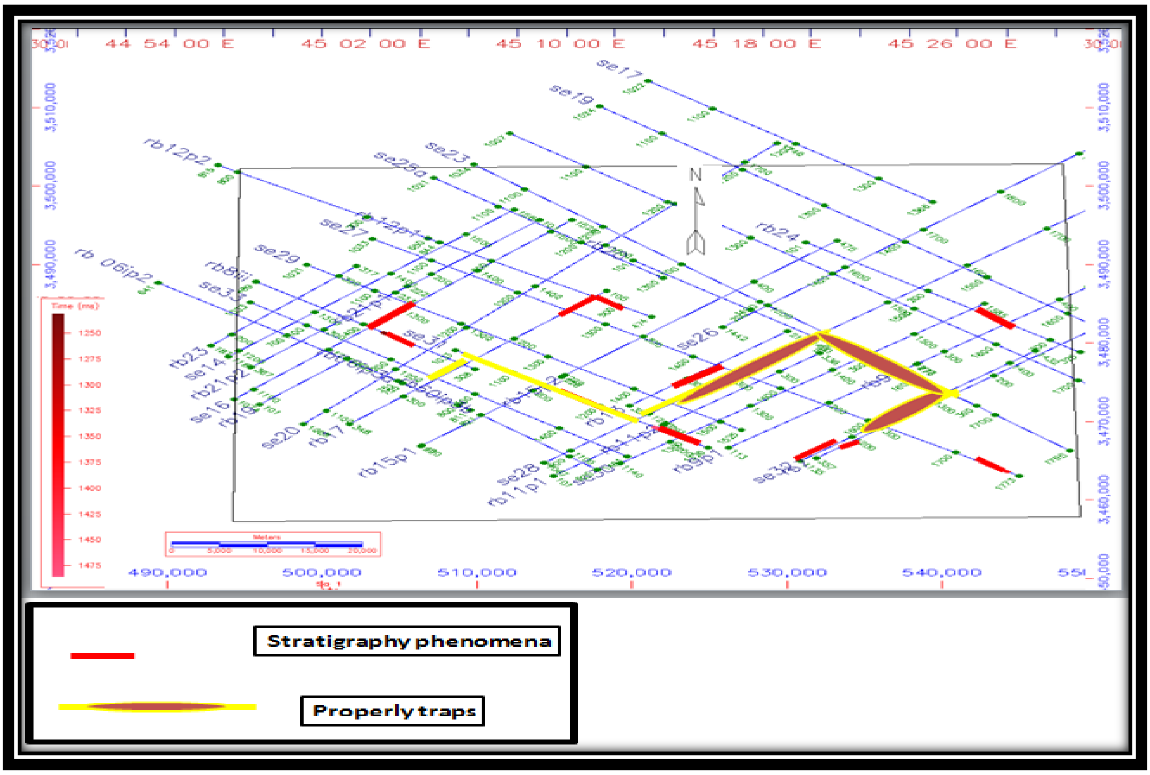

Figure 22-Shows the proper traps that determined from attribute and seismic reflection configuration

Conclusions

1. Synthetic seismogram was generated from Dn-1 and Ns-1 wells to identify the formations ; it showed fair to good matching between the seismic trace and synthetic trace .
2. The time maps of the studied reflectors showed existence of several phenomena as noses generally they have northeast – southwest trend.
3. Velocity maps of the studied reflectors showed that the velocities generally irregular increase with depth due to inhomogeneity of the sedimentary layers as a result of differing facies and depositional environments.The velocities of each reflector increases within the boundaries of the study area to the south-west and decreasing towards the northeast.
4. Depth maps of the three studied reflectors showed that the depth increases to the northeast and decreasing towards the southwest within the boundaries of the study area .
5. Two types of seismic facies were specified:
   a- Zubair reflector display parallel configuration.
   b- Yamama and Gotnia displays the progradational configuration

6. Using seismic attribute techniques including instantaneous phase showed stratigraphic features such as mound and flatspot which indicate hydrocarbon accumulations . Instantaneous frequency showed low frequency in areas of hydrocarbon accumulations. instantaneous amplitude attribute showed that the low amplitude values are observed in study area , which are probably the area of hydrocarbon reservoir.

Referances

1. Dobrin , M. **1976**. *Introduction to Geophysical Prospecting*, 3rd ed., McGraw Hill. Int. co., International Student Edition 386 p.

2. Al-Sinawi **.1981**. *Introduction to Applied Geophysics*, first ed., Printed at Mosul University .142 p.
3. Yilmaz,O**. 1987**.Seismic data processing, SEG series: *Investigation Geophysics*, V.2 526 p.
4. Telford, W.M., Geldart, L.P., Sheriff, R.E. and Keys. D.A. **1976**. *Apllied Geophysics*, Cambridge University press, 860 p.
5. Milsom , John **.2003**. *Field Geophysics*, 3rd. Ed. University College London, 232 p.
6. Al-Ameri T. K., Al-Ekabi A.H. , Al-Jawad S.N. **2014.** Palynomorph stratigraphy , palynofacies and organic geochemistry assessments for hydrocarbon generation of Ratawi Formation, *Iraq. Arab J Geosci* 7(4):1433-1455.
7. Lindseth, R. **1979.** Synthetic sonic logs – a process for stratigraphic interpretation: *Geophysics*, 44, 3-26.
8. Sheriff, R.E. **1980.** *Seismic Stratigraphy*, IHRDC, Boston, 277 p.
9. Gadallah , M. R., and Fisher , R. **2009.** *Exploration geophysics,* Springer-Verlag Berlin Heidlberg, 262p.
10. Taner, M.T. and Sheriff R.E., **1977**. Application of amplitude, frequency and other attributes to stratigraphic and hydrocarbon exploration. AAPG Memoir 26, pp: 301-327.
11. Khorshid S. Z. and Kadhm A.D. **2015**. Subsurface Investigation of Oligocene Geologic Formations Age , East Baghdad Oil Field ,*Iraqi Journal of Science* ,V.56 , No.4C , pp: 3441-3451.
12. Al-Ridha N.A. and Ali H. M. **2015**. Study the Image of Wasit Subsurface Structure Using 3D Seismic Data Center of Iraq . *Iraqi Journal of Science* .V.56, No.4C , pp: 3513-3523.
13. Alridha N. A. and Muhsin S. U. **2015**. Seismic attributes analysis in Balad oil field – center of Iraq, *Arabian Jornal of Geosciences* ISSN 1866-7511, V. 8, No.5 , pp: 2785-2798.
14. Walker R.G. **1992a.** *Facies models and modern stratigraphic concepts* . In :Walker R.G. ,James N.P. (eds) facies models : response to sea-level change . Geological Association of Canada , st John's , Newfoundland , pp: 1-263 .