DOI: 10.24996/ ijs.2017.58.4B.16

ISSN: 0067-2904

Structural and Stratigraphic Study of Hartha Formation in the East Baghdad Oil Field, Central of Iraq.

Salman Z. Khorshid[1], Falih M. Duaij[2], Hayder H. Majeed*[1]
[1]Department of Geology, College of Science, University of Baghdad, Baghdad, Iraq.
[2]Oil Exploration Company, Iraqi Oil Ministry, Baghdad, Iraq.

Abstract

Three-dimensional seismic reflection study was conducted for the Eastern Baghdad oil field which is located in the middle part of Iraq within Al-Madaaen province that belong to Baghdad governarate, South of Diyala River , this field includes two southern parts (S1 and S2), the study area was about 781.905 km ^{2} for the upper Cretaceous age, synthetic seismogram was generated from data of EB-5 and EB-1 wells. Saadi reflector was picked and identified to determine the Hartha Formation. The seismic sections and time slice maps confirmed that the upper Cretaceous age was affected by faults and the indicators of faults ended within Hartha Formation and continue to the deeper formations with increasing intensity. The attribute section was applied on time slice and shows that the area was affected by normal fault parallel to the structure of the field trends (NW-SE). Time, velocity and depth maps of Hartha reflector depending on data from wells (EB-1, EB-2, EB-6, EB-30, EB-52, EB-54) the maps show the structural picture of East Baghdad structural nose opened toward NW and trending (NW-SE) that confirmed by 3D volume which prepared for the studied area. DHI was identified as flat spot, dim spot and sag , when applying attributes like (instantaneous phase and Instantaneous Frequency) has been proved the absence of hydrocarbons in EB-15 well on other hand found in adjacent wells such as EB-2 and EB-5 because of facies changes and not structural change. A scaling facies change was identified at (inline 40910 and inline 47960) , Mound (inline 48310), as well as the work of the Isochron map, which was used to find Isopach and a suitable site for drilling wells.

Keywords: Hartha Formation Facies change and Direct Hydrocarbon Indicator study, upper Cretaceous age-East Baghdad oil field.

دراسة تركيبية و طباقية لتكوين الهارثة في حقل شرق بغداد، وسط العراق

سلمان زين العابدين خورشيد[1]، فالح مهدي دعيم [2]، حيدر حميد مجيد[1]*
[1]قسم علم الارض، كلية العلوم، جامعة بغداد، بغداد، العراق.
[2]شركة الاستكشافات النفطية، وزارة النفط العراقية ، بغداد، العراق.

الخلاصة

تم أجراء دراسة زلزالية انعكاسية بالأبعاد الثلاثة لحقل شرق بغداد الواقع وسط العراق ضمن قضاء المدائن التابع لمحافظة بغداد، جنوب نهر ديالى ، والذي يتضمن الجزئين الجنوبين (S1 و S2)، حيث بلغت مساحة منطقة الدراسة حوالي 781.905 كم^2 للعمر الطباشيري العلوي. تم عمل الاثر المصنع من بيانات البئر EB-5 . تم التقاط عاكس السعدي وتمييزه لتحديد تكوين الهارثة. وأكدت المقاطع الزلزالية وخرائط

*Email:Haidar_geo85@yahoo.com

الشرائح الزمنية أن العصر الطباشيري العلوي تأثر بالفوالق وأن مؤشرات الصدع انتهت في تكوين الهارثة وتستمر في التكاوين العميقة مع زيادة شدتها. تم تطبيق attribute section على الشريحة الزمنية واظهر أن المنطقة تأثرت بالفوالق الاعتيادية (normal fault) بالتوازي مع محور تركيب شرق بغداد (NW–SE).
أظهرت خرائط السرعة و الزمن لعاكس الهارثة التي استخدمت بيانات من ابار
(EB–1, EB–2, EB–6, EB–30, EB–52 and EB–54) ووضحت ان الصورة التركيبية للحقل عبارة عن خشم تركيبي مفتوح باتجاه NW و انحداره (NW–SE) و تم تأكيد ذلك من خلال عمل مكعب زلزالي ثلاثي الإبعاد. تم التوصل الى وجود الدلائل الهايدروكاربونية DHI مثل (flat spot and dim spotعند تطبيق Atrributes مثل (Instantaneous phase and Instantaneous Frequency)
وقد ثبت عدم وجود الهيدروكربونات في بئر EB–15 ووجودها في الآبار المجاورة مثل EB–5 و EB–2 وتم تحديد سبب المشكلة وهو تغير سحني وليس تركيبي.

Introduction

Seismic methods are the most effective, and the most expensive, of all the geophysical techniques used to investigate layered media and common features to reflection and refraction surveys [1]. The role of seismic reflection gives more direct and detailed picture of the subsurface geological structures, it gives seismic sections, time and velocity contour maps to determine a structural trap, as well as, seismic stratigraphy and seismic facies. The structure of subsurface formation is mapped by measuring the variation in the reflection times from one place to another on the surface. Depth to reflecting interface can be determined from the times using velocity information that can be obtained from reflected signals or from surveys in available wells [2]. The seismic reflection exploration method passed through numerous development stages from mid last century to present time included the field survey, data processing and interpretation. Basically, most of conventional survey are reconnaissance with (2D), while the 3D survey is carried out to estimate the hydrocarbon accumulations and development of the fields. 3D survey gives huge amount of the seismic data which permit a better interpretation and gives detailed picture to the subsurface geology [3].

Location of the Study Area

East Baghdad oil field lies in the middle of Iraq and far from the center of Baghdad about 20 Km to the east [4] the whole south area of East-Baghdad project is 1201 Km^2 contains three part (S1, S2 and S3). This study includes two parts (S1 and S2), the area of these two part is 781.905 Km^2, this structure trends in the direction (NW-SE) with approximately 100 Km length and extends from the Taji to Azizia area across the Diyala River where most of this structure is covered by agriculture area [5, 6] Figure-1.

Figure 1- Location map of the study area.

Loading of 3D Seismic Data

The data of 3Dsiesmic reflection is loaded in pre- stack and post stack time migrated format in SEG-Y to Geoframe workstation , the base map of the study area is constructed with global coordinates browser WG 1984 UTM system. This process involves entering the first and last inline number, the first and last cross line number, the divided space between bin size along inline direction and cross line direction as shown in Figure-2.

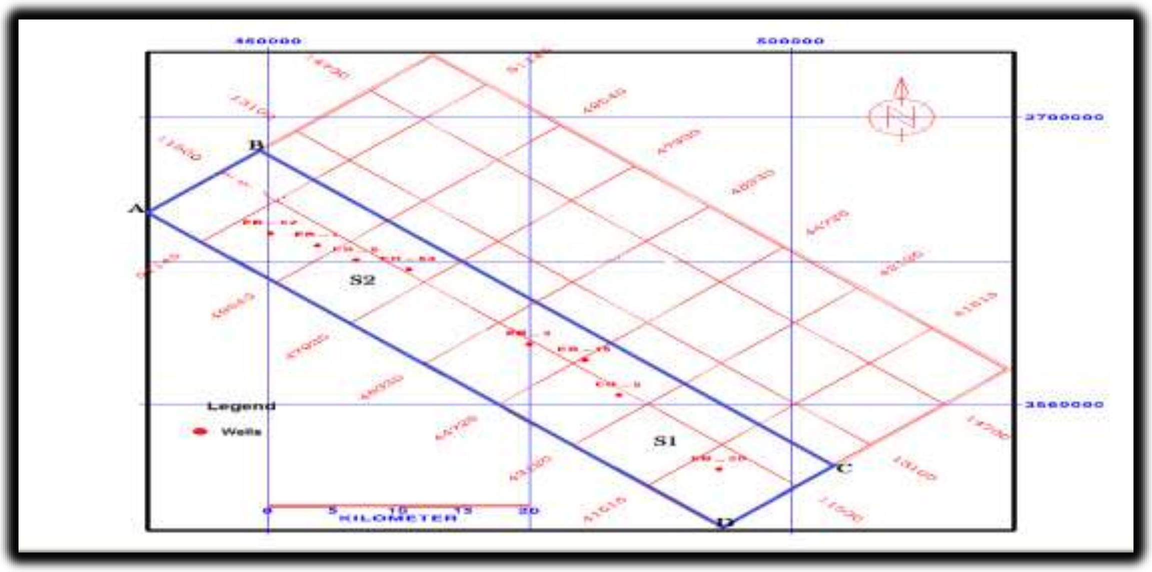

Figure 2-Base map of the study area.

Check-Shot Survey

The best way for velocity measurements is to explode charges of dynamite near the surface be side a deep borehole and record the arrival times of waves received by geophone that placed inside the wells at a number of depths spreaded between its top and bottom of the target (Hartha) formation . After that the data can be comparied to surface seismic data by using the sonic log and creating a synthetic seismogram [7, 8]. A process of calibration of time curve with depth for sonic and velocity logs for the purpose of correcting time values of sonic log according to the field velocity survey. Figure-3 shows the check shot of EB-5. Using of seismic data that cover the well area to extract the wavelet shapes which dependant in the process of convolution to convert reflection coefficient values to seismic signal in amplitude.

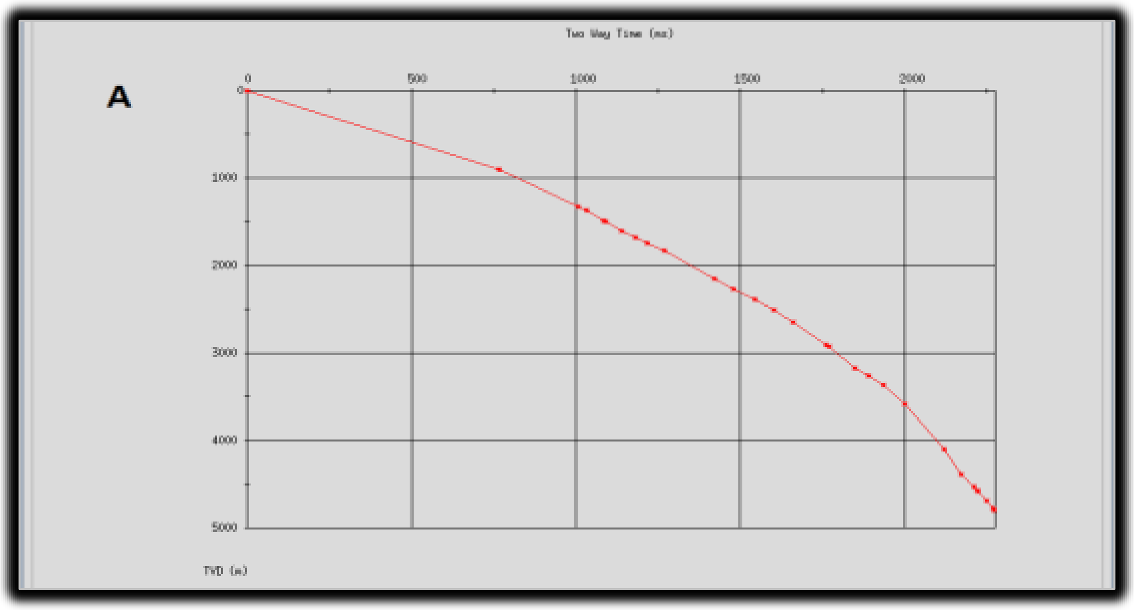

Figure 3- Shows check shot curve for East Baghdad well-5.

Synthetic Seismogram Generation

Synthetic seismograms were generated for East Baghdad well-5 using GeoFrame software package. Synthetic is refered in [9, 10] to the main steps for generation of the synthetic seismogram which they are:

1. Computing the acoustic impedance ($I = \rho \times v$) Where:

v: Is seismic velocity.

ρ: Is density measured from density logs. .

2- calculating the reflection coefficients of the vertical incident wave on reflector separating two groups of time intervals such (i) and (i+1) that have values of acoustic impedance (ρi vi) and (ρi+1, vi+1) respectively. Experimentally, choice of wavelet is made to prepare the synthetic seismogram. The sonic log data are compared with the well velocity survey which symbolizes the direct method to measure the geological velocity (average velocity) of geological strata. The synthetic seismogram traces of the East Baghdad well for EB-5 were generated using programs within the IESX (synthetic programs). These programs have ability to extract the relation between the time and depth functions in the well location. This relation is very important in determining the reflection on a time axis of seismic section and synthetic trace against the require bed in the well. The sonic logs were transformed from the depth to the time domain using the check shots that were provided and used to make synthetics from the computed reflectivity series convolved with a Ricker and extraction wavelet to match the dominant frequency of reprocessed 2D seismic data. After that calibration must be done on seismic section of the synthetic as shown in Figures-4. This figure shows good matching between seismic section and synthetic seismogram. The continuity of reflectors, seismic section (VA) which is passing through well EB-15 that is matching the synthetic trace as shown in Figure-5. The picked reflectors wavelets appeared as peaks on synthetic trace (positive reflection) but in different intensity.

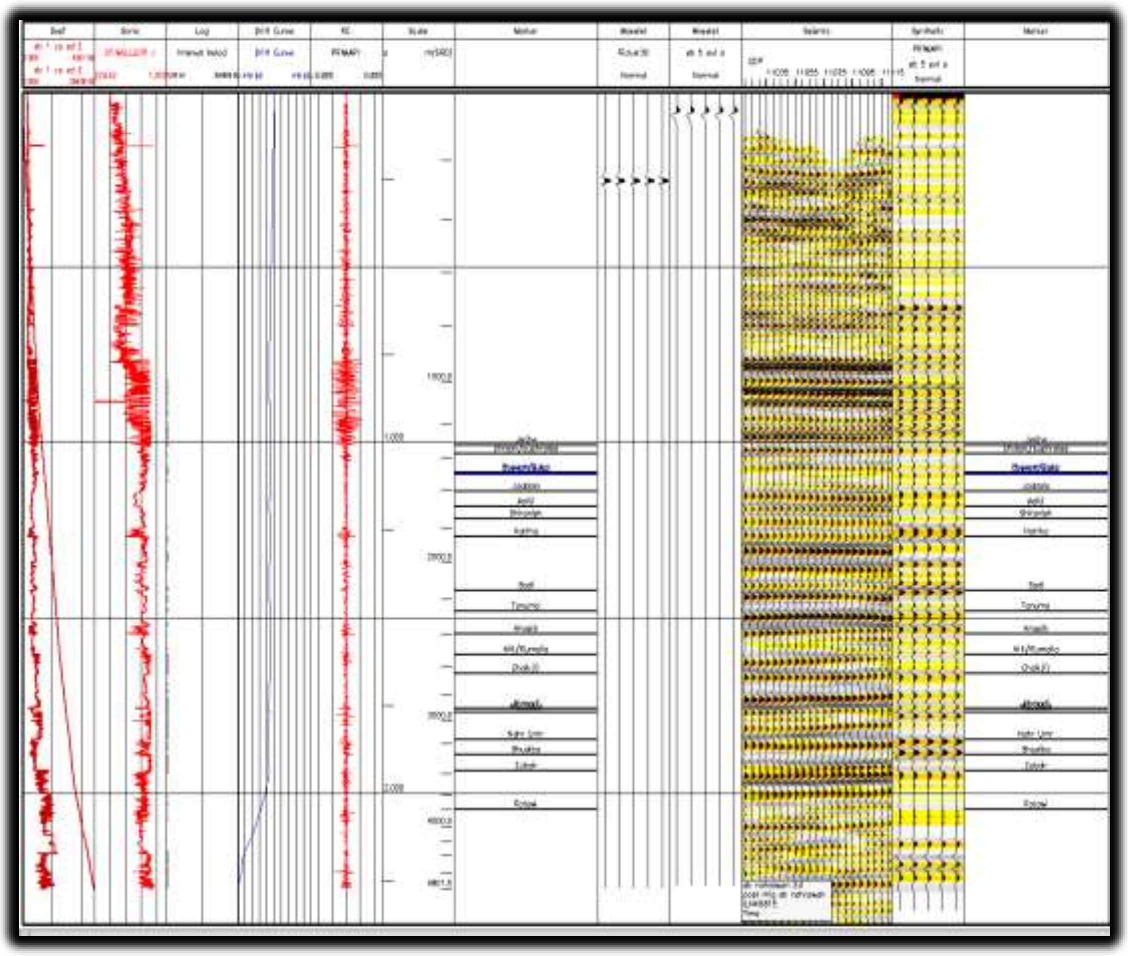

Figure 4- Shows the synthetic seismogram of EB-15.

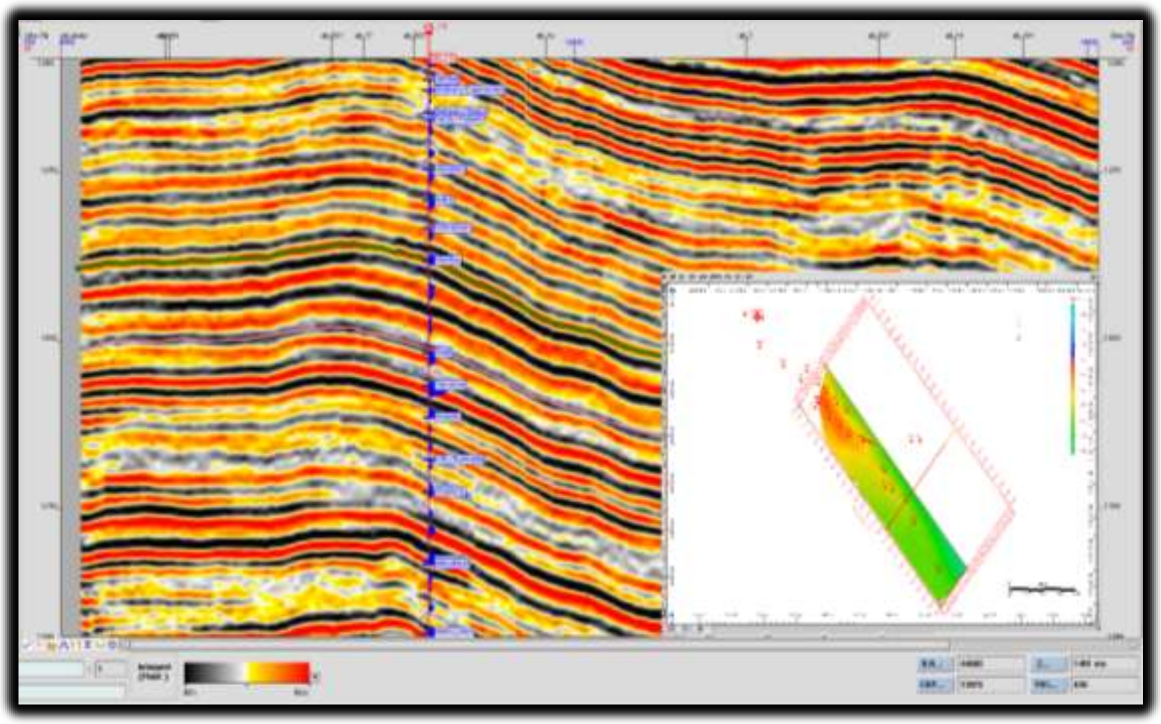

Figure 5- Seismic section (VA) shows the continuity of reflectors passing through well EB-15 that matchs the synthetic trace very well.

Time Map of base of the Hartha Reflector

Two Way Time map (TWT) of base of Hartha has been prepared with reformatted scale (1/100000) by using special mapping (CPS3) program with contour interval (10) millisecond, datum surface represents sea level. The TWT map of base of Hartha Figure- 6 showed that East Baghdad structure is a nose structure opened toward North West, The closure did not appear because of the missing of data survey due to the presence of Diyala river. From Figure-6 it is clear that the TWT in this map at the NW part is less than the SE part, this is because the SE part is deeper than NW part.This map shows that the structural nose trends to NW-SE direction as well as from tracking layers that the two small faults are apear in the study area.

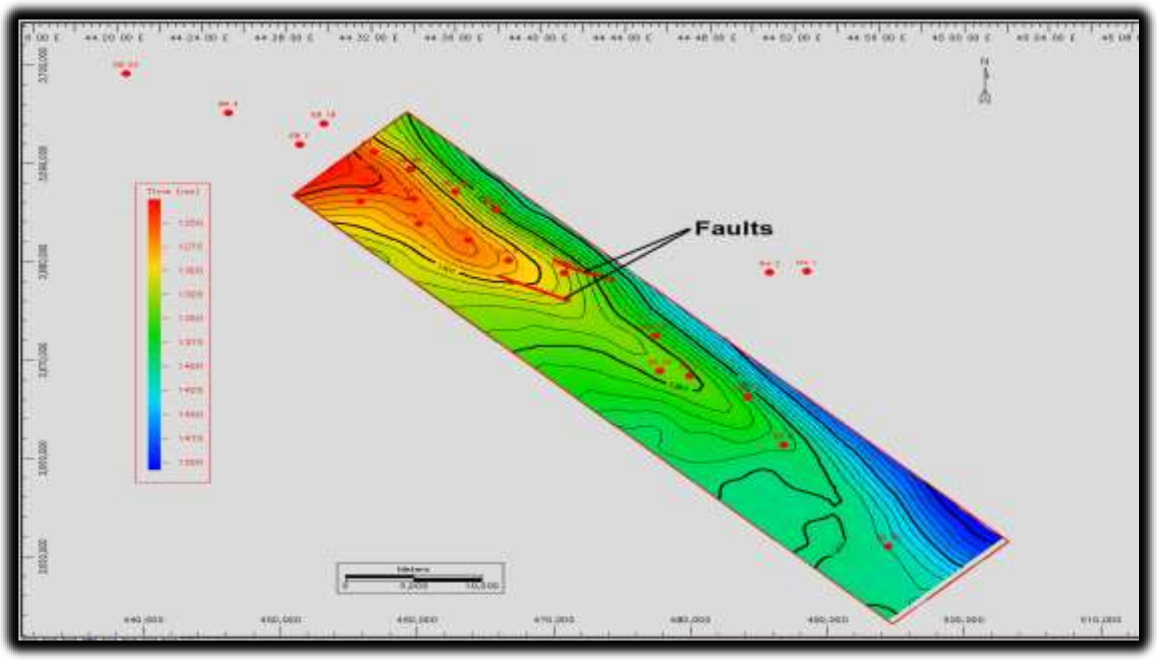

Figure 6- Shows Two way time map of base of Hartha Formtion.

Velocity Map of base of Hartha Reflector

The velovity map is import to find depth of formation. In the current research wells (EB-2, EB-6, EB-5, EB-54, EB-1 and EB-52) are used to find average velocity and that means the real average velocity of real reference level to a certain point below the surface [9], then convert the TWT maps to depth maps. Velocity map of base Hartha with scale (1/100000) and contour interval of (20) m/sec, is drawn the base map of Hartha velocity values increase in the eastern and south east parts of the study area and decrease progressively toward south west and north west at shows in Figure -7.

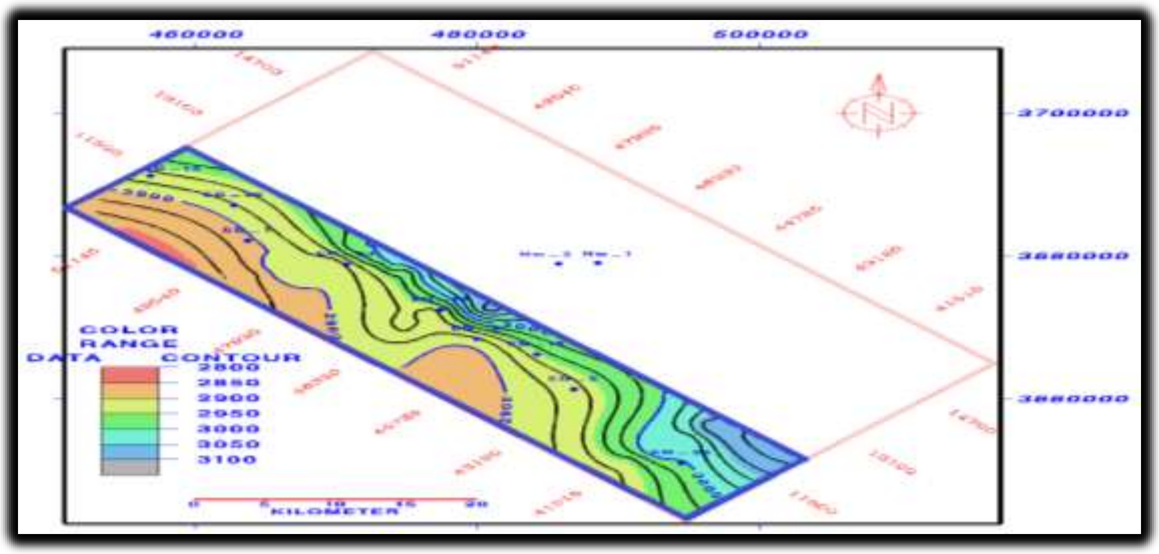

Figure 7- Shows Velocity Map of base of Hartha Formation.

Depth Map of base of the Hartha Reflector

From time map and average velocity maps above, the depth map of base of Hartha reflector with scale (1/100000), contour interval (20) m is prepared, and the datum surface was sea level.

Depth at any point = OWT × Vav. at that point

It is noted that the depth of base Hartha is less in the northwest because it represents structural nose and increases toword the east, south and southeast directions, due to the exposure of the region to subsidence [10]. Figure-8 shows depth map of Hartha.

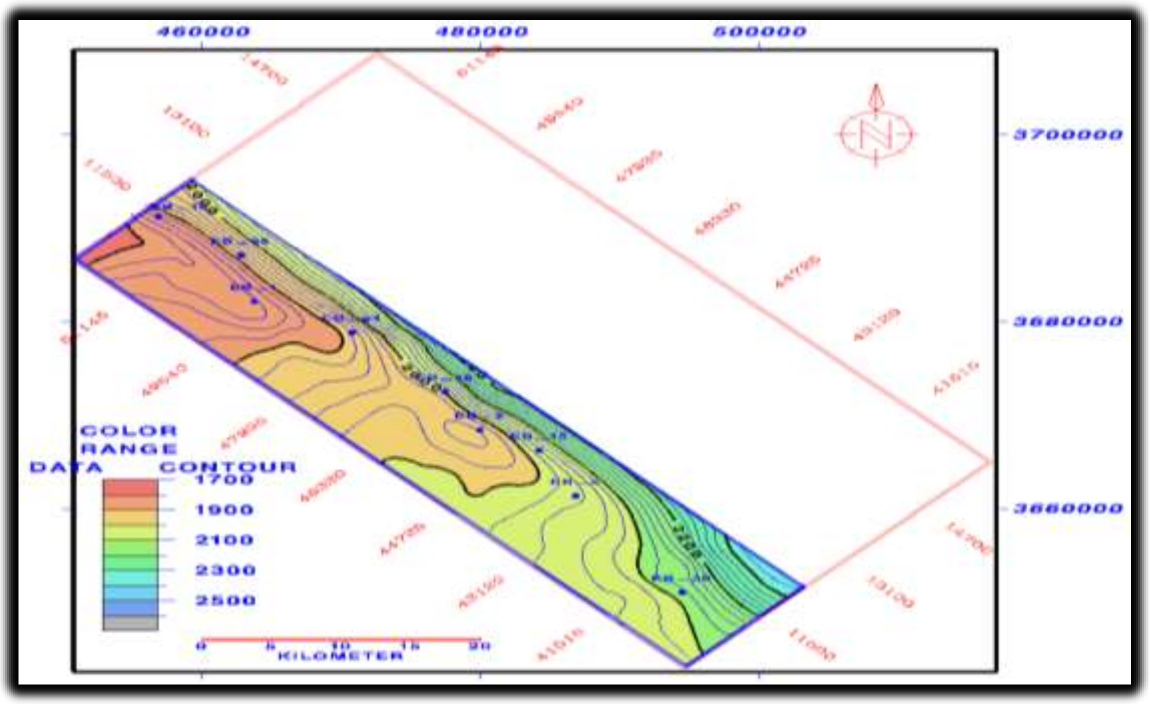

Figure 8- Shows depth map of Hartha.

Interpreting Amplitude

By studying the amplitude sections accurately and applying seismic attributes and flattening technique to determine the areas where Direct Hydrocarbon Indicator (DHI) is located like dim, bright and flat spot. When determining a phenomenon (DHI), that focused it and return to the geological information of the area studied. Dim spot is a local low amplitude seismic attribute anomaly that can mark the existence of hydrocarbons and is therefore known as a direct hydrocarbon indicator (DHI).Whereas flat spot is a seismic attribute anomaly that is shown as a horizontal reflector cutting across the stratigraphy elsewhere exist on the seismic image[11]. Figure-9 seismic section, shows the EB-6 penetrates flat spot, dim spot and fault in inline 49180.

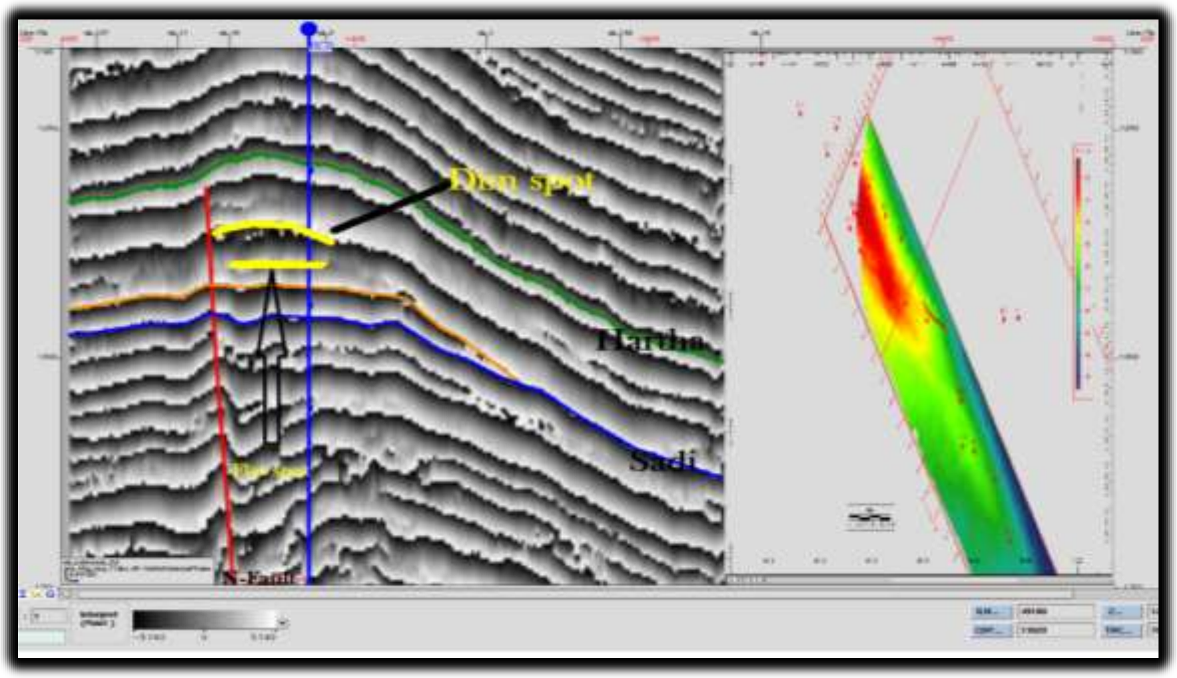

Figure 9- Seismic section, shows the EB-6 penetrates flat spot,dim spot and fault in inline 49180.

Seismic Attributes

In this section the Instantaneous phase and Instantaneous frequency are studied to show the facies in the study area as follows:

1-Instantaneous Phase

It is one type of the attributes that used to detect direct hydrocarbon indicator (DHI), which range between +/-180 degree discontinuity that occurs with instantaneous phase. Reflectivity of intensity is an influential tool to recognize bright and dim spots. Phase knowledge is advantageous in delineating such interesting features as faults, onlaps, and prograding reflections [12, 13]. A track was taken passing through wells EB-5, EB-15, EB-2 and EB-24 to determine the reason for the lack of oil in the Well 15 and its presence in other wells . The difference between well EB-15 and well EB-5 that contain oil, the well EB-5 shows in 1390 ms but the comparison between EB-15 with EB-2 and EB-24 that have oil the problem take place in with 1415 ms , in both cases, there was facies change around the EB- 15 well , which prevents hydrocarbon from reaching it .as shows in Figure-10 .

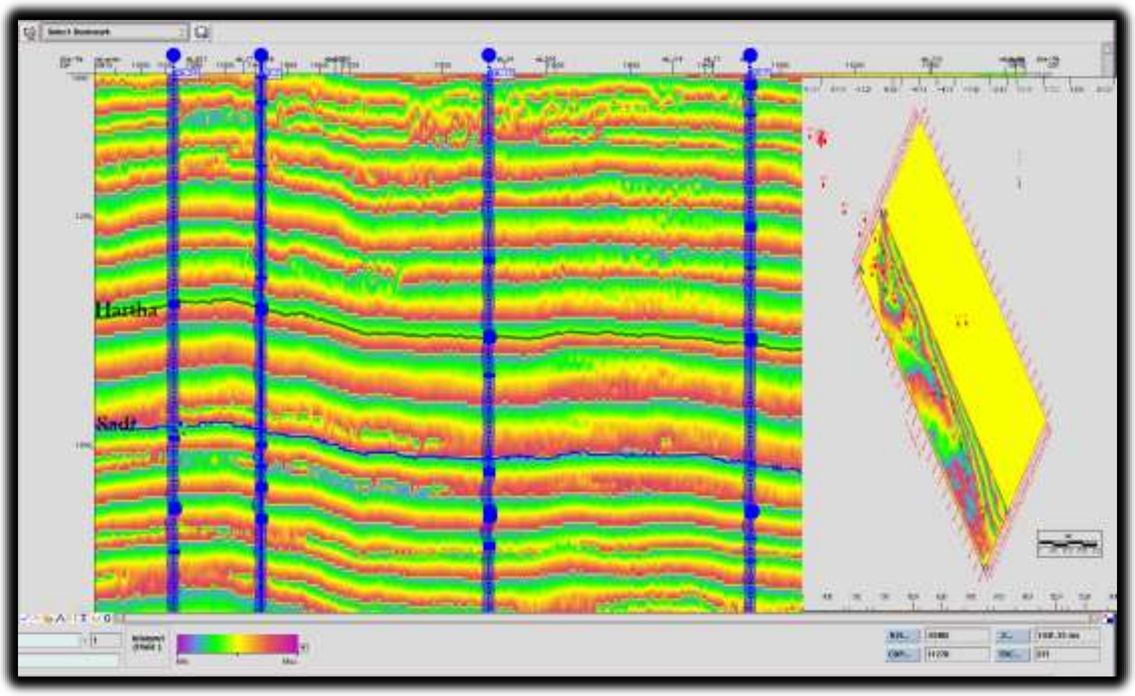

Figure 10- Shows facies change between track(EB-5, EB-15, EB-2 and EB-24) wells.

2- Instantaneous Frequency

One of the attributes applications used to determine the location of hydrocarbons . The instantaneous frequency application between two wells section to know and confirm the problem of the presence of oil in well EB- 5 and not being in the well EB-15. The instantaneous frequency value at well EB-5 is low, this indicates that it is porus, while when moving to a EB-15 well the instantaneous frequency value starts to increase with low pores [14,15] . The Figure -11 with inline 43890 shows exist facies change between the (EB-5 and EB-15) wells that prevents the arrival of hydrocarbons.

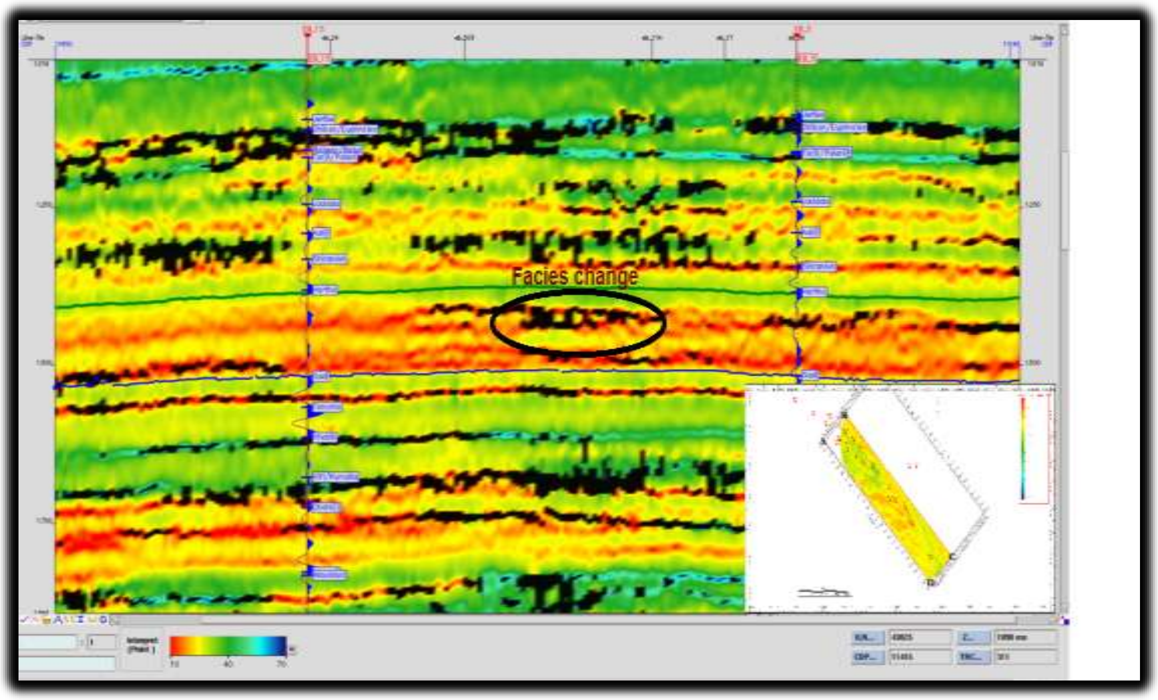

Figure 11- Shows Instantaneous Frequency inline 43890.

Facies Change

A lateral or vertical differentiation in the lithologic or paleontologic features at the same time of deposition [16]. It shows a change in the depositional environment . In Figure-12 with inline 40910 shows facies change, this result from variation at the sea level in this period. This difference reflects that the Hartha Formation is a beach area with a shelf environment, also noted the absence of the upper part of the Hartha Formation in the north-western part of the field that indicates that this area has been rose and eroded. Figure-13 shows two mounds and Normal Faults of Hartha Formation in inline (48310).

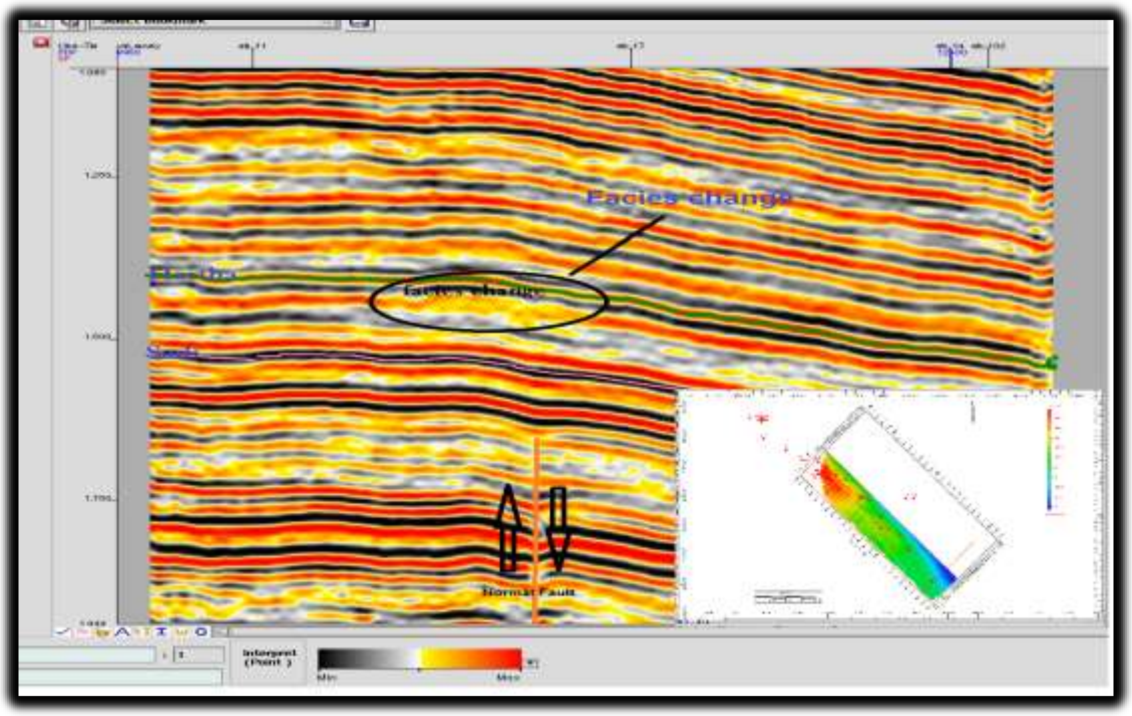

Figure 12- Shows the facies change of Hartha Formation in inline 40910.

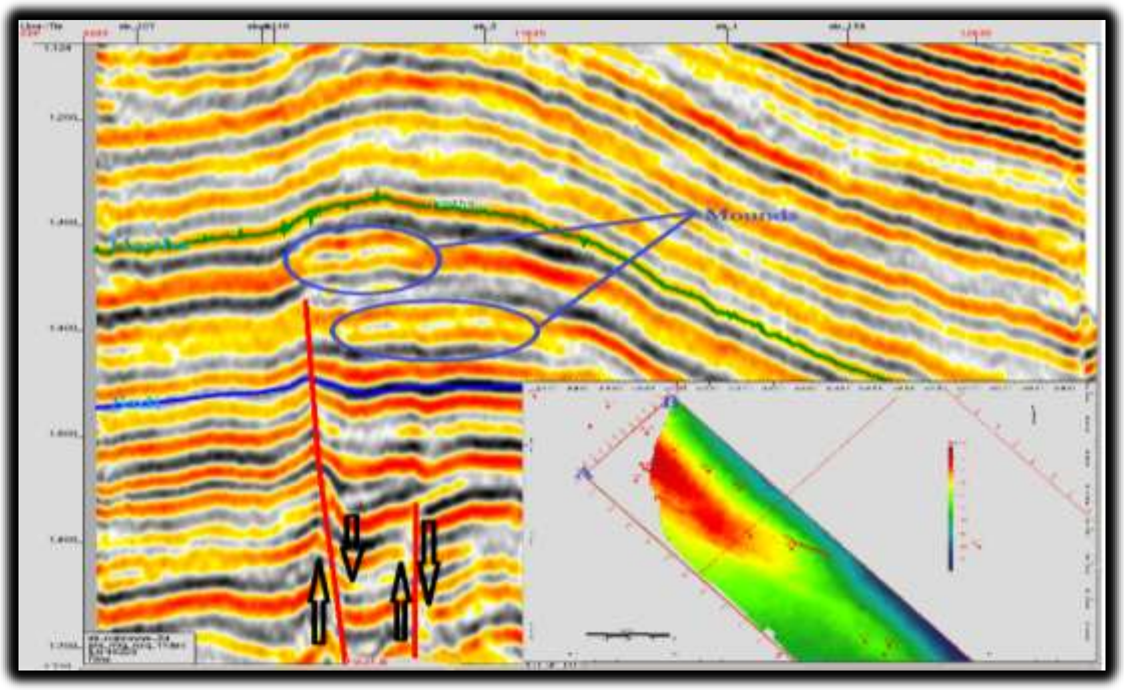

Figure 13- Shows mound on Hartha Formation in inline 48310.

Conclusions

The following conclusions can be derival from this research :-

1. Time slice map of base of Hartha showed the presence of faults in Cretaceous formations and the seismic sections showed the effect of faults on deeper formations and these faults end with Hartha Formation.
2. The TWT and depth maps of base of Hartha reflector showed that the structural picture of East Baghdad field as a structural nose opened toward NW . The values of TWT are low at the NW parts of the study area this indicates that this side is uplifted, on other hand the SE part of the study area is lower in the NW part because the TWT is high.
3. The area is exposed to rise due to faults and the presence of uncomformity in the northwestern part as well as the disappearance of the upper part of the Hartha Formation that indicates the area was exposed to erosion.
4. The reason for the lack of oil in EB- 15 well is due to facies change that means the reason is stratigraphy not structure, because there is no fault near this well.
5. The application of seismic attributes between wells EB-15 and EB-5 shows that there is a difference in the lithology and that the frequency value is low at the well 5 indicating that the porosity is high and vice versa for well EB-15.

References

1. Milson, John. **2003**. *Field Geophysics*. 3rd. Ed. University College London, 197 p.

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

3. Yilmaz, O. **1987**. Seismic Data Processing, SEG series. *Investigation Geophysics*, V.2 526 p.

4. Oil Exploration Company. **2013**. Geophysical-geological evaluation study for East Baghdad field (southern area 2) - 3D survey, *Oil Exploration Company Library*, **3**: 18p.

5. Oil Exploration Company. **2006**. Internal geological report for East Baghdad field, *Oil Exploration Company Library*, **2**: 22 p.

6. Al-Jawad, Mohammed Saleh and Kareem, Khalid Ahmed. **2016**. Geological Model of Khasib Reservoir- Central Area/East Baghdad Field. *Iraqi Journal of Science*, **17**(3): 1- 10

7. Anstey and Geyer. **1987**. *Borehole velocity measurements and the synthetic seismogram*: Boston, MA, IHRDC, 355 p.

8. Khorshid, Salman Z. and Kadhm, Ayat D. **2015**. Subsurface Investigation of Oligocene Geologic Formations Age, East Baghdad Oil Field, Central Iraq. *Iraqi Journal of Science*, **2016**, **57**(1A): 154-162.

9. Sheriff, Robert E.and Geldart, Lloyd P. **1995**. *Exploration Seismology.* (2 ed.) Cambridge University Press, pp. 415–418.

10. Jassim, S.Z. and Goff, J.C. **2006**. *Geology of Iraq*. Dolin, Prague, Czech Republic, ISBN 80-7028-287-8.

11. Khorshid, Salman Z. **2016**. Alki Haitham D. and Zaid Abdalkarim M., Subsurface Investigation of Merjan oil field Depending on 3D Seismic Reflection Central Iraq. *Iraqi Journal of Science*, **57**(4A): 2457-2469.

12. Taner, M.T. and Sheriff, R.E. **1977**. Application of Amplitude, Frequency, and Other Attributes to Stratigraphic and Hydrocarbon Determination. *In American Association of Petroleum Geologists Memoir*, **26:** 301-327.

13. Khorshid, Salman Z., AL-Sharaa, Ghazi H., Ali, Layalen H. **2016**, Seismic stratigraphy study of the east Razzaza within late Jurassic –early Cretaceous era (Central Iraq). *Iraqi Journal of Science*, **57**(4B): 2692-2704.

14. Vetrici, D. G., and Stewart, R. R. **1996**. 3-D seismic attributes. CREWES research report, p45.

15. Taner, T. **1992**. *Attributes Revisited, Rock Solid Images*. Houston, Texas (published **1992**).

16. Heckel, P.H. **1977**. Origin of phosphatic black shale facies in Pennsylvanian cyclothems of mid-continent North America. *American Association of Petroleum Geologist Bulletin*, **61**: 1045–1068.