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Seismic stratigraphy study of the east Razzaza within late Jurassic –early Cretaceous era (Central Iraq)

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Abstract

This study deals with seismic structural and stratigraphic interpretation that applied on the East Razzaza (central of Iraq) area, by using 2D seismic data from Oil Exploration Company. Three main seismic reflectors are picked. These reflectors are Zubair, Yamama and Gotnia Formations, which were defined by using petrophysical well logs and synthetic traces that calculated from sonic- logs of the wells East Baghdad-1(Eb-1) and West kifl-1(Wk-1) using Geoframe program, to suggest a stratigraphic model for them. Structural maps of formations are prepared to obtain the location and direction of the sedimentary basin and shoreline. Seismic interpretation of the area approves the presence of some stratigraphic features in the studied formations. Some distributary buildup mound and carbonate platform. Yamama is interpreted here to represent a carbonate platform. Seismic attributes technique was used to predict the physical properties distribution of Yamama succession. Instantaneous frequency and amplitude maps of Yamama shows low anomaly, this may indicate porous calcareous rocks in that location that contain fluids.

Keyword: Seismic stratigraphy-East Razzaza-Late Jurassic-Early Cretaceous.

دراسة زلزالية طباقية لشرق الرزازة ضمن عصر الجوراسي المتأخر –الطباشيري المبكر وسط العراق

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الخلاصة

هذهِ الدراسة تتعامل مع التفسيرات التركيبية والطباقية التي طبقت على منطقة شرق الرزازة– وسط العراق. بواسطة استخدام المعلومات الزلزالية ثنائية البعد المتوفرة في شركة الاستكشفات النفطية. حيث التقطت ثلاث عواكس للتكاوين الزبير واليمامة والقطنية. والتي التقطت من خلال استخدام المجسات البتروفيزيائية والاثار المصنعة للمجسات الصوتية للبئرين (شرق بغداد–1، غرب الكفل–1) بواسطة برنامج(Geoframe)،وذلك لغرض عمل موديل طباقي للعواكس.اعدت خرائط تركيبية للحصول على موقع واتجاه الحوض الرسوبي وتحديد خط الساحل. اثبتت التفاسير الزلزالية للمنطقة وجود ظواهر طباقية في التكاوين المدروسة منها تقبب متراكم ومنصة كاربونية وكذلك فسّر تكوين اليمامة بوجود منصة كاربونية متراكمة، كذلك استخدمت تقنية الملامح الزلزالية لتخمين الخواص الفيزياوية لتتابع اليمامة، خرائط التردد والسعة

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الانية لتكوين اليمامة اظهرت انخفاضات شاذة،وهذهِ تعتبر مؤشر على مسامية الصخور الجيرية الحاملة للموائع في المنطقة .

Introduction

The seismic reflection method absorbs more than 90% of the money spent world-wide on applied geophysics. Most surveys are aimed at defining oil bearing structures at depths of thousands of meters using hundreds or even thousands of detectors [1]. With reflection methods one can locate and map such features as anticlines, faults, salt domes, and reefs where many of these are associated with the accumulation of oil and gas [2]. The studied area (East Razzaza) is located in the middle parts of Iraq, and belong to three governorates (Baghdad, Karbala and Anbar governorates) on the western side of Mesopotamian basin between Euphrates river and Razazza lake, Figure -1. The aim of this research is to apply a new software interpretation system (Geoframe) to interpret a (2D) seismic data available in Oil Exploration Company for surveys carried out in East Razzaza for the purpose of application of seismic attributes to predict the hydrocarbon accumulations that may present within Zubair, Yamama and Gotnia Formations and determining the seismic structure, stratigraphic picture and facies changes for the Zubair, Yamama and Gotnia Formations in the area which are covered by two dimensional survey for locating the probable reservoir.

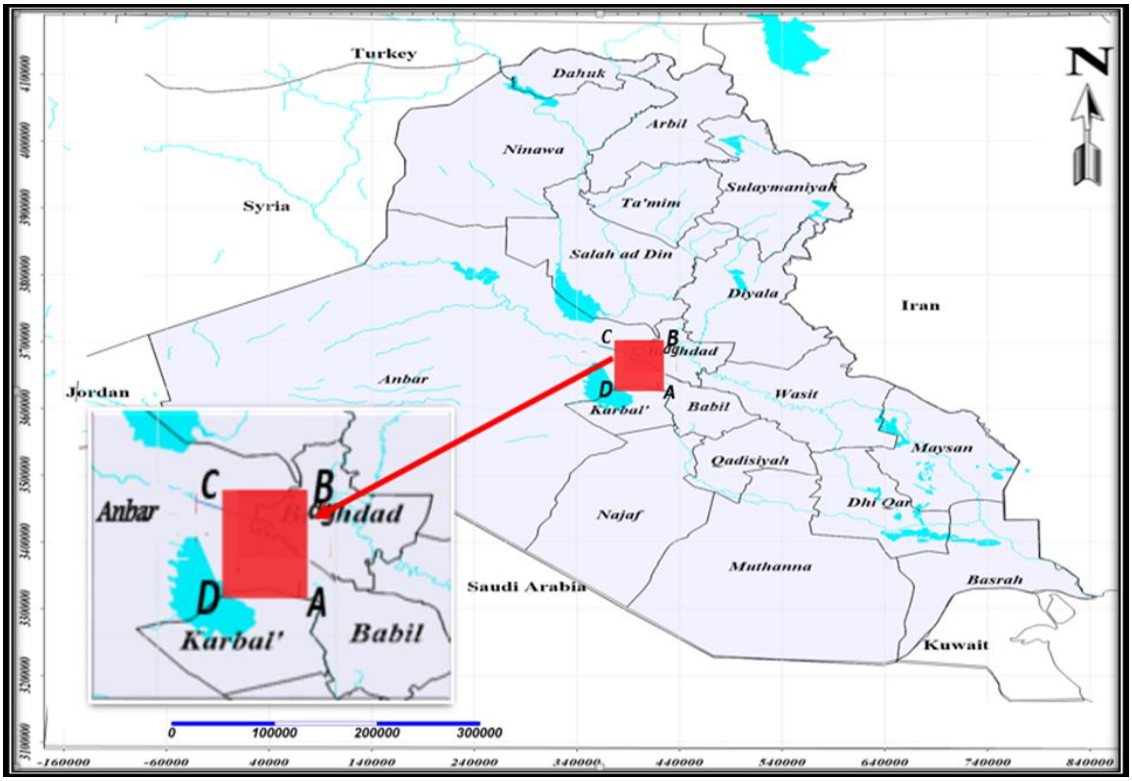

Figure 1- Iraq map shows the study area.

Data Acquisition

Base map preparation

Processed seismic data are loaded in the interactive workstation of interpretation in SEG-Y format and before starting; special subprograms must be operated to define the required data for loading. 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 strike line and dip line numbers, the separated distance between bin sizes along strike line direction and dip line direction. Base map includes definition of the geographic coordinates in UTM coordinates system of study area, Figure -2.

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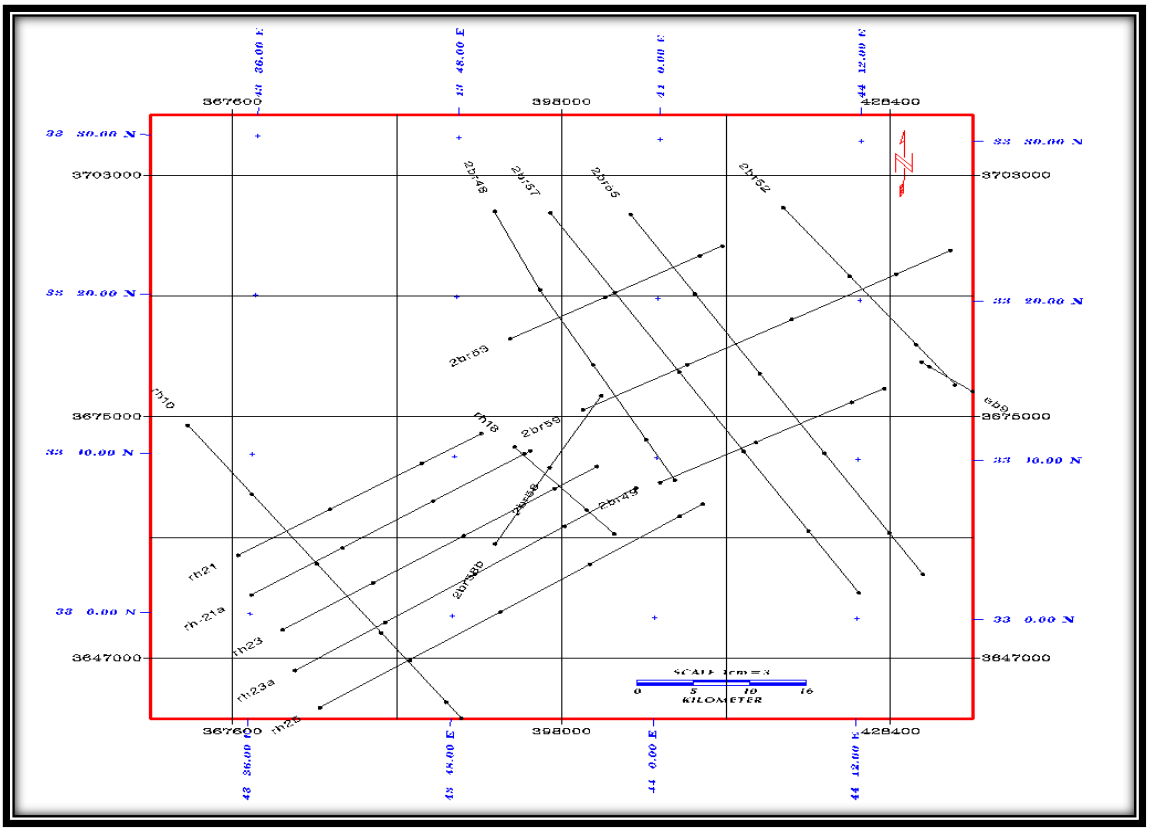

Figure 2- Illustrates a base map of study area, (2D survey).

Synthetic seismograms

Synthetic seismograms Figures- 3and4 are artificial reflection records made from velocity logs by conversion of the velocity log in depth to a reflectivity function in time and by convolution of this function with a presumed appropriate wavelet or source pulse [3]. Synthetic seismograms were generated for Eb-1 and Wk-1 wells using GeoFrame software package. Basically, seismic well tie allows well data, measured in units of depth, to be compared to seismic data, measured in units of time. The sonic and density logs were transformed from depth to time domain. This conversion will permits correlation of horizon tops identified in well with reflections present in the seismic section. The picked reflectors wavelets appeared as peaks on synthetic trace (positive reflection) but in different intensity. The Zubair corresponds to a trough. This is very reasonable because the rocks in Zubair are shale as well as the sandstone is characterized by high porosity and lower density. For this reason the reflection coefficient of sandstone in this interface is negative (trough).The Gotnia and Yamama corresponds to a (peak) because the rocks in Gotnia and Yamama are limestone which is characterized by low porosity and higher density. For this reason the reflection coefficient of this interface is positive (peak).

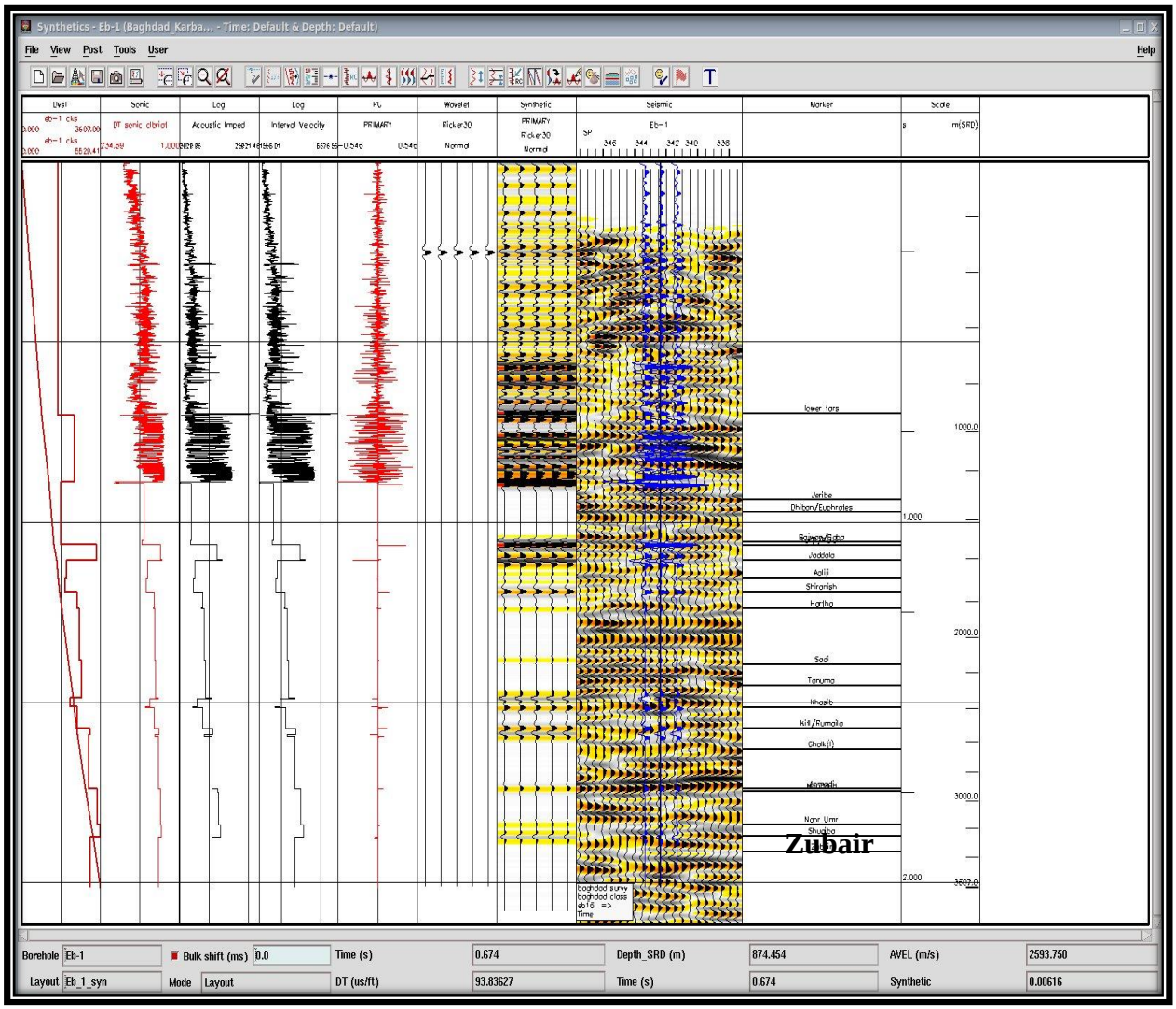

Figure 3- Illustrates the synthetic seismogram of Eb-1 well.

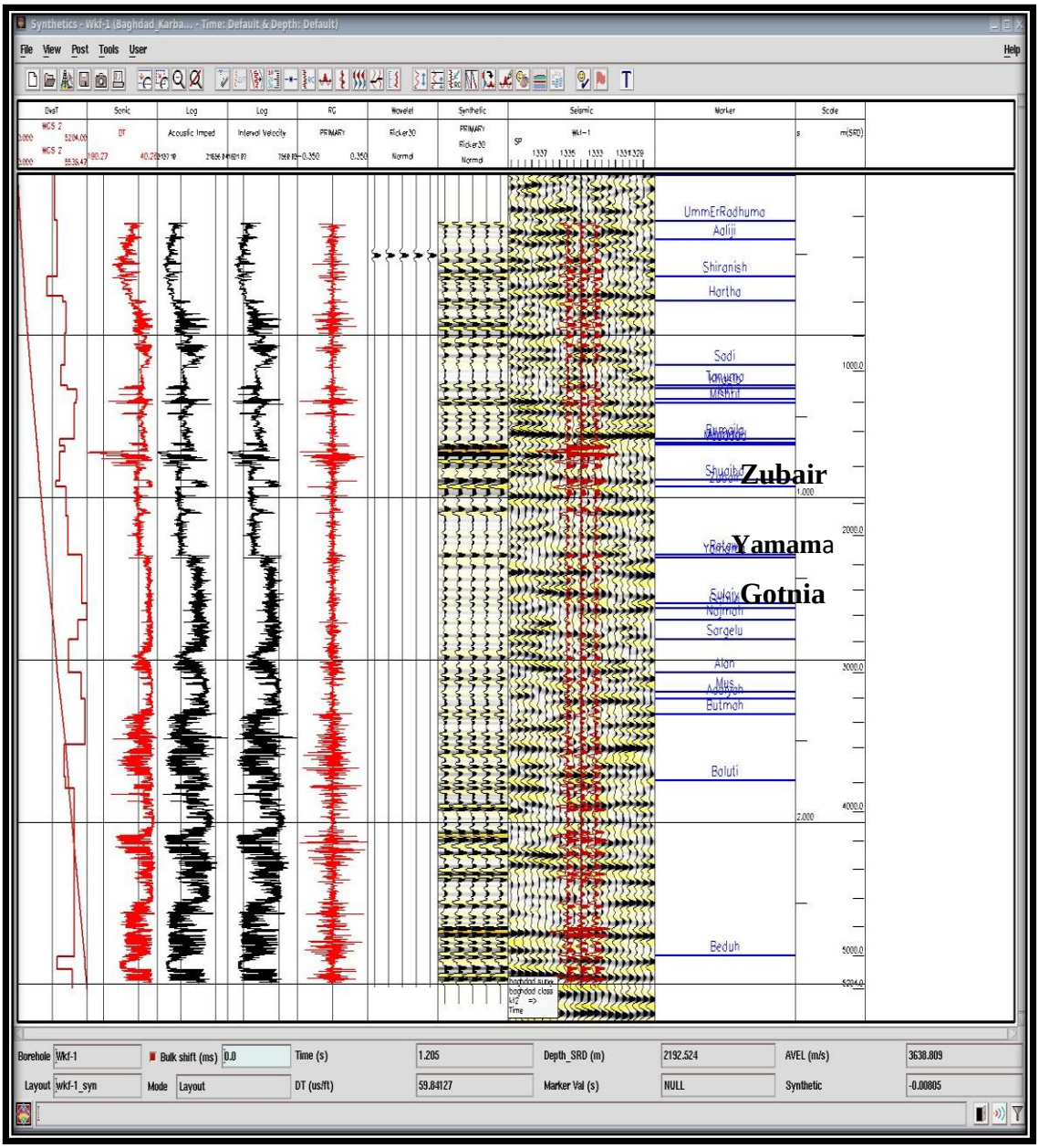

Figure 4- Illustrates the synthetic seismogram of Wk-1 well

Interpretation of Seismic Data

After completing the process of creating synthetic seismogram and identification of reflection then picking the reflectors represented by Zubair, Yamama and Gotnia Formations. As previously mentioned the synthetic seismograms have been created for Eb-1 and Wk-1, in order to identifying the reflectors will depend on:-

• The well records of sonic logs and integrated velocity survey.

• The well that was drilled in adjacent area.

• The synthetic seismogram was loaded on seismic section in order to match the seismic signal and the results of matching were very good.

Structural Picture of the picked Horizon

Depending on analysis of the seismic data, synthetic seismogram and well ties [4], it is easy to recognize and pick three reflectors: Zubair reflector, Yamama reflector and Gotnia reflector. After the definition of studied reflectors using synthetic seismograms in time domain for wells (Eb-1,Wk-1), we picked these reflectors in all area to prepare the time maps which are converted later to structural maps in depth domain by using velocity data of these reflectors, for describe the structural features of selected horizons from two way time(TWT) structure maps.

Time, velocity and depth maps

Time maps

The time maps may carry important information on the subsurface geo-logic features. Zubair, Yamama and Gotnia Formations two way time maps. Figure -5 shows Yamama TWT map as an example which is dominated by NE-SW trending high to the East and drops to the West. The structure rises sharply to the North East. In the middle area the structure depicts ridges extends NW-SE trend on the surface it takes nose structure shape. These ridges represent accumulation of sediments which may contain oil.

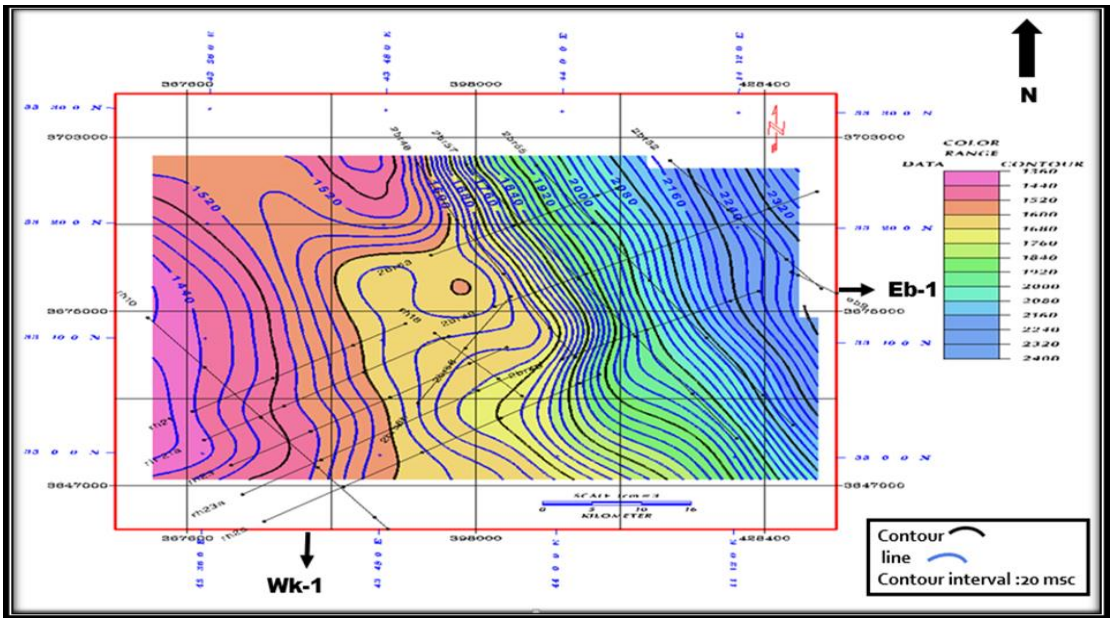

Figure 5- Shows the Yamama two way time map.

Velocity maps

To obtain depth maps, the picked time data of any reflector is needed to the velocity data. The more accurate velocity to be used in time to depth conversion is the average velocity, which can be computed directly from well velocity survey (check shot) [5]. For the two wells the area (Eb-1 and Wk-1), check shot data are used to prepare the velocity maps. The velocity map of Gotnia shows the average of velocity increases in SW trend, Figure -6.

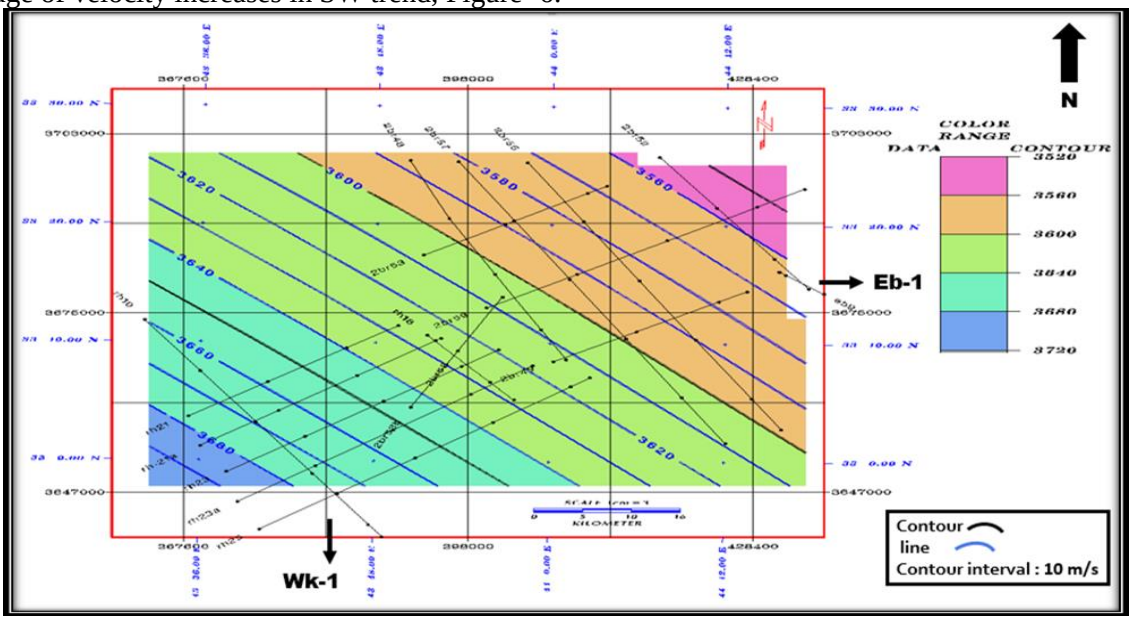

Figure 6- Shows the Gotnia Velocity Map.

Depth maps

The time map of a given reflector is used with its average velocity map to extract the depth map, as follows:

Depth at any point = (velocity × TWT /2) at this point.

Zubair, Yamama and Gotnia depth maps reveal a structural feature having a general trend in the SE-NW direction. We noticed a decrease at the West and gradually increases toward the East and North East of the basin. The noses of structure observed in the middle part of the area, Figure -7 shows Yamama depth map as an example.

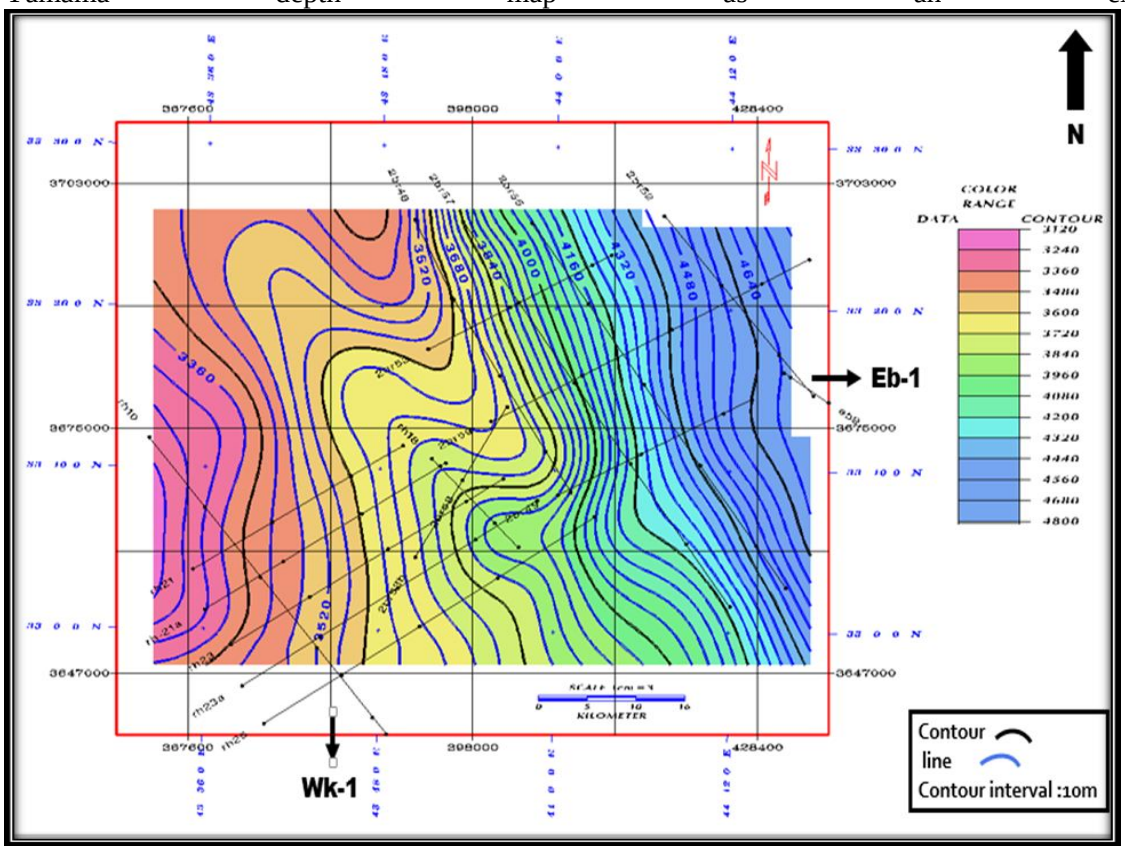

Figure 7- Shows the Yamama- depth structure map.

Stratigraphic Interpretation

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 [6]. Based on seismic character and reflections patterns two distinct intervals were observed and distinguished in the preview 2D seismic survey; these intervals are:

1. An upper interval of parallel folding reflections comprising the (Zubair–Yamama) Formations. This sequence separates middle cretaceous from lower cretaceous Zubair Formation which represent the first sequence.
2. A basal interval of semi-parallel slightly diverging reflection comprising the (Yamama- Gotnia) Formations.

Sequence Stratigraphy of the Studied Formations

- Zubair Formation

The Zubair Formation is interpreted to show thickness and depositional sequence represented by using the log data for the identification of the individual parasequences within Zubair area. Both Eb-1, Wk-1 wells are essentially composed of alternating shales and sandstones with some siltstones. The variation in lithology displays some regularity, towards the shore. In the west the formation is composed mostly of sands only. Towards the basin the formation contains more and more shales and becomes almost purely shale near the east of the area.

-Yamama Formation

Yamama Formation is interpreted as three depositional sequences representing the base which is an initial low stand (LS), remaining to top as carbonate package; it represents the highstand (HS) and transgressive systems tracts (TST). Within the Yamama sequence, three reflection sequences that can be mapped across the entire platform top, Figure-8. The Yamama sequence appears to initially backstep and then prograde from SW-NE in the highstand. These latter seismic events can be interpreted as prograding clinoforms. Major interpreted environment of deposition are interpreted including the shelf margin, upper slope and inner shelf, and basin. Note that transgressive and high stand system tracts dominate, with transgressive system tracts being associated with major periods of shelf margin aggradations, as build-up and rising sea level. In terms of petroleum systems we are most likely to encounter source rocks in the deep water basinal settings. Reservoir distribution is harder to predict because of the effects of complex diagenesis associated with carbonate rocks. Primary reservoir facies would be concentrated within and around the rim margin (reefs, rudist build-ups and oolitic shoals) Figure -9.

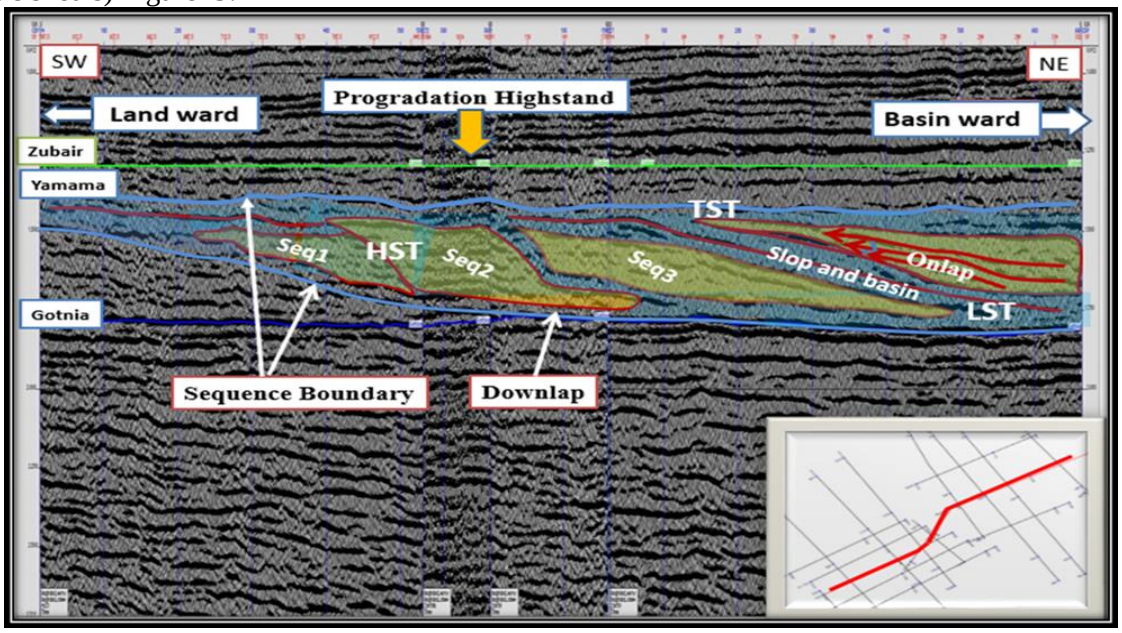

Figure 8- Illustrates sequence stratigraphy of the section.

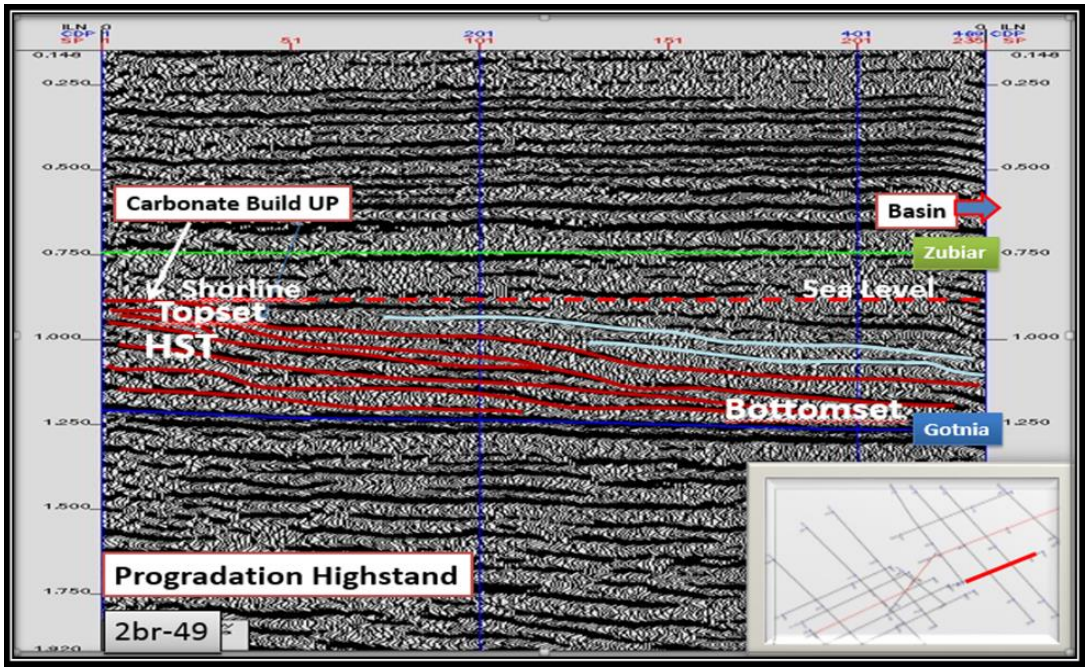

Figure 9- Shows reservoir facies.

-Gotnia Formation

Gotnia sequence represents a complete carbonate sequence which was deposited on the shelf and continental slope of the basin. It is clear on seismic section and in Wk-1 well. The lithological data from wells indicates that Eb-1, Wk-1 consist mainly of argillaceous limestone, evaporate and marls, which is an indicator of deep water environment. It is thought that the continued progradation causes the basin itself to become smaller in areal extent and therefore creates an evaporitic basin. This interpretation appear continued progradation further away the basin off from marine circulation and creates an evaporitic basin.

Seismic Reflection Configuration

In the studied area of two Formations (Zubair- Gotnia), two main types of seismic reflection configuration are observed.

1- Zubair reflector display parallel configuration.

2- Yamama to Gotnia display the progradational configuration.

Zubair reflector is characterized by high to moderate amplitude and continuity. Reflection configurations of Zubair indicate wide, relatively uniform lateral extent in sedimentary basin, and limestone strata; sandstone is rare. The shelf facies consist of neritic shale and generally transgressive. While Zubair represents delta platform facies consisting of shallow- water, high-energy marine (delta-front) sandstone. The second type of reflection configuration in the studied package which includes Yamama and Gotnia reflectors is progradational configuration, with two fundamentals types of progradational configuration called oblique and sigmoid. The concluded sigmoid model is associated with progradation of shelf system. The depositional energy may be high, and the evidence on that is the reefal limestone and predominance of oolites in Yamama, Figure -10.

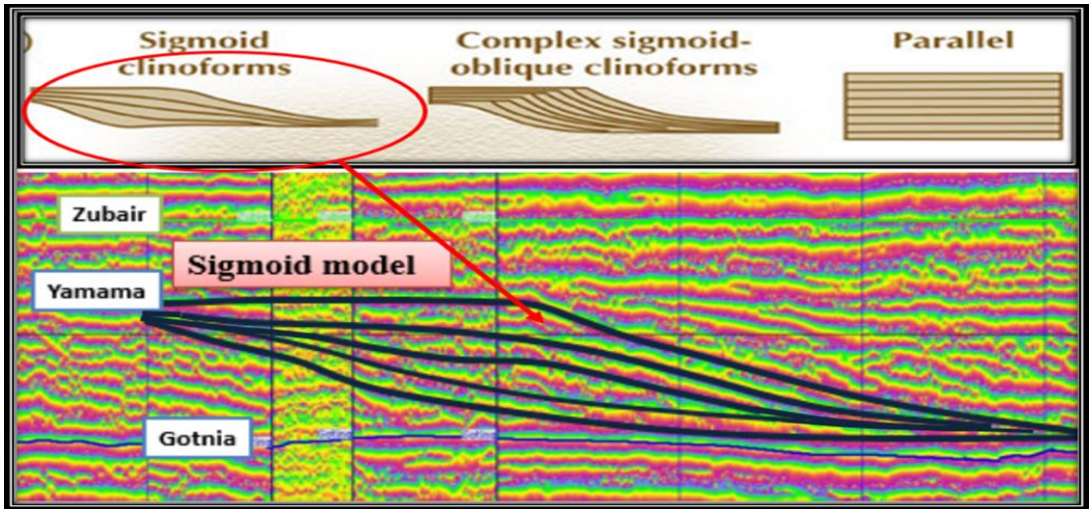

Figure 10- Shows sigmoid model in the study area.

Seismic Attribute Sections

Instantaneous phase

Instantaneous phase is measured in degree ($-\pi$, π) it is independent of amplitude and shows continuity and discontinuity of event, it show bedding very well and its best indicator of lateral continuity. Figure -11 is useful to explain the system tract model.

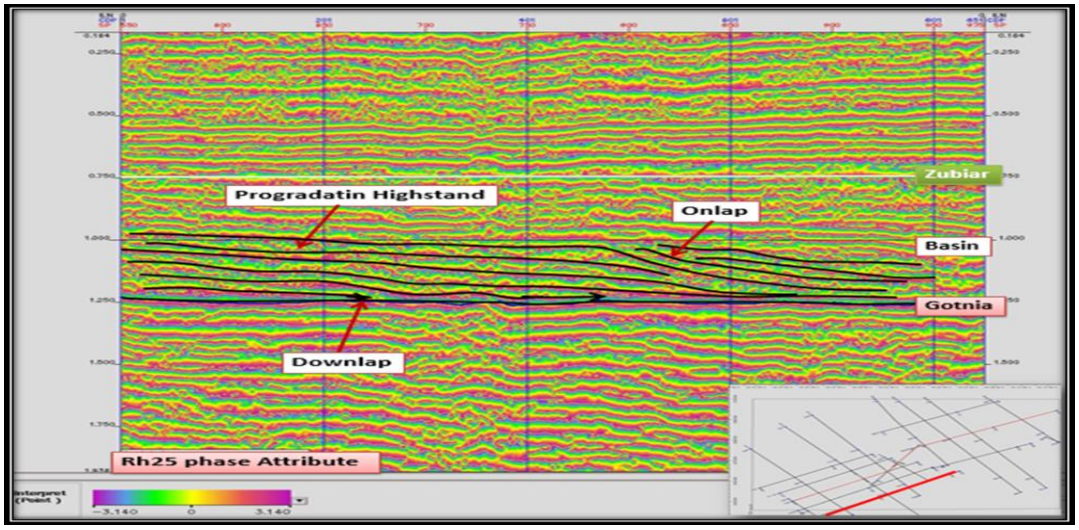

Figure 11- Application of Instantaneous phase attribute on the 2D seismic section in the study area.

Instantaneous Frequency Sections

It is used for visualizing regional depositional patterns [7]. Frequency tuning can indicate changes in bed thickness. Spikes indicate noise or discontinuous points where frequency can become zero, negative or anomalously large, Figure- 12.

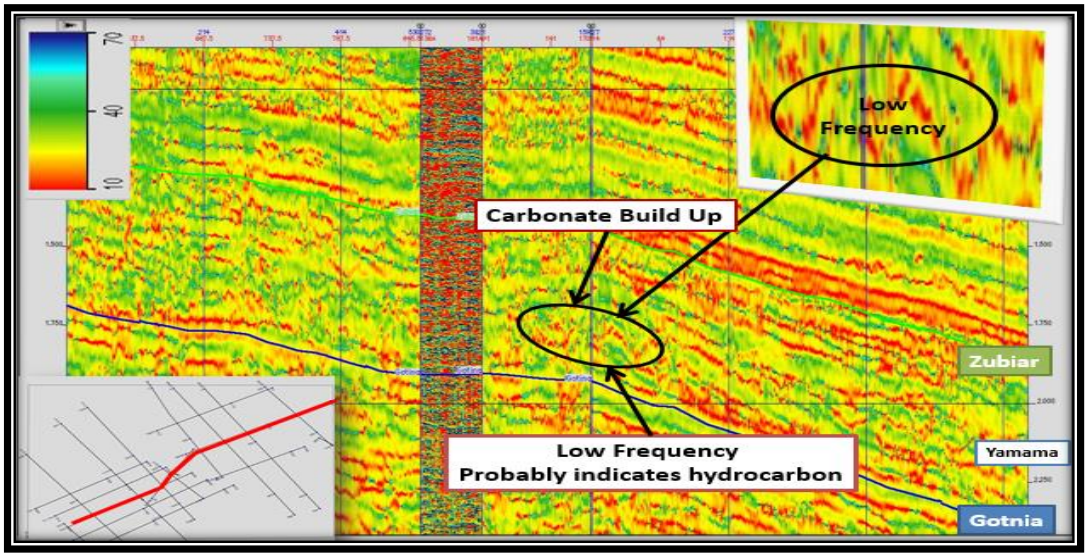

Figure 12- Shows Instantaneous frequency attribute in the study area.

Mound

Reflection from top and side of the depositional feature, and onlap of overlying reflection on to buildups [8]. Many seismic attributes displayed are useful to explore the stratigraphic phenomena in the area like channel, mound, and unconformity. Figure -13 explains the mound by applying phase attribute photo gray on composite section.

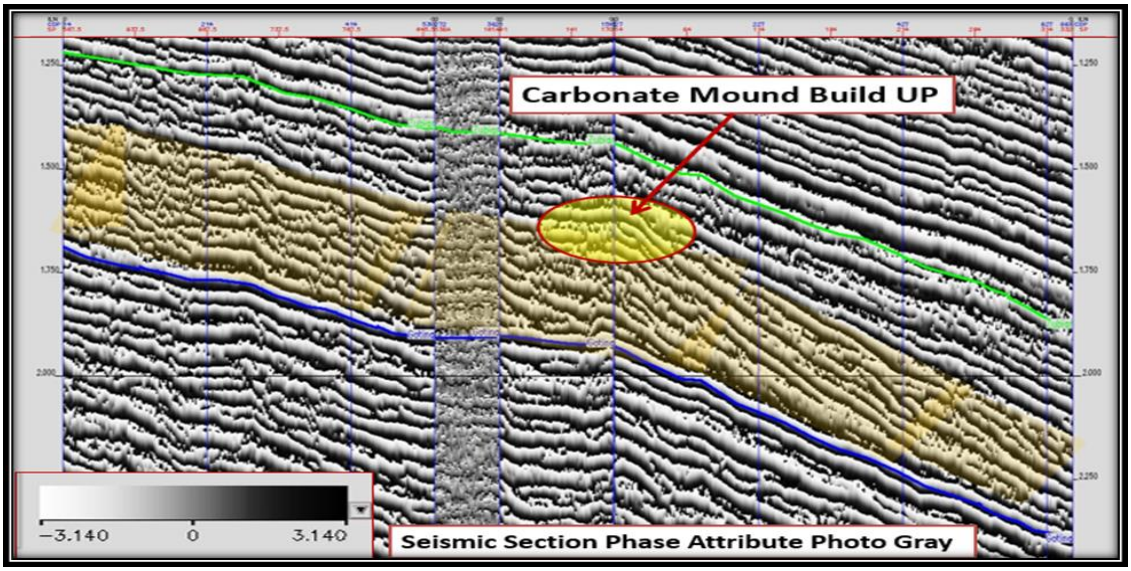

Figure 13-Seismic section phase attribute photo Gray in the study area.

Geological model

Geophysical data are best interpreted in tight integration with the geological data. Combining the most practical and effective geophysical data, 2D geological modelling works to achieve business-focused results. 2D geological models are attributed with petrophysical properties and adjusted to match the geophysical field data. Our structural, formational, and facies modelling software tools ensure that 2D geological models respect a consistent structural, stratigraphic, and topological framework in addition to ensuring consistency between the geological models and geophysical data. Working with an extensive set of 2D, exploratory data analysis to ensure data integrity and enhance interpretational insight, providing results in common 2D formats for the easy communication of ideas. All required link data that work on it to make the best image to the subsurface. Figure -14 shows the best image for geological model that is correspond with the interpreted seismic data. On the basis of interpreted data it will be able to identify two of the stratigraphy traps, and identify two well (A-Well in the sequence-1 of Yamama Formation and B-Well in the Sequence-2 of Yamama Formation).

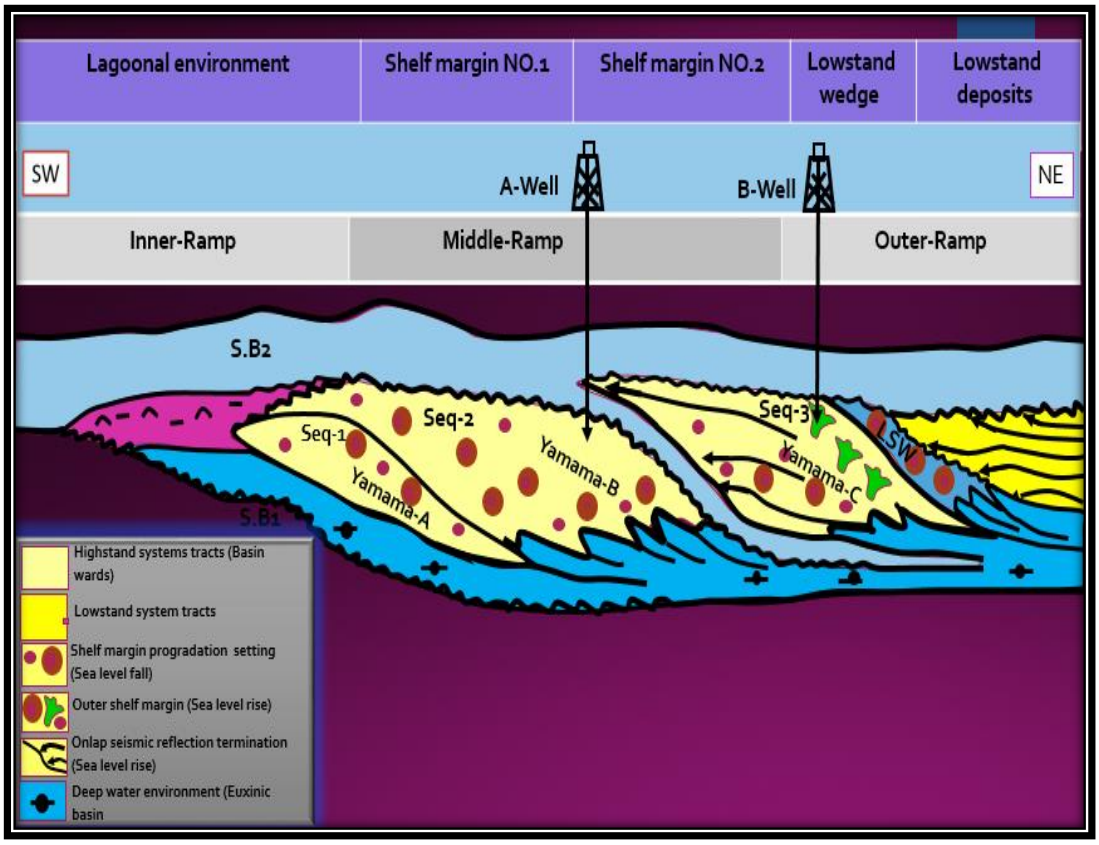

Figure 14- Shows the stratigraphy traps and the proposed wells by geological model.

Conclusions and Recommendations

Gotnia, Yamama, and Zubair wavelets appeared on synthetic seism-ograms as peaks (Yamama and Gotnia) and trough (Zubair) in different intensity, because they have higher density than the above and under reflectors densities. The TWT depth maps and average velocity maps of the studied area showed the structural picture of East Razazza. The trending structural noses was toward NW-SE, these noses are compatible with carbonate build up features, which identified in the region. Depth maps reveal that the minimum depth values are noticed at the west and gradually increase toward the east and northeast till the middle part of the axis where structural anomalies and rises are observed. The deepening increases from west to northeast, which reflects the transition from the continental slope towards the basin. This is confirmed by the behavior of the TWT and average velocity maps. Two seismic facies were determined: Zubair reflectors display parallel and Yamama and Gotnia facies is progradational configuration (sigmoid) subjected to truncation erosion to steam onlap onto carbonate platform surface. Yamama Formation is interpreted as three depositional sequences representing the base which is an initial low stand, remaining to top as carbonate package; it represents the highstand and transgressive systems tracts. The geological model that was drawn is the final outcome of the research, where identifying two stratigraphic traps promising hydrocarbon.

We recommend to use three-dimensional surveys to obtain high resolution power to confirm the stratigraphic features on the time sections, study more wells surrounding the studied area and correlate many wells probes, also drilling of wells that have been identified and that penetrate to Yamama Formation.

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