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## Structural Interpretation of Seismic Data of Mishrif Formation in East Abu-Amoud Field, South-eastern Iraq

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### Abstract

The seismic method depends on the nature of the reflected waves from the interfaces between layers, which in turn depends on the density and velocity of the layer, and this is called acoustic impedance. The seismic sections of the East Abu-Amoud field that is located in Missan Province, south-eastern Iraq, were studied and interpreted for updating the structural picture of the major Mishrif Formation for the reservoir in the Abu-amoud field. The Mishrif Formation is rich in petroleum in this area, with an area covering about 820 km<sup>2</sup>. The seismic interpretation of this study was carried out utilizing the software of Petrel-2017. The horizon was calibrated and defined on the seismic section with well-logs data (well tops, check shot, sonic logs, and density logs) in the interpretations process for identifying the upper and lower boundaries of Mishrif Formation. As well, mapping of two-way time and depth structural maps was carried out, to aid in understanding the lateral and vertical variations and to show the formation of the structural surfaces. The study found that Mishrif thickness increases toward the east, which means that it increases from the Abu-Amoud field in Nasiriyah towards the East Abu-Amoud field in Missan province. The aim of the study is to draw a high-resolution structural image of the East Abu Amoud field in southeast Iraq and to show the types of the existing faults and structures in the study area.

**Keywords:** Mishrif Formation, Structural interpretation, depth map, Abu-Amoud field.

التفسير التركيبي للبيانات الزلزالية لتكوين المشرف في حقل ابوعامود الشرقي، جنوب شرق العراق

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### الخلاصة

تعتمد الطريقة الزلزالية على طبيعة الموجات المنعكسة من السطوح البينية بين الطبقات، والتي بدورها تعتمد على كثافة وسرعة الطبقة، وهذا ما يسمى بالمقاومة الصوتية. تمت دراسة وتفسير المقاطع الزلزالية لحقل أبو عامود الشرقي الواقع في محافظة ميسان، جنوب شرق العراق لتحديث الصورة التركيبية لتكوين المشرف الرئيسي للمكمن في حقل أبو عامود الشرقي. تكوين المشرف غني بالهيدروكربونات في هذه المنطقة، والتي تبلغ مساحتها حوالي 820 كيلومتر مربع. تم تنفيذ التفسير الزلزالي لهذه الدراسة باستخدام برنامج البتريل 2017. تم

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معايرة العاكس وتعريفه في المقطع الزلزالي لبيانات سجلات الآبار: سطح التكوينات، ومعلومات لقطعة الفحص، والسجلات الصوتية، وسجلات الكثافة في عملية التفسيرات لتحديد الحدود العليا والسفلى لتكوين المشرف. وكذلك تم رسم الخرائط التركيبية الزمنية والعمقية التي تساعد في فهم التغيرات الجانبية والعمودية وإظهار تكوين الأسطح التركيبية، ووجدت الدراسة أن سمك المشرف يزداد باتجاه الشرق مما يعني أنه يزداد من حقل أبو عامود في الناصرية باتجاه حقل شرق أبو عامود في محافظته ميسان. الهدف من الدراسة هو رسم صورة تركيبية عالية الدقة لحقل أبو عامود الشرقي الواقع جنوب شرق العراق وبيان أنواع الغوائل والتراكيب الموجودة في منطقة الدراسة.

## Introduction

Mesopotamia Basin in central Iraq is one of the basins of major importance in the world in containing petroleum fields. It constitutes a wide asymmetric syncline with different structures in complexity [1]. East Abu-Amoud field is one of the most favorable hydrocarbon fields in the Mesopotamian basin. Mishrif Formation is a heterogeneous carbonate Formation. It represents the most productive petroleum-producing reservoir in southern Iraq, deposited during the Upper Cretaceous age within the main retrogressive depositional cycle "Cenomanian-Turonian stage" in this area. The Mishrif Formation is divided by a prominent unconformity to two big-scale regressive sequences, that are particularly distinguished in the east of Mesopotamian Basin. Several units of the reservoir are existing in both sequences. The west part of the basin is predominated by the lower sequences, which have relatively little reservoir intervals. The shallower water reservoir units in the east of the basin are thick, reflecting relatively high subsidence rates throughout the Cenomanian. Subsidence rates in the western part of the basin are lower, while reservoir units are thinner and more bounded. The stratigraphic relations between carbonate deposits of the top of Mishrif and the top of Rumaila Formations in central Iraq are complex. Carbonate was deposited in either (1) an outer shelf or basin setting the Formation of Rumaila; or (2) the shallowest water inner shelf setting of the Mishrif Formation. The Rumaila Formation units constitute fine-grained marly and chalky limestones; they alternate with the thicker units of the Mishrif Formation, which in general are composed of coarse-grained carbonate.

The role of the seismic reflections method in petroleum research is to provide the most precise pictorial representations of the earth's underground and its geological structures. It confers seismic data, velocity, and time contour maps to determine traps of structural, stratigraphic and seismic facies. It is utilized in achieving an internal stratigraphic geometry interpretation in terms of environmental paleo-geographic depositions, in adding to sedimentary analysis of basins [2].

Reflection coefficients of successive interfaces between the layers function of reflection of the reflection coefficient or log is known. These logs are derived from the acoustic impedance log. The function of reflectivity is the property of layers that we are looking for [3].

Karim and Al-Aaraji (2021) [4] carried out a study concerning the stratigraphic and structural seismic interpretation of Yammama Formation in East Abu-Amoud Field, Missan Province, Southeastern Iraq. The study aims to update the structural image of the Yammama oil Formation in the field.

The main goal of the present paper is to study the structural interpretation of seismic data of Mishrif Formation in East Abu-Amoud Field, Southeastern Iraq.

## Area of study

The results of the gravity (achieved by BPC, Basra Oil Company) and aeromagnetic (achieved by CGG, the Geophysical French Company) surveys are promising to implement detailed surveys of the areas, as the structural setting shows the hydrocarbon potential in other areas of southern Iraq, involving the study area [5]. East Abu-Amoud field is located in southern Iraq within the administrative boundaries of Missan Province. It is about 45 km west of Amara district, and 40 km southeast of Abu-Amoud field. The area is characterized by its

flat terrain, situated within a flat alluvial sediment region. The study area is surrounded on the eastern side by the marshland region, where it is affected by the high levels of water during the flood period, as shown in Figure 1 [6, 7].

Points	Coordinates	
	X	y
A	631912.78	3535098.82
B	624946.03	3520230.01
C	674111.80	3499091.72
D	682934.94	3516819.96

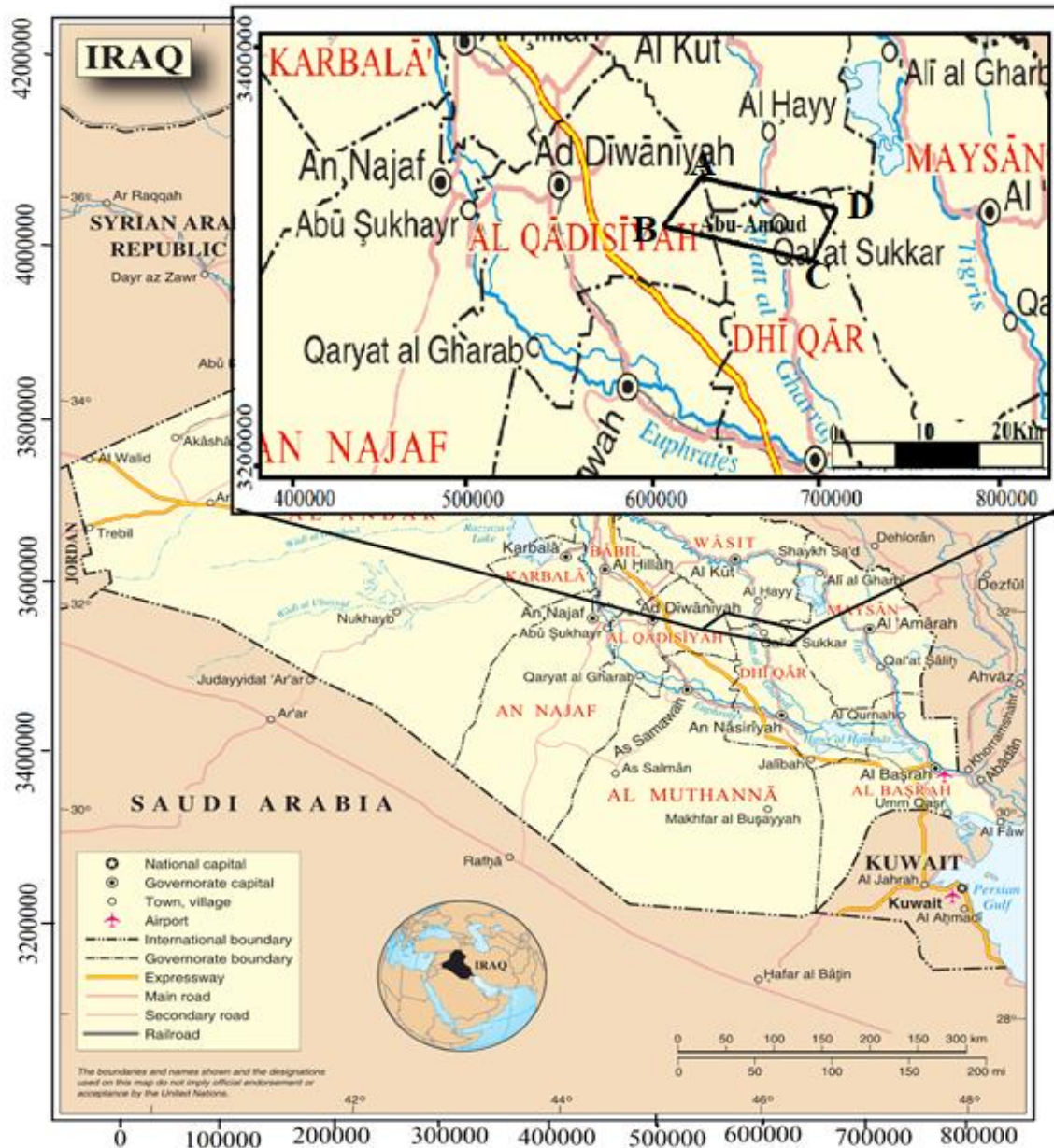


Figure 1-Location map of the study region.

**Geological setting**

Both tectonic and isostatic activities are controlling depositions of the Mishrif Formation in Iraq. According to the stratigraphic sequence of the upper Cretaceous age in Iraq [6], the



Mishrif Formation belongs to the latest Cenomanian-Early Turonian stage Super-sequence. In turn, it is equivalent to the topmost portion of the tectonic stratigraphic Megasequence [8], which was deposited on a passive margin setting. The study region is located in the Mesopotamian structural zone, which is subdivided into the Zubair, Tigris, and Euphrates tectonic subzones [9]. The stratigraphic profile of this subdivision shows an evident thickness of the Mishrif Formation along the Tigris subzone, which implies high subsidence rates there. Each of these subzones is, in turn, distinguished by high and low structures with various trends that were formed by the deformation of the northeastern Tethyan margin of the Arabian Plate in the Cenomanian Early Turonian ages (Figure 2) [10]. Several structures in southern Iraq are the consequence of salt diapirism, as specified by the existence of negative gravity residuals below some supergiant oil field structures, like Zubair, Rumaila, and Nahr Umr [6, 9, 11, 12]. Some of these structures began rising during the Early Jurassic [13].

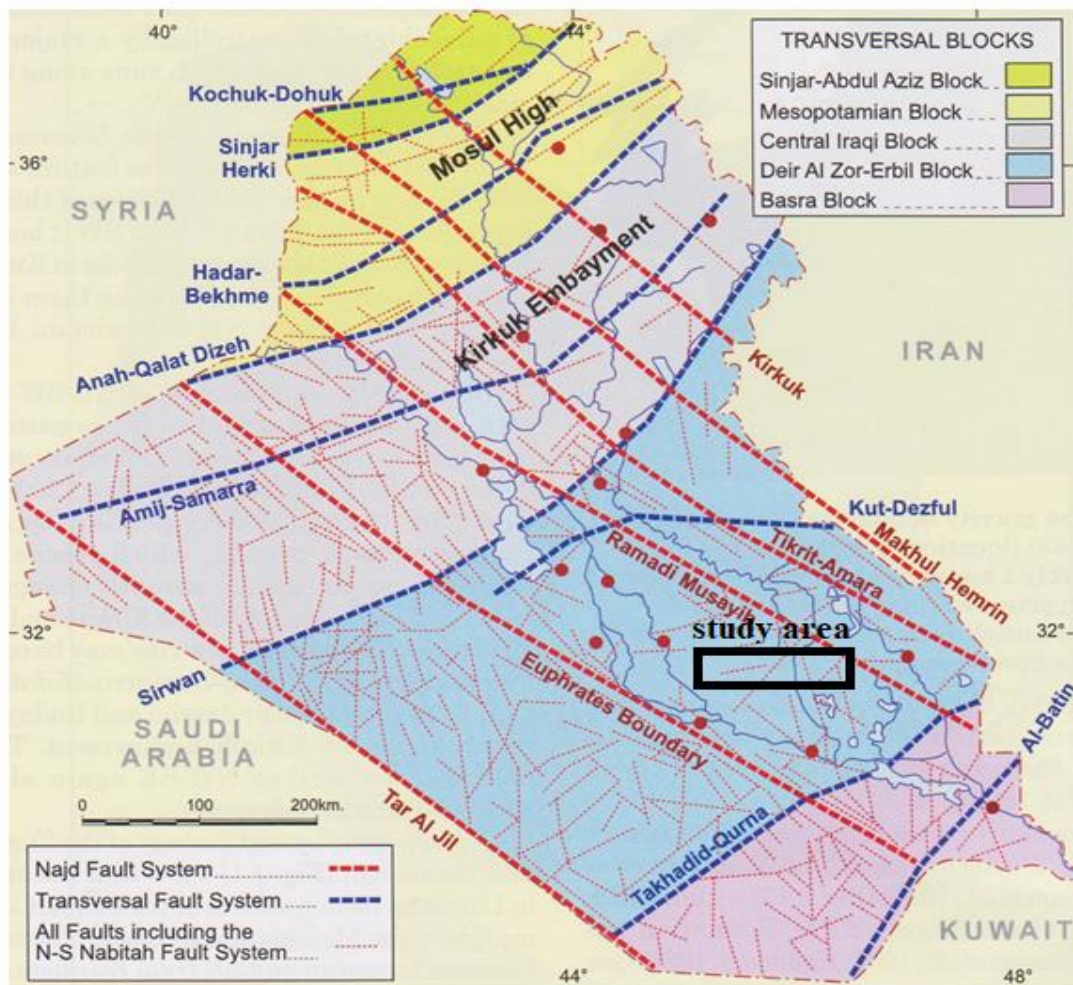
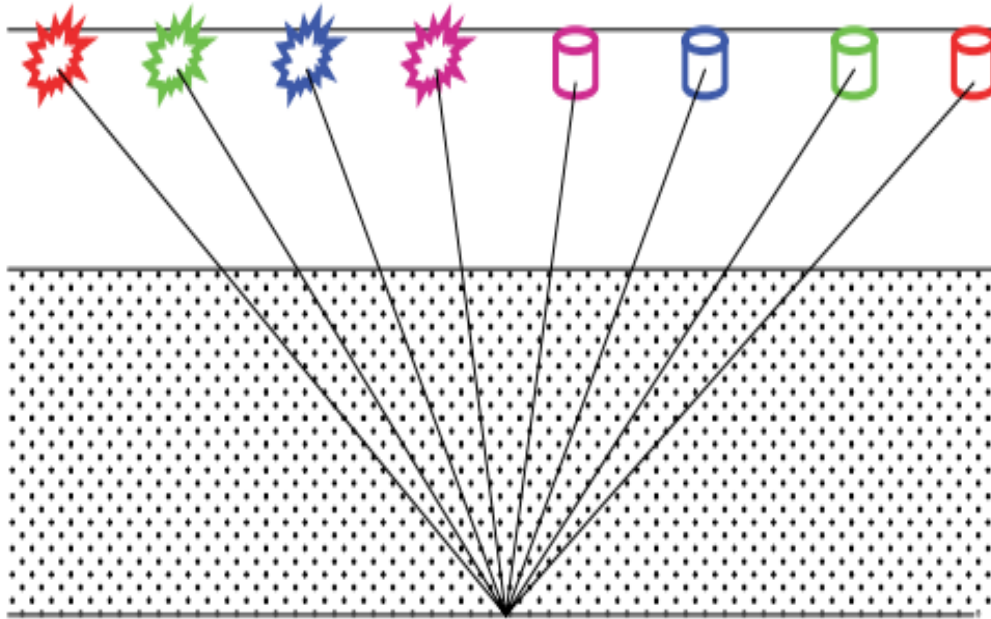


Figure 2-Fault systems in Iraq [7].

### Seismic waves reflection

Reflection of seismic waves is an approach of geophysics exploration which utilizes the essentials of seismology for the estimation of the properties of earth subsurface from reflected seismic waves. The method requires a controlled seismic energy source, such as dynamite, air gun, or a seismic vibrator. Seismic waves cause mechanistic disturbance which travels in the earth at a velocity controlled by the acoustic impedance of the medium in which they are traveled. The acoustic impedance,  $Z$ , is calculated by the function:  $Z = v * \rho$ , where  $\rho$  is the density of the layer and  $v$  is its velocity. The goals of seismic interpretation are to

achieve a geological information from the maps of the interpreter's seismic reflections [17].  
Seismic



**Figure 3-**Generation of several fold coverage during seismic surveys [17].

interpretation involves traces and correlations along with continuous reflectors through-out the 3D dataset, utilizing these as essentials to the geologic interpretation [16]. The aim of seismic interpretation is the production of structure maps that reflect the spatial variation in depth of given geologic layers. Utilizing these maps, the petroleum traps can be specified and models of the subsurface can be generated, which allows volume computations to be made, as shown in Figure 3 [15, 16].

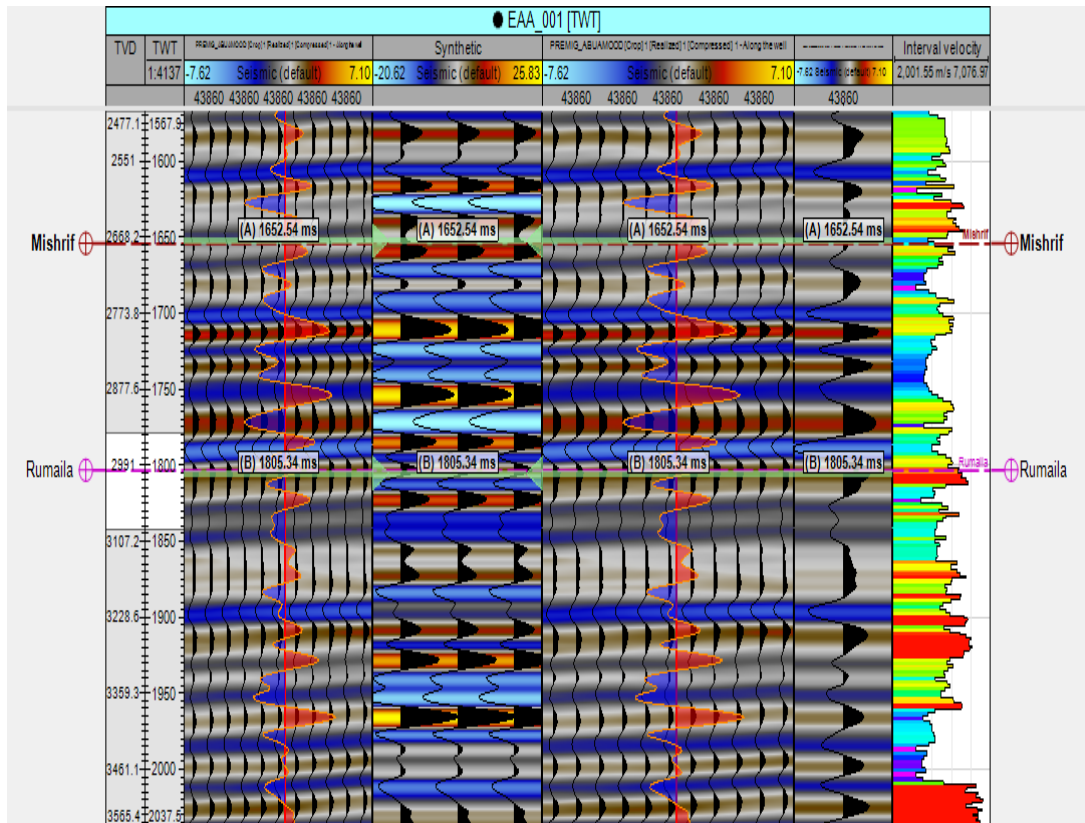
$$RC = \frac{(Z_2 - Z_1)}{Z_2 + Z_1} \quad \text{-----} 1$$

RC= Reflection coefficient

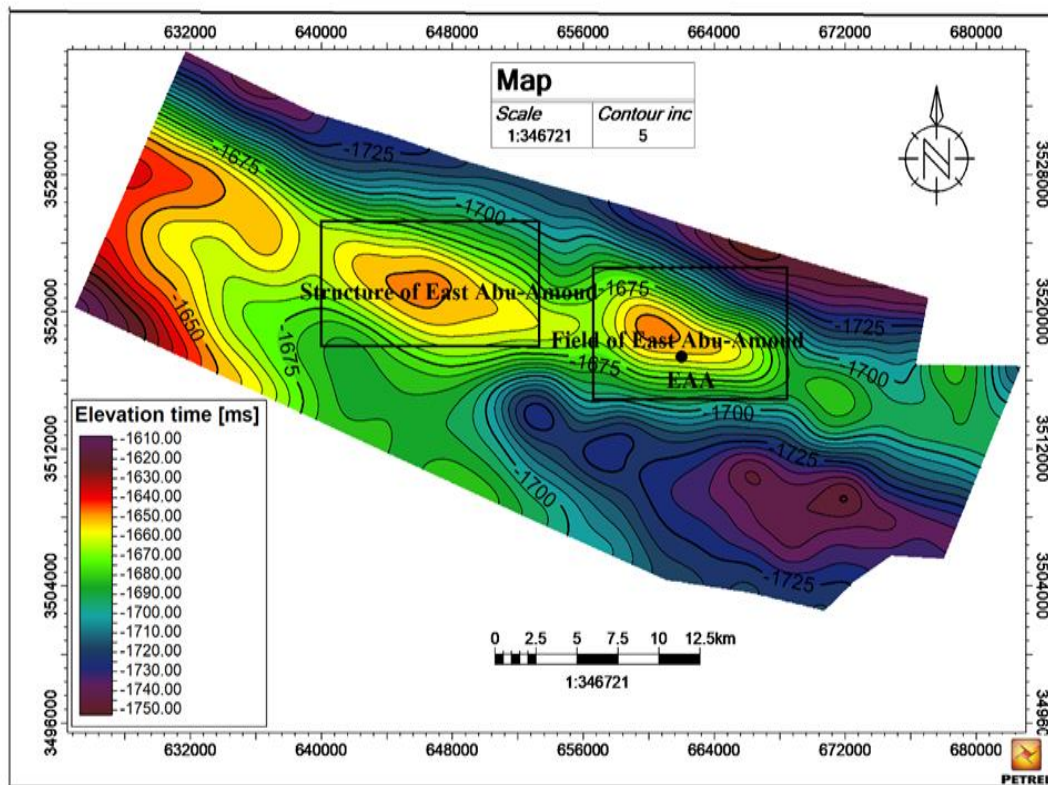
The aim of the present study is to draw a high-resolution structural image of the East Abu Amoud field in southeast Iraq and to show the types of the existing faults and structures in the study area.

### Methodology

To achieve the objectives of studying and updating the subsurface image of Mishrif Formation, which is the major formation of interest in this study, seismic data were obtained and a synthetic seismogram was created, as demonstrated in Figure 4, followed by a structural interpretation on time and depth maps.



**Figure 4-**Synthetic seismogram showing the location time of Mishrif Formation in East Abu-Amoud (EAA) oilfield.



**Figure 5-**Two-way time map of the top of Mishrif Formation.



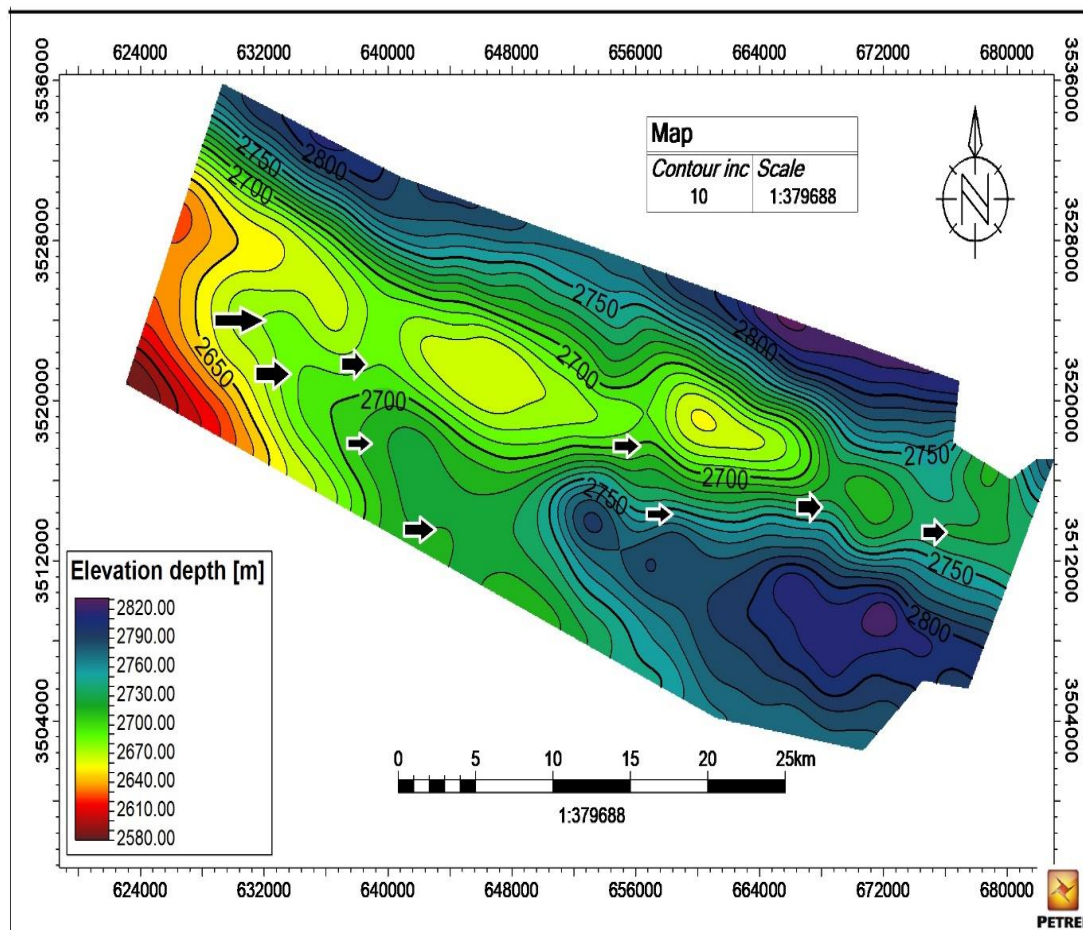
## Results

### Two-way time map of the top Mishrif Formation

The map of two-way time of the uppermost Mishrif Formation is shown in Figure 5. The map illustrates that the value of closure time in the structure of East Abu-Amoud is 20 milliseconds, while that in the structure of East Abu-Amoud is about 15 milliseconds. The Mishrif Formation descends (slopes) from the Abu Amoud field, which is located in Nasiriyah province, to the East Abu Amoud field, which is located in Missan governorate, at a rate of 100 milliseconds.

### Depth map of the top of Mishrif Formation

The map of two-way time was converted to a depth map by constructing a velocity model to the Mishrif Formation. A depth map gives a structural image of the area that is closer to reality than a time map. The depth map of the top of Mishrif Formation, where the closure of the Field of East Abu-Amoud is 40 meters and that of East Abu-Amoud is 20 meters. The top of Mishrif is located at a depth of about 2677 meters at the East of Abu-Amoud field. Fault systems appear as transversal (Figure 2), being oriented NE-SE or E-W. The black arrows indicate the faults in the area. The transversal fault systems involved two major trends; the eastern trend, that is most dominant in E and NE parts of Iraq, and the northeastern trend, which dominates the E and N parts of Iraq, as shown in Figure 6.



**Figure 6-** Faults of the top of the Mishrif Formation in the depth domain.

## Discussion

The Cenomanian-Early Turonian cycle consists of the Formations of Ahmadi, Rumaila, and Mishrif. Mishrif Formation comprises an upward shallowing cycle, associated with the continuity of the compression of the tectonic system, leading to unconformity at the top

Mishrif Formation, and overlain by the Khasib Formation. Through the study of the structural map of the top of Mishrif Formation, it was observed that the fault systems that affect the this cycle are of transversal type .

### Conclusion

The Mishrif Formation in the East Abu- Amoud field contains two domes of large size. These structures may comprise structural traps with a hydrocarbon content. The direction of system faults in the study area, as illustrated in the maps of depth and time, during the Cenomanian stage is trending northeast to southwest.

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