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# STRUCTURAL STUDY OF EAST BAGHDAD OIL FIELD, CENTRAL IRAQ

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## ABSTRACT

The area of East Baghdad is one of the important oil fields in Iraqi region; it is lying within the Mesopotamian Foredeep Basin. This subsurface structural study of the area is based on the information of the oil wells and the previous seismic section pass through the area, which was used in the construction of the structural cross-section. Through the above information the study can be devised the difference in thickness of sedimentary formations in the basin during Mesozoic and Cenozoic periods of geological time and the structural interpretation for the area especially faults, then know oil migration paths through it.

**KEYWORDS**: *Subsurface, structure, oilfield, Baghdad, Iraq.*

## INTRODUCTION

East Baghdad oil field is located in the center of Iraq in Salah ad-Din governorates, 10 km east of Baghdad city (Fig.1). The area of the field is about 120 Km in length and between 20 to 30 Km in width (Harding and Lowell, 1979). East Baghdad oil field extends toward Northwest – Southeast from Taji area, Northwest of Baghdad to North of Al-Saouira city in the Southeast of Baghdad. East Baghdad Field is a group of oil fields which discovered in 1976 and the first production for it was in 1980. Many oil wells were drilled in that field, which reached to the formations of the Cretaceous and one of them penetrates all Cretaceous formations and reaches Chiagara Formation of Upper Jurassic, it is the oil well No.1. Less and Falcon (1952) evaluated the tectonic movements in some structure within the Mesopotamia plane, and their study showed that the continuous fall in alluvial plain is the primary factor that continually allows deposition. Mitchel (1957) noted the new tectonic activity of Mesopotamia plane based on structural features and the ancient shores of the lakes. Buday and Jassim (1984) were showed that many deep transversal faults with trend NE-SW in the tectonic map of Iraq matched with linear features list. Numan (1984) stated that the horizontal and vertical interaction between basement blocks resulting from the continuity of tectonic plates in the phanerozoic dominated the nature of time and space distribution of sedimentary basins in Iraq. Buday and Jassim (1987) showed that about 25% of the lineaments have a NE–SW direction, which is parallel to Greater Zab and Lesser Zab rivers and to the Amij Samarra–Halabcha deep seated fault, which intersects the Shari playa at its southern part, while the rest of the lineaments, which represent 25% of the total lineaments have N–S direction. These lineaments are parallel to the proposed Tigris Fault. Numan (2000) explained the major tectonic events that have occurred in Iraq in Cretaceous period and that area has seen a geodynamic inversion in tectonic regimes from regional tension to compression.

Al-Sharhan and Narin (2003) and Aqrawi *et al*. (2010) published the important books in clarifying the oil system tectonic characteristics of the Middle East in general and Iraq in particular. The orientation of the lineament sets which detected in the area is NW-SE, NE-SW and N-S directions. These directions are parallel to the major structures in the region. The lineaments formed as a result of regional stresses which activate movements along old fault systems and form graben structures (Jassim *et al*., 2006).

The result of this study was the western side of the reservoir originated by steep slopes and scarps which extend for about 40 km and these slopes and scarps have various kinds of mass movements which represent unstable slopes. Moreover, the researcher divided the western side of the reservoir into five zones and showed the stability of the dam will influence by unstable slopes (Sissakian *et al*., 2006). Jassim *et al*. (2007) studied Shari Playa and found it a closed basin located in central Iraq and characterized by the development of clastic and saline sediment facies during the last 6000-6500 years. Fouad and Sissakian (2011) described some NE-SW linear features in the Mesopotamia Plain and back them to Neotectonic activities. Sadi (2013) studied the subsurface geology for Tanuma Formation in the east of Baghdad city by checking 90 thin sections and he recognized mineral and some fossils and found that the formation composed of dolomite in the form of rhomboid crystals within micrite ground mass, and the most significant fossils are planktonic and benthic foraminifera, and concluded that Tanuma Formation depositional environment was changed from sub-basinal into deep shelf environment.

Al-Mutury *et al*. (2016) studied the seismotectonic of Badra-Amarah fault, Iraq-Iran border. They found that the area seismically was active because it lies on the most seismically active fault in Iraq and it is located within the seismic zone that could suffer a major damage. The contact between stable shelf (the Inner Platform) and unstable shelf (the Outer Platform) is suggest as “the concerned contact” which has almost the same trend of Abu Jir-Euphrates Active Fault Zone and its extreme southeastern part where its location is hidden under thick Quaternary sediments (Sissakian *et al*., 2017).

This study tries to give information about the variation in thickness of different sedimentary formations and the main faults in east Baghdad oil field during the Paleozoic, Mesozoic, and Cenozoic of geological time in order to get an idea of subsurface geology of the study area by using cross-section passing through the oil wells of the field. Besides that to know the main phases affected in the area to get a better understanding of the structural framework of the region.

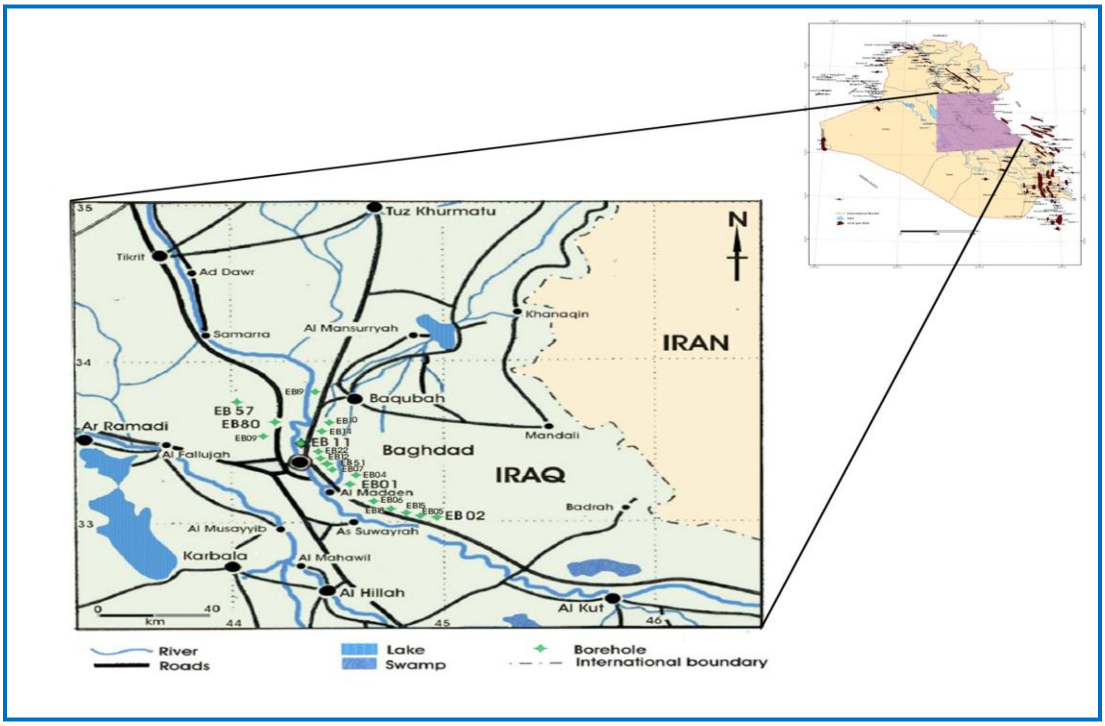


**Fig. 1: Location of the study area.**

## METHODOLOGY

In order to achieve the task of this research, it has to collect data that is related to the study area from different sources such as previous studies, thesis, published articles, technical reports, well logs, final geological well reports, and seismic sections, then construct a structural cross-section connecting among the drilled oil well of East Baghdad which are 9,19,10,14,11,22,12,7,4,1,6,18,15 and 5. These wells are cut many different lithological formations, so the connection among these wells can get a good subsurface structural interpretation (Fig.2). Besides that, a good seismic section got from previous studies which help in support the aim of this study (Fig. 3).

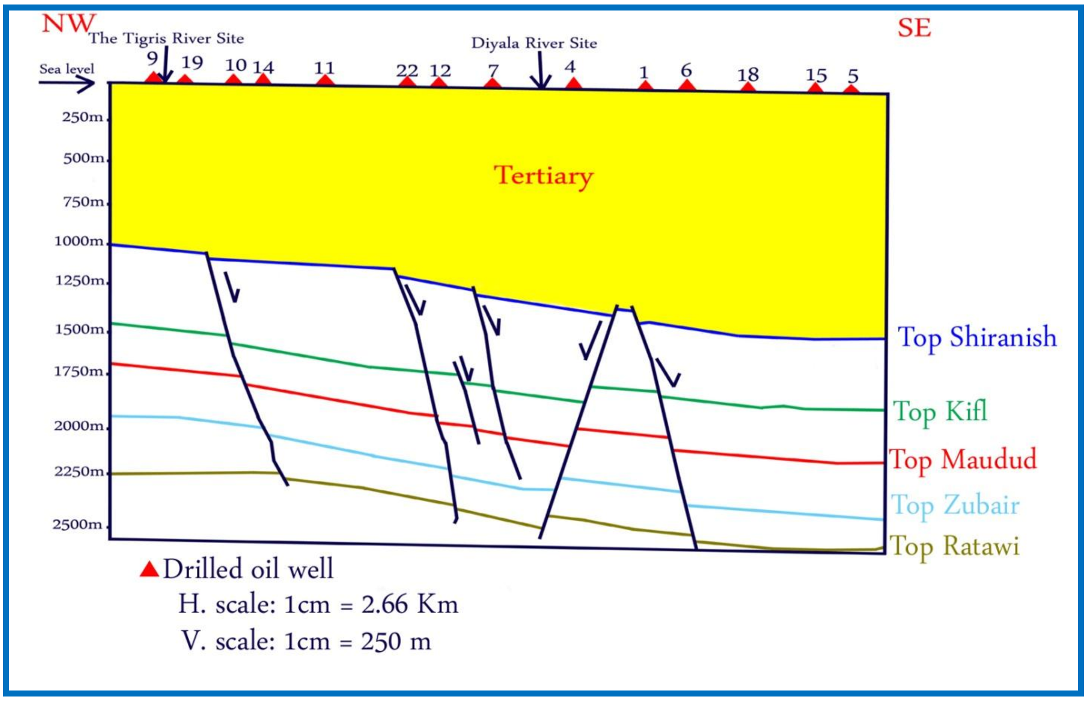


**Fig. 2: Longitudinal and structural cross-section along East Baghdad oil field.**

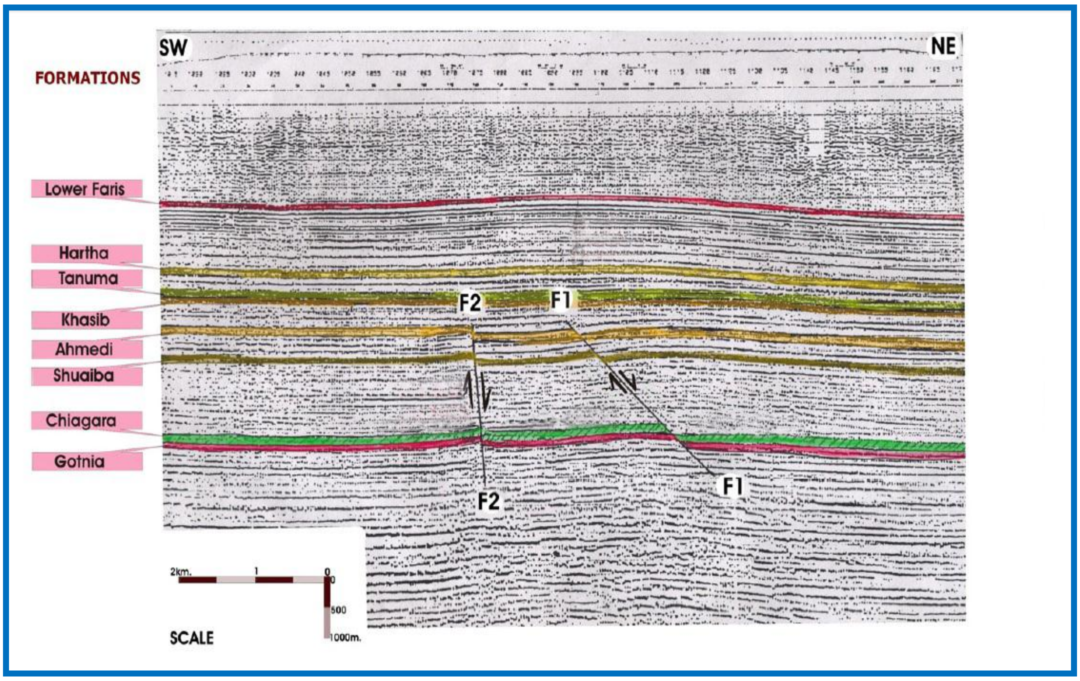


**Fig. 3: Seismic cross-section of East Baghdad Oil Field (Modified after Al-Ameri, 2011).**

**Geological setting**

***1. Stratigraphy***

There are many formations in the field, a show with details in (Fig.4). The stratigraphic section consists of many types of rocks which were deposited in marine and lagoon environments such as carbonates, shale, anhydrite, marl, sandstone, and siltstone. These deposits are expanding in geologic time from Jurassic, Cretaceous up to Pliocene (Al-Ameri, 2011).

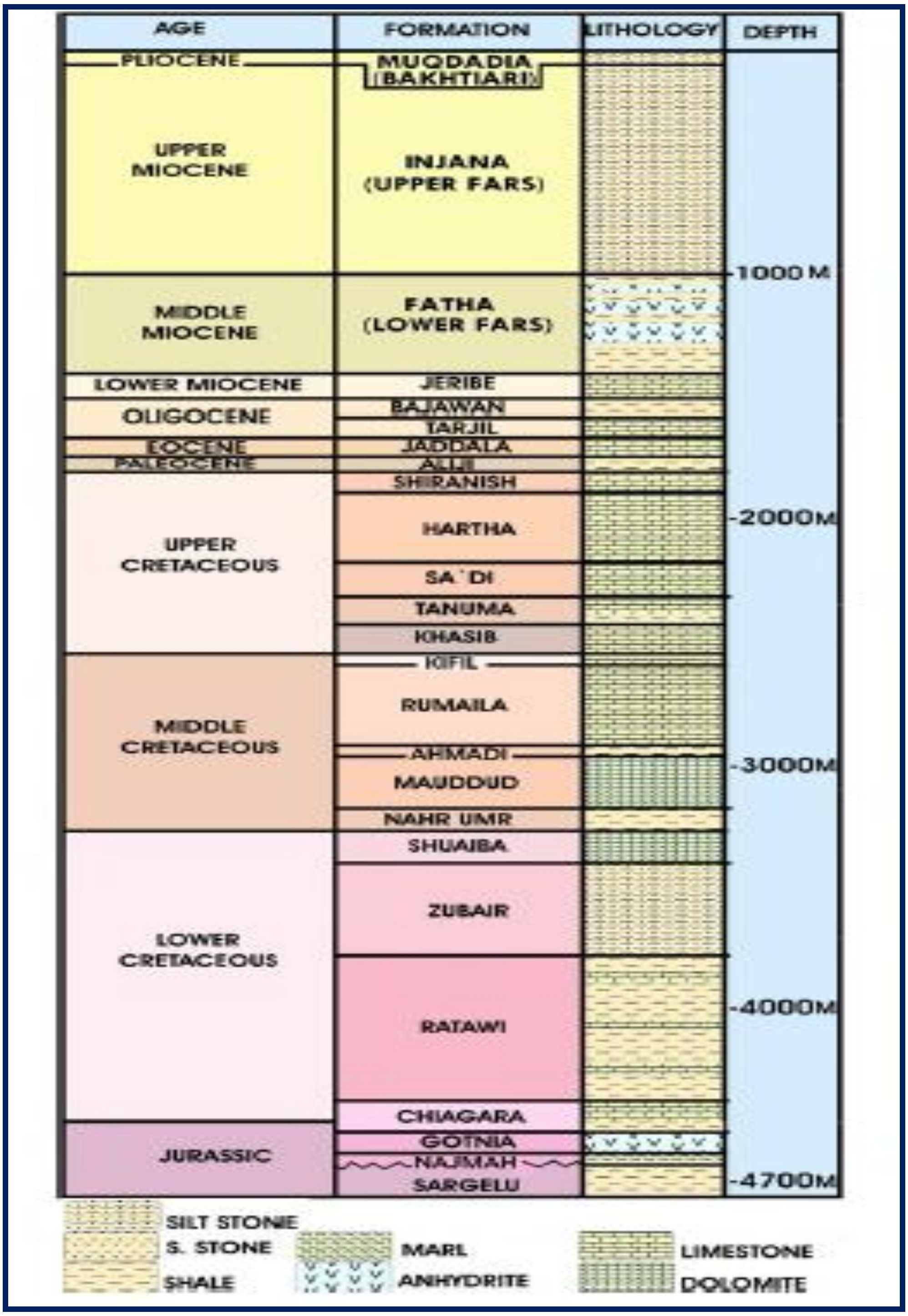


**Fig. 4: Stratigraphic column of East Baghdad Oil Field.**

The Quaternary sediments covered the Mesopotamia Plain and no pre-Quaternary rocks are exposed in the area. The main sediments of the Mesopotamia Plain have come from the Tigris, Euphrates, Diyala and Adhaim Rivers. The Quaternary sediments show tremendous development in the Mesopotamia Plain. These sediments consist of gravels, sands, silts, and clays that are mainly related to the cyclic fluvial sediments of the Tigris and Euphrates Rivers, with their tributaries and distributaries. These sediments form flood plains with a complex network of natural levees, channels, and terraces.

### *2. Structure*

This region was undergoing tectonic activities with regressive and transgressive cycles (Sharland *et al*., 2001) that allowed saving of high organic matters, leading to the advancement of the biggest oil and gas reserves in the Arabian Region. There are many faults in the field with NW-SE trending structure (Fig.5), with oil production which comes from the late Cretaceous Tanuma Formation, fractured carbonates of Khasib Formation and from the early Cretaceous sandstone of Zubair Formation.

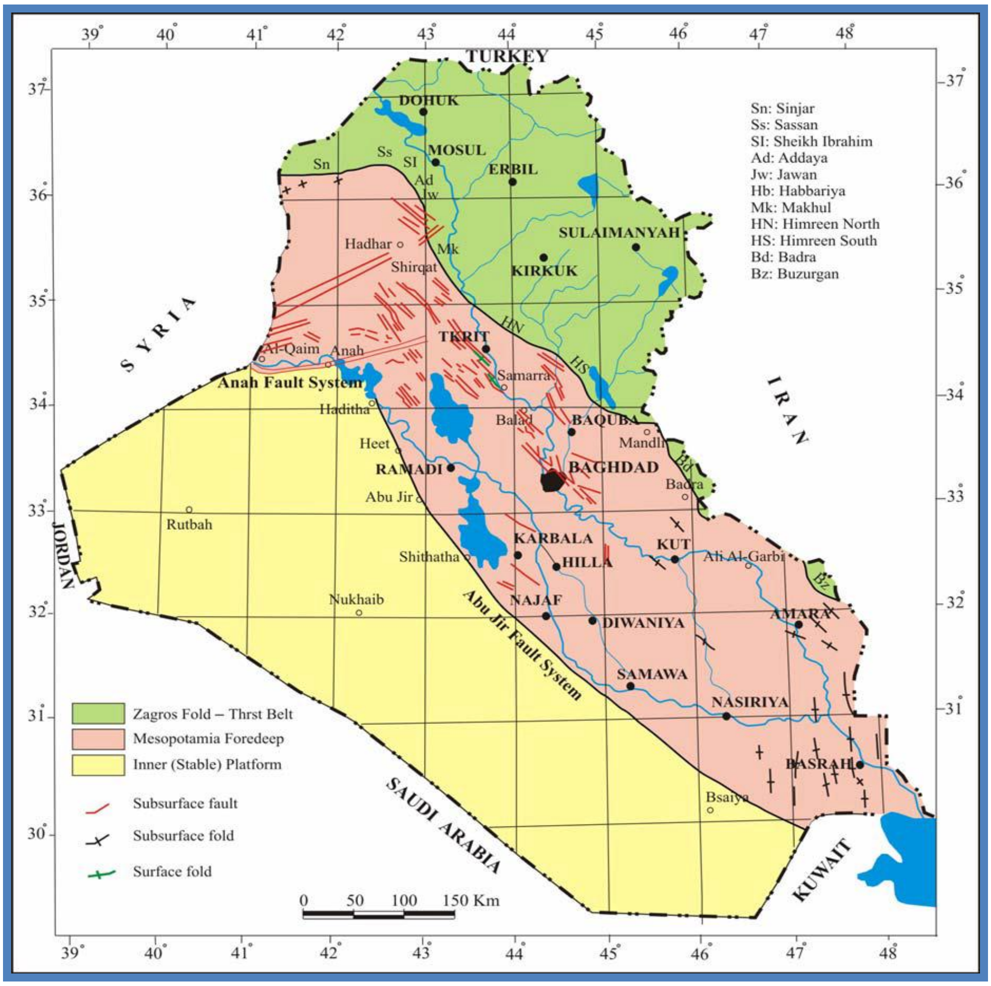


**Fig. 5: Structural Map of Mesopotamia Foredeep (Modified after Fouad, 2010).**

In other Cretaceous reservoirs, the oil has been successfully checked out such as the carbonates of Hartha, Mishrif/Rumaila Formations, clastics of Nahr Umr and mixed clastics/carbonate of Ratawi Formations (Al-Ameri, 2011).

## DISCUSSION

The longitudinal section along East Baghdad oil field (Fig. 2) has many normal faults. The tension phase was started in the Triassic and continuous to the end of Cretaceous. It was the reason for the development of all basins in the area. The direction of tension forces is NE-SW which generates the NW-SE normal faults. The faults begin at about 1000 m in depth. The thickness of sedimentary formations affected by these faults and also they affected the hydrocarbon distributions in the oil field. A compression phase was started during the Tertiary and continuous to Upper Pliocene ages, this phase has a direction of NE-SW; it was responsible for all the folds and thrusts in the area. Fox & Ahlbrandt (2002) show that the surface of the Mesopotamian zone is flat and covered by Quaternary fluvial-eolian deposits of the Tigris and Euphrates Rivers and marsh/ lacustrine sediments of southern Mesopotamia, therefore the resulted faults do not appear on the surface because of the Tertiary sediments cover which reaches to about 1000 m in thickness.

The faults in NW side are finishing at about 2250 – 2400 m, while they continue in SE side to reach 2500 m or more (Fig.2). The normal faults are present in 19, 22 and 12 oil wells. Here the hanging wall falls down and the foot wall rising up, with a slight effect on tops of Shiranish, Kifl, Maudud, Zubair and Ratawi Formations. A small normal fault appears in the middle of the section in oil well No. 12, at about 1600 m to penetrate the top of Kifl and Maudud Formations and stop at about 1900 m before it reaches the top of Zubair Formation (Fig. 2). Two opposite normal faults in 7 and 1 oil wells the first fault is dipping towards SE and the second is dipping towards NW to form a low area or graben between them, while the normal faults in 1 and 6 oil wells forming horst between them because there is rising in tops of formation appear in the area between tow faults (Fig.2).

It also appears in seismic section two main faults (Fig. 3), the first one is normal with NE dipping and it cutting tops of Ahmadi, Shuaiba, Chiagara and Gotnia Formations, while the second fault is normal, semi-vertical and it cutting the tops of same Formations that mentioned above. These faults are making a good path allow to oil migration along the permeable calcareous sand and shale beds within Chiagara Formation in the horizontal movement to a path through faults in vertical movement and finally reaching to the anticline traps or reservoir rocks which representing by Shuaiba, Ahmadi, Khasib, Tanuma and Hartha Formations. Terminate of these traps are filled from the crest to the spill plane, where oil spills below the trap into nearby permeable beds. The spilled oil migrates along tensional joints until it is trapped in the Lower Fars Anhydrite seal (Al-Ameri, 2011).

There are many types of traps in this section, they are:

**1- Stratigraphic traps**: which form as lenses of fractured calcareous shale of Chiagara (Al-Beyati, 1998), and Ratawi Formations.

**2-Structural traps:** they are:

**A.** Fault traps for the Shuaiba and Ahmedi Formations sealed with a secondary filling of the fractured area along the faults by the calcareous material.

**B.** The trap of Khasib Formation with a wide anticline closure of limestone that is characterized by an average porosity of 15% and average permeability of 45 md (Al-Gailani, 1996).

Central Iraq is tectonically unstable because of the regular reactivation of basement blocks (Buday and Jassim, 1987). Due to the transverse movement of basement blocks, the structure of the area is highly faulted which resulted in the formation of longitudinal wrench faults from the early Cenomanian. Many of these faults resemble positive flower structures as it appears on seismic sections (Harding and Lowell, 1979). That is the reason of divided the field into numerous structural blocks.

To the east of Baghdad, the structure is simple buckle folds formed by the regional compression that was generated by the collision of the Arabian-Urasian plates and has the same trend of Zagros fold-thrust belt. The trending NW-SE of the faults has been developed in northern part between South Mosul and South Baghdad. These faults are normal faults type and forming a complex set of grabens, half grabens, and solitary faults. Some of these grabens have been partially inverted forming anticlinal folds or structural nose above them, whereas other has not. These extensional faults are late Cretaceous structures (Fouad, 1998 and 2007; and Fouad and Nasir, 2009).

C.F.P (1981) and Khaiwka (1989) investigated the structural history of East Baghdad oil field and indicated that the structural complexity results from oblique-slip growth faults and later folding and faulting.

## CONCLUSION

The area came under tow tectonic phases. The oldest one is a tension phase which started since Triassic and continuous to the end of Cretaceous. It was the reason for the development of all basins in the area. The direction of tension forces is NE-SW which generates the NW-SE normal faults. The thickness of sedimentary formations was affected by these faults. The faults are contributing to the migration of the oil through the formations then pass through many types of faults to reaching to the traps. The variation in thickness of different sedimentary formations during the Paleozoic, Mesozoic, and Cenozoic of geological time and its importance in generate, pass and storage the oil by their type of rocks which control the migration of oil. The second tectonic phase was a compression phase which started during the Tertiary and continuous to Upper Pliocene ages, this phase has a direction of NE-SW it was responsible for all the folds and thrusts in the area.

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