

Study the North West extensions of Makhul structure using remote sensing techniques (central Iraq)

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Abstract

Research includes the study of the North West Extensions of Makhul structure using remote sensing techniques (central Iraq) which is located to the north of Baiji province in Salahuddin governorate, which lies 240 kilometers north of the city of Baghdad, located within the operations of the North Oil Company.

The aim of the present study is to re-define extensions of Makhul structure by the use of visual space (satellite systems and landsat7 ETM) after it was observed that there is a difference for determined the North West Extensions for structure of what is mentioned in previous studies.

I have been using the space visuals and available previous studies for the Makhul structure and North Western Extensions him in determining the dimensions, in addition to the show faults in the research area and relations with the Makhoul structure and its extensions. It has also been taking the results of wells drilled in the research area (Makhul - 1, 2 and Mityaha -1), for the purpose of assessing hydrocarbon reservoir, and we are relying on the explanatory information from the images and spatial data and received from the satellite (LANDSAT 7) according to the system ETM (Enhancement Thematic Mapper). It has also rely on the definition and identification of some units geomorphologic home on the intensity of the color, tone and texture. a network of drainage pattern is essential.

Using satellite data and previous studies point showing that the length of the Makhul structure more than 95.500 km and not 37 km, and the area affected by the operations raise

distinct and different stages. it has been divided into four parts of Makhul structure (from the southeast to the northwest), a south-eastern part, part crescent, which includes the Saded structure, the middle part, which includes the Cehel structure and north-western part, which includes the Mityaha structure. The hydrocarbon possibilities in the study area, it is in spite of the weakness of the possibilities hydrocarbon in the southeastern part of the Makhul structure (wells Makhul-1,2) and the northwestern part formerly known the Mityaha structure (well Mityaha -1), but the middle part (the structure Cehel areal) may be possibilities hydrocarbon better and more possibilities from the other parts.

Introduction

This research deals with the study of the northern stretches of Makhul structure, where the structure of Makhul starts from the Fat ha area that separates the Hamrin structure (Albu fadul Dome) for the Makhul structure, it lies to north of Baiji of the province of Salahuddin, which lies 240 km north of the city of Baghdad, located within the operations of the North Oil Company, it is worth noting that North West stretches to Makhul structure within Salahuddin and Naenva, figure (1).

Classified Makhul structure within the low folded zone, which is asymmetrical Fold and with double plunge, and extended toward the northwest – southeast, parallelism Zagros Mountains, the advantage of the north-eastern flank of the fold between ($^{\circ} 10-^{\circ} 60$) towards the northeast, while the range dip of southwest flank between ($^{\circ} 30 -^{\circ} 70$) toward the southwest and reaches a maximum height has about 450 m above mean sea level and 300 m above the flood plain of the Tigris River.

The Makhul structure Installation view of many oil companies has noted in the beginning of the last century, so exploratory wells were drilled in it, drilled exploratory well Makhul -1 in 1937 and ended in 1939, including drilling then well Makhul -2 drilled in 1955 on the southeast flank of the southern dome to Makhul structure, but the wells did not have important oil reserves, and in the nineties of the last century were drilled several wells to inject oil surpluses from the Baiji refinery in the Tertiary formations.

Through research and exploration in the region has also been working on the Mtyaha structure and which is located to the far north-west of the Makul structure for the purpose of determining whether the relevant Hydrocarbon content composition, were drilled exploratory wells (Mtyaha -1) in 1974 and arrived in drilling depth in which to 2870 meters, which showed the results of drilling an oil and tar evidence is weak in a number of formations, but the tests were negative and discouraging.

In this research, and for the purpose of determining the northwestern extensions to Makhul structure been relying on the explanatory information from images and spatial data received from the satellite (LANDSAT 7) according to the system (ETM) (ENHANCED THEMATIC MAPPER). It also depended on the definition and identify some of the major geomorphological units depending on the intensity of the color (tone), texture and drainage pattern basically, were given a good geomorphological seeing and showed the regional distribution of these units in addition to the geological structures such as folds and faults.

Search location

Search location lies in central Iraq, it is located along a linear 360 05' -340 50' north and linear 430 45' –420 45' east and to the west side of the Tigris river, is bordered to the west, the valley of the Thar Thar area, and the eastern side the Tigris River, while the southeast side is bordered the northern Hamrin (Albu Fadhul Dome), as shown in Figure (1).

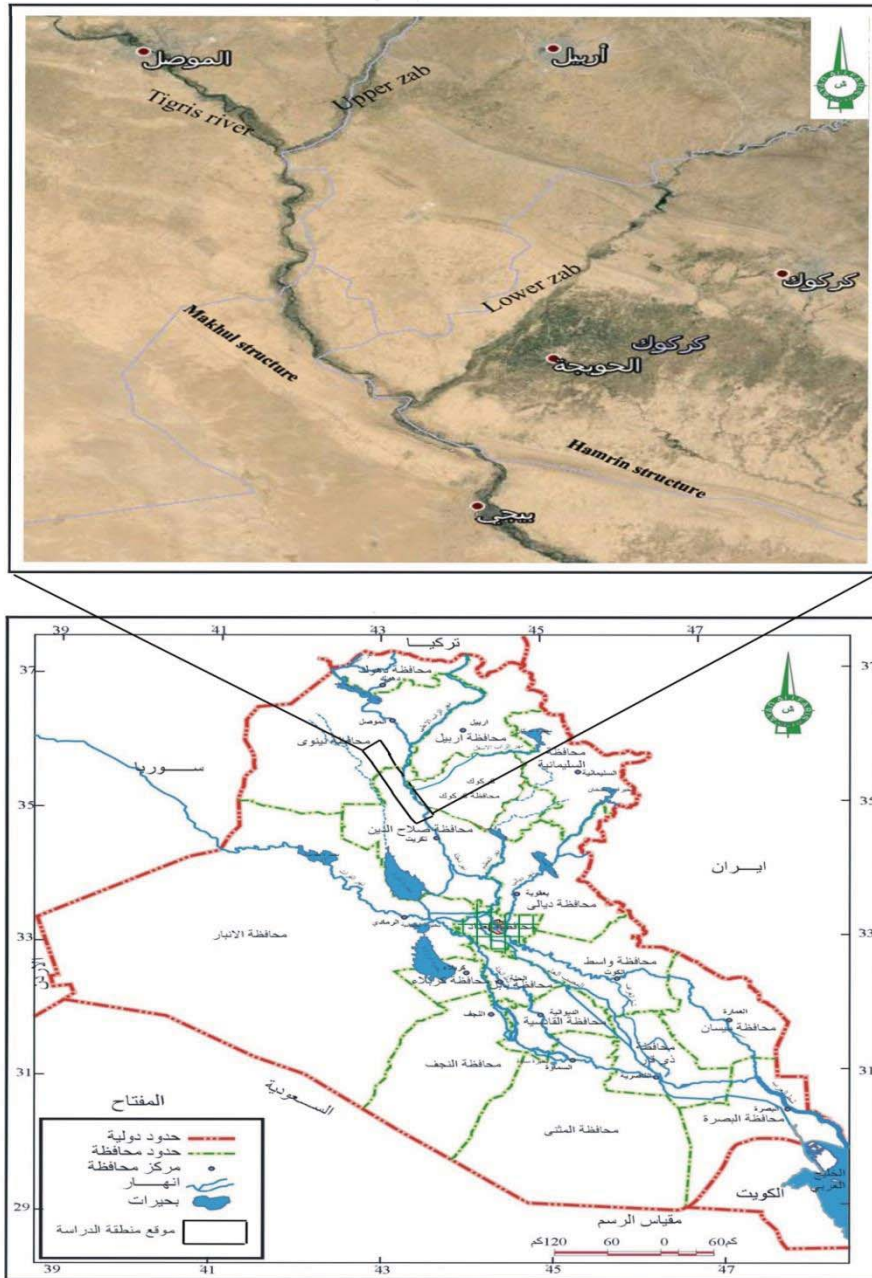


Fig.(1). Shows the location and extent of the search area (Makhul structure) within Salahuddin and Nineveh governorates.

Aim of the research

The aim of current research is to re-define the extensions Makhul structure through the use of visual space (satellite systems and LANDSAT7 ETM) after it was observed that there is a difference in determining the northern stretches of Western structure of what is mentioned in the previous studies.

Geological research area:

1. Tectonics and structural search area:

Iraq is generally considered an important region from the tectonic viewpoint since it is located on the edge between two major tectonic units belonging to the Phanerozoic age. These are the Arabian Plate and the Iranian and Turkish Plates. Iraq belongs to the Arabian Plate structured under the Iranian and Turkish Plates. This structuring has finished in the middle Eocene age when the continental part of the Arabian Plate collided with the continental block of the Iranian and Turkish Plates. This resulted in the mountains and different geological structures. Structures in Iraq extended into two directions. The first (northwest - southeast) is the direction of the Zagros Mountain and the second (east - west) is towards the range of Toros Mountain [22].

Iraq was tectonically divided by researchers into many divisions depending on different bases. Bolton details the folded zone in this classification depending on the geomorphologic features as Thrust zone, Folded zone, Unfolded zone [5]. While depending on the geosynclines notions Ditmar divided Iraq into four structural zones [7]. In studying the revision of Iraq's geology, Buday made his division according to structural and tectonical bases. He classified Iraq's geology into zones and subzones. Then he introduced the same divisions in the developed style when he divided Iraq tectonically depending on the geosynclines notions [6]. The modern tectonic division for Iraq suggested by Jassim and Goff is an extension of [8] and [6] where Iraq is divided into three main unite [11]:

- 1 - Units of stable shelf.
- 2 - Units of unstable shelf. Where the study area is located within the c
- 3 - Units of Zagros suture.

Numan [14] explained Iraq tectonically according to the plate tectonic theory after the supremacy of the geosynclines notions. Further, Numan focused on transformations in explaining Iraq's tectonically from the geosynclines concepts into the Plates Tectonics bases [15]. He also explained the tectonic orogeny in Iraq within the Phanerozoic succession in a form of a historic scenario from the Cambrian till Recent age.

He wrote down through this tapering processes resulting from thermal swelling and separation between the Arabian plates on the one hand and the Iranian and Turkish plates on the other hand as well as from another side, he supremacy of the new Tethys Ocean. Then he explains how the subduction process take place in the Iranian side in the Tithonian-Cenomanian and eventually collision took place between the Arabian plate and the Iranian and Turkish plates in the Eocene – Recent age. He added that this collision is compatible with the Red sea opening. In addition, Numan asserts that the peak period of the Alpine orogeny in the Pliocene take place because of the continental collision [16].

The end of the Cretaceous age is regarded as a new stage of the tectonic movements called (Alpine orogeny). The result of that orogeny was the started closure of the new Tethys Ocean and the deformation of the northern and northeast edge of the Arabian Plate [12]. This represents the last stage of the subduction in oceanic crust below the Iran plate, and the beginning of the continental collision between them.

Ilhan points out that the Laramide orogeny represents the first stage of the Alpine orogeny [10]. This orogeny reached its peak in the Maastrichtian age and it resulted in the beginning of the collision between the Arabian with the Iranian Plates.

At the end of the Santonian age, the Laramide orogeny began (Table of comparison between regional of lithologic units. This led to developing the pattern of the depositional

basin in the study area (western shoulder of deep graben, after that there was a whole regression of sea level due to the process of regional uplifting of the area and other regions surrounding the study area. This led to formed of a regional unconformity surface between the Cretaceous and Tertiary ages. Hence, the first stage of the Alpine orogeny ended, the second stage of the Alpine orogeny (stable phase) began at the Paleocene till the end of the middle Miocene ages. At the beginning of the middle Miocene age (Langhian) and during about 1 million years, a little marine progress took place with continuity of system faults (harmonic throw faults). This led to the deposition of the Jeribe Formation, which was represented by a shallow marine environment (limestone and dolomitic limestone).

As for the Serravallian age during about 5 million years with the continuity of the same system of faults a marine regression took place and it was followed by a wide marine overwhelming leading to the deposition of Fatha Formation (sequence of depositional cycle consisting of anhydrate, limestone, marl and silt), at the end of the deposition of that formation, the stable stage of the Alpine orogeny finished.

At the end of the Miocene - Recent age, the last stage of the Alpine orogeny began and it reached its peak at the Pliocene age. It led to the opening of the Red Sea opposite to clockwise and eventually collision between the Arabian plate with the Iranian and Turkish Plates. That resulted in forming of Zagros Mountains and Toro's Mountains[2].

Makhul structure extend in previous studies about 38 km towards the northwest-southeast [1], and it follows the trend and the behavior of most of the structures in the area and parallel to the Zagros Mountains series.

The foot hill zone

According to modern tectonic division in Iraq suggested by Jassim and Goff [11] is an extension of Buday and Jassim [6] represents this zone boundary between the unstable shelf and stable shelf. The stable shelf, which is divided into Makhul and Hamrin subzones), as it is located Makhul structure in the third block between Hadhar- Bekhma fault in the

north-west and the Anah-Qaladiza fault in the south-east, and the depth of the basement rocks which is about 8-11 km, according to the structural map of Iraq and came in Jassim & Goff [11], the study area is located within the foot hill zone, figures 2 and 3.

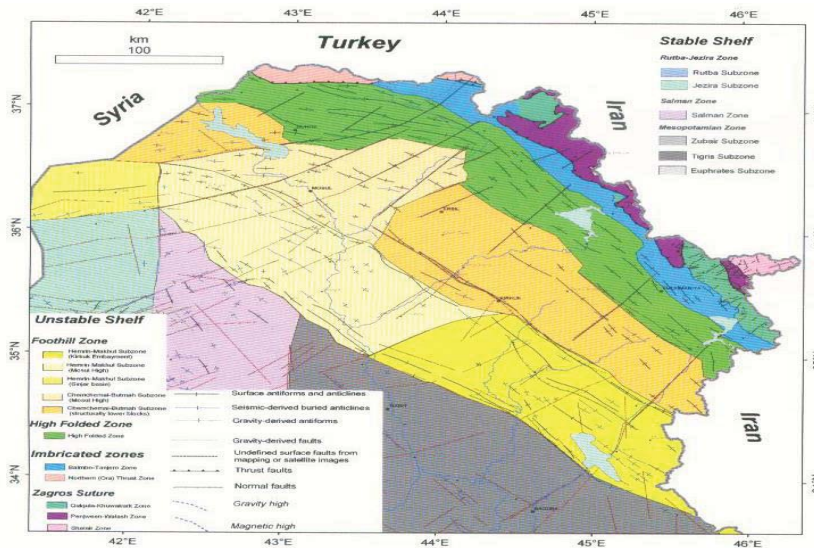


Fig. (2) Illustrates the (foot hill zone) modern tectonic division of Iraq [11].

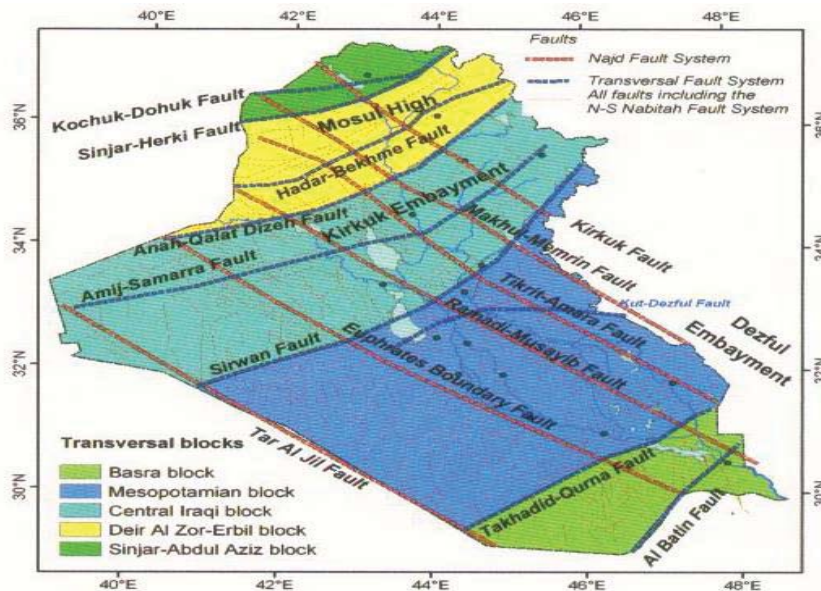


Fig. (3) Shows the systems faults basement rocks (Najed & Transversal system faults)[11].

2. Surface stratigraphy of the search area:

The search area is characterized by a cover sedimentary influenced by late Alpine orogeny, where sedimentary rocks in the search area extended from lower Miocene to Recent, where exposed geological formations (one of the oldest to newest) Euphrates, Dhiban, Jeribe, Fat ha, Injana and finally Quaternary depositions and Recent sediments.

The following geological formations outcrop in the search area: -

1. Euphrates Formation.
2. Dhiban Formation.
3. Jeribe Formation.
4. Fat ha Formation.
5. Injana Formation.
6. Quaternary deposits and Recent Sediments.

Method of work

Observed in the research area, there are Geomorphological phenomena likely reflect what happened and get the tectonic processes in the region (Morphotectonic) which is one of the entrances of important Neotectonic studies dealing with the latest structural appearances resulting in the Earth's crust and its activity throughout its history tectonic extended since the end of the Tertiary age (Neogene) or in the first half of the Quaternary [4, 20] and it can be considered as land movements (Orogeny) extended since the Miocene to the present time are important in the configuration of Morphotectonic elements of any area [21] and therefore it was necessary to study these phenomena of images and spatial data, in addition to mention previous studies to clarify the structural status of the search area and redefine the North West extensions of Makhul structure.

Drainage patterns in the search area:

The weathering processes and erosion and the quality of the rock, deformation tectonic leave raised by the forms of the earth formed in the region and through the interpretation of

satellite images. it has been distinguish two types of drainage patterns, Palio and modern, and it has been used drainage patterns as a sign arising in the interpretation of Morphotectonic phenomena [3, 23].

Types of drainage patterns in the search area:

1. Palio drainage

Rivers are Considered in the search area of the obvious signs of oldest these patterns and they were formed with Alpine orogeny in the region in general, which started from the end of the Cretaceous to the present time [13] and [23]. We find this river separates the large geological structures also separates the different tectonic zone in some areas such as the Tigris River, Thr thar Valley, upper Zab River (plate 1). In fact, these Palio drainage patterns take up main faults in the region to ease drilling it and thus give an indication Morphotectonics of faults.

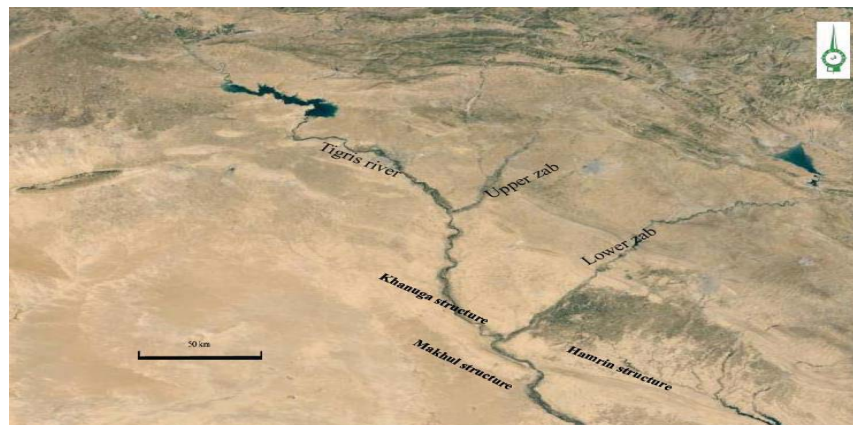


Plate (1) Shows the path of the Tigris River and other rivers and their movement on faults.

2. Recent drainage patterns

Of course, these patterns follow the tectonic processes, but it is not be the abyssal depths with began Alpine orogeny, but occur in order according to the process intensity with the offer conditions and bio-climate and hydrological where rain water helps to drill

her paths to open one's joints and small faults are present in the structure of the region, these patterns determine the general limits of Makhul structure that natural different tectonic areas (high and low at the same time).

Faults of search area

The fault can be defined as a cut in the rock mass on which a sensible movement takes place due to their being affected by a deformation process [8, 9, 17, 19]. In this study, the focus was primarily on regional large faults (macroscopic faults), which extends to large distances and not those which are known as (mesoscopic fault) on the exposed rock level as described [18].

It is noted that the general trend of the Tigris River fault is the same direction Makhul structure and Zagros (northeast - southwest), but this trend has been graded according to the vertical faults regional and local in the search area, if we started from the north or north-west towards the south or south- east note the Tigris River path is then shown in Figure (4).

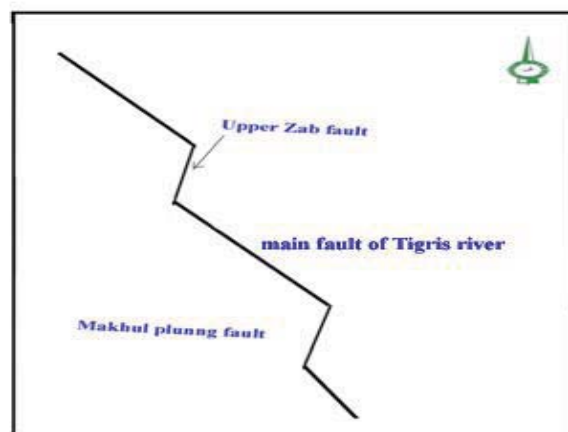


Fig. (4) Shows the path of the Tigris River from the north or northwest towards the south to southeast.

The intersection of any faults with Tigris river fault executes to plunging and folding structure in that region, with the lower Zab fault Khanoga structure ends [23], and with the

Makhul plunge fault (Fat ha area) Makhul structure ends. Also, the different faults of the Tigris River to prevent transmission of the northeastern flank of the previous structures to the opposite side of the river, which gives strong evidence that these faults had existed basically was effective before these structures are formed in the region. And to reconsider the behavior of the river and river faults first and how sit these structures parallel river second, it will give a strong indication again that this region in general affected from large faults and semi-parallel (plate 1), this explains existence the narrow syncline fold between Makhul and Khanoga structures in horizontal space does not exceed 10 km containing two anticline structures(Makhul and Khanoga) with the valley between them, figure (5).

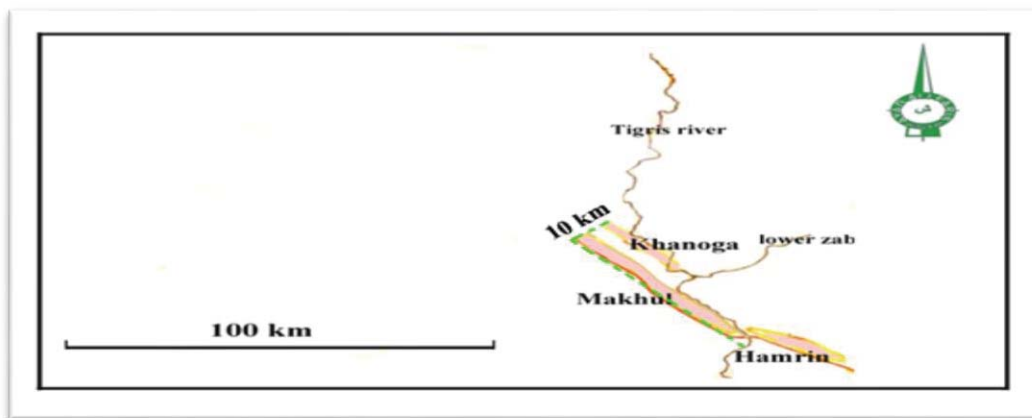


Fig. (5) Shows the fold between the narrow syncline fold between Makhul and Khanoga structures.

Also, the main fault of the Tigris River oldest movement from the vertical fault him (lower Zab fault and Makhul area fault) thus maintained the fault on the longitudinal between Makhul and Khanoga structures away from fragmentation.

Makhul area fault

We did not notice through the use of space-based data clear extensions the fault for this, except for the area between the Makhul and Hamrin structures and a distance of about 10 km towards the north east south-west (plate 2).



plate (2) Show the fault that separates the Makhul and Hamrin structure.

Lower Zab fault

This fault is very clear and extend along the lower Zab River for more than 100 km to disappear trace with the existence of Tigris River fault and Makhul structure for starts to appear again in the same direction, and dissented from which patterns discharge parallel to the Makhul plunge fault and a length of more than 15 km and take the same behavior of sharp angles until it is connected Thir thar Valley, there are distance a few Km. northward group faults parallel to the lower Zab and clear a lineation on the surface of the earth, plate (3), and that these faults and lineation Morphotectonic phenomenon see their effects are very clear on the deviation in the axis of Makhul structure halfway towards the northeast, which give an indication about the fault movement in that direction, plate (4).



plate (3) Shows a group of parallel faults for lower Zab fault to the southwest of the search area.



plate (4) Axis shows the deviation in the Makhul structure.

Upper Zab fault

The effect of this fault does not appear directly in Makhul structure, and that this fault was a power that led to the deviation Tigris river fault towards the northeast, leaving a wide and stable geographic area in the search area and influential indirectly on fold higher. Plate (1).

Makhul structure

Various previous studies mentioned that the Makhul structure extends for a distance of about 38 km Figure (5) and parallel Tigris River and Kanokh structure. a study extension structure through satellite images, and Noted drainage patterns in the region and surface rock, (plate 4), its clear that the place previously mentioned does not represent in fact of the matter, but the southeastern part of the structure, a high portion of the Observatory and high resolution, and it may rise for a distance of 270 meters above ground level and different from the surrounding high land at a rate of 100 meters.

It can be divided Makhul structure Figure (6) to: -

1. South eastern part: stretching for a distance of 29 km started from the fault plunge of Makhul structure and a wide surface average about 3,200 meters, with an average height of 100 meters from the lands that surround it. Plate (5).

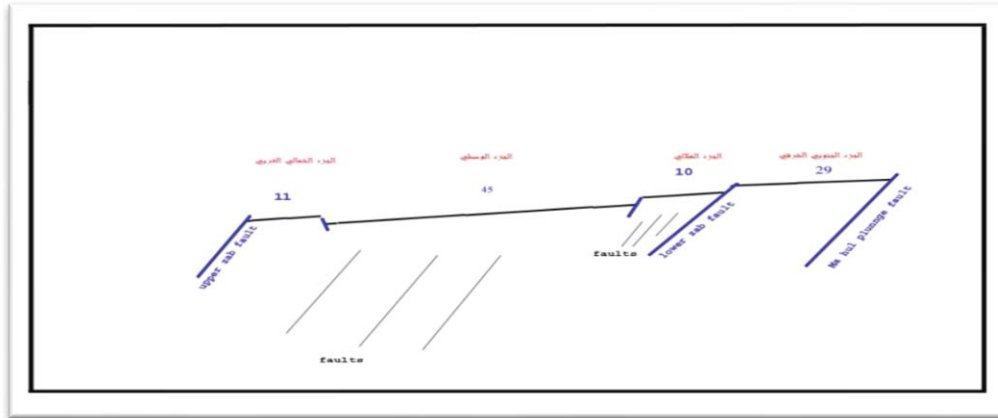


Fig. (6) Longitudinal section shows the divide of the four parts of Makhul structure.



plate (5) Shows the Makhul structure apparent on the surface (the southeastern part).

2. Croissant part of the structure: extending for a distance of approximately 10,500 km and an average of surface 3,200 km, it is noticeable that this relatively croissant part of reflection High Relief, we believe that the reason for the existence of the croissant phenomenon for structure in this area to the parallel faults to each group and that parallel lower Zab fault (plate 3), in which the movement occurred in two opposite directions, leaving flexion point for the of khanoga structure, the rate croissant phenomenon to this part of the Makhul structure and through this movement as evidence Morphotectonic we can say that the Tigris River fault execute to high pressure due to Alpine Orogeny, which ultimately execute to the appearance of khanoga and Makhul structure, but Folding force in

the Makhul structure was more because of incurrence to power faults movement in the southwestern flank of the structure, and occurred movement towards the northeast and confined oblique fault as part of the Tigris River faults, which double in Khanoga structure in that region, and thus leave a good geographical distance to deviation Makhul structure and figuration the croissant phenomenon (plate 4).

3-middle part of the Makhul structure: extends for a distance of 45 km and is subsurface for the most part, and do not go up on the surrounding land but several few meters. We would like to note that the sources and previous literature oil companies reported the existence of two small structures, first is called Saded and the second is called Cehel and which are located within this part of the Makhul structure. Figure (7).

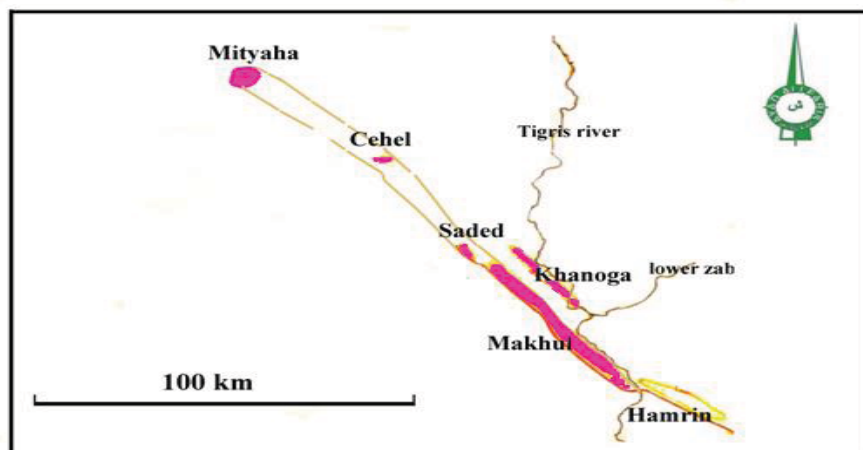


Fig. (7) Shows the structures of Saded, Cehel and Mityaha, their relationship to Makhul structure.



Plate (6) Illustrate extend the Makhul structure toward the northwest.

The extension structure seems clear in this part through the drainage patterns and the reflection outcrop spectral her (plate 6, Figure 8), We believe that the conversion for this part of structure to the subsurface structure is due to the existence of lower Zab fault and parallel fault with her, which affected the progress Tigris River fault in that region, which leaving wide a geographic area affectived negatively on the force of Folding (Alpine orogeny) of this part to be with the adversity of low folding and unclear on the surface, as though this part deviation towards the southwest at about 2 km, which could be saddle in this area of the structure (fold), and the reason for this deviation is due to the existence of several developing geological structures between Makhul structure and Tigris River fault, and is oblate as a result of tectonic pressure limit for the Makhul structure in a narrow space resulted for the deviation. Therefore believe that the oblate structure was growing faster than Makhul structure (Fold) in that part, it was helped by the existence of parallel faults to Zab fault, which deviated the saddle area.

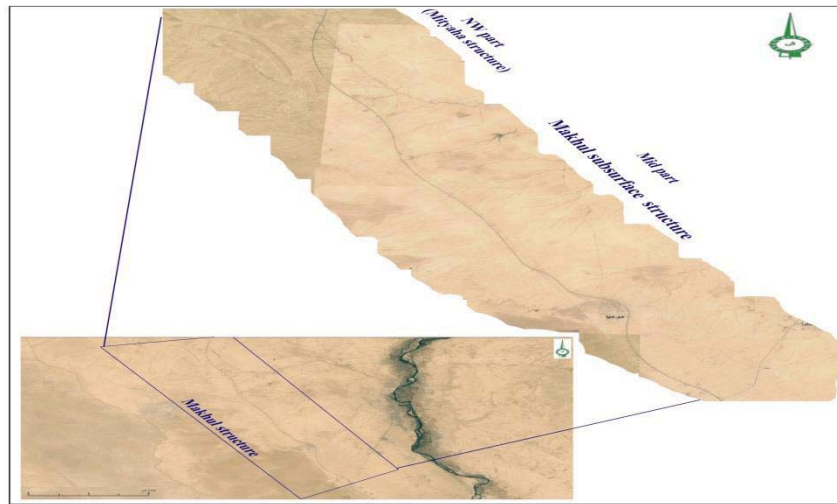


Fig.(8) Illustrate along the Makhul structure toward the northwest and drainage patterns in the search area.

4-last part (North West) extends for a distance of about 11 km or called in the oil literature Mityaha structure, in fact, it is nothing the last extension of the Makhul structure, there is a note that the high average of topographical for layers starts appears again for up to 40 meters from the surrounding lands to look clear very high resolution through rock layers and drainage patterns, figure (8), we have said [7], up to the possibility that Makhul structure to Mityaha structure.

From the above Makhul structure can say that the length is about 95.500 km to be a giant structure in the region, and here we would like to note the existence of the structural phenomenon of parallel to the Makhul structure, but on the western side of the Thir Thar valley has a similar scenario for the growth of Khanoga and Makhul structure, (plate 7)



Plate (7) Shows the structural phenomenon of parallel to Makhul structure.

The use of the digital color processing spatial data of the study area, which picked up the RGB system Geomatica program. Filters were used complementary basic colors, as well as the use of pseudo colors spatial data to enhance the interpretation of the extension of the Makhul structure toward the northwest down to the structure of the called Mityaha . It has been observed through the use of this software and digital processing and chromatography recognizes that extends from Makhul structure for more than 95 km. and this method is considered important in determining expanded through this structure. Plate (8).

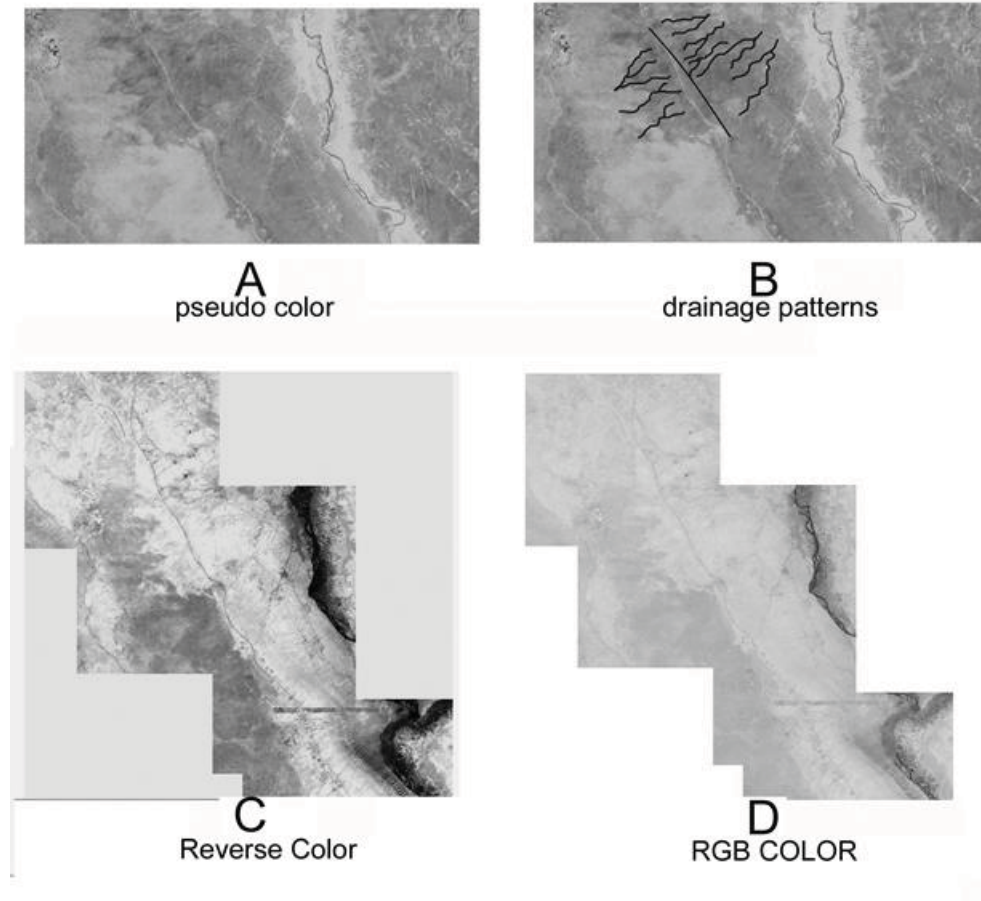


Plate (8) The digital color processing by Geomatica program.

Hydrocarbon possibilities in the search area

Although drilling two wells in the southeastern part of the Makhul structure (Makhoul - 1, 2) wells and one in the northwestern part of the (Mityaha -1), which showed that the evidence is not encouraging hydrocarbon wells in Makhul -1,2 where it was not where oil reserves, as well as, the well Mityaha -1 which showed the results of drilling an oil evidence and weak in a many of formations, but the tests were negative and discouraging, the Makhul structure is important from the reservoir for two reasons, the first considered the boundary between the stable and unstable shelf, the second they occur near and parallel the Tigris River faults.

That by dividing the Makhul structure into four parts (southeastern part, croissant part, the middle part and the northwestern part) note that the middle part of the structure area, known in the oil literature Cehel structure area be lower structurally than other parts of the structure, the Subsurface structure extends for a distance of 45 km, which was determined by drainage patterns and the reflection outcrop spectral her, and thus the possibilities may be hydrocarbon better and more encouraging from the other parts because it is subsurface, which could help to save hydrocarbon content from seepage to the surface and generally in our perception that the existence of hydrocarbon content in this part may also be of heavy oils and which also helps the potential for the existence of hydrocarbon content are faults that may or deter transmission oils from one part to another horizontally in the same structure.

Conclusions:

1. The length of the Makhul structure more than 95.500 km, not 37 km.
2. The area affected by the operations a distinctive uplifting and at different stages.
3. Makhul structure was divided into four parts (from the southeast to the northwest), a southeastern part, croissant part, which includes the of Saded structure, the middle part, which includes the Cehel structure and northwestern part, which includes the Mityaha structure.
4. Despite the weakness of the possibilities hydrocarbon in the southeastern part of the Makhul structure and the North West, previously known Mityaha structure, but the middle part of the possibilities may be hydrocarbon better and more encouraging from the other parts.
5. The existence of the structural phenomenon of parallel to the Makhul structure on the western side of the Thir Thar valley may have a similar scenario for the growth of Kanoga and Makhul structures.

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