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Study of the Rocks and Analysis of Morphotectonic Uplift Between Kirkuk and Qara Chauq Anticlines Using Remote Sensing Techniques

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ABSTRACT

This study aims to demonstrate the morphotectonic evidence (drainage pattern, formations of sedimentary rocks, structural ridge deformations and spectral reflectance differences…etc.) for tectonic uplift with the syncline zone between two major anticlines, Kirkuk anticline in the northeast and Qara Chauq anticline in the southwest. The study area is located in the low folded zone at the geographical coordinates of 35º 45´ to 35º 55´ North and 43º 30´ to 44º 00´ East. In this study, the tectonic uplift was named as Dushwan uplift, because the uplift of the rocks was adjacent to Dushwan village.

The regional stress, originating from the collision of the Arabian plate with the Eurasian plate, is still affecting the study area, as presented by the rock deformations of the southwestern structural ridges of Kirkuk anticline and the whole Qara Chauq structure. It is dividing the drainage pattern basin within the major syncline into two different drainage basins with different directions from the center of this uplift, in addition to the rocks deformation of the eastern plunge of Bai Hassan anticline. This uplift was demonstrated through four sectional profiles made by using Google Earth and Global Mapper software.

In addition, the uplift of the rocks was identified by the visual interpretation of the satellite images and the digital interpretation of the DEM and satellite images using software (such as Arc GIS and Global Mapper) for the study area.

The above morphotectonic evidence indicate that the rocks in the study area are influenced by tectonic activity (Dushwan uplift) through three suggested mechanisms; First, propagation of two synclines, one existed between Kirkuk anticline and Bai Hassan Anticline and the other located between Qara Chauq anticline and Guwair anticline of a northwest- southeast trend. Second, this uplift of the rocks was resulted by a deep-seated fault that extends to the basement faults with a northeast- southwest direction. Third, a Salt Diapir was forced from salty formations existed in this area.

Keywords: rocks, Dushwan uplift, Kirkuk anticline, sedimentary rocks, Bai Hassan anticline, Iraq.

دراسة صخور وتحليل مورفوتكتونية مرتفع دشوان بين تركيبي كركوك وقرة جوخ باستخدام تقنيات التحسس النائي

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الخلاصه

تهدف الدراسة الى عرض الدلائل المورفوتكتونية في الصخور الرسوبية(نمط التصريف – التشوه التركيبي – اختلاف الانعكاسية الطيفية...الخ) لمرتفع دشوان .حيث تقع منطقة الدراسة ضمن منطقة الطيات الواطئة والموجودة ضمن الاحداثيات الجغرافية (´45 º35 – ´55 º35) شمالا و(´30 º43 – ´00 º44) شرقا وتحاط بطية كركوك من الشمال الشرقي وطية قرة جوق من الجنوب الغربي .

تم تحديد مرتفع دشوان في هذه الدراسة بواسطة التفسير البصري والرقمي للبيانات الفضائية وكذلك التفسير الرقمي لأنموذج التضرس الرقمي (DEM).

الجهد الاقليمي الناتج من تصادم الصفيحة العربية مع الاوراسية لايزال تأثيره مستمر ضمن منطقة الدراسة . والذي يتمثل بتشوه الجزء الجنوبي لتركيب كركوك ومعظم تركيب قرة جوق وينقسم نمط التصريف الى اتجاهين مختلفين من مركز مرتفع دشوان ، وكذلك التشوه الحاصل للغاطس الشمالي الغربي لتركيب باي حسن.

هذا المرتفع اثبت وجوده من خلال اربع مقاطع للصخور الرسوبية. ثلاث منها رسمت من ال Google earth اما المقطع الرابع فاخذ بواسطة برنامج Global Mapper .

كل هذه الدلائل المورفوتكتونية برهنت على ان منطقة الدراسة تأثرت بالنشاط التكتوني. ومن خلال ثلاث مقترحات :

1- نمو في الطية المقعرة المحصورة بين تركيبي كركوك وقرة جوق من وسط الطية وانقسامها الى طيتين مقعرتين الاولى بين تركيبي كركوك وباي حسن والاخر بين تركيبي قرة جوق والكوير باتجاه شمال غرب – جنوب شرق .

2- أن هذا المرتفع التكتوني هو نتيجة صدع عميق من الصدوع الموجودة في صخور القاعدة باتجاه شمال شرق – جنوب غرب .

3- اندفاع ملحي قد تم دفعه من تكوين ملحي موجود ضمن الصخور الرسوبية في المنطقة.

كلمات مفتاحية: صخور، مرتفع دشوان، طية كركوك المحدبة، صخور رسوبية، طية باي حسن المحدبة، العراق.

INTRODUCTION

The uplift in the study area is the portion of the total geologic uplift of the mean earth surface rocks that is not attributable to an isostatic response to unloading. The increase in the mean elevation of Dashwan area can only occur in response to tectonic processes of anticline shortening. This process can redistribute large stress from an elevated region to a topographically lower area.

The remote sensing data showed a pattern of ground uplift centered between Kirkuk and Qara-chuq anticlines, on the highway between Debaikah and Makhmour. This uplift is considered as a topographic and geological anomaly according to the surrounded anticlinal structures (Kirkuk and Qara-chuq anticlines), which is the original reason for focusing on this feature specifically.

In addition, this area is considered as one of the richest places containing a high amount of hydrocarbon in Iraq and any uplift in the rock bed might cause a hydrocarbon re-migration or affect the hydrocarbon in the adjacent trap. Adding to that, in this study, we are trying to improve the detection of trapped hydrocarbon in the earths subsurface from the space, which has been a target of geoscientists since satellite imagery became widely available for commercial use some years ago. However, much skepticism still argues that such an approach is not possible.

The study area is located near Dashwan village at Kirkuk governorate in the northern area of Iraq Figure-1.

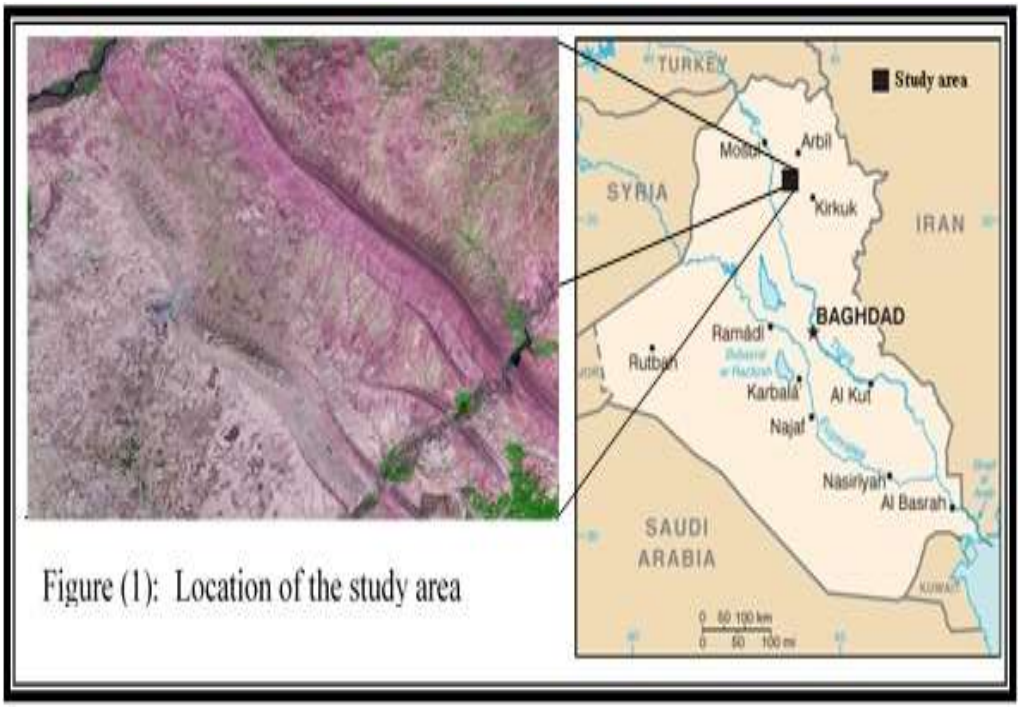

Figure (1): Location of the study area

The main objective of this study is to conduct an updated investigation for the uplift of the rocks based on the most constrained factors affecting the structural ridges of the anticlines, drainage patterns, formations of sedimentary rocks, and topographic morphology.

This study was focused on analyzing the morphotectonics of the Dashwan uplift and determining the geological cause for this tectonics. Also, we aimed to clarify the most active geological structures in this mechanism using remote sensing techniques.

Geological setting of the study area

The northern areas of Iraq are considered geologically as one of the most important areas, since they have different rock structures and are very complicated in morphology. Another reason is their location near the collision zone of the plate's boundary between the Arabian and Eurasian plates (Iranian and Turkish micro-plates). Therefore, these areas are very active tectonically [1].

The geology of Iraq is closely related to the Zagros orogenic belt in southwest Iran. These Cenozoic mountains are formed as two continental plates, Arabia and Asia, collided and the Tethys Sea that once lay between them completely closed. The highly deformed and over thrust section of Zagros is present only in the northeastern region of Iraq. The Mesopotamian plains are part of a long, vast foredeep basin developed in front of the rising Zagros in the post-collisional Oligocene-Neogene times.

- According to [1], Iraq can be divided into three tectonically different areas; Stable Shelf, Unstable Shelf, and Zagros Suture Zones.

The studied area lies within the Unstable Shelf of the Arabian Platform. The Unstable Shelf is characterized by structural trends and facies changes that are parallel to Zagros-Taurus Suture belt [1, 2].

The lithological sequence in the study area shows varying rocks from tertiary to quaternary formations, especially at Kirkuk and Qarachuq anticlines, while the uplift site has a recent deposit that belong to the Quaternary period (Quaternary deposits). These deposits mainly consist of slope deposits (existing at anticline break of slope in both sides of Kirkuk and Qarachuq anticlines) and Polygenetic deposits. These deposits consist of coarse rock fragment deposits such as gravels and boulders with fine deposits such as sand, silt and clay. These deposits reach to several meters in thickness depending on the topography of the area, while they are thick in the study area because it is a syncline area between Kirkuk and Qarachuq anticlines. The most prominent portion of these deposits is called the Polygenic Sediments (Pleistocene-Holocene), mostly covering the flat area in the synclines and mainly consisting of a transported sandy, silty, clayey soil. Some limestone also exist as rock fragments

cemented by gypsiferous material, the thickness of which ranging from few centimeters to few meters of sedimentary rocks [3], as shown in Figure-2.

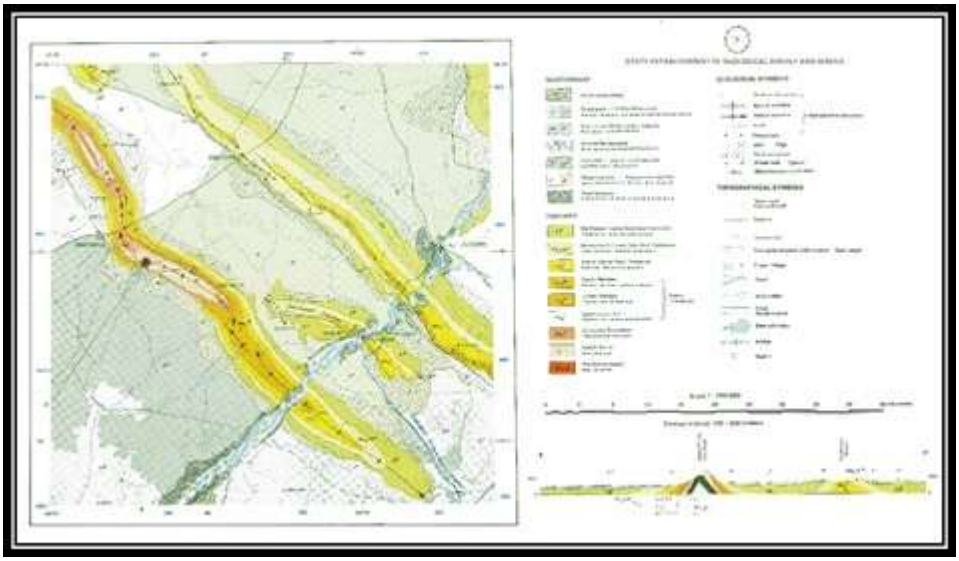

Figure 2-Geological map of the study area [3].

Morphologic changes in landforms of the study area

The morphology of the geological structures in the study area has been modified as a response to the evolution of this uplift of the rocks. They have been recognized by the geological map of the study area and the satellite images.

1- Drainage pattern response

It has long been noted that the rock structures and/or ongoing tectonic activity in an area often will impact the geometry of the fluvial system, and that this influence is reflected in the overall arrangement of streams forming regional drainage networks (drainage pattern) [4].

The response of the drainage pattern in the study area represents clear evidence to this uplift, through dividing the drainage system at the uplift into two major catchment areas, each flowing in the opposite direction to the other (Figure-3). This morphotectonic feature provides a noticeable demonstration for the behavior response of the drainage pattern to any morphotectonic evolution, such as the uplifting tectonic [3].

2- Topographic deformation

The study area shows a topographical rise that exists between Kirkuk and Qara Chauq anticlines in the northeast-southwest direction. Also, a convex profile was demonstrated through a profile section (Northwest-Southeast) across this topographical rise, using Global Mapper. The highest elevation refers to 299 m above S.L., at the middle of this topographical feature Figure-4). The topographic landforms might reflect a local tectonic uplift with respect to the drainage pattern response at that topographic landform [2].

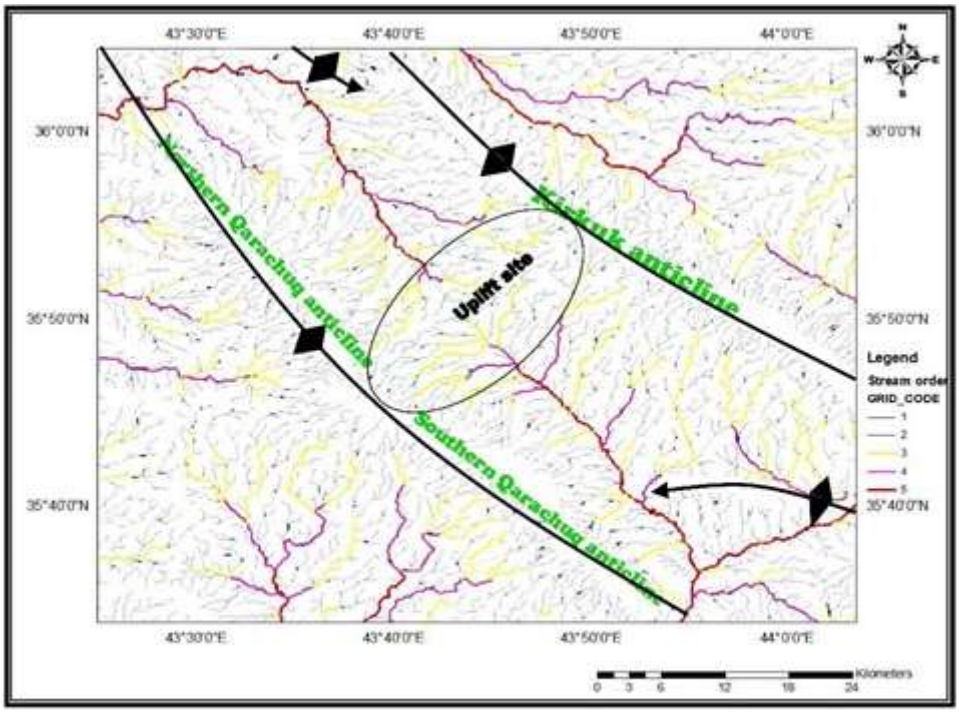

Figure (3): Drainage map of the study area, showing the impact of the uplift on the drainage pattern

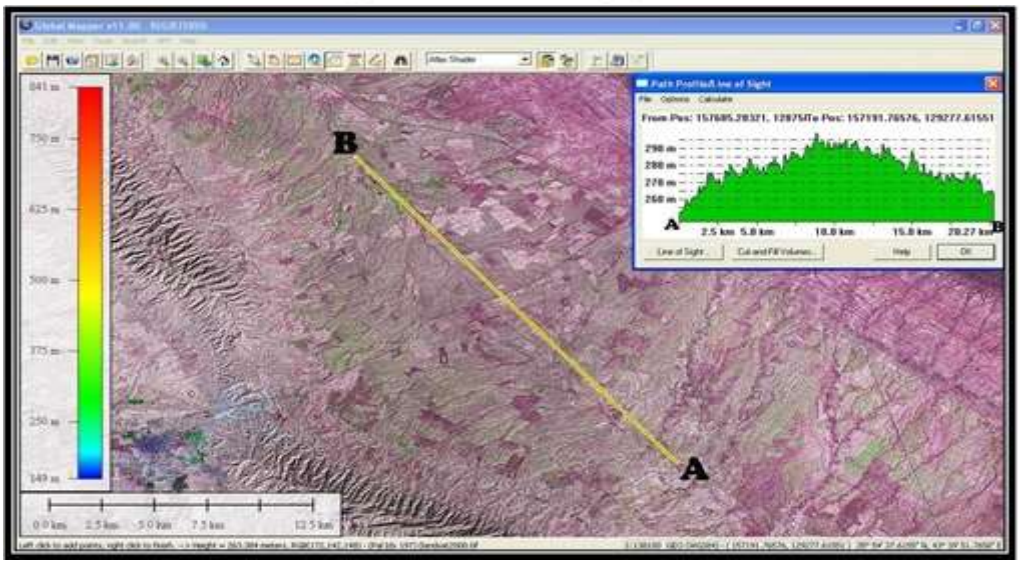

Figure 4-Topographic profile demonstrating the topographic uplift in the study area.

3- Rock deformatios of structural ridges

The deformation in the structural ridges at the southwestern limb of Kirkuk anticline and northeastern limb of Qarachuq anticline is obvious at the contact area between the uplift and both anticlines. The structural ridges at the location form a curved shape of the rocks because of the uplift impact on it. Another deformation is sited at the north eastern limb of Kirkuk anticline, represented by tilted structural ridges that form a steeper dip than that of the regular structural ridges along the north eastern limb of Kirkuk anticline. This deformation on both structural ridges refers to local stress nearby to those anticlines. The fact that a constant tectonic driving force can produce different uplift rates over time has important implications for interpretation of active tectonics rates, when evaluating folds and particularly if the limbs of the fold dip steeply [4].

There are strike-slip faults situated obliquely with the axes of Kirkuk and Qarachuq anticlines, but with different trends and probably similar geometry. The faults that exist at Kirkuk anticline have a

northwest-southeast trend, while the faults at Qarachuq anticline have a northeast-southwest trend. These faults act as sinistral strike-slip faults which refers to local tectonic in the middle of the syncline, revealing a radial force toward both anticlines Figure-5. The fault represents a morphotectonic deformation on the anticlines by the uplift of the rocks [5, 6].

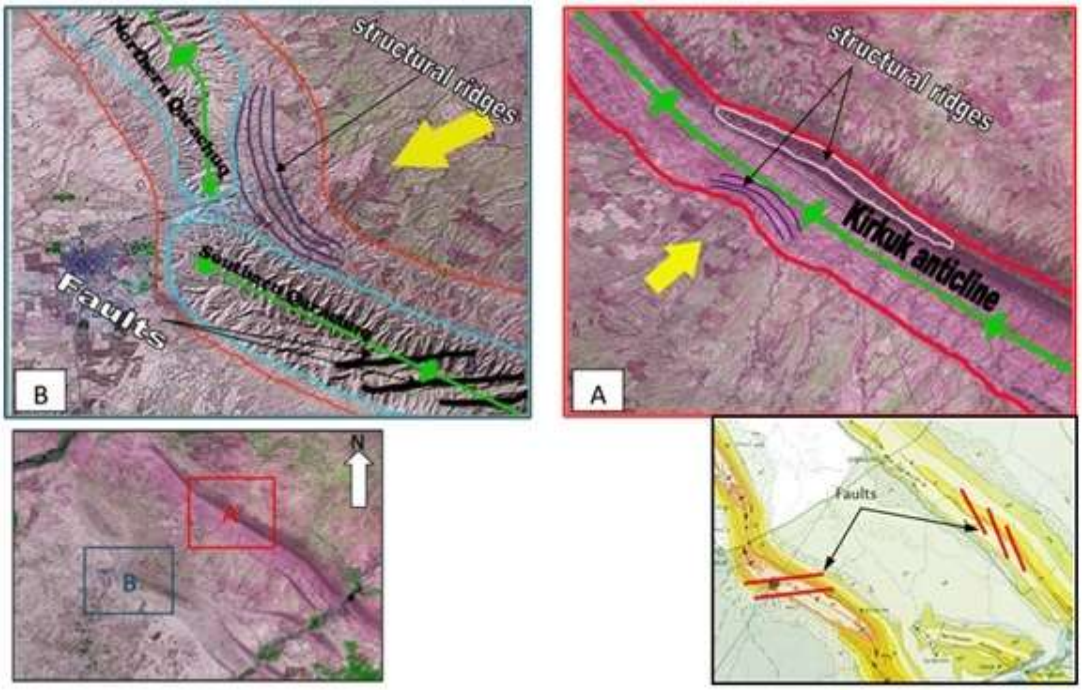

Figure 5-Deformation on structural ridges at Qarachuq and Kirkuk Anticlines as a result of the uplift.

4- Syncline division

The syncline between Kirkuk and Qarachuq anticlines represents a major sedimentary rock basin between both major anticlines. At the northwestern plunge of this syncline, there is another anticline (Gwair anticline), whereas at the southeastern plunge there is an anticline called Bai Hassan. Both anticlines are limiting the growth of this major syncline toward the northeastern and southeastern directions. Therefore, the existence of those two anticlines qualifies the theory of a syncline growth from the center that is divided into two minor synclines, which are growing in the center of the major syncline and forming uplift at their new plunges in the middle [4].

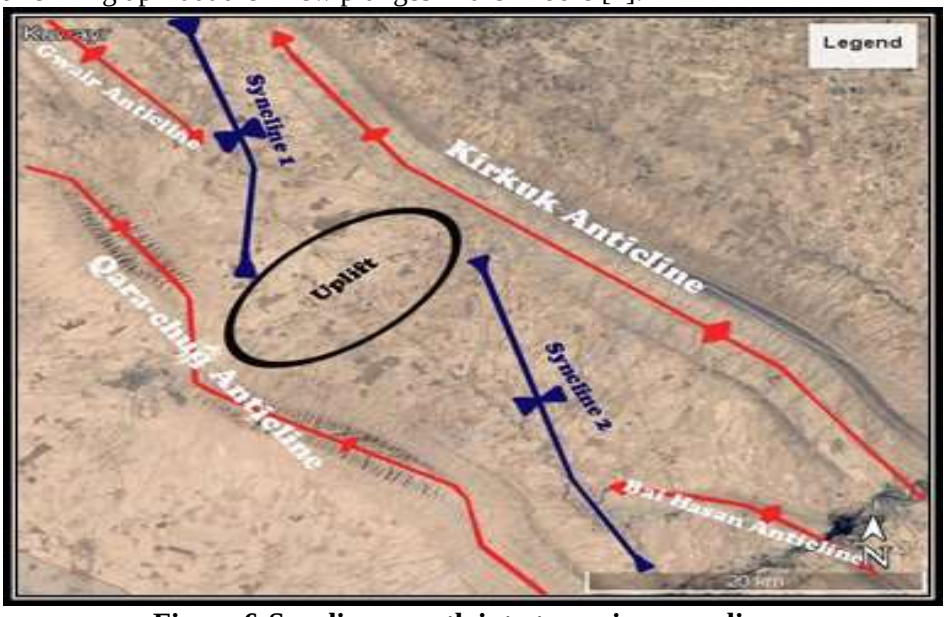

Figure 6-Syncline growth into two minor synclines.

CONCULSIONS

During the visual interpretation of the satellite images of the rocks in the study area, many landform deformations have been recognized as an evidence for longitudinal uplift. This uplift is located transversely in the middle of the syncline between Kirkuk and Qarachuq anticlines with a trend of northeast-southwest, dividing the syncline basin into minor sedimentary rock basins. Also, many morphotectonic evidences have been extracted to conclude the reason of the uplift of the rocks in this area. These evidences include the deformation of the outer structural ridges of Kirkuk and Qarachuq anticlines, the topographic transverse uplift with the major syncline axis, the division of the drainage pattern of the syncline in the sedimentary basin into two catchment areas, and the strike-slip faults on Kirkuk and Qarachuq anticlines with an oblique attitude at the anticline axis.

As a final result, based on the complexity of the above evidences, a proposal has been extracted to elucidate the reason of the uplift in the study area. The conclusion is that the major syncline propagation (between Kirkuk and Qarachuq anticlines) has been trapped at the northwest and southeast directions. This form has caused a syncline propagation from the middle to be divided into two minor synclines that extend in the northeast-southwest trend. This is due to the capping of the lateral propagation of the major synclines technically because of two other small anticlines (Gwair anticline from the northwest and Bai Hassan anticline from the southeast). These two anticlines limiting that later propagation, or might be there another proposal for inherited fault has been reactivated in quaternary period (but no evidences yet available for the fault existence in this area). This uplift of the rocks might influence the hydrocarbon status at Kirkuk anticline if it has marked impacts on the deep formation underneath it. Moreover, another scenario for the uplift is the possible intrusion of the salt diapirs into the surface without exposure to the surface, which led to the formulation of the uplift in this area.

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