

# Neotectonic Indications from the Western and Southern Deserts of Iraq

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## Abstract

The Iraqi Western and Southern deserts are part of the Iraqi Stable Shelf (Inner Platform) that belongs to the Arabian Plate. Therefore, both deserts lack tectonic forms like folds and faults; however, very rarely faults and regional lineaments can be seen in both deserts. Although both deserts are tectonically stable, tens of Neotectonic indications can be seen everywhere in both deserts. Among those indications are: Straight valleys, perpendicular valley bendings, sinkholes aligned along straight lines, dislocated valleys, knickpoints within valleys aligned along straight lines, regional lineaments, anomalous valley shapes, trends, and types, dissected alluvial fans. We have used existing geological maps of different scales and Esri World Imagery to recognize those Neotectonic indications. All those recognized features are excellent indications that both the Iraqi Western and Southern deserts are tectonically not stable. Accordingly, new terminology is suggested instead of the Stable Shelf (Inner Platform) which is the “Less Disturbed Shelf”.

## Keywords

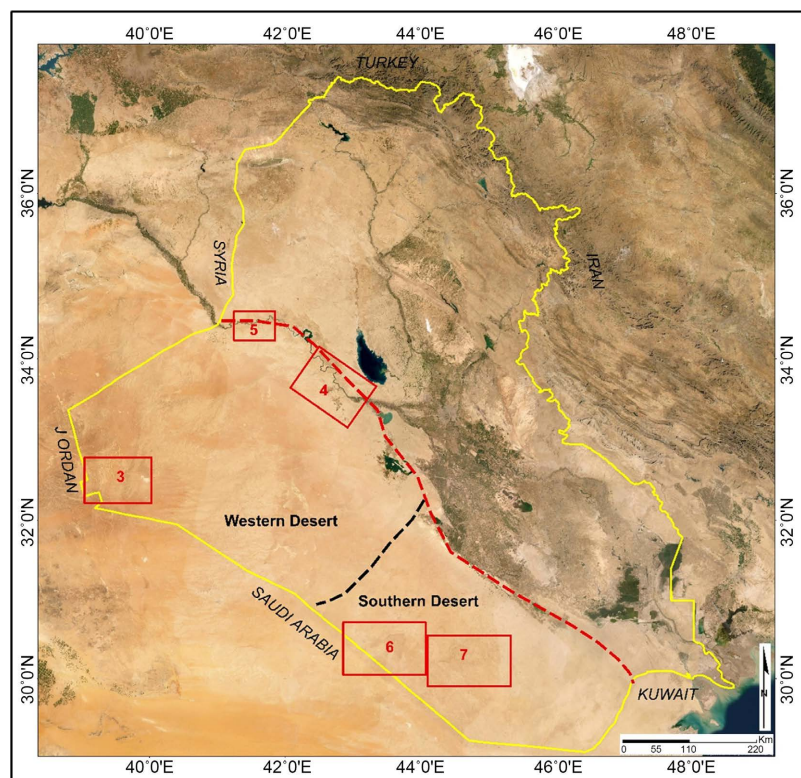
Neotectonics, Iraq Western and Southern Deserts, Knickpoints, Dislocated Valleys, Anomalous Valley Shapes

## 1. Introduction

The Iraqi territory is divided tectonically into two main domains: unstable and stable. The Western and Southern deserts (**Figure 1**) are considered within the tectonically stable parts of the territory [1] [2] [3] [4]. All published tectonics maps have included the Iraqi Western and Southern deserts within the tectonically stable unit of Iraq (**Figure 2**).

This division of the two tectonic domains is attributed to the collision of the Arabian and Eurasian (Iranian) plates [3] [5]; it is worth mentioning that the Iraqi territory forms the northeastern part of the Arabian Plate, which exhibits convergent boundary with the Eurasian Plate [6]-[12]. The collision of the Arabian and Eurasian plates is still ongoing since the Lower Cretaceous and has developed the Zagros Foreland Basin, which is a continuously sinking basin. Along this basin, the Zagros Fold-Thrust Belt and the Mesopotamian Foredeep are located both suffer from tectonic unrest [5]. Consequently, tens of anticlines are developed, and hundreds of faults of different types. This is attributed to the exerted forces by the collision of the two mentioned plates [4]. The Iraqi Western and Southern deserts; however, lack almost any surface structural indication for tectonic deformation; therefore, were considered within the Stable Shelf [1] [13], whereas [3] considered both deserts in the Inner Platform (Figure 2).

This work aims to confirm that in Iraq there are no tectonically stable parts. No doubt that the intensity of folding and tectonic disturbances culminate southwards from the convergent tectonic plate boundary at the extreme northeastern part of Iraq (The Zagros Suture Zone, Figure 2). Therefore, the Iraqi Western and Southern deserts suffer from less Taconic disturbances as compared to the Unstable Shelf (Outer Platform) tectonic units; however, tens of indications exist, which indicate tectonic unrest. Accordingly, elucidating those indications are also the aim of this work.



**Figure 1.** Esri Satellite image. The red dashed line is the approximate contact between the Unstable Shelf (northwards) and the Stable Shelf (southwards) (Fouad, 2015). The red rectangles are the locations of the presented figures in the text.

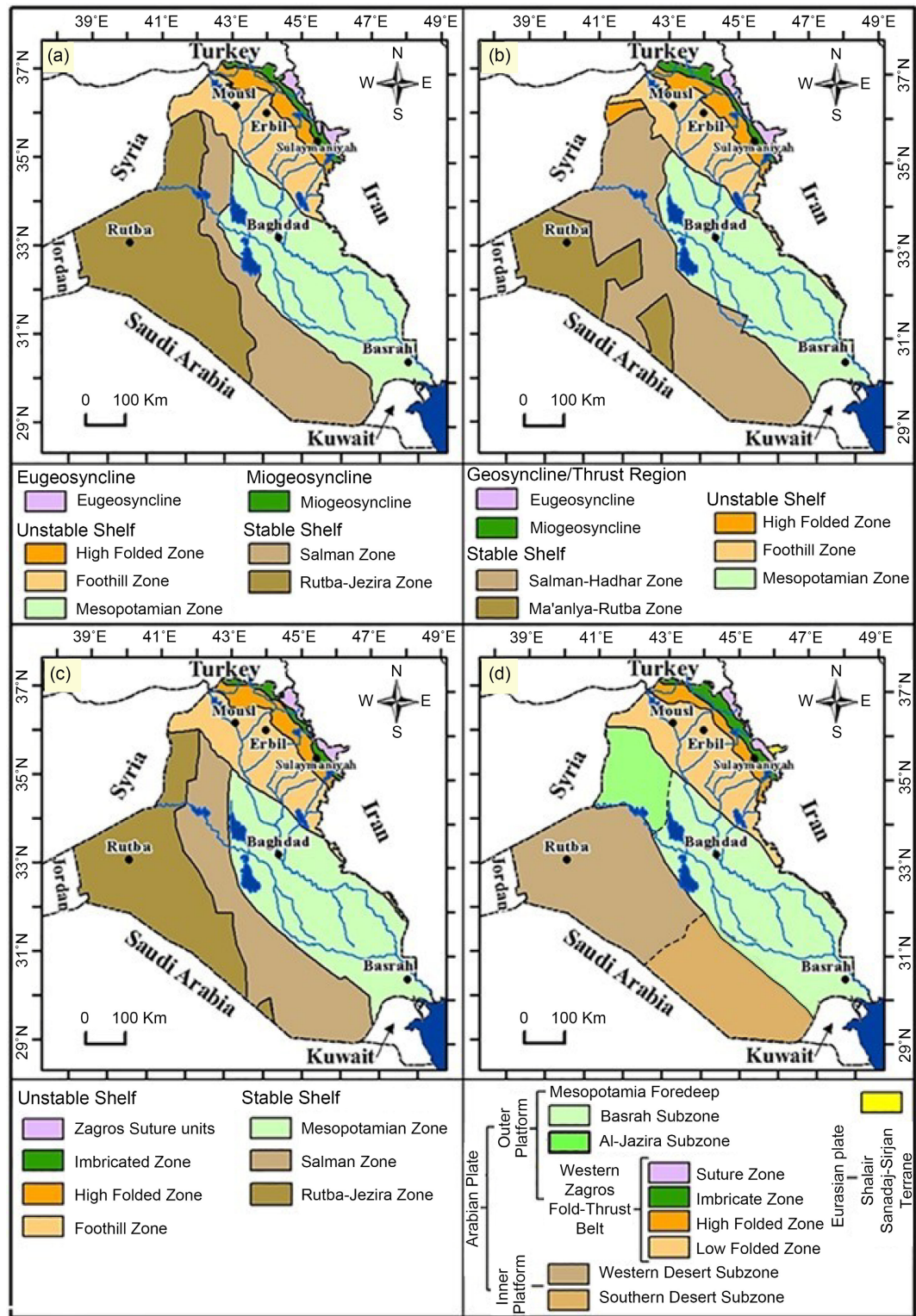


Figure 2. Main tectonic zones of Iraq, after [1] [3] [13] [15].

## 2. Materials and Methods

Tens of published papers and geological maps at different scales were reviewed to conduct this research, besides the interpretation of different satellite images to

recognize Neotectonic indications within the studied area. The locations of presented examples are shown in (Figure 1). Tens of field investigations were carried out from 2012-2021 during which the majority of the recognized Neotectonic indications were observed. We have adopted the opinions of many researchers to indicate Neotectonic activities, among those researchers are: [14] [16] [17] [18]. Among the recognized features, which are good indications for Neotectonic activity are 1) truncated valleys, 2) oriented asphalt seepages along structural lineaments, 3) oriented terraces, 4) oriented sinkholes, and 5) circular valleys.

### 3. Results

From the studied geological maps of different scales, interpretation of high-quality satellite images, and field investigations, the following examples are presented to confirm that the Iraqi Western and Southern deserts are tectonically unstable.

#### 3.1. Western Desert

The Iraqi Western Desert covers large parts of the Iraqi territory (Figure 1), it comprises of flat plain dissected by deep and long valleys and the existence of long cliffs. Although no surface folds exist in both deserts; apart from the Anah anticline; however, there are many subsurface folds; some of them form oil and gas fields, and even extend outside of the Iraqi territory. This is one of the indications that the Western desert is tectonically not stable. A few more examples are given too.

##### 3.1.1. Wadi (Valley) Hauran

This is the largest valley in Iraq in the extreme southern part, the branches of the valley show clear indications of Neotectonic activity. Some branches are truncated in their middle parts (Figure 3). For example, at point A, the brunch is truncated and flowing in two opposite directions. The brunch between B and C is truncated and the western part is directed northeastwards to point D. In all cases, the traces of the old valleys are clear (Figure 3).

##### 3.1.2. Hit Vicinity

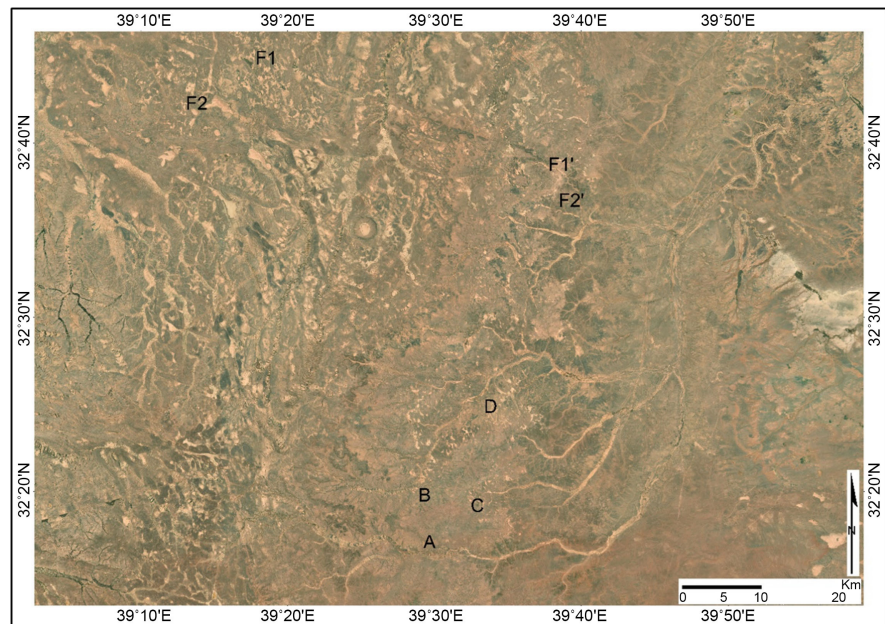
At the Hit vicinity, there are tens of bitumen seepages (Figure 4), all are aligned at NNW-SSE. Many valleys flow along this trend and join perpendicularly to the main valleys (Points 1, 2, and 3, Figure 4). Some valleys exhibit right angle multi bends along their courses (Points 4 and 5, Figure 4). All these are good indications for Neotectonic activity with the Iraqi Western Desert.

##### 3.1.3. Anah Anticline

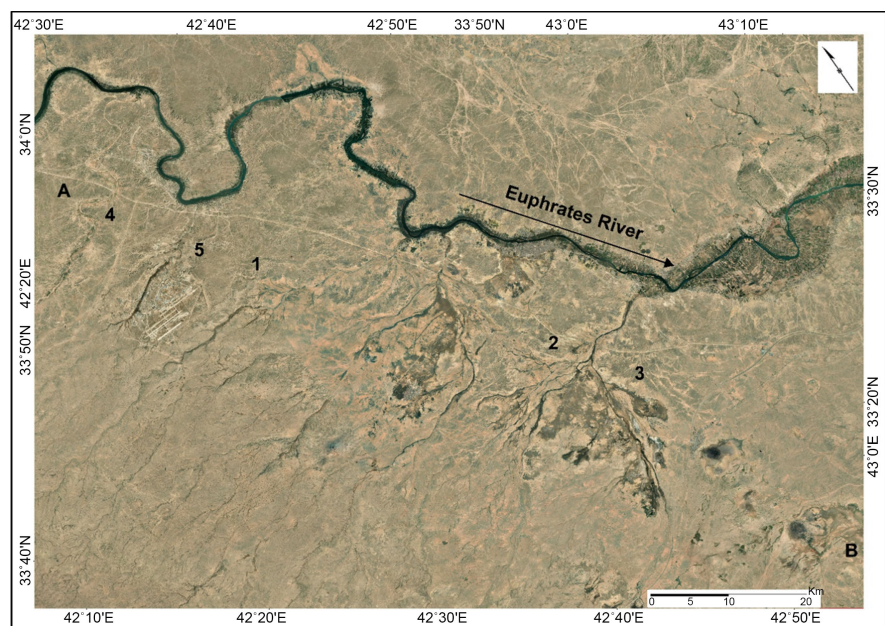
The Anah anticline is an outstanding geomorphological and structural form in the Iraqi Western Desert (Figure 5). Four valleys dissect the axis of the anticline forming water gaps (Figure 5). Along the lineament A-B-C (Figure 5), the valleys exhibit knickpoints. Moreover, tens of valleys of different orders change their trends and follow in different directions.

### 3.2. Southern Desert

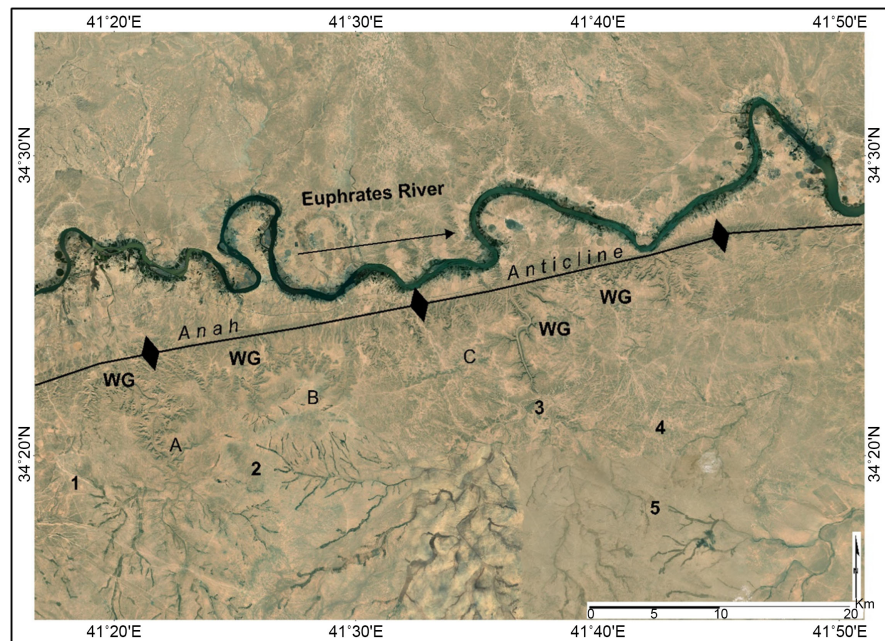
The Iraqi Southern Desert covers large parts of the Iraqi territory (**Figure 1**), it comprises of flat plain dissected by shallow and short valleys, some of which are blind valleys. It is also characterized by being intensively karstified. The following examples confirm that the Southern Desert is tectonically not stable.



**Figure 3.** Esri Satellite image showing truncated valleys and changing their trends due to Neotectonic activity.



**Figure 4.** Esri Satellite image showing bitumen seepages at Hit vicinity. Note the alignment of the seepages along line A-B, note the straight valleys at points 1, 2, and 3, which have courses parallel to the alignment A-B and not following the general topographic gradient, and note right angle multi beds of valley courses at point 4 and 5.



**Figure 5.** Esri Satellite image showing the Anah anticline. WG = water gap, A-B-C is alignment, at points 1, 2, 3, 4, and 5, the valleys exhibit abnormal forms and/or change their trends.

### 3.2.1. Southwest of Al-Najaf Vicinity

Many circular valleys (C1, C2, and C3) are developed around a circular karst form (Figure 6), and other circular forms (1, 2, 3) are developed with diameters up to 17 km and even more. To the north of the intensively karstified areas (the black dots in Figure 6), the valleys have straight courses (SV, Figure 6) flowing NE wards which is the general gradient direction.

### 3.2.2. South of Al-Samawa Vicinity

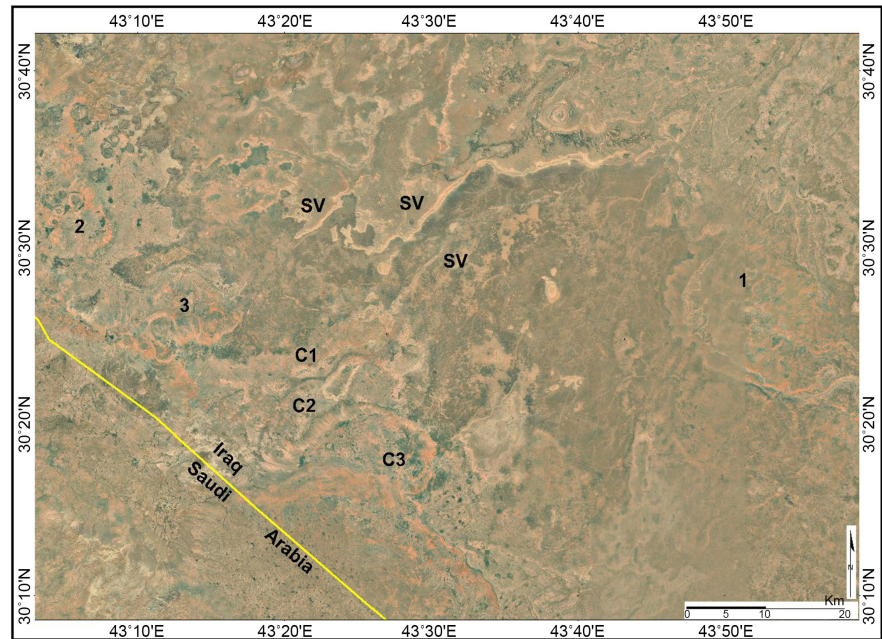
Tens of circular and oval karst depressions are developed in this vicinity; some are marked in Figure 7, and their diameters attain up to 14 km. Special circular valleys are developed in opposite directions (C1, C2, and C3, Figure 7). Straight valleys (SV) flow near karst forms without being influenced by the karst depressions (Figure 7), whereas the majority of the depressions are surrounded by circular valleys (CV, Figure 7).

## 4. Discussion

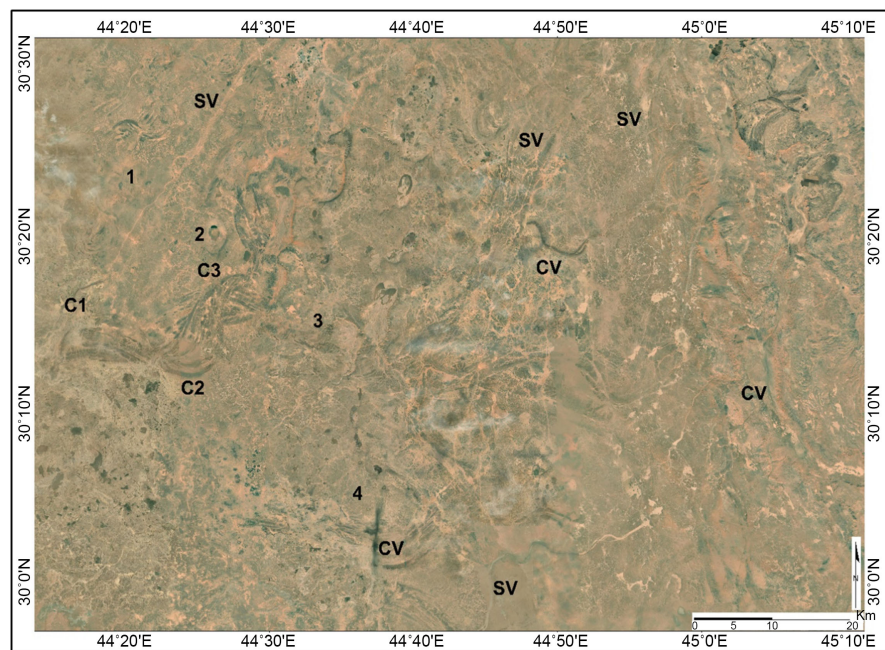
All interpreted and presented examples (Figures 3-8) are related to Neotectonics activities because they all are developed during the Quaternary Period. This means the Iraqi Western and Southern deserts suffer from Neotectonic activities; consequently, suffer from tectonic unrest. Accordingly, both deserts' areas are tectonically unstable, not as mentioned and shown by different authors, among them are: [1] [3] [13] [15].

The Neotectonic activity started in Iraq during the Upper Miocene [19]. Many authors; however, have considered the beginning of the Neotectonic from the

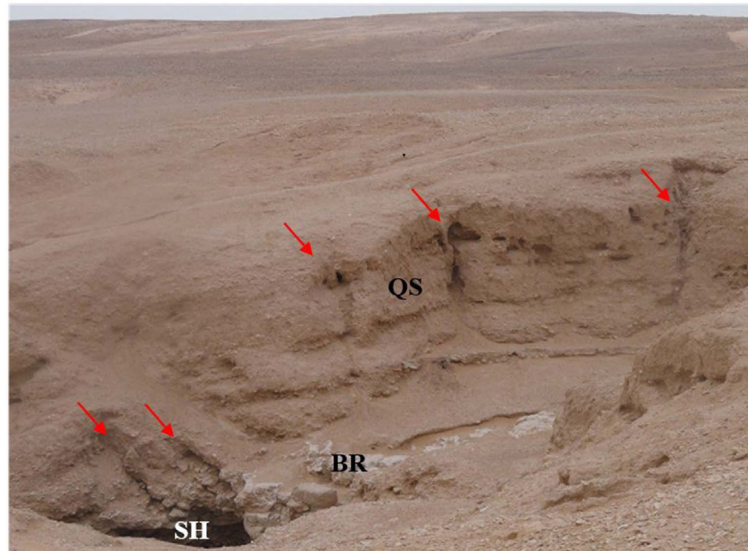
Middle Miocene; among them are: [14] [16] [17] [18] Pavlides [14], however, suggested that “Neotectonic is the study of young tectonic events, which have occurred or are still occurring in a given region after its orogeny or after its last significant tectonic set-up”.



**Figure 6.** Esri Satellite image showing of southwest Al-Najaf vicinity showing circular valleys (C1, C2, and C3), circular karst depressions (1, 2 and 3), SV = Straight valley, the small black dots are sinkholes.



**Figure 7.** Esri Satellite image showing of south Al-Samawa vicinity showing special development of circular valleys (C1, C2, and C3), circular karst depressions (1, 2, 3, 4 and 5), CV = Circular valley, SV = Straight valley.



**Figure 8.** Field photo of jointed thick Quaternary sediments in Al-Salman Depression. The red arrows are pointing to the developed joint system. SH, BR and QS stands for Sink Hole, Bed rock and Quaternary sediments.

In the current study, the dissected valleys, abnormal trends and shapes of valleys, and jointed Quaternary sediments (**Figure 8**) are considered indications for Neotectonic activities. Such cases are confirmed by [20]. The presence of the water gaps along the Anah anticline is a good indication of the lateral growth of the anticline; consequently, is considered Neotectonic activity. Such a case is also confirmed by [21] [22] [23] [24].

The recognized Neotectonic indications in the Iraqi Western and Southern deserts are good evidence that both deserts are suffering from tectonic unrest and exhibit different disturbance forms. However, the intensity of disturbances decreases in both deserts as compared to the northern and northeastern parts of Iraq. This is attributed to the remoteness of the deserts from the convergent boundary between the Arabian and Eurasian plates [6]-[11]. Therefore, we highly recommend using the term “Less Disturbed Shelf” instead of Stable Shelf or Inner Platform (**Figure 2**).

## 5. Conclusion

From the presented data in the current work, the Iraqi Western and Southern deserts suffer from tens indications for Neotectonic activities. Among those indications are dissected valleys, abnormal trends and shapes of valleys, and jointed Quaternary sediments. Moreover, circular and oval karst depressions are developed with diameters attain up to 14 km, circular valleys are also developed, and straight valleys were recognized to flow near karst forms without being influenced by the karst depressions. Water gaps are developed in the Anah anticline, which are good indications for Neotectonic. Accordingly, both the Western and Southern deserts suffer from tectonic unrest, which means they cannot be considered within the tectonically stable parts of Iraq. Consequently, this means

there are no tectonically stable areas in Iraq.

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### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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