# Neotectonic Indications from the Western and Southern Deserts of Iraq

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**Research Article**

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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, faults; however, very rarely faults and regional lineaments can be seen in both deserts. Although both deserts are tectonically stable; but tens of Neotectonic indications can be seen everywhere in both deserts. Among those indications are: Straight valleys, perpendicular valley bending's, 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) that is “Less Disturbed Shelf”.

## 1. Introduction

The Iraqi territory is divided tectonically into two main domains: unstable and stable. The Western and Southern deserts (Fig. 1) are considered within the tectonically stable parts of the territory [(Buday and Jassim, 1987, Jassim et al., 1990, Al-Kadhimi et al., 1997, Jassim and Goof, 2006, Aqrawi et al., 2010, Sissakian and Fouad, 2015, Fouad, 2015) in Sissakian et al., 2017]. All published tectonics maps have included the Iraqi Western and Southern deserts within the tectonically stable unit of Iraq (Fig. 2). This division of the two tectonic domains is attributed to the collision of the Arabian and Eurasian (Iranian) plates (Alavi, 2004; Sissakian, 2013; Fouad, 2015), it is worth mentioning that the Iraqi territory forms the northeastern part of the Arabian Plate, which exhibits convergent boundary with the Eurasian Plate (Berberian and King, 1981; Beydoun, 1991; Beydoun and Hughes Clarke,1992; Alsharhan et al., 1997; Blanc et al., 2003; Burberry et al., 2010; Burberry, 2015). 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 (Sissakian 2013). 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 (Sissakian and Fouad, 2015). The Iraqi Western and Southern deserts; however, lacks almost any surface structural indication for tectonic deformation; therefore, were considered within the Stable Shelf [(Buday and Jassim, 1987, Jassim et al., 1990, Al-Kadimi et al., 1997, Jassim and Goff, 2006) in Sissakian et al., 2017], whereas Fouad (2015) considered both deserts in the Inner Platform (Fig. 2).

Figure 1. Esri Satellite image of Iraq. The red dashed line is the approximate contact between the Unstable Shelf (north of the line) and the Stable Shelf (south of the line), the contact is from Fouad (2015). The black dashed line represents approximate contact between the two deserts, contact is from Sissakian and Fouad (2015).

The red rectangles are the locations of the presented figures in the text.

Tens of published papers and geological maps at different scales were reviewed in order to conduct this research, besides interpretation of different satellite images to recognize Neotectonic indications within the studied area. The locations of the interpreted and presented examples are shown in (Fig. 1). Tens of field investigations were carried out since 1972–1988 during which majority of the recognized Neotectonic indications were observed.

The aim of this work is to confirm that in the Iraqi territory there are no tectonically stable parts. No doubt that the intensity of folding and tectonic disturbances culminate southwest wards from the convergent tectonic plate boundary at the extreme northeastern part of Iraq (The Zagros Suture Zone, (Fig. 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 2. Main tectonic zones of Iraq, [**A)** after Buday and Jassim (1987), **B)** after Al-Kadhimi et al. (1997), **C)** after Jassim and Goff (2006), and **D)** after Fouad (2015) in Sissakian et al., 2017].

## 2. 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.

# 2.1. Western Desert

The Iraqi Western Desert covers large parts of the Iraqi territory (Fig. 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, even outside of the Iraqi territory. This is one of the indications that the Western desert is tectonically not stable. Few more examples are given too.

# 2.1.1. Wadi (Valley) Hauran

This is the largest valley in Iraq (Fig. 1), in the extreme southern part, the branches of the valley show clear indication for Neotectonic activity. Some brunches are truncated in their middle parts (Fig. 3). For example, at point A, the brunch is truncated and is flowing in two opposite directions. The brunch between B and C is truncated and the western part is directed northeast wards to the point D. In all cases the traces of the old valleys are clear (Fig. 3).

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

# 2.1.2. Hit Vicinity

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

## 2.1.3. Anah Anticline

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

Figure 4. Esri Satellite image showing bitumen seepages at Hit vicinity. Note the alignment of the seepages along the 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 ate 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.

## 2.3. Southern Desert

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

## 2.3.1. Southwest of Al-Najaf Vicinity

Many circular valleys (C1, C2 and C3) are developed around a circular karst form (Fig. 6), 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 Fig. 6), the valleys have straight courses (SV, Fig. 6) flowing NE wards that is the general gradient direction.

## 2.3.2. South of Al-Samawa Vicinity

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

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.

## 3. Discussion

All interpreted and presented examples (Figs. 3, 4, 5, 6 and 7) are related to Neotectonics 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 areas, not as mentioned and shown by the previously mentioned authors, among them are: [(Buday and Jassim, 1987; Al-Kadhimi et al., 1997} in Sissakian et al., 2017]; Jassim and Goff (2006); Fouad (2015).

The Neotectonic activity started in Iraq during the Upper Miocene (Obruchev, 1948). Many authors; however, have considered the beginning of the Neotectonic from the Middle Miocene; among them are: Pavlides (1989); Becker (1993); Markovic et al. (1996); Cloetingh et al. (2002); Koster (2005). Pavlides (1989), 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 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.

In the current study, the dissected valleys, abnormal trends and shapes of valleys are considered as indications for Neotectonic activities. Such cases are confirmed by Kumanan (2001). The presence of the water gaps along the Anah anticline are good indication for the lateral growth of the anticline; consequently, is considered as Neotectonic activity. Such case is also confirmed by Burbank and Pinter (1991), Keller et al. (1999), Burbank and Anderson (2001), Ramsey et al. (2008).

# Conclusions

From the presented data in the current work, the Iraqi Western and Southern deserts suffer from tens indications for Neotectonic activities. Accordingly, they suffer from tectonic unrest, this means they cannot be considered within the tectonically stable parts of Iraq. Consequently, this means there are no tectonically stable areas in Iraq.

# Declarations

### Competing Interests

All authors declare that they have no financial interest.

### Data Availability

The datasets generated during and/or analysed during the current study are all presented in the current manuscript.

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# Figures

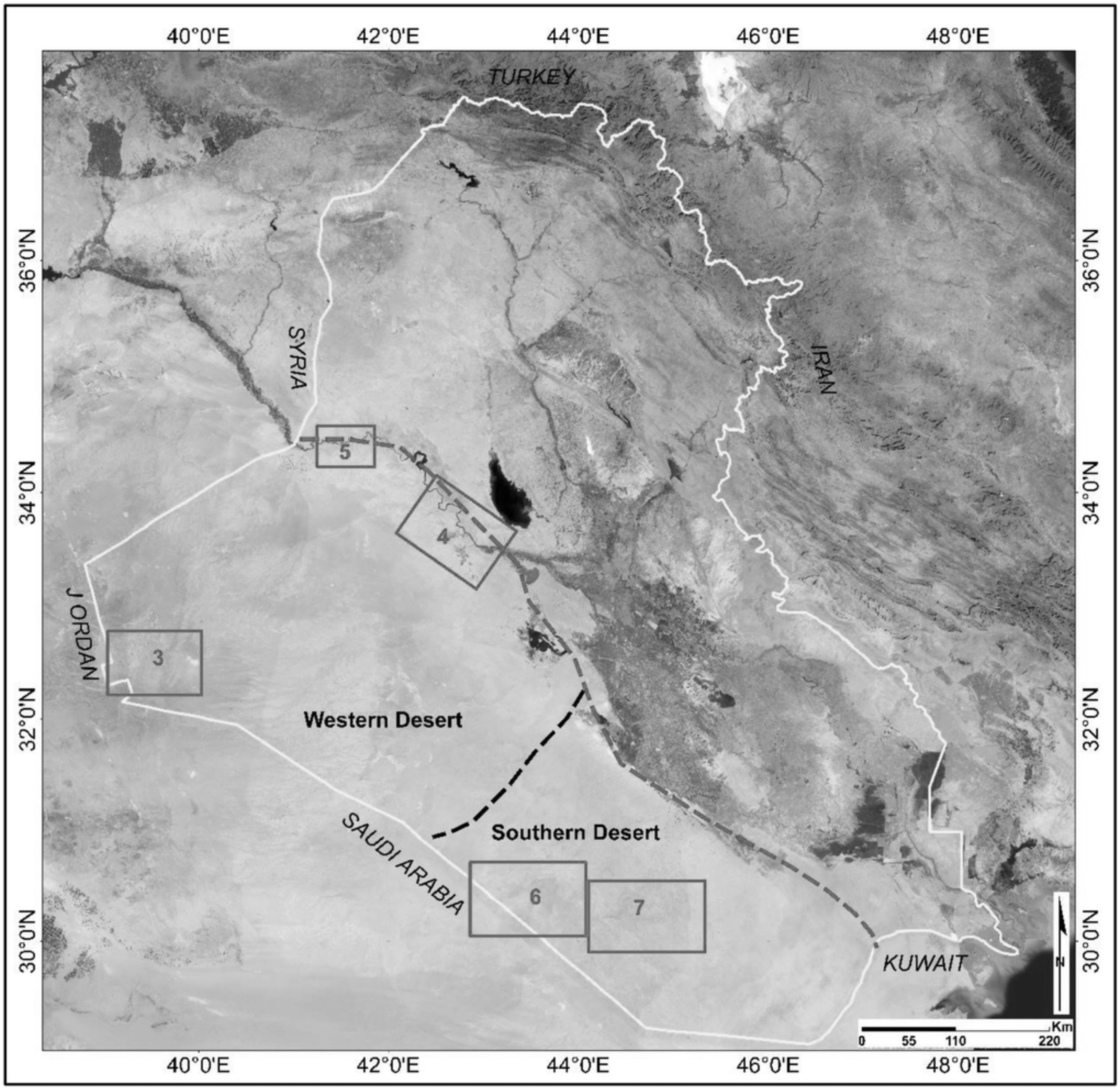


**Figure 1**

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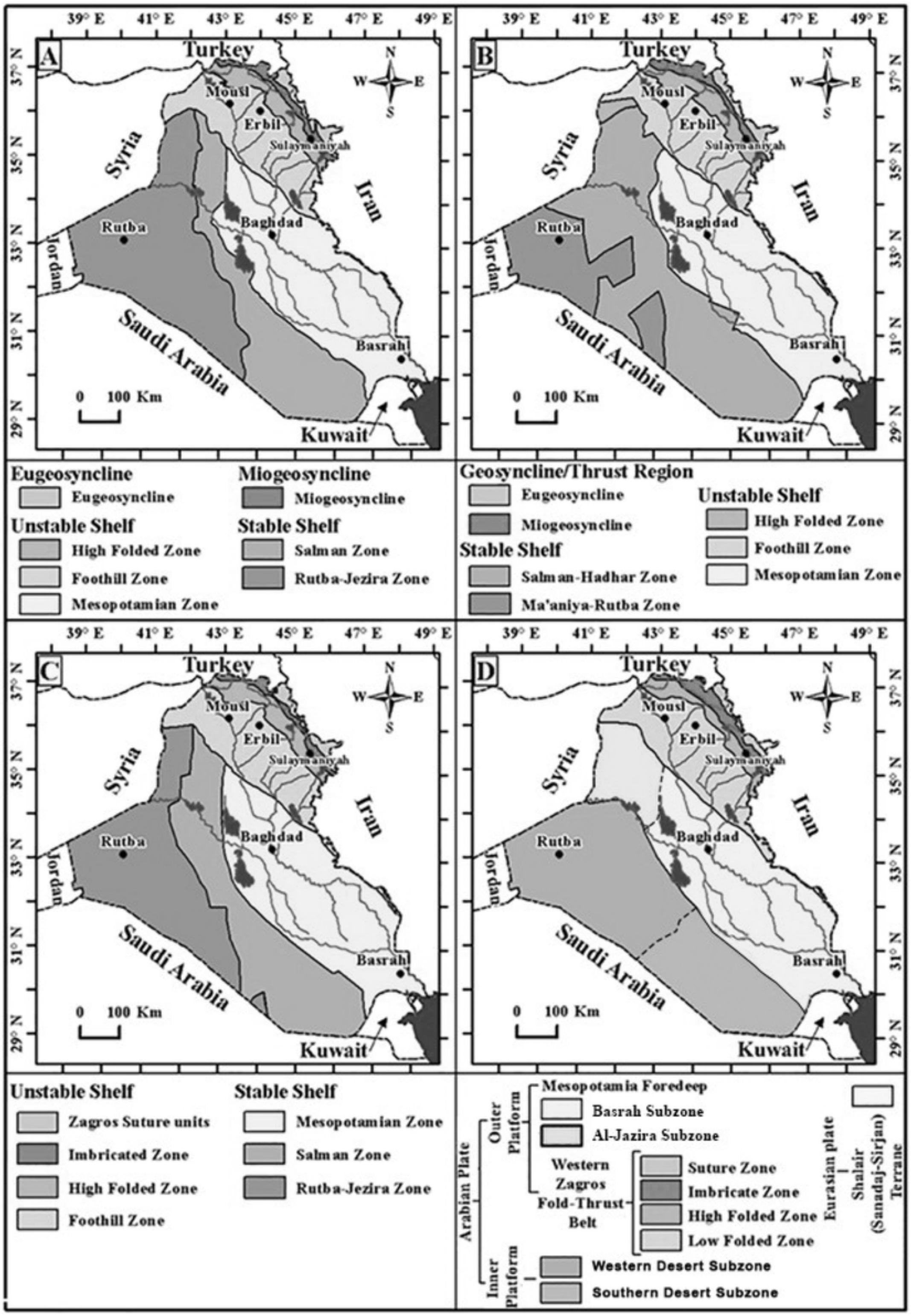


## Figure 2

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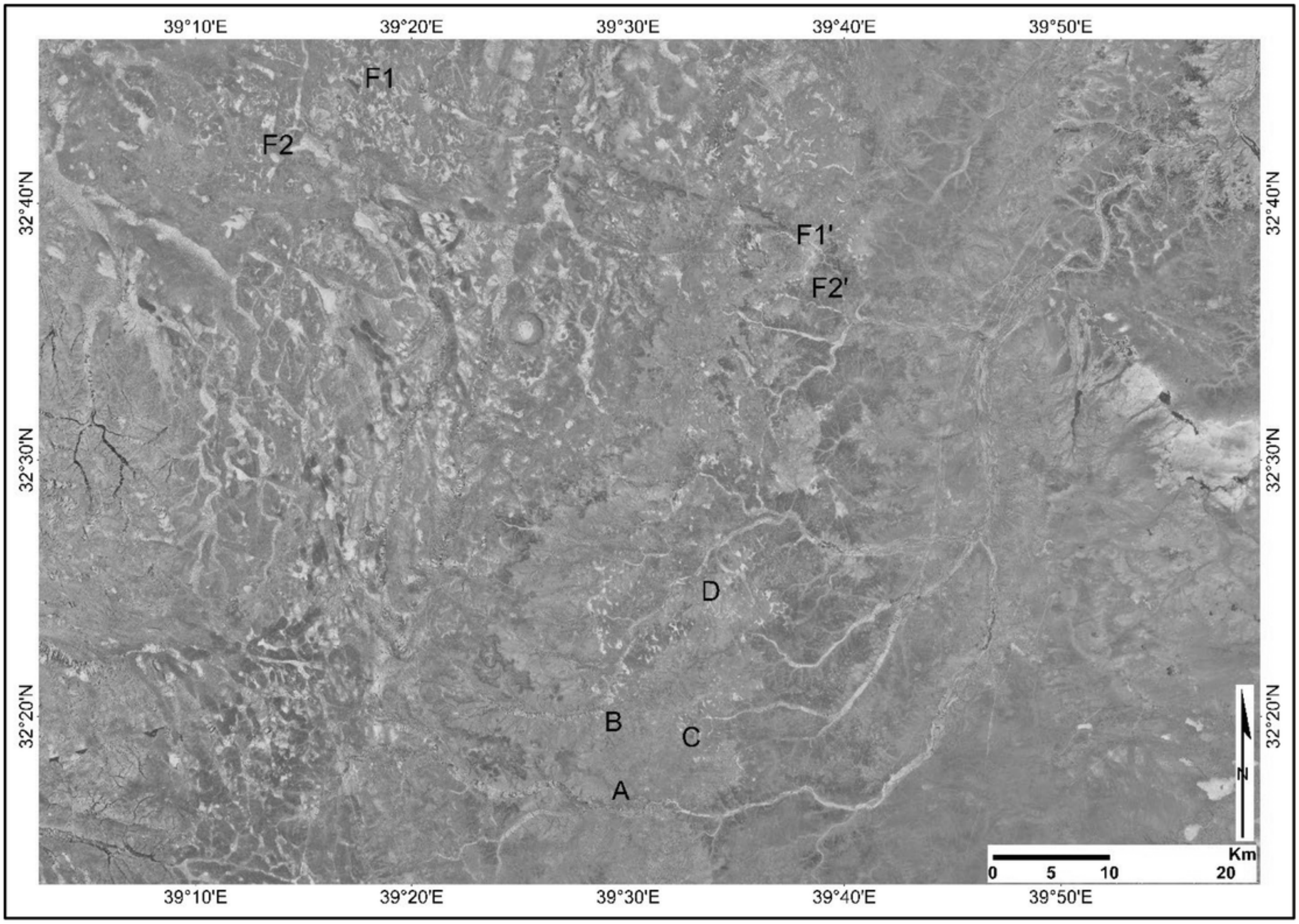
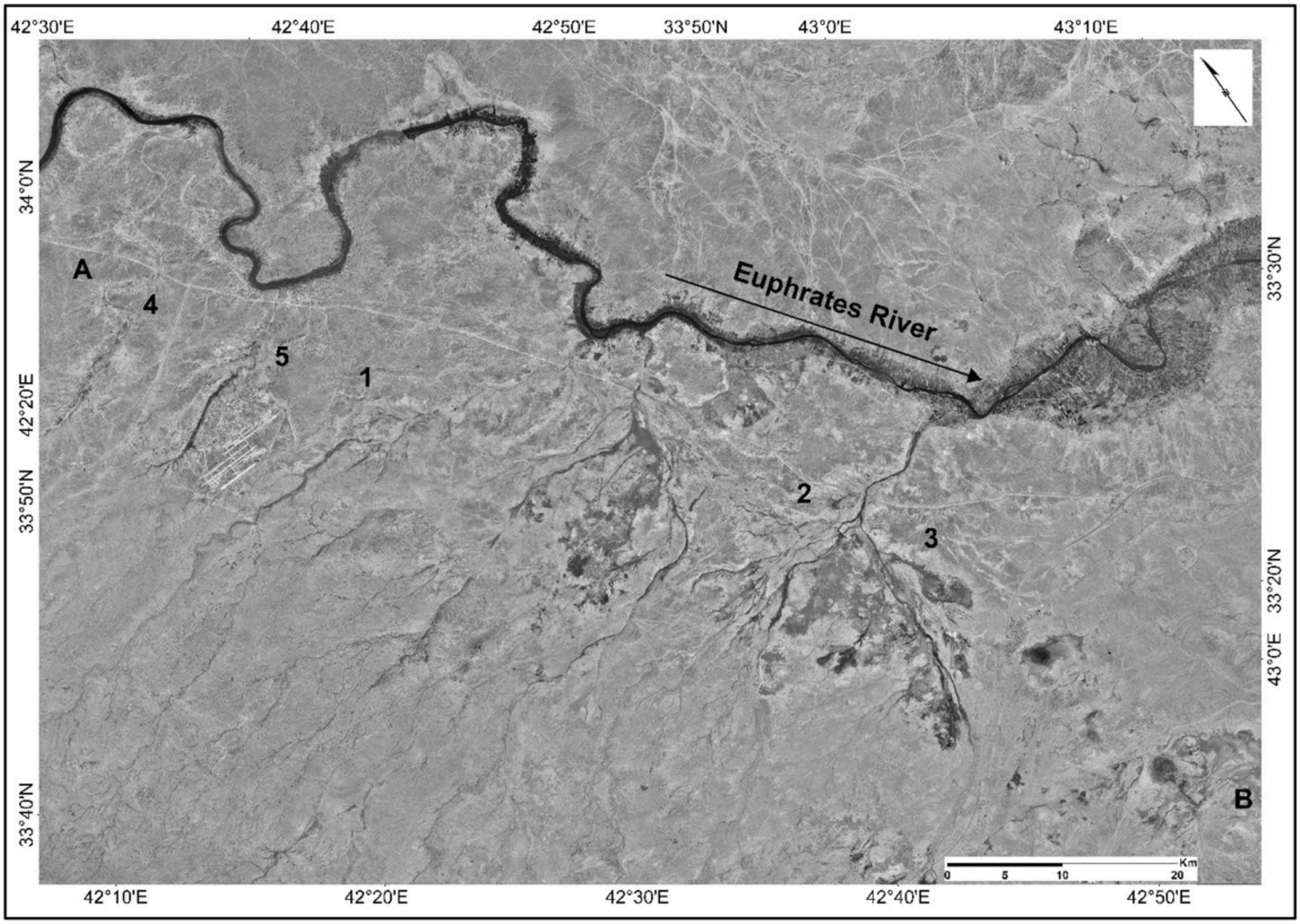


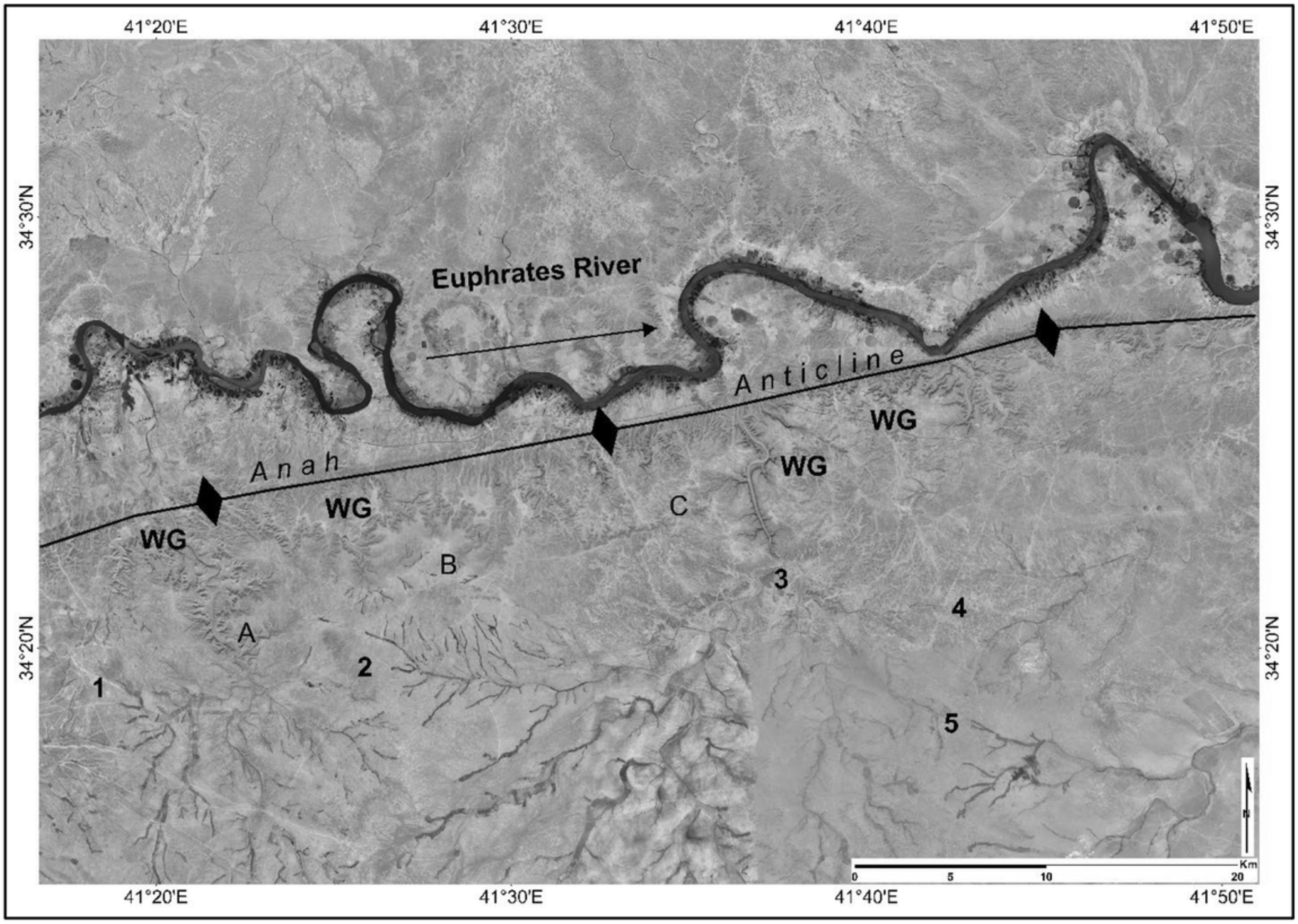

## Figure 3

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



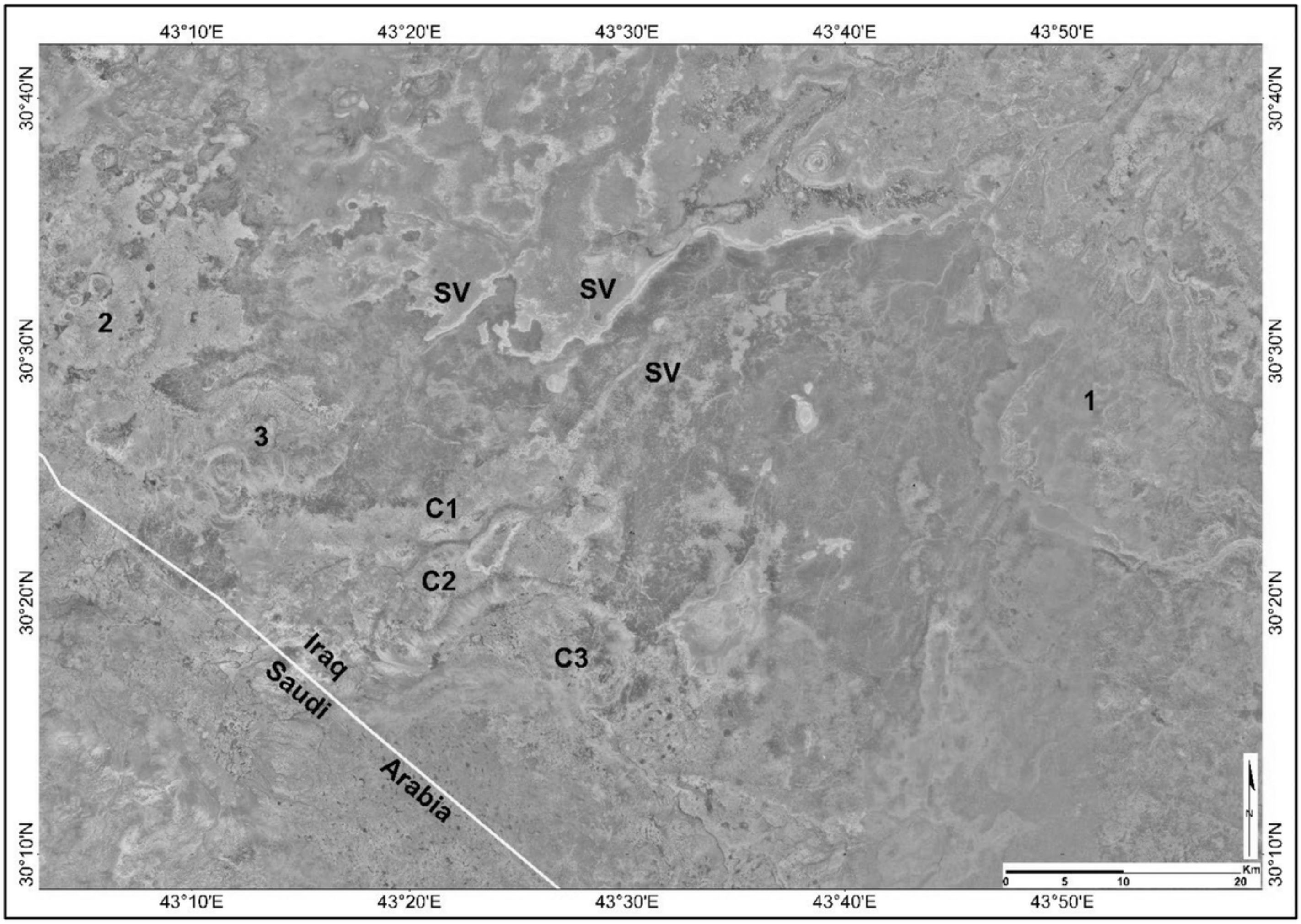

## Figure 4

Esri Satellite image showing bitumen seepages at Hit vicinity. Note the alignment of the seepages along the 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 ate point 4 and 5.



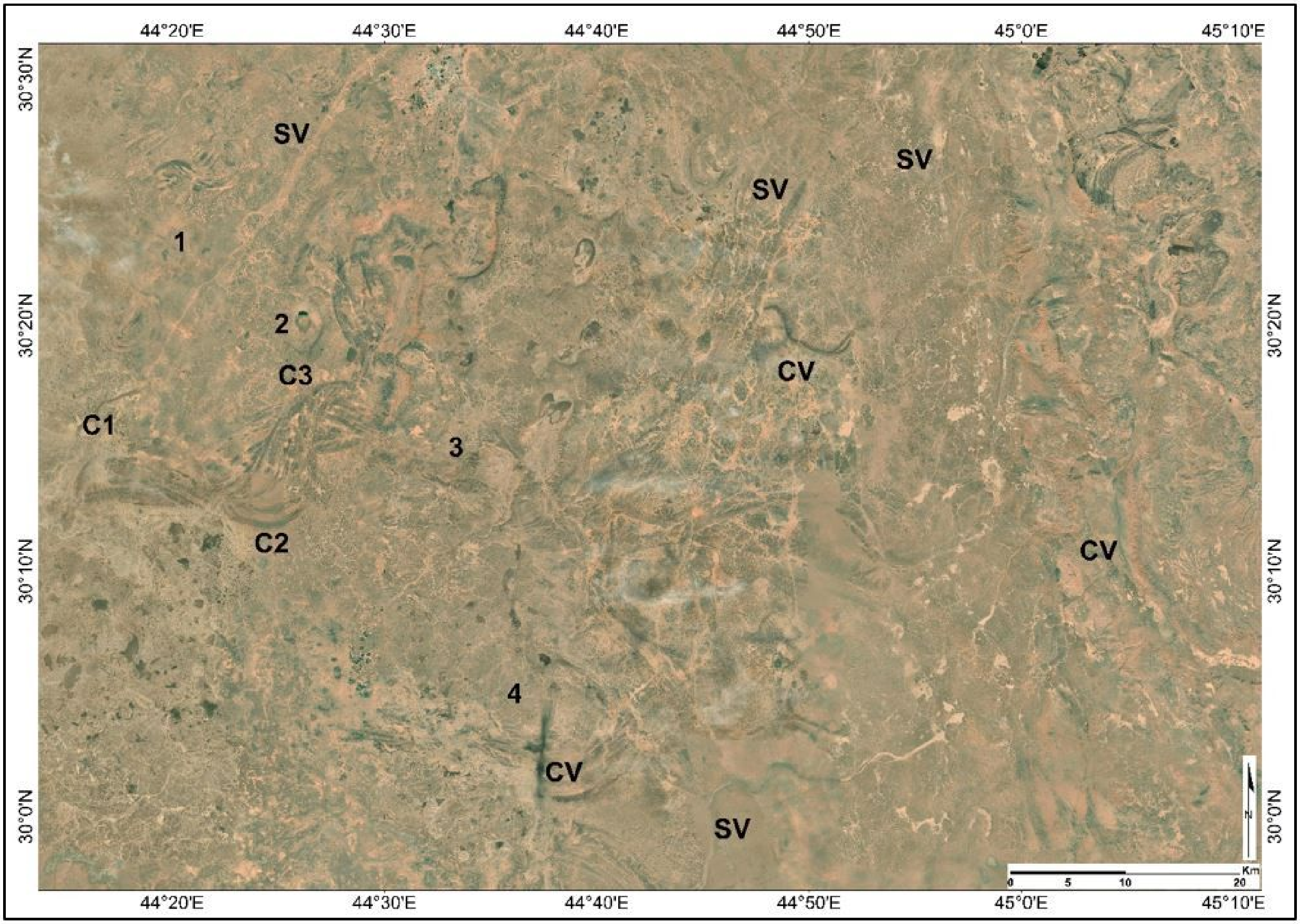

## Figure 5

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.




## 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.