Structural Evolution of the Mesopotamia Plain

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Abstract

The geological setting of the Mesopotamia Plain of the central and south parts of Iraq is a part of the Mesopotamia fore deep with the tectonic framework of Iraq. The Mesopotamia Plain is a large subsiding basin covered by thick Quaternary sediments of the Tigris and Euphrates Rivers with their tributaries and distributaries. It has been receiving pre-Quaternary sediments from the adjacent rising mountains, in the north, northeast and east, and from the Inner Platform, in the west and south, too.

The Mesopotamia Plain is a mobile tectonic zone and contains several buried structures including folds and faults. Recent tectonic activity of some of these structures is recorded through their effects on the Quaternary stratigraphy and present geomorphological landforms, such as abandoned river channels, active and inactive alluvial fans and topographic expressions of some active subsurface anticlines, all together indicating Neotectonic activity of the plain.

التطور التركيبي للسهل الرسوبي

المستخلص

الوضع الجيولوجي للسهل الرسوبي في وسط وجنوب العراق هو جزء من حوض مابين النهرين ضمن الهيئة التكتونية للعراق. ان السهل الرسوبي هو حوض كبير مستمر بالهبوط ومغطى بكامله بترسبات العصر الرباعي السميكة لنهري دجلة والفرات وروافدهما وتفرعاتهما. استلم هذا الحوض ترسبات ما قبل العصر الرباعي من بقية أجزاء حوض مابين النهرين وحزام زاكروس الجبلي, من الشمال والشمال الشرقي والشرق, وكذلك من الجزء الداخلي المستقر من المسطبة العربية, من الغرب والجنوب.

ان حوض السهل الرسوبي هو نطاق بنيوي متحرك ويضم العديد من الطيات والصدوع. ان للعديد من هذه التراكيب تأثيرات على رواسب العصر الرباعي والأشكال السطحية الحالية (الأشكال الجيومورفولوجية), مثل قنوات الأنهار المتروكة, المراوح الفيضية النشطة والخامدة, والأشكال الطوبوغرافية لبعض الطيات تحت السطحية, جميعها دلائل على وجود حركات بنيوية حديثة في هذا الحوض.

Introduction

The Mesopotamia Plain of the Iraq is addressed to the area that is covered by quaternary fluvial sediments of the Tigris and Euphrates rivers. This area, which occupies central and southern Iraq, is a flat terrain in general with gentle slope from northwest to southeast towards the Arabian Gulf. Geomorphological features related to recent fluvial accumulations such as natural levees, river terraces, alluvial fans, flood plains etc., are very common on the surface, whereas significant features of tectonic origin are almost absent. Because of the thick Quaternary cover, structural information is extremely limited, and can only be obtained indirectly.

Location and boundary of Mesopotamia Plain

The Mesopotamia Plain forms the central and the southern parts of Iraq. The investigated area is enclosed between latitudes 32^0 N and 35^0 N and longitudes 43^0 E and 48^0 E. (Figure 1). Early workers have considered it a part of the Unstable Shelf of the Arabian Platform ([1]; [2]; [3] and [4]) have referred to this area as the Mesopotamian Zone, and considered it as a separate structural unit within the Unstable Shelf. The Mesopotamia Plain bordered from the northeast by the first superficial and topographic prominent anticlinal ranges represented by Makhoul, Himreen, Badra and Bazargan. Southwestern boundary of the Zone coincides with the Euphrates Fault Zone, extending NW to Al-Ramadi city, then swing sharply in N-S direction to follow the Thirthar valley and terminates against Makhoul Range [5].

Geological Setting

The Mesopotamia Plain is covered by different Quaternary sediments that range in age from Pleistocene to Holocene, and in thickness from few meters up to 180 meters; they are represented by fluvial sediments of the Tigris and Euphrates Rivers and their distributaries [6]. No structural features are can be seen on surface within the area, except a main fault escarpment that extends from south of Al- Najaf city to south of Nasiriyah city [7]; [8] and [9]. It forms part of the western borders of the plain, with the adjacent Iraqi southern desert. The rolling topography, in the northern parts indicates subsurface anticlines that are still rising up, such as Balad, Samarra, Tikrit and Baiji anticlines [10]. These anticlines, with other surface features, like the drainage pattern, shifting of the main river courses, abandoned river channels active and inactive alluvial fans are good indicationsfor neotectonic movements [11].

The Zagros Fold – Thrust Belt is the product of the structural deformation of the Zagros Foreland Basin, whose present day remnant is the continental Mesopotamia and the marine Arabian Gulf Basin [12].

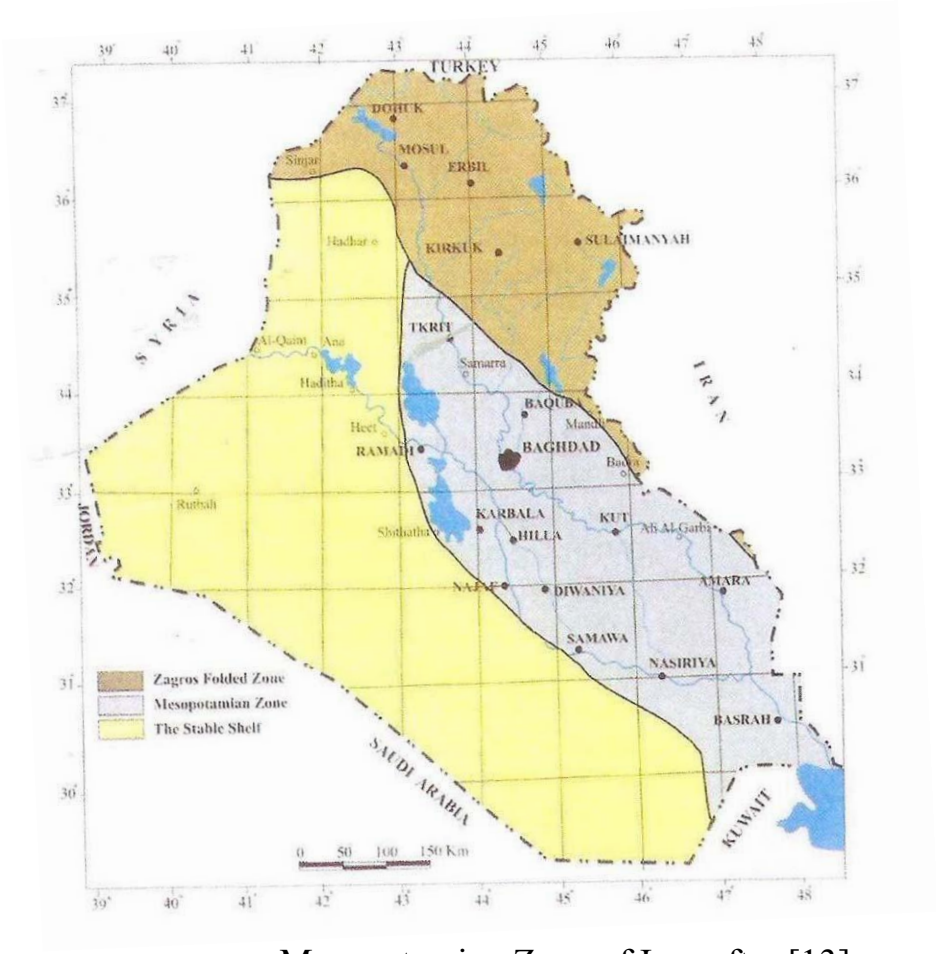

Figure 1: Mesopotamian Zone of Iraq after [13]

Structure

The Mesopotamia plain is a flat terrain, slopping very gently toward the Arabian Gulf. Structural features are absent on surface. It contains several subsurface structures including faults and folds that are entirely concealed beneath the Quaternary cover.

Folds:

Surface folds are almost absent in the Mesopotamia Plain. The NW –SE trending Tikrit and Samara folds are the only exception, though they are hardly recognized on surface because of the Quaternary cover. Due to growth, the Quaternary sediments are uplifted along these structures with about (10- 15) m relief in comparison with the surrounding. Consequently, local drainage divide lines developed along the crests of these structures.

Subsurface folds and structural noses are rather common structures within the Mesopotamia Plain. They are hidden beneath Quaternary cover, usually with NW-SE trend in the central and eastern parts, following the general trend of the Zagros fold – Thrust Belt, but deviate largely in the extreme southern part where the folds are N – S trending [14].

The folds of the Mesopotamia Plain are of three genetic types [14]:

1 – Fault-related folds that have developed above an initial fault boundary structural troughs because of structural inversion phenomenon. Consequently, the geometry and the trend of such folds match the trend and geometry of the underling initial structural trough. Tikrit and Samarra are examples of this type.

2 – Simple buckles folds, which formed as a result of the regional compression that was generated by the Arabian – Eurasian (Iranian) Plates collision. Such folds are NW – SE trending following the regional trend by Zagrros Fold – Thrust Belt.

3 – N –S trending folds, this type is limited to the extreme southern part of Mesopotamia Plain, following the old inherited fractures of N –S Arabian trend, which is best developed in the north of the Arabian Gulf region. The folds are usually long, broad and with low amplitudes, such as Zubair and Rumaila structures.

Faults:

A network of NW – SE trending faults have been developed in the northern part between south Mosul and south Baghdad, in particular. These faults are of normal type and forming a complex set of grabens, half grabens and solitary faults. Some of the grabens have been partially inverted, forming anticlinal folds or structural noses above them, whereas others have not [15].

Neotectonics

The Mesopotamia Plain is a subsiding basin with a NW –SE trend and of oval shape. The maximum subsidence, as expressed by means of contour lines, is 2500 m, being measured on the top of the Fatha Formation (Middle Miocene), it forms an elongated oval shape, with NW – SE trend and extends from east of Al- Khalis, for about 30 km, to west of Badra, for about 10 km [8], (Figure 2).

The Mesopotamia Basin is asymmetrical, indicating very steep eastern rim as compared to the western one. This asymmetry is typical of foreland basins, formed because of plate collision, manifesting the shape of the subsiding foreland basin, in front of the rising Zagros Mountain. Such asymmetry also indicates tectonic tilting of the basin. The length of the basin, in Iraq is about 540 km, whereas the width is variable, it is 80 km, in the extreme northern part,

200 km between Hilla and Badra, and 230 km between Samara and Ali Al-Gharbi, and 40 km near Basra [5].

Within this huge continuously subsiding Mesopotamia Basin, there are many uplifted areas, which are still active, indicating Neotectonic movements. Those areas are evidenced by many Quaternary landforms, like topographic indications, abandoned river channels, shifting of river courses, active and inactive alluvial fans. Such features are evidences for neotectonic activities [16], [17], [18].

The majority of the uplifted areas; within the Mesopotamia Plain represent nowadays oil fields. Their trend differ in the plain, in the central and northern parts of the basin, they have NW-SE, whereas in the southern part of the basin, the trend changes to N – S. it is also noticed that the distal parts of the majority of the alluvial fans, both active and inactive, which are developed in the plain, are parallel to the those uplifted areas (oil fields).

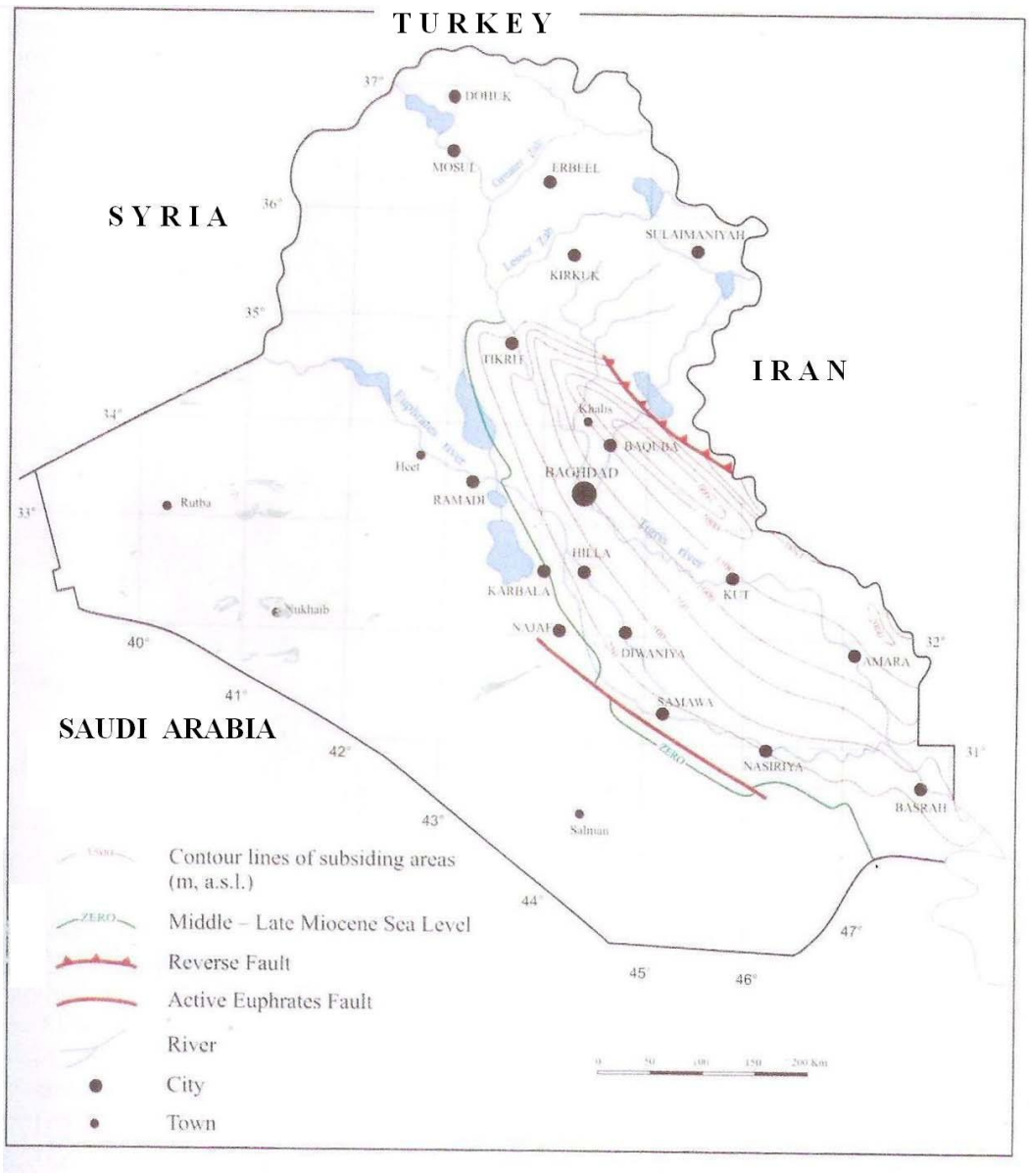

Figure 2: Neotectonic map of the Mesopotamia Plain [8]

Neotectonic Indications

There are many indications, in the Mesopotamia Plain were observed, which indicate Neotectonic activities. The indications are mentioned hereinafter.

1 – Abandoned River Channels

The Tigris River has abandoned channels in different places within the Mesopotamia Plain. The main one is between Al-Gharraf River and the current river channel (Figure 3) [9].

The abandoned channel is either the old course of the Tigris River or that of Al-Gharraf River. The growing of the subsurface anticlines in the area was the main factor for abandoning of the river its original channel [16], [19].

The Euphrates River has also abandoned its channel, between Samawa and Nasiriyah cities, it is south of the current river [9]. The main reason for abandoning of the channel is the activity of the Abu Jeer Fault Zone [5].

Figure 3: Google Earth image showing the olds of Al-Gharraf River, due the growing of subsurface Ahdab and Abu Amood anticlines (Ahdab is few kilometers NW of the image area, Abu Amood is marked by AA)

Note: The dashed lines represent the ancient courses of the rivers; the small arrows indicate the exact location of the river course

2 – Shifting of River Channels

The Tigris River has continuously shifted its course and is still shifting [16]. Interpretation of the Google earth image confirms the shifting of the river course between Samarra and southern of Baghdad, that was previously running in the middle part of a huge alluvial fan, which is called Al-Fatha Alluvial Fan [9]. The traces of the old channel are still in small parts, although the major part is vanished by urbanization and agricultural activities.

The Tigris River has also shifted its course south of Numaniyah town to south of Kut city, most probably due to growing of subsurface Aziziyah anticline (Figure 4). Al-Gharraf River also has shifted its course in two areas (Figure 3); the reason is the growing of subsurface Ahdab and Amood anticlines [16]. Such activities are attributed to Neotectonic movements by many authors [20]; [19], and [18].

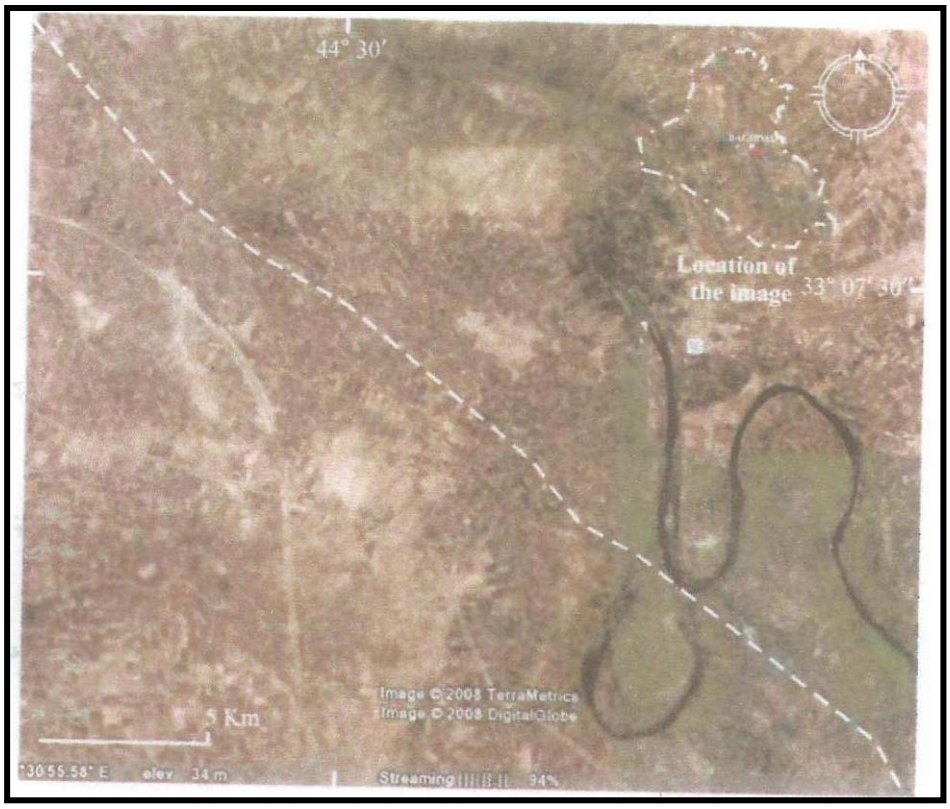

Figure 4: Google Earth image showing traces of the old Tigris River course, south east Baghdad. Note: The dashed line represents the ancient courses of the river. [5]

3 – Alluvial Fan Activities

Alluvial Fans are developed, mainly due to the drop in the energy of the stream that of the sediments, due to drop in the gradient of the stream. On the other hand, the active indicates continuous subsiding of the distal part of the fan, whereas inactive fan indicates uprising of the distal part of the fan.

Along the eastern margin of the Mesopotamia Plain, a well-developed system of alluvial fans is developed (Figure 5 and 6). They are of Pleistocene age [9].

Alluvial fans system, near Badra developed due to continuous subsiding of the Mesopotamia Plain (Figure 5). The inactive nature of other alluvial fans (Figure 6) may be attributed growing of Bazargan and Halfaya subsurface anticlines. The influence of water supply and climatic changes should not be ignored [5].

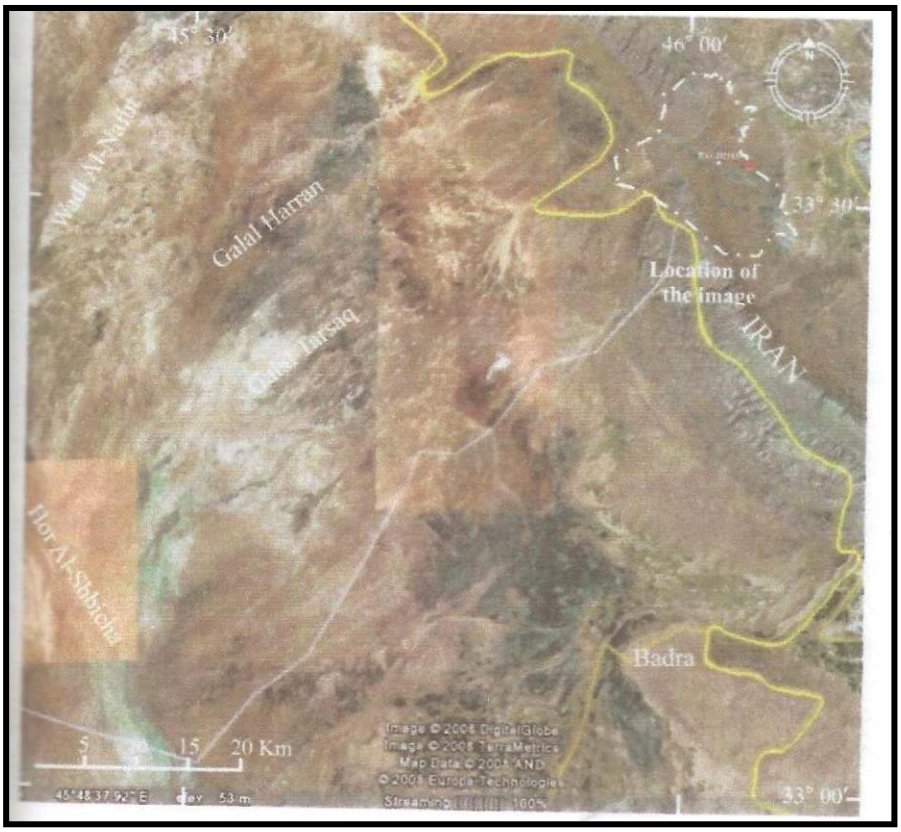

Figure 5: Google Earth image showing complex alluvial fans system, near Badra, developed due to continuous subsiding of the Mesopotamia Plain

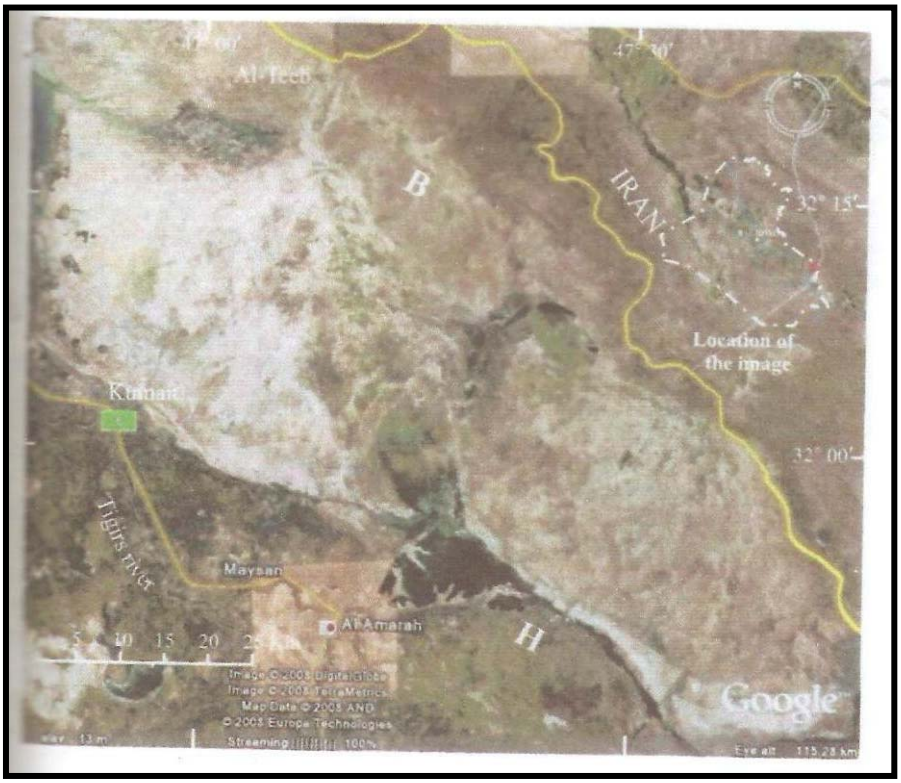

Figure 6:

Google Earth image showing a big inactive alluvial fan, between Kumait and Amara, the fan is inactive most probably due to uplifting of Bazargan (B) and Halfaya (H) subsurface anticlines

Conclusions

The Mesopotamia Plain is an integral part of the Zagros Fold – Thrust Belt. It is the extension of the present day expression of the continental part of the major Zagros Foreland Basin. The Mesopotamia Plain is an elongated basin lies between the first topographic mountain front of Zagros Orogenic Belt that extends from Bazargan to Sinjar, and the stable interior of the Arabian Platform, which is bounded by Anah – Abu Jeer Fault Systems.

The Msopotamia Plain is an asymmetric basin with a wedge- shaped Profile. The maximum sediment thickness; within the basin occur adjacent to the orogenic front and gradually decreases southwest towards the unreformed continental interior. The Mesopotamia Plain is a mobil zone, and contains a number of buried tectonic structures including folds, faults and diapric structures.

The maximum record subsidence, in the Mesopotamia Plain is 2500 m, as measured on the top of the Fatha Formation. The basin is asymmetrical, indicating very steep eastern rim as compared to western one. The asymmetry is

attributed to the collision of the Arabian and Iranian Plates, manifesting the shape of the subsiding foreland basin in front rising Zagros Fold – Thrust Belt.

Many of the buried structures are still active, indicating Neotectonic movements. Their recent activity can be observed through their effects on the Pleistocene – Holocene stratigraphy.

There are different landforms, like abandoned river channels, shifting of river courses and active and inactive alluvial fans, all together are good indications for Neotectonic movements in the Mesopotamia Plain.

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