



## The Transition Tectonic Zone Between the Two Parts of the Platform in Iraq: A Review Study

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### Abstract

The changes of the tectonic boundary locations between the stable and unstable shelf on different version of the tectonic maps of Iraq is discussed. It is found that the location of the boundary varies due to philosophy and the type of the geological parameters. It is used the stratigraphic, geophysical, structural, geochemical, hydrological and others information in delineating the boundary. The deep crustal structures obtained by using gravity data show that the boundary shifted toward the west by about 100 km in southern Iraq. According to the review, and when taking in consideration all the geological and geophysical parameters from the lower crust to the earth surface, it is believed that the boundary is not a line but it is a tectonic crustal zone. This zone represents a transition zone between the main two regions of the platform in Iraq, and it is segmented to many subzones by transverse faults. In addition, it is believed that the data of the parameters of shallow geology confirm the eastern side of the main zone, while the lower crustal structures confirm the western side of the main zone.

**Keywords:** Tectonic Boundary, Transition zone, Isostasy, Crust, Iraq

### النطاق الانتقالي بين منطقتي المنصة التكتونية في العراق

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### الخلاصة

جرت عدة تغيرات على الخارطة التكتونية للعراق خصوصا على الحد الفاصل بين الرصف المستقر وغير المستقر خلال الاصدارات المتعددة لهذه الخارطة. ومن خلال مراجعة اسباب تلك التغيرات تبين انها تقوم على عدة اسس منها فلسفة التقسيم الذي اعتمد من قبل الباحثين وتوفر معلومات جيولوجية اضافية من الدراسات الطباقية او التركيبية او الجيوكيميائية او من الموارد المائية او المعلومات الجيوفيزيائية ومعلومات الابار. اظهرت معلومات دراسات القشرة الارضية والتوازن الارضي انحراف الجزء الجنوبي من الحد الفاصل بين الرصيف المستقر وغير المستقر نحو الغرب بحوالي 100 كم. حاولت الدراسة الحالية جمع كل العناصر المعتمدة في رسم الحد الفاصل ومن ضمنها نتائج دراسات القشرة الارضية والتوازن الارضي وبناء على النتائج المقارنة توصل الباحثون الى اعتماد نطاق انتقالي بدلا من وضع خط واحد للحد الفاصل. هذه النطاق الفاصل ينقسم الى اجزاء بواسطة الفوالق المستعرضة. يعتقد ان المنطقة الانتقالية تضم معظم التغيرات الجيولوجية الممتدة من سطح الارض الى اسفل القشرة الارضية تحت العراق. ويلاحظ ان معطيات الخصائص الجيولوجية القريبة من سطح الارض يكون تاثيرها واضح قرب الجانب الشرقي فيما تنعكس التأثيرات الجيولوجية والجيوفيزيائية العميقة قرب الجانب الغربي من النطاق الانتقالي المقترح .

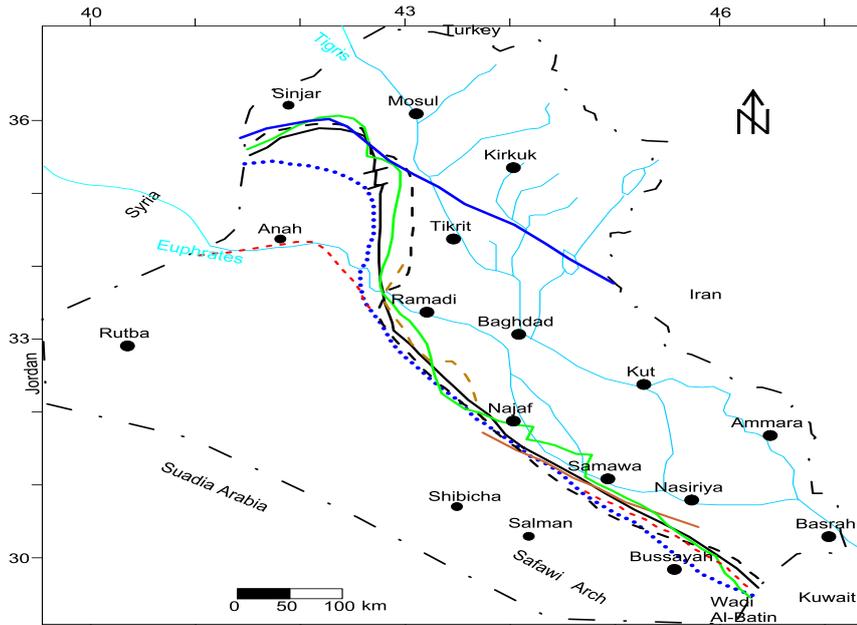
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## Introduction

The tectonic situation of any area represents the description of the arrangements of the elements including the main faults and tectonic zones. The tectonic map of Iraq was modified many times since 1984. The continuous geological studies, reinterpretation of the available geological and geophysical data, and development of the tectonic philosophy caused the modification with the tectonic map of Iraq (Al-Mashadani [1], Buday and Jassim [2], Abbas [3], Al-Kadhimi et al [4], Al-Ethawi [5], Sissakian and Deikran [6], Fouad [7], [8]). This paper discussed some stages of the modification of the tectonic map of Iraq and the ideas of the authors concerning only one tectonic element. The consider tectonic element is the boundary between stable and unstable shelf in Iraq (the boundary between inner and outer platform). Hit-Abu- Jir and Euphrates Faults are segments in this boundary. This boundary is the main tectonic element in the western part of Iraq. It may be considered as the western limit of surface and subsurface structures that effected by collision of Arabian and Iranian plates.

### Review of the western boundary in the tectonic maps of Iraq:

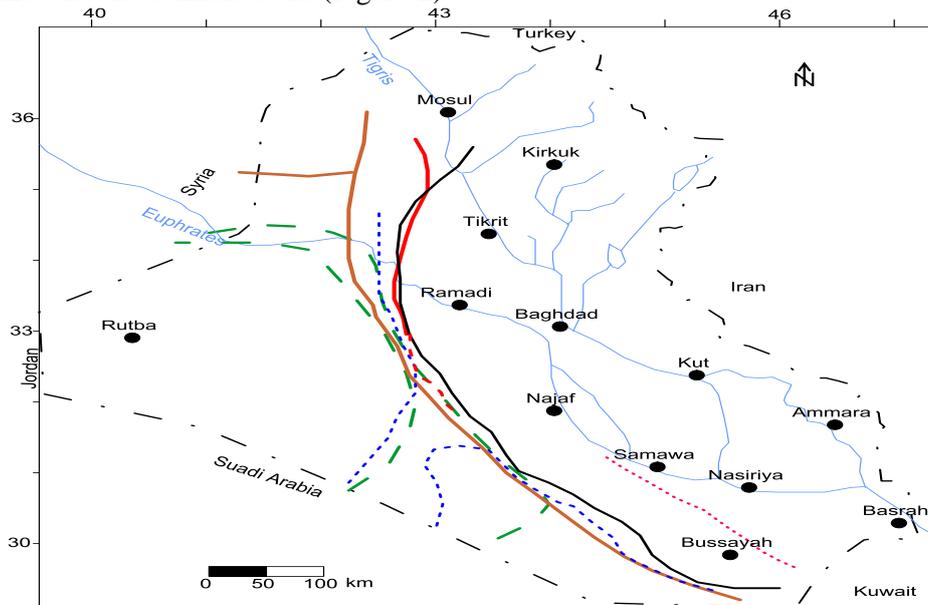
Al-Mashadani [1] studied the geodynamic evolution of Iraq sedimentary basins. He depends on the gravity data to divide Iraq into three zones by two main tectonic boundaries. The first boundary considered as boundary between stable and unstable shelf and separate the western parts of Iraq as stable shelf. The stable shelf characterized by gravity anomalies values range +10 to -50 mgal. The second boundary separate the Mesopotamian zone in the center and south, from the foothill (folded) zone in northern Iraq. The Mesopotamian gravity values range from -30 to -80 mgal, while folded zone gravity values greater than -80 mgal. Buday and Jassim [2] studied the tectonic of Iraq in detail and they separate the western zone of Iraq according to the idea of absence of the effect of Alpine movements in this zone. So, they considered the Alpine effect on the sedimentary secession as a tool to trace the boundary between stable and unstable shelf. Abbas [3] used the geophysical data with emphasize on gravity interpretation to move the tectonic boundary in its northern part to west. He believed that the boundary lying west of Wadi Al-Tharthar by about 50 km. Al-Kadhimi et al [4] modified the tectonic map depending on the interpretation of the geophysical data. They traced the boundary between stable and unstable shelf in its northern part at the mid area between those boundaries obtained by Buday and Jassim [2] and Abbas [3]. Al-Ethawi [5] processed and interpreted the gravity and magnetic data in southwestern part of Iraq. He found that the boundary between stable and unstable in its southern part is coincide with the tectonic boundary traced by Buday and Jassim [2]. But from Najaf to Al-Ramadi Cities the boundary shifted toward the east by about 25 km. Sissakian and Deikran [6] revised and reconstructed the neotectonics map in western Iraq. They recognized many neotectonics movements such as active faults and dislocated drainage systems depending on remote sensing data interpretation. They traced a major fault southwest Samawa City. This fault is part of the boundary in its southern part (Figure-1). Jassim and Buday in Jassim and Goff [9] believed that the long surface anticlinal Chain of Makhul, Hemrin North, Hemrin South, and Besht-ikuh, from the northwestern to the southeastern, respectively may be represent the boundary between stable and unstable shelf. This surface anticlinal chain trending northwest -southeast (Figure-2). They also believed that this boundary (fault) may be represent the late cretaceous extension and it is reactivated during the Pliocene and still active at present time. This boundary is excluded in this study because it is neglected the subsurface structures in the Mesopotamian Zone. Fouad [7] and [8], prepared the 3<sup>rd</sup> edition of tectonic map of Iraq. He considered the western part of Iraq as the inner platform zone instead stable shelf, which characterized by the absence of the Alpine compressional deformation. He used the morphological and physiographical information to subdivide this zone into western desert subzone and southern subzone. The 3<sup>rd</sup> edition of the tectonic map of Iraq region shows coincidence of the boundary of the inner platform in its southern part with the previous editions of the tectonic map. The main difference are the drift of the boundary toward the west at the point of intersection of this boundary with Anah transvers fault and nearly parallel to the Euphrates River (Figure- 1). It is appropriate to mention here that the western desert subzone in the last edition of the tectonic map 2015, is approximately coincide with that zone previously prepared by Al-Banna and Al-Rawi [10].



**Figure 1-** Shows the tectonic boundary between stable and unstable shelf in Iraq according to many authors, Al-Mashadani 1984 (.....), Buday and Jassim 1987 (---), Abbas 1995 (—), Al-Kadhimi et al 1996 (—), Al-Ethawi 2002 (—), Jassim and Buday in Jasim and Goff, 2006 (—) Sissakian and Deikran 2009 (—), and Fouad 2012, 2015 (—).

**Review of the western tectonic boundary from Isostasy and Crustal thickness of Iraq**

The isostatic anomaly map of central and south of Iraq prepared by Al-Banna [11]. He obtained the zero-isostatic line which is found to be lying toward the west of Ramadi city then running to the south nearly parallel to Euphrates River in the west side then ending at the southern limit of Wadi Al-Batin (Figure-3). The basement deep faults of Western Desert and Al-Jezira areas were delineated depending on the interpretation of gravity and magnetic data by Al-Banna [12], [13]. The eastern longitudinal faults in those studies considered to be coincide with the western tectonic boundary which called Hit- Abu- Jir fault. Depending on the variation in the relation of gravity and elevation values the complete isostatic zone is delineated in central and south of Iraq by Al-Banna and Al-Rawi [10]. The complete isostatic zone coincides in the northern part with Anah fault then change its trend to the south with Abu-Jir fault at the middle part, while its last part drift to southwest trend to the area between Shibacha and Salman towns (Figure-2).



**Figure 2-** The thin crustal thickness axis, the complete isostatic compensation and the major basement faults related to the boundary between stable and unstable shelf from gravity studies of deep crustal structures published by many authors, Al-Banna 1991 (.....), Al-Banna 1992a (—), A-Banna 1992b (—), Al-Banna and Al-Rawi 1993 (—), Al-Banna and Al-Heety 1994 (—), Al-Banna et al 2001 (.....), Al-Banna et al 2013 (—).

In another study the crustal thickness map of Iraq is constructed depending on gravity data models which constrained by deep seismic results Al-Banna and Al-Heety [14]. They delineate the low crustal thickness line in Iraq. This line runs parallel to the western tectonic boundary of Iraq but shifts toward the west in the southern part. Al-Banna et al [15] interpreted the gravity and magnetic data in addition to many parameters including elevation, basement depth, mean thermal gradient anomaly axis, and the western boundary of the lineament of sedimentary structures from Paleocene to Pleistocene in Southern Iraq. They delineated mainly three boundaries divided southern Iraq into four subzones. The most important one is the transition subzone which covers an area which includes the variation of most considered parameters. This subzone runs west of Nasiriyah city in the eastern side and passing through Salman and Bussaya towns in the western side (Figure-2). Al-Banna et al [16] depends on the ratio of gravity to elevation value, which normalized to ideal ratio to obtained the zero line of complete compensation of Iraq, which represent the boundary between two different tectonic regions. This boundary line may be representing the boundary between the two platform regions.

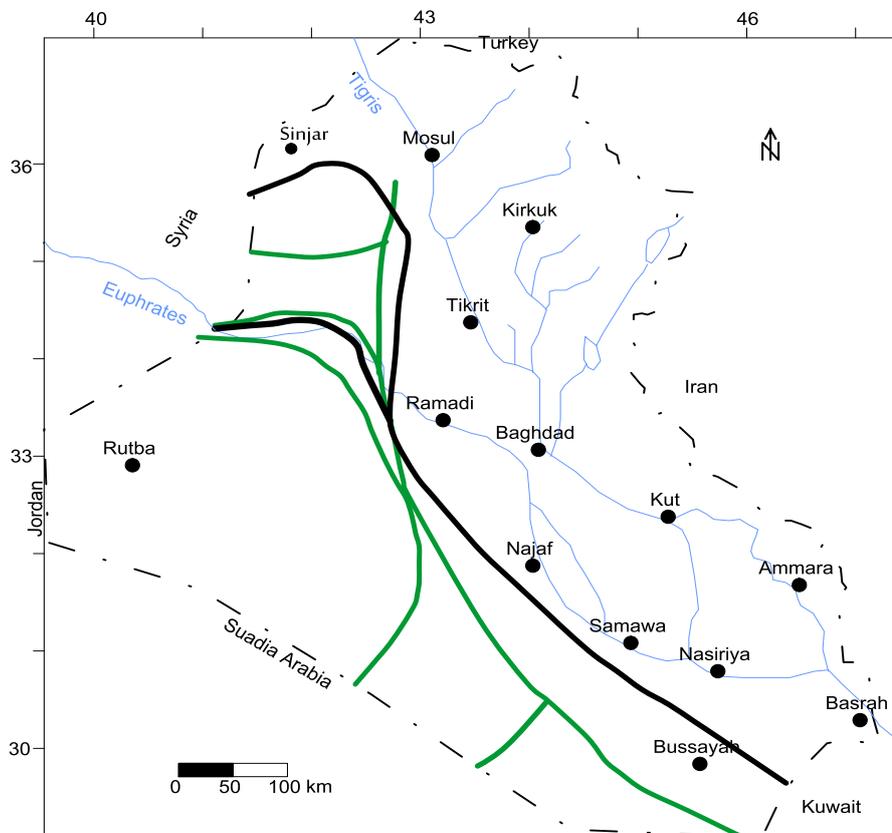
### Discussion

The tectonic map of Iraq was updated many times during the period from 1984 to 2015 by many authors. Most of them are geologists at Iraqi geological survey. They mostly depend on the geological and geophysical data which available from their company in addition to inventory seismic reflections data section and geological interpretation Oil Exploration Company. More information was available from professional individuals at the Iraqi universities. The tectonic elements, which including the boundaries, zones, and faults, sometime changes from edition to another according to the used geological information or change in the philosophy of authors. Most authors accepted the idea of presence of western tectonic boundary between two regions, stable and unstable shelf (inner and outer platform). Figure- 1 shows the locations of this boundary, as delineated by the authors. The authors considered this boundary depending on a physiographic, surface geology, structural, stratigraphic secessions, subsurface information, elevation and geophysical interpretation bases. Most authors treated the geological and geophysical information, which extended from the earth surface to the basement rocks. The western tectonic boundary of most studies can be represented by one regional trend line (Figure-3). The tectonic boundary in general can be divide into two parts which they are north and southern parts. The northern part trending north-south and it is located at the western side of Al-Tharthar Valley. This part drifts toward the west southern Sinjar Mountain in the northern end, and the southern end also drifts toward the west coincide with Anah Fault. The southern part starts from west Ramadi city and runs southward west of Euphrates River until reach the mid part of Wadi Al-Batin (Figure-3).

The crustal thickness, Isostatic, and basement studies (e.g. Al-Banna 1991, Al- Banna And Al-Rawi 1993, Al-Banna and Al-Heety 1994, Al-Banna etal 2013...) for the period from 1991 to 2013 delineated a clear boundary in western side in Iraq, which may be coincide with the tectonic boundary between the stable and unstable shelf. This boundary in the northern part coincide with the tectonic boundary, except the drift in the north end to nearly conform the Khlesia Graben and in the southern end confirm Anah Graben. The boundary line runs toward the south west of Euphrates River but, it is located to the west of the tectonic boundary by an approximately distance 10 km west Ramadi to 100 km nearly at Bussayah town, then it continues up to the ending at the nearly at southern end of Wadi Al-Batin (Figure-3). This boundary has two branches toward the west and bounded the area between Shibich and Salman towns.

The relatively large difference in location of the tectonic boundary and the deep crustal boundary is at the southern part of Iraq. The difference may be due to the change in the lithology of the lower part of the crust which delineated in the deep crustal studies and not considered in the relatively shallow tectonic boundary considerations. Al-Banna [17] believed that the basement rocks of western part of Iraq consist of many types of rocks according to the variation in the gravity and magnetic anomalies. In order to solve the problem of the relatively shallow tectonic considerations and the deep crustal structures together, it is reliable to consider the boundary as one zone (Figure-4). This zone includes all the geological and geophysical consideration and can be named as a transition zone between stable and unstable zones. The boundary according to the crustal structures at the west of the transition zone and the tectonic boundary at the east of this zone related to the shallow geological parameters. The boundary of transition zone varies slightly from that of Salman subzone shown in the tectonic map prepared by Budy and Jassim [2], but it is nearly coincided the middle part with the zone

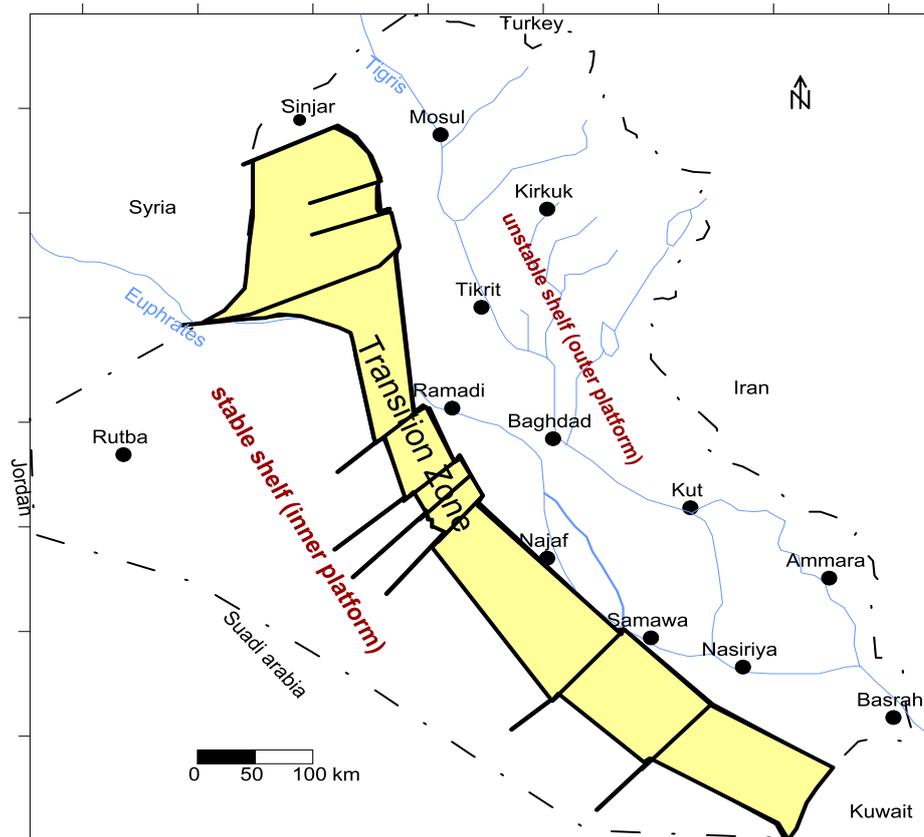
that suggested by Al-Banna and Al-Rawi [10]. This transition zone varies from Salman subzone of Buday and Jassim [2], in its northern part and with some modification in the southern part. The complete isostatic compensation as suggested by Al-Banna and Al-Rawi [10] located in this transition zone. Ma'ala [18] discussed the tectonic of the southern desert of Iraq. He believed that the Euphrates fault zone is an extension of Abu- Jir Fault zone and the main structural element in southern desert is Safawi Arch. The northern boundary of Safawi Arch coincides with the southern branch of the complete isostatic zone prepared by Al-Banna and Al-Rawi [10]. This southern branch of the complete isostatic boundary, coincides with the transversal fault that passes nearly north Najaf City with northeast- southwest trend and it is located in the transition zone. Awadh et al [19] deduced from a geochemical exploration study of the springs and hydrocarbons and gas seepage in Abu- Jir fault, they found that the average width of Abu-Jir Fault zone is 48 km and its length may be 467km. They also believed that Abu- Jir Fault can be considered as a zone. Awadh et al, located Abu-Jir Fault zone in an area within the suggested transition zone of this study. Therefore, the authors believed that this transition zone may separate two regions those different in types, trends, and density of faults. They may also be different in the degree of stability, where the eastern part is tectonically more active.



**Figure 3-** The main trend of the tectonic boundary between stable and unstable shelf in Iraq, from the tectonic maps (—), and from the interpretation of gravity data of deep crustal structures (—).

## Conclusions

The main conclusion of this study is the delineation of the transition zone between, the stable and unstable zones (the inner and outer platform) in western part of Iraq. The northern part of this zone covers the area northern Anah Fault which is called Al-Jazira region. The southern part extended nearly parallel to the Euphrates River in the western side with a stripe width 50 km. west of Ramadi City to about 100 Km. west of Samawa Town. This zone shows variations in most geological parameters from the lower part of the crustal structures to the surface of the earth.



**Figure 4-** The suggested transition zone between stable and unstable shelf (Inner and outer platform) and the possible transvers faults along this zone.

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