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Interpretation of Potential Fields and Detection of Deep Faults of Kut-Dewania- Fajir Area, Central Iraq

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Abstract
Gravity and magnetic data are used to study the tectonic situation of Kut-Dewania- Fajir and surrounding areas in central Iraq. The study includes the using of window method with different spacing to separate the residual from regional anomalies of gravity and magnetic data. The Total Horizontal Derivative (THD) techniques used to identify the fault trends in the basement and sedimentary rocks depending upon gravity and magnetic data. The obtained faults trends from gravity data are (N30W), (N60W) (N80E) and (N20E) and from magnetic data are (N30W), (N70E), (N20E),(N10W),(N40E). It is believed that these faults extend from the basement to the lower layers of the sedimentary rocks except the N60W trend that observed clearly in gravity interpretation. It is believed that this trend may be related to sedimentary cover only. Most residual gravity and magnetic anomalies coincide with each other concerning location and extension, which indicate that they may be created from common sources. There is a large positive gravity anomaly located at east of Hai-Fajir cities coincide with the relatively negative residual RTP magnetic anomaly. It is believed that this anomaly may represent an uplift structure within the sedimentary cover lying over deep basement rock.

Keywords: Gravity and magnetic, RTP, Fault detection, Kut-Dewania, Central Iraq.

تفسير المجال الجهدي وتحديد الفوالق العميقة لمنطقة الكوت والديوانية والفجر،وسط العراق

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الخلاصه
اجريت دراسة للمعطيات الجذبية والمغناطيسية عن منطقة الكوت والديوانية والفجر المناطق المحيطة بها في وسط العراق للتعرف على الوضع التكتوني في المنطقة . تضمنت الدراسة استخدام طريقة تغير النافذة (window) لفصل الشواذ الجذبية و المغناطيسية المحلية عن الاقليمية .فيما استخدمت طريقة الانحدار الافقي الكلي (THDR) في معالجة المعطيات الجذبية والمغناطيسية وذلك لتحديد اماكن الفوالق ومعرفة اتجاهاتها في صخور القاعدة العميقة و في الصخور الرسوبية. تم تحديد اتجاهات الفوالق في منطقة الدراسة من المعلومات الجذبية وهي الاكثر عددا وطولا (N20E,N80E,N60W,N30W) ، ومن المعلومات المغناطيسية كانت أتجاهات الفوالق هي الاكثر عددا وطولا (N40E,N10W,N20E,N70E, N30W) ويعتقد ان هذه

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الفوالق ممتدة من صخور القاعدة الى اعماق قريبة من سطح الارض ، بأستثناء الاتجاه N60W الذي ظهر واضحا في المعلومات الجذبية ويعتقد انه يرتبط بالعمود الرسوبي فقط. معظم الشواذ المتبقية للجاذبية والمغناطيسية كانت متوافقة في المواقع والامتداد ويحتمل انها ناتجة عن مصادر مشتركة . هناك شذوذ جذبي متبق موجب شرق محور مدينتي الحي والفجر يتوافق في الموقع والاتجاه مع شذوذ مغناطيسي متبقي سالب نسبيا ويعتقد ان هذا الشذوذ ناتج عن تركيب مرتفع في الغطاء الرسوبي والذي يقع فوق صخور القاعدة العميقة.

Introduction

The gravity and magnetic fields used for long time to study the geological situations in different regions all over the world, Garland; (1951)[1], Kanasewich and Agarwal; (1970)[2], Arnaud Gerkens; (1989)[3], Al-Yasi; (1997)[4], Al-Heety; et.al. (2017)[5]. Many authors prepared techniques to determine the gravity and magnetic source parameters such as locations of boundaries and depth, Miller and Singh; (1994)[6], Oruc (2011)[7], Eshaghzadeh; (2015)[8]. Salako (2014)[9] used the Source Parameter Imaging (SPI) method to determine the depth to basement surface. Ahmed et al (2013) [10] studied the basement tectonic of eastern Yemen region, from the aeromagnetic data. They applied numerous derivatives to estimate the edges detection and trends of magnetic source, these derivatives include the Total Horizontal Derivative (THDR), Analytical signal (AS). They found that the contact anomalies locations are fitting the boundaries of the positive and negative anomalies of the RTP map. Saada (2016) [11], study the area lies at the eastern Desert – Egypt, from the aeromagnetic data. He applied numerous derivatives to estimate the edges detection and depth of magnetic sources, these derivatives include the Total Horizontal derivative, Tilt derivative, Analytical signal, from these application of derivatives good correlation results were noticed between these techniques indicating good correlation between them in delineating the general structural framework of the area. AL-Banna ,(2000)[12] , used the amplitude –direction matrix technique to determine the predominant trends of Bouguer, regional and residual anomalies of Anah and north Nasyria areas. He found that the predominant trends of anomaly of north Nasyria are N35W and N55W. Al-Rawi et. al., (2009)[13] delineate the main tectonic trends of the area south of Nasyria and Amara cities at the southern part of Iraq using the directional filtering technique. They concluded that the tectonic trends in southern Iraq are N-S and NW-SE. Ghalib et. al., (2014)[14] study the subsurface structures in Hur AL-Huwazah area by gravity and magnetic surveys . They determine the basement depth of source of the anomalies of RTP magnetic data.

The THDR and the residual potential maps have been constructed for the study area to locate the boundaries of the magnetic and gravity sources. The correlation between the results is considered to detect the main trends of boundaries (contact, or faults), in order to define the main tectonic boundaries in the study area.

Location and tectonic setting of study area

The study area is situated in central part of Iraq Figure- 1. Tectonically, it is lying in the unstable shelf within the Mesopotamian zone [15]. This zone is an asymmetrical foredeep with regional dip to the NE and E, that contains buried faulted structures below the Quaternary cover, separated by broad syncline. The fold structures mainly trend NW-SE in the eastern part of the zone and N-S in the southern part, some NE – SW trending are structures existed [15]. Two main longitudinal faults (Najid faults system) crossing the studied area. First fault represented by Tikrit-Amara fault, this fault is located in the east part of study area. The second fault is Ramadi-Musaib fault.The extension of this fault acrossing the central part of the studied area diagonally [8]. In outside parts two longitudinal faults are bounded the studied area. These faults are Makhol-Hamrin at the east and Euphrates faults at the west [15]; Figure- 1.

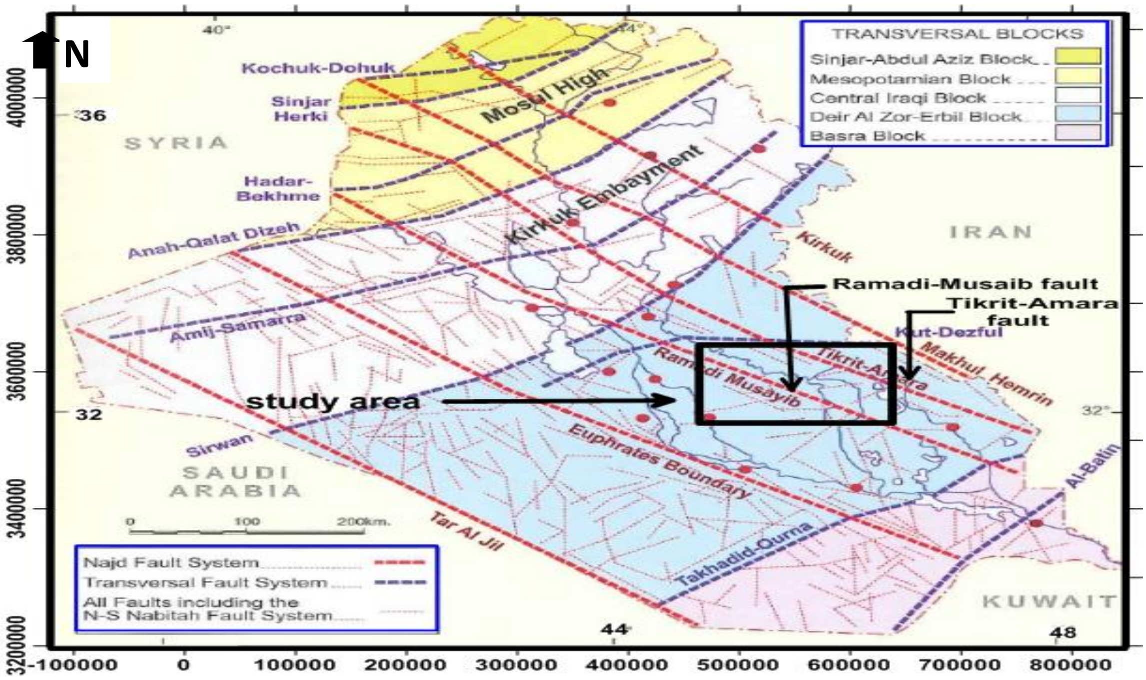

Figure 1-Tectonic map of Iraq showing location of study area (15).

Available data and Processing

The Total Magnetic Intensity map (TMI) of the study area is a part of the Aeromagnetic map of Iraq. The airborne magnetic survey was achieved by C.G.G. 1974 [16]. The grid lines of the survey were done with space interval of 2 km. The TMI data are reduced to pole in order to obtain the Reduction To Pole (RTP) magnetic map; Figure- 2. The object of this process is the positioning of the anomalies above the causative bodies. This process is achieved by GET GRID program that is available at the Oil Exploration Company (OEC).

Bouguer anomaly map of the study area was compiled at a scale of 1:1000000 with 1 mgal contour interval. This map is published by GEOSURV [17]. The data were acquired between 1960 and 1990. These maps were digitized at grid interval (2 * 2) km; Figure- 3.

These maps are enhancement using the Total Horizontal Derivative (THDR) and the seperation of the residual anomalies with 2 interval spacing windows, these are 48 and 24 km.The resultant maps are interpreted to evaluate the tectonic situation of the study area.

Description of magnetic map

The RTP map shows the values of contours map change from 5150 to 4850 nT; Figure- 2. Generally the area characterized by two anomalies trending nearly NW-SE. The first anomaly situated at the western side, which is a positive magnetic anomaly (Q) with maximum value 5150 nT, while the second is relatively low anomaly and situated at the eastern side of the study area (B) with the lowest magnetic value of 4850 nT. There are another two relatively small anomalies, relatively positive one at the southeast corner (L) with magnetic value 4975 nT, while the relatively low magnetic anomaly at the southwest corner of study area (D) with magnetic value 4925 nt.

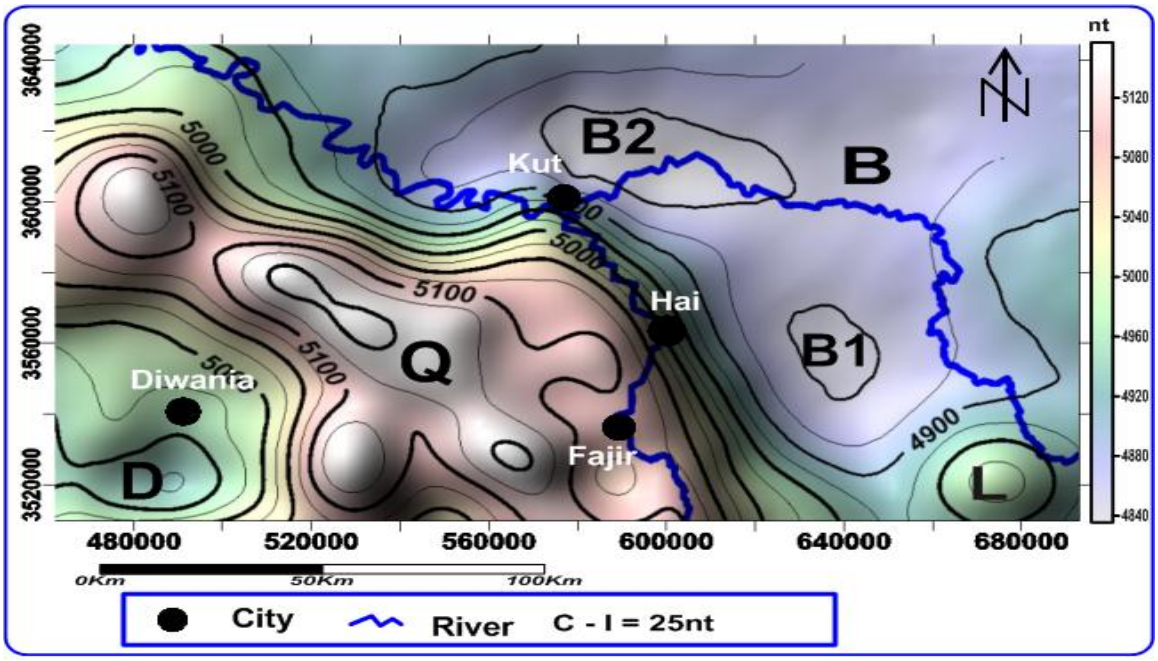

Figure 2- The Reduced To Pole (RTP) magnetic map of the study area.

Description of Bouguer gravity map

The dominate features of the Bouguer anomaly map of the study area reveal a considerable regional gravity gradient towards the east and northeast of study area , which is associated with the deepest region of the Mesopotamia Basin. The negative gravity anomaly (R) is the lowest gravity value (-88 mgal) in the study area, which is situated at the Iraqi – Iranian border. Generally the gravity map Figure- 3 shows many positive gravity is anomalies, represent from the west to east M, K, P and A. While the negative gravity anomalies represented by S, C and V. The closed positive anomalies are (M) anomaly with (-44 mgal), which trending northwest- southeast, and (A) anomaly with gravity value (-54 mgal) and trending northwest –southeast lying at the southeast part. The only closed negative gravity anomaly in the study area is (V) anomaly, which is a semicircular in shape trending nearly north northwest – south southeast with gravity value (-63 mgal).

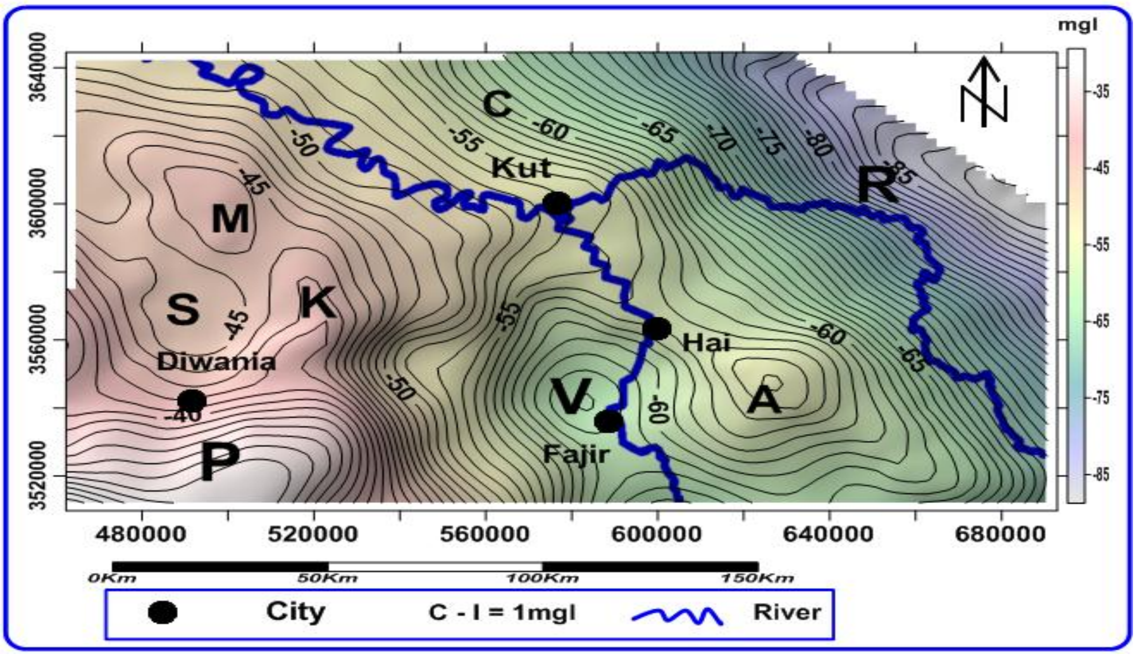

Figure 3- Bouguer gravity anomaly map of study area showing the main anomalies.

Total Horizontal Derivative (THDR) of magnetic and gravity data

The total horizontal derivative technique is a process of calculation the change in gravity and magnetic values with the horizontal distance. It represents the resultant of two horizontal derivatives,, these are the horizontal derivative in X direction and second is horizontal derivative in Y direction This method usually is used to detect the maximum change in the potential field, which indicated the boundaries of causative source in the subsurface, or the discontinuities and the fault locations, [18].

The total horizontal derivative technique is applied to the RTP magnetic data, Figure- 4. The maximum values of THDR are delineated and many faults with different trends are detected. The length and trends of these faults are measured. The percentage of length of each fault to the total summation of faults lengths and the summation of number of each trend faults are plotted on the rose diagram Figures- (6, 7). The main trends according to the number and length of faults show the following trends (N30W), (N70E), (N20E), (N10W) and (N40E); Figure- 5.

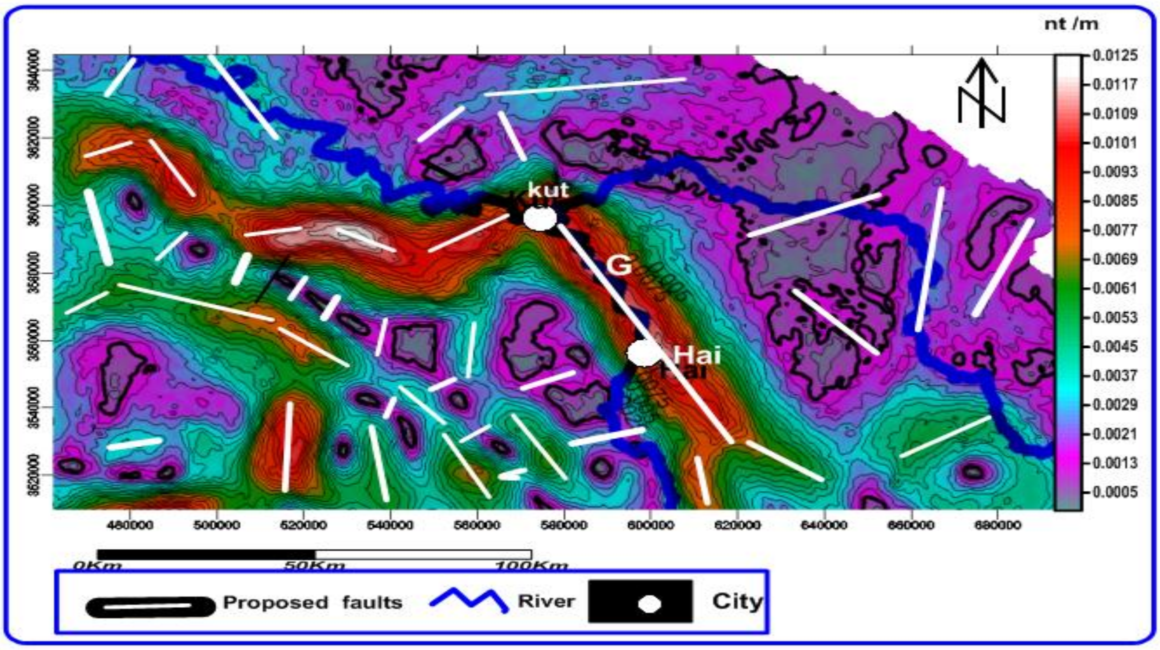

Figure 4- Total horizontal derivative of magnetic map showing distribution of faults deduced from magnetic data.

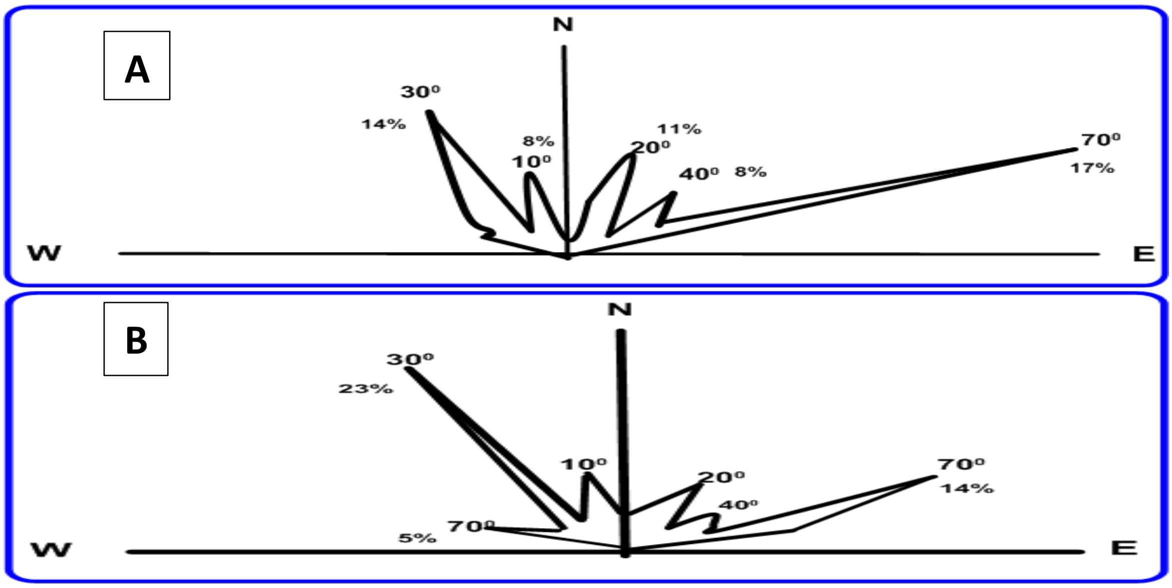

Figure 5- (A)- Rose diagram showing the percentage of number of faults with trend inferred from magnetic data. (B)- Rose diagram showing the percentage of length of fault with trend inferred from magnetic data

The THDR of gravity map used to delineate fault trends which may be found within the basement or in the sedimentary cover, Figure-6. The number and length of the detected faults are measured and plotted on rose diagram, and the main trends of faults found to be as follow (N30W), (N60W), (N80E), (N20E). These faults include major faults generally trending NW-SE parallel to Najd faults system. It is believed, that one of these fault corresponding to Ramadi-Musaib fault.

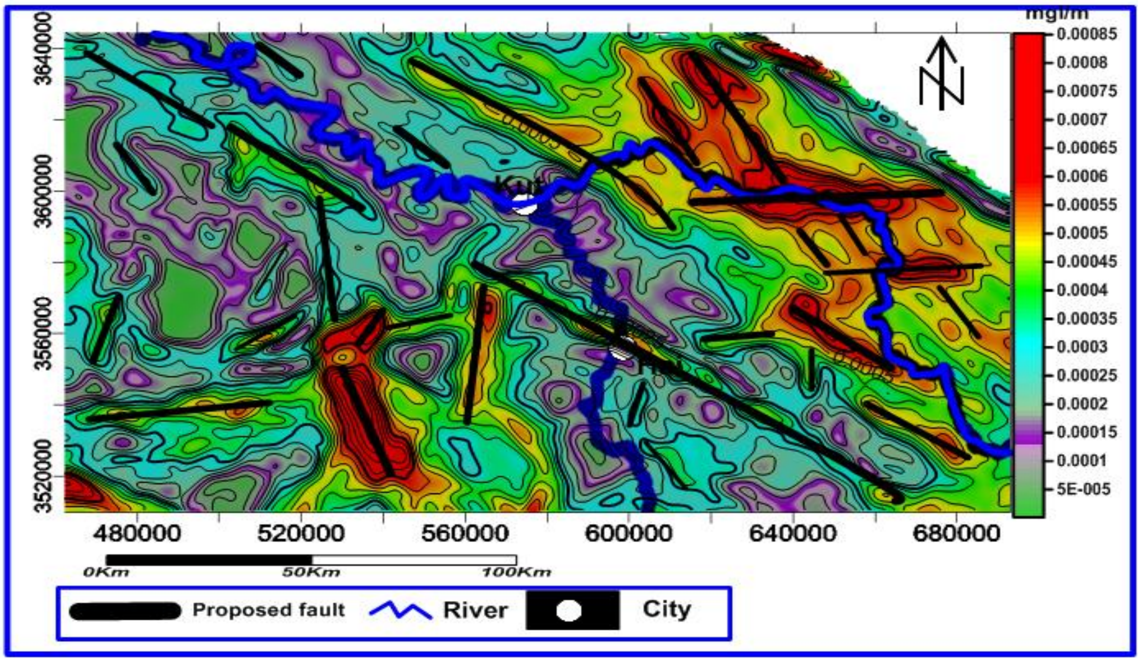

Figure 6- Total horizontal derivative of gravity map showing the distribution of faults deduced from gravity data.

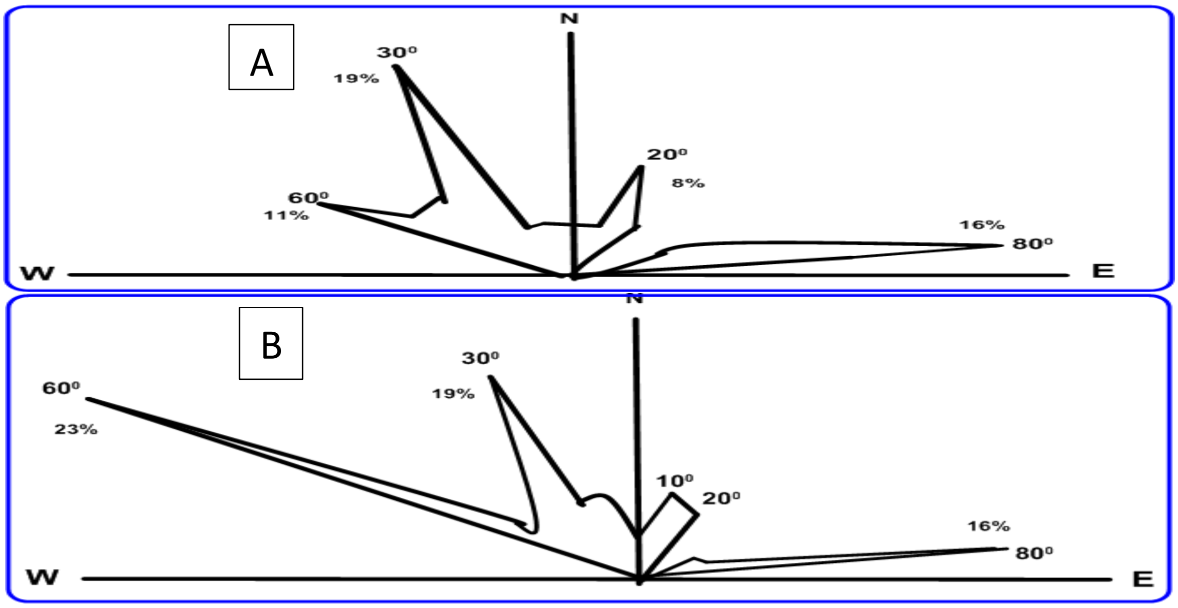

Figure 7- (A) - Rose diagram showing the percentage number of faults with trend inferred from gravity data. (B)- Rose diagram showing the percentage length of fault with trend inferred from gravity data.

The Residual of the RTP and Gravity Maps and Iheir Interpretations

The magnetic anomalies in the study area reflect mainly the effect of the basement, while the gravity anomalies related with the deep and shallow sources including the sedimentary rocks. In order to evaluate the study area tectonically, the gravity and magnetic residual anomalies must be separated from regional anomalies. The separation carried out using windows analysis method with different scale. The window analysis method is applied to the gravity and RTP magnetic maps of the study area by using the Surfer program. The effect of deep basement rocks and sedimentary structures are obtained from the gravity and magnetic residual maps, using 48km and 24km windows. The residual anomalies of the RTP magnetic maps of 48Km and 24Km windows are approximately similar in location and trends, with little variation in amplitude, Figure- 8, and Figure- 9. The residual gravity anomalies of 48Km and 24Km window are similar in location with little variation in amplitude and trends, Figure- 10 and Figure- 11. Comparison of the residual RTP magnetic maps with the residual gravity maps shows that the location and trends are coincide for most anomalies. The coincidences of all the residual RTP magnetic and residual gravity anomalies indicate that the potential fields reflect the same sources. The important conclusions from the residual maps are summarized by the followings: 1- Most sources are within the basement rocks. 2- The anomalies may reflect the lithology of basement more than the morphology of basement due to the relatively high magnetic anomaly values that ranges from 70 to 140 nT and depth of basement reach approximately 9 to 11 km. The faults obtained from THDR of RTP magnetic and THDR of gravity maps are traced over the residual anomaly of RTP magnetic and the residual gravity maps with different windows, Figures- (8, 9, 10 and 11). It is believed that some lineaments indicated the faults, while the others reflect boundaries resulted due to the variation in lithology of basement rocks.

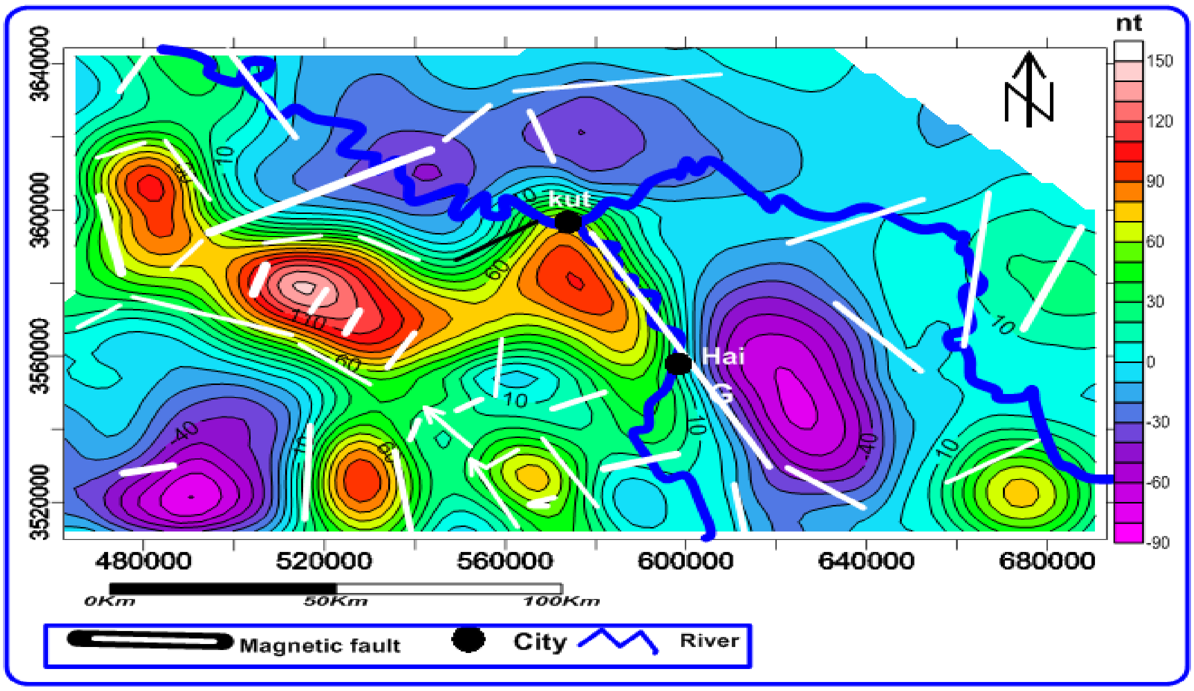

Figure 8- Residual magnetic map (window 48km) showing possible faults inferred from magnetic data.

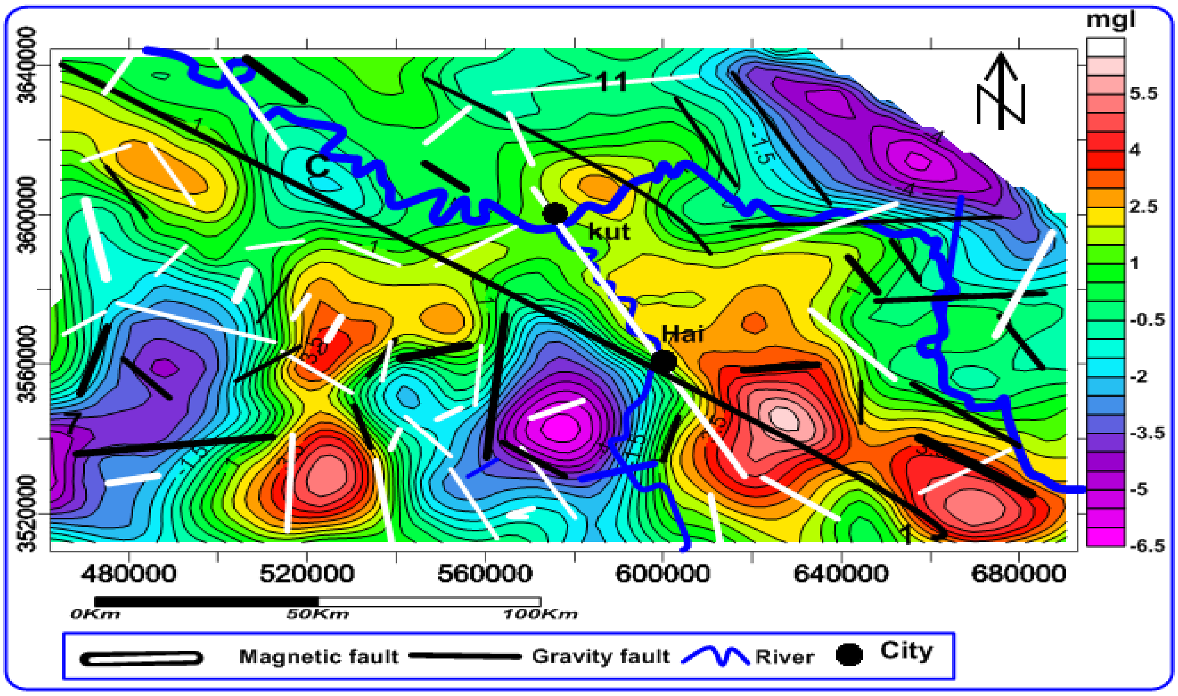

Figure 9- Residual gravity map (window 48km) showing possible faults inferred from gravity and magnetic data.

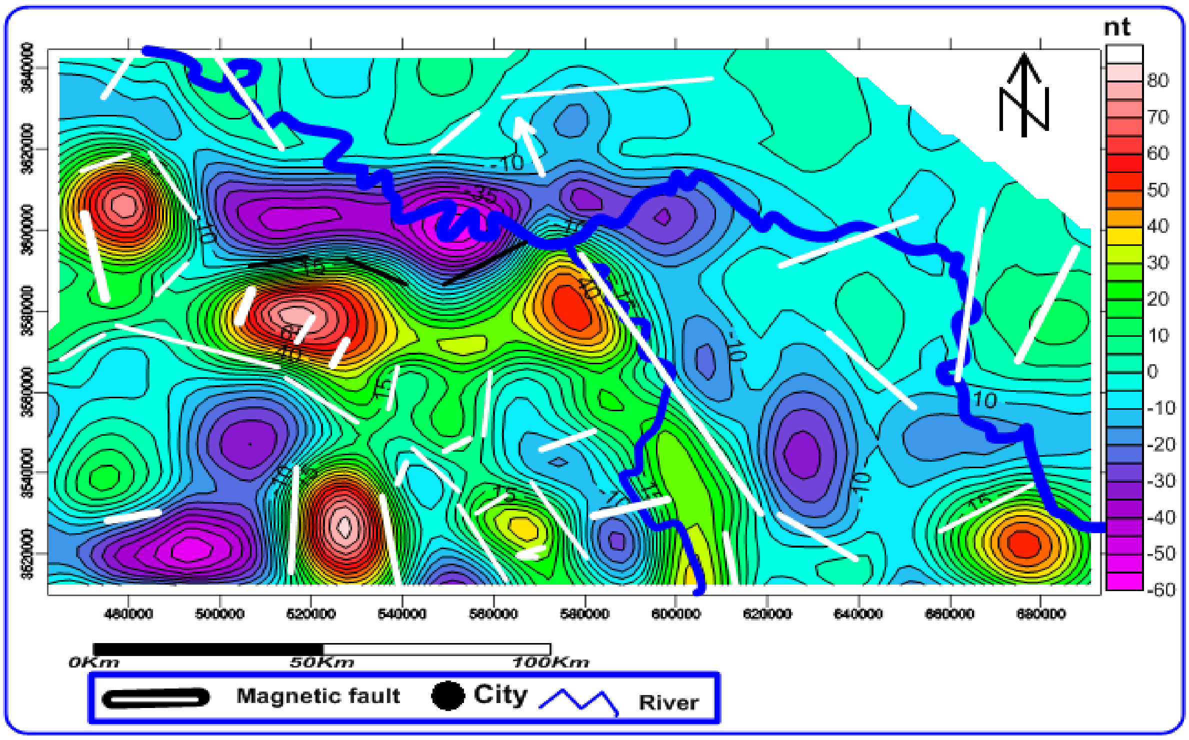

Figure 10- Residual RTP magnetic map (window 24km) showing possible faults inferred from magnetic data.

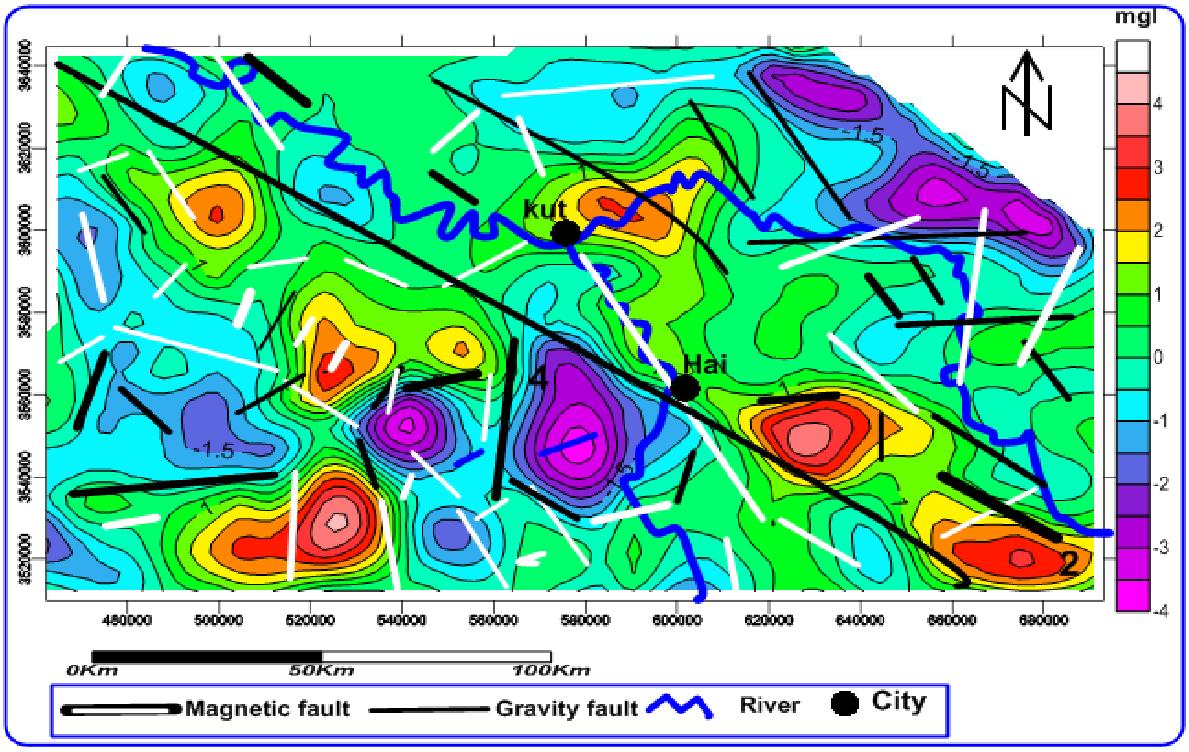

Figure 11- Residual gravity map (window 24km) showing possible faults inferred from gravity and magnetic data.

Discussion of fault types

The most important fault trend in the study area is NW-SE trend. This trend was detected from the interpretation of the THDR of RTP magnetic, THDR of gravity, the residual maps of the magnetic and gravity windows 24 km and48 km. The most important and longer fault is Gharaf fault that trending N30W. This fault mapped mainly from magnetic interpretation. It is nearly lying along Gharaf River, and it seems to separate the study area into two parts these are west and east parts. The eastern side seems to be deeper than the western part. It is believed that this fault may be referring to Proterozoic period. Another fault appears in gravity data trending N60W and intersected the first trend at north Hai City. These two faults may be part of the main longitudinal NW-SE, named Rammadi- Musaib fault, which crosses the study area diagonally.

Other main fault in the study area is that located east of Kut, accompanied with Tigris River and intersected the transverse fault east of Kut City. This fault may represent the longitudinal NW-SE, Tikrit-Amara fault.

Many NE-SW faults are detected such as that southeast Kut and those at the eastern part of the study area. These faults appear in THDR of magnetic map trending N70E and in THDR of gravity map trending N80E. These faults considered as transverse faults. It is believed that these faults causing the variation in the flow of rivers stream in the study area.

Most of faults trending N20E, N10E, and N10W are situated at the western part of the study area. These faults predominately delineate the boundary of magnetic sources, which may indicate basement lithological variations.

Conclusions

The analysis and interpretation of RTP magnetic and gravity data of Kut- Hai and surrounding area led to many conclusion, these are as follows:

1-The prodominat trends of faults detected in the area are N30W; N80E and N20E.

2- Other fault trends are N10W and N60W detected from RTP magnetic map and gravity maps respectivly, while the faults trending N60W detected from THDR of gravity map only.

3-The major longitudinal faults in the study area are detected in addition to many other faults, it is believed that these faults are not continuous. They are seems as inline segments, with gaps or intersected by transverse faults.

4- The residual RTP magnetic and the residual gravity anomalies comparison may indicate that the potential fields reflect the same sources. The important conclusions from the residual maps are most of the sources are within the basement rocks and the anomalies may be reflect the lithology of basement more than the morphology of basement.

5-Most residual RTP magnetic and residual gravity anomalies are coincide, except some small anomalies. The important one of these anomalies is the great positive gravity anomaly, which located between Tigris and Gharaf rivers, at the east and southeast of Hai city with NW-SE trend. This anomaly coincides with relatively negative residual magnetic anomaly with same trend. It may represent uplift in the sedimentary cover lying over the basement rocks in relatively deep basin.

Refernces

1. Garland, G. **1951**. Combined analysis of gravity and magnetic anomalies, *Geophysics*, **16**: 51-62.
2. Kanasewich E. R. and Agarwal, R. G. **1970**. Analysis of combined gravity and magnetic fields in wave number domain, ***J.*** *Geophysical Res.*, **75**: 5702-5712.
3. Arnaud Gerkens, J. C. **1989**. Foundation of exploration geophysics, Elsevier, Amsterdam, 667p.
4. Al-Yasi, A. I. **1997**. Use of the potential methods in studying deep geologic structures in the western desert , Iraq, Ph. D. thesis , University of Baghdad, 128p.
5. Al-Heety E. M., Al-Mufarji M. A. and Al Esho L. H. **2017**. Qualitative interpretation of gravity and aeromagnetic, *International J. of Geosciences*, **8**: 151-166.
6. Miller, H. G. and Singh, V. **1994**. Potential field tilt-a new concept for location of potential field sources, ***J.*** *Appl. Geophysics.* , **32**: 213-217.
7. Oruc, B. **2011**. Edge detection and depth estimation using a tilt angle map from gravity gradient data of the Kozakli- central Anatolia region, Turkey, *Pure Appl. Geophysics.* , **168**(10):1769-1780.
8. Eshaghzadah, A. **2015**. Image edge detection of the total horizontal gradient of gravity data using the normalized tilt angle, *Geodynamic Research International Bulletin*, **3**(4): 28-33.
9. Salako, K. A. **2014**. Depth to basement determination using Source Parameter Imaging (SPI) of aeromagnetic data: An application to upper Benue Trough and Borno Basin, Northeast, Nigeria, *Academic Research International* ; Lodhran City, **5**(3): 74-86.
10. Abu Eta, A. S. , Al- Khafeef A. A. , Ghoneimi A. E. , Abd Alnabi S. H. and Al-Badani M. A. **2013**. Application of aeromagnetic data to detect the basement tectonic of Eastern Yemen region, *Egyptian Journal of Petroleum*, **22**: 277-292.
11. Saada, A. S. **2016**. Edge detection and depth estimation of Galala El-Baharia Plateau, Eastern Desert –Egypt, from aeromagnetic data, *Egyptian Journal of Petroleum*, **2**: 25-41.
12. Al-Banna, A. S. **2000**. Application of Amplitude- direction matrix technique for gravity data of Anah and North Nasyria region, *Iraqi J. Sci*. ,**42C**(1): 108-128.
13. Al-Rawi, F.R., Al-Yasi A. I. and Al-Rahim A. M. **2009.** Delineation of the main structural and tectonic trends in south Iraq, using directional fan filtering techniques, *Iraqi Bulletin of Geology and Mining*, **5**(2): 75-86.
14. Amin, G. F., Yass A. M., Al-Bahadily H. A. , and Mussa A. S. **2014**. Gravity and magnetic survey to delineate subsurface structures in Hor Al-Huwazah area, *Iraqi Bulletin of Geology and Mining*, **10**(2): 59-85.
15. Jassim, S. Z. and Goff, J. C. **2006**. Geology of Iraq, published by Dolin, Prague and Moravian Museum, Brno. Czech Republic, 341p.
16. Companie Generale De Geophysique (CGG) **1974**. AeromagnAetic survey and interpretation report, GEOSURV library, Baghdad, (Unpublished).
17. Al-Khadimi, J. A., Sisskian, V., Fattah, A. S. and Deikran D. B. **1996**. Tectonic map of Iraq, Published by GEOSURV.
18. Salem, A., Wilham S., Firhad D., Smith R.and Ravat D. **2008**. Interpretation of magnetic data using tilt derivative, ***Ge****ophysics*, **73**, L1-L10.