Processing and simulation of the gravity data around Baghdad area

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Abstract

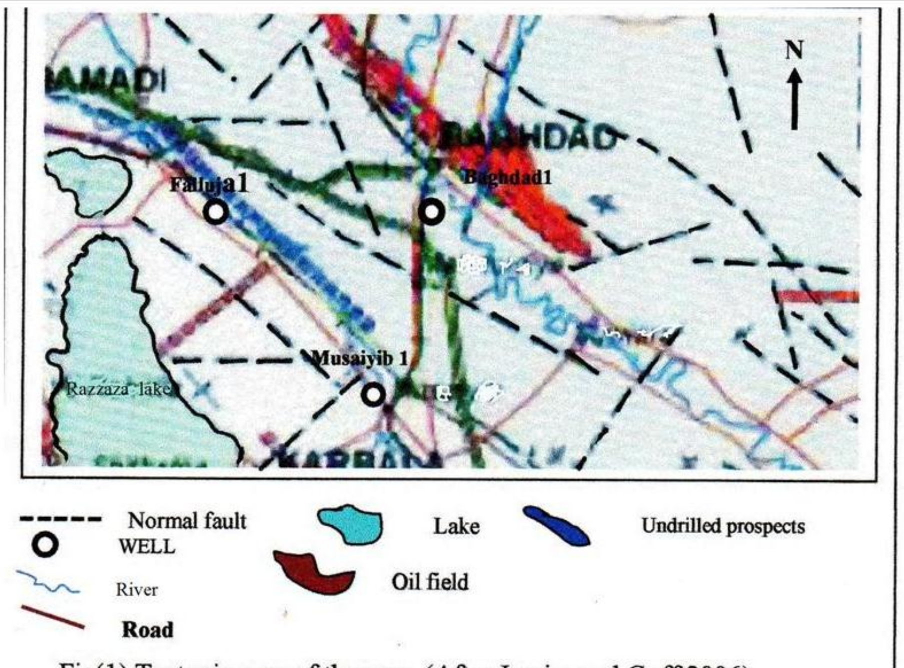
The Bouguer anomaly map around Baghdad area is used and separated its components into two parts of possible shallow and deep origins, using linear convolution(Low pass filter) method. Those of shallow origin shows successive elongated gravity "highs" and " lows " with Zagros trend. They are attributed to subsurface Tertiary and lower Cretaceous undulations having NW-SE trend. Faulting in this direction is deduced within Shuaiba Formation , which reflects the reasonable geological structure.

Introduction

The study site , lies to the east and southwest of Baghdad area on both sides of Euphrates and Tigris rivers .It consists of two distinct morphological units, namely the desert plain occupying the greatest part and alluvial plain lying along the Euphrates and Tigris rivers. This area is related tectonically to the Mesopotamian zone, which contains buried faulted structures below the Quaternary cover, separated by broad synclines . The folded structures mainly trend NW – SE in the eastern part of the zone and N – S in the southern part ; some NE – SW trending structures occur . The Mesopotamian zone is divided into three sub zones; the Zubair sub zone in the south with N-S trending structures , the Euphrates sub zone in the west , and the Tigris sub zone in the NE with NW – SE trending structures.(Jassim and Goff,2006)

The tectonic map of the Tigris sub zone is the most extensive and mobile unit of the Mesopotamian zone. It contains broad synclines and narrow anticlines predominantly NW-SE , accompanied by normal faults .As well as this sub zone contains NW-SE groups of buried anticlines of relatively low amplitude associated with longitudinal faults (confirmed by seismic surveys) Fig.1 (Jassim and Goff,2006).

For the deeper litho logical succession, the logs of wells Falluja-1, Musaiyib-1 and East Baghdad- 1(Fig. 1)shows that the rocks dip eastwards and southeast from Falluja-1 and become deeper in Musaiyib-1 and east Baghdad- 1.



Fig(1) Tectonic map of the area. (After Jassim and Goff,2006)

The available seismic evidences about the present area, in general, is the reflection lines presented by AL-Majid(1992) which they lie some ten kilometers to the northeast of the study area. It shows seismic depth map of Fat' ha Formation (M.Miocene) occurring at a depth of about 700 m. at the north and 1200 m. at the south which are folded gently . The data also shows a depth map to the top of Shuaiba Formation (L.Cretaceous) at depth of about 3000 m. with intensely folded and faulted more than Fat' ha formation.

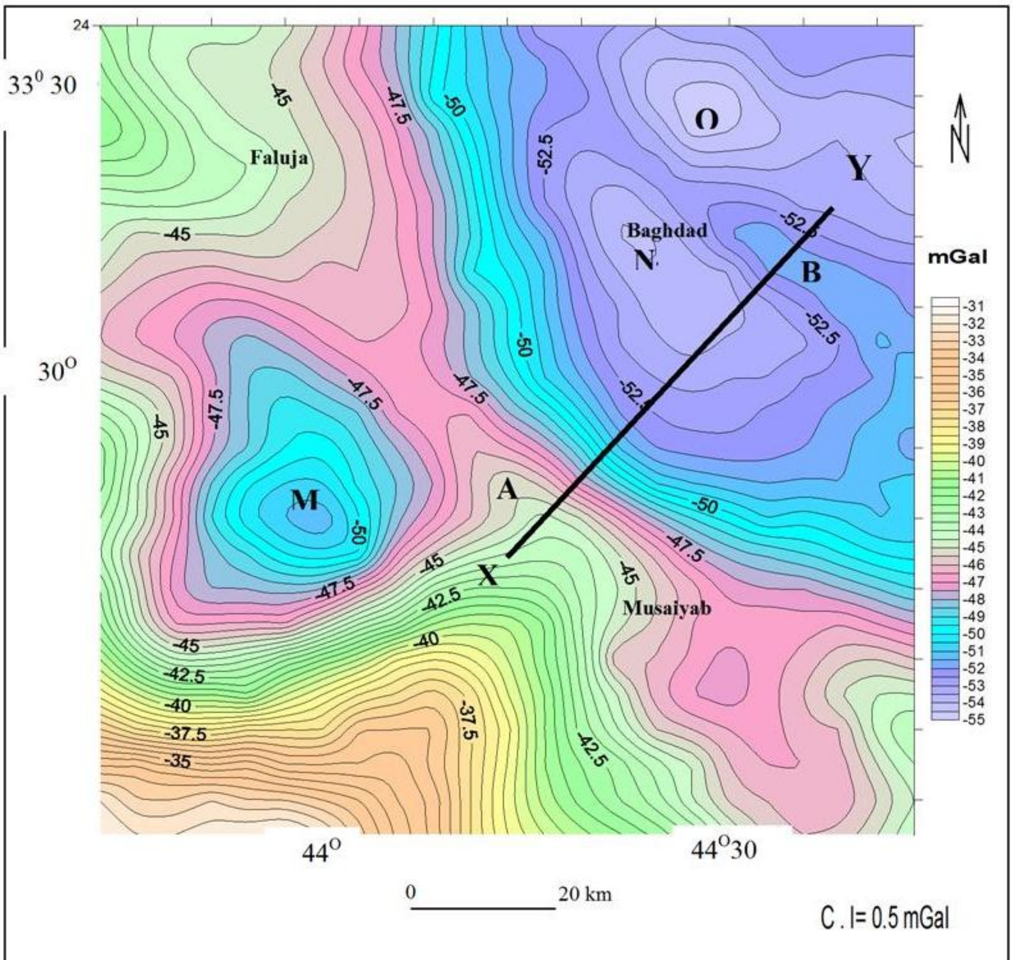
Furthermore, gravity evidences to the north of the present area (AL Shaikh and Al-Mashhadani, 1997), show that the source of the local anomalies of Alpine trend related to the faulted structure within Shuaiba formation with minor broad undulation within Fat' ha formation.

Aziz (1981) interpreted the gravity anomaly (Musaiyib anomaly)to the west of Baghdad by using a density contrast of 0.19 gm/cc for the Maudud Formation (lower/upper cretaceous) .The source of this local anomaly is due to folded structure within Maudud Formation and it has an Alpine trend .

The aim of the present study is to analysis or interpret the Bouguer anomaly map of the area around Baghdad and then delineate the subsurface shallow structures that create such local anomalies by using analytical technique .

Processing of Gravity Data

The Bouguer anomaly map of figure (2) has been constructed by Iraqi petroleum company on scale 1:200 000 (IPC, Geophysical Atlas, 1960). The anomalies showed marked variation in magnitude and generally have various trends. The regional gravity field is uniform and decreasing eastward.



Fig(2)Bouguer anomaly map of studied area (IPC , Geophysical Atlas

Careful examination of the map shows gravity "lows" and "highs"anomalies. The gravity "low" at the southwest (anomaly M) is abroad and semi-circular in shape covering a large area . Moving toward the northeast , there is an elongated broad "low" (anomaly N) trending NW-SE, and further to the northeast there is another elongated gravity "low"(anomaly O) trending NW-SW. There are a well defined gravity "highs"(anomaly A and anomaly B) which lie between gravity "lows" and characterized by an elongated nose-like shape trending NW-SE and parallel to the previously defined three "lows".

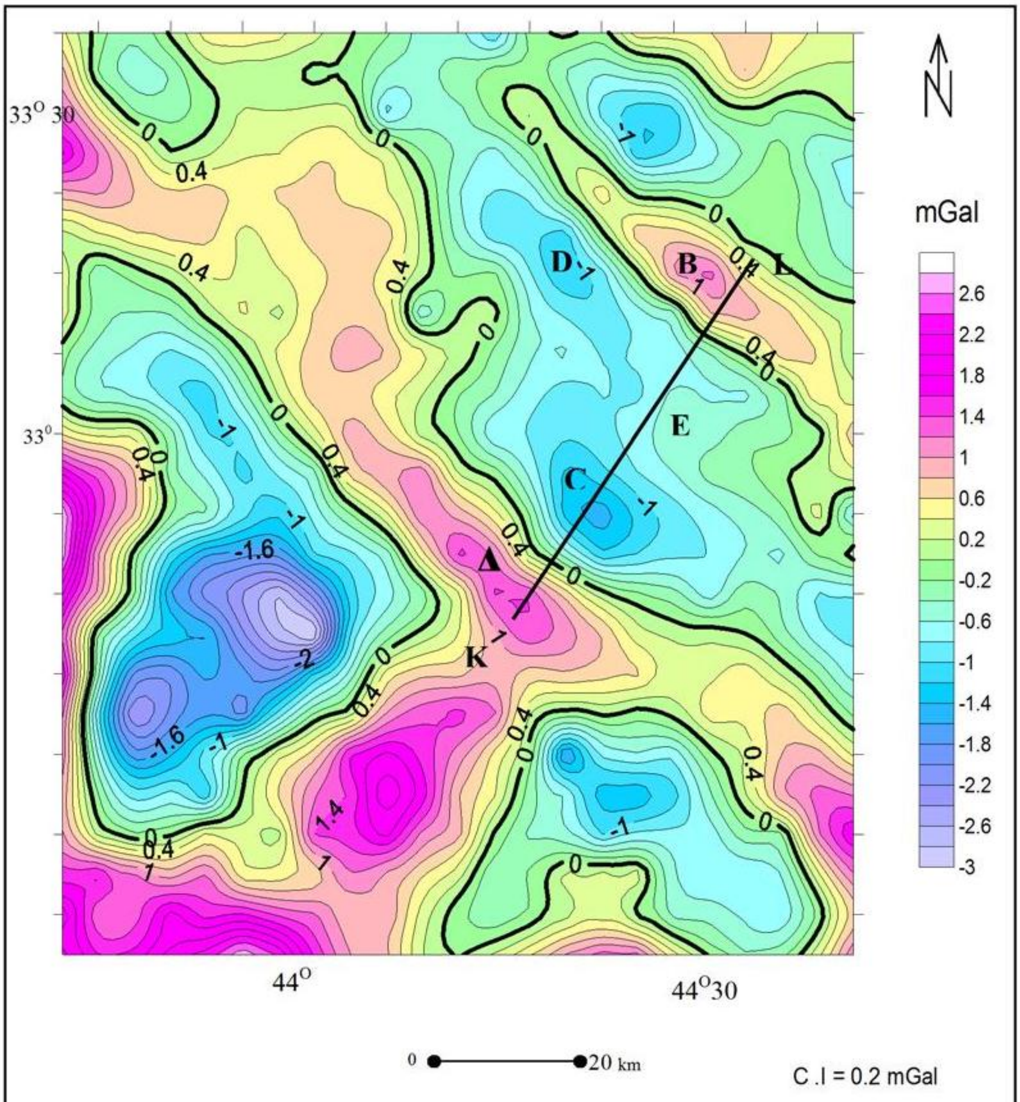
Screening of these local "highs" and " lows" in the present study by using the linear convolution method (Surfer,2002) has been adopted. The linear convolution method involves averaging the potential data around the gravity station. The residual values are directly dependent upon the size of the filter(n*m) based on the number of *Rows*(n) and *Cols* (m), along with the weights for each grid node in the neighborhood (the weights are all equal to one).

Using the linear convolution (Low pass filter), residual anomaly map has been constructed (Fig.3), with contour interval 0.2 mGal .The regional contours map figure(4), shows a smooth regional gradient increasing southwest. Two smooth "lows" marked in the west and northeast are also observed, these two "lows" are separated by an intermediate "high". This part of the field is usually of large wavelength and reflects deep-seated sources.

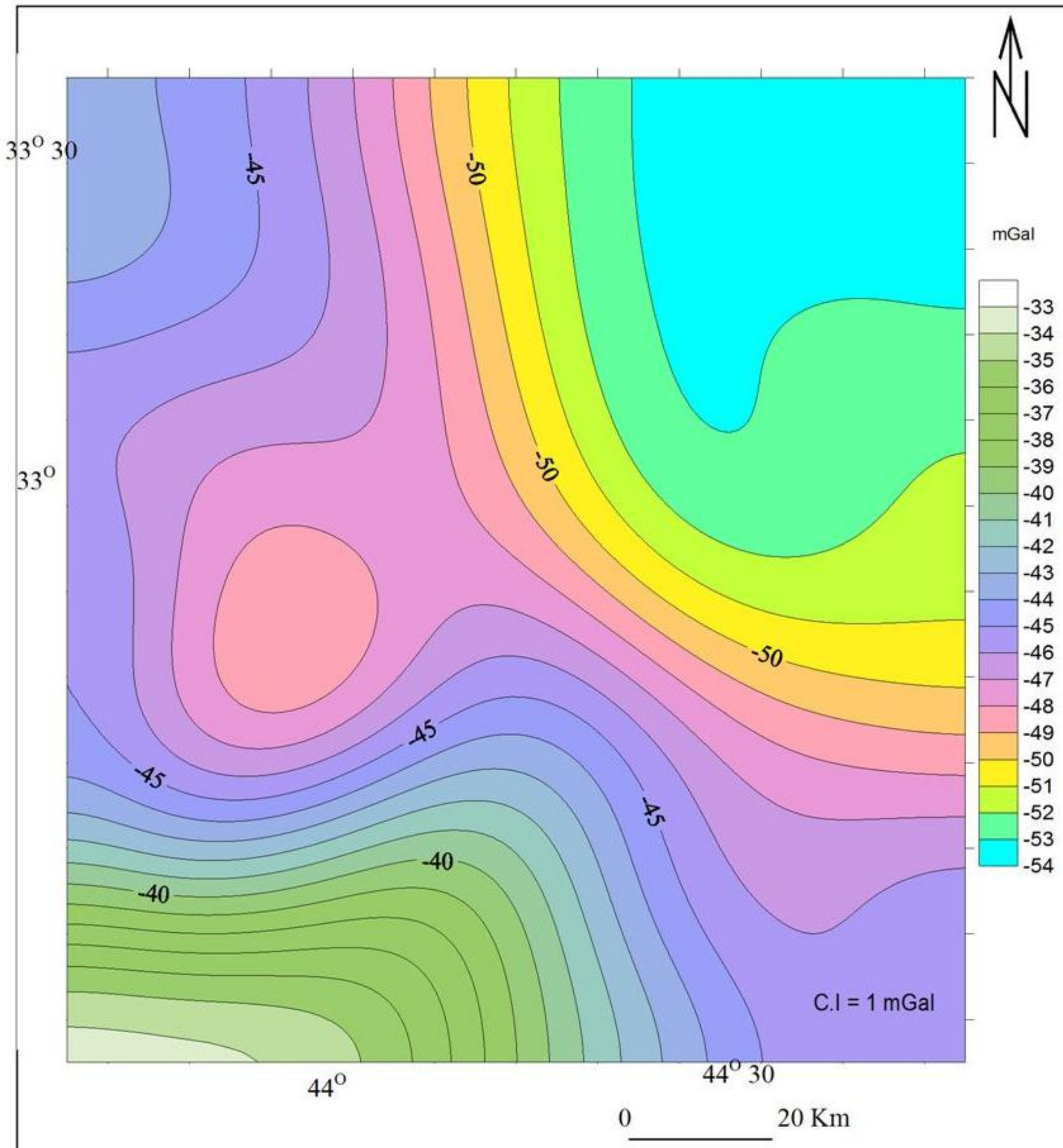
The local anomalies consist of two main "high" (Aand B) and two main "lows"(C and D on fig. 3), in between two "lows" there is a relative broad "high" (E) with small amplitude. Anomaly (B) occurs to northeast and is shown by relatively sharp converging of the contours that persist for the whole extent of the anomaly.

Anomaly (A) occurs on the southwest part of the map with similar characteristic shapes but slightly broader in the NW part than anomaly (B). This change in the shape of the anomaly from northeast to the southwest may indicate that the northeastern anomaly (B) is nearer to the folded zone and more intensely folded and faulted, in addition the contour gradients for both gravity "highs" show steep gradient toward the gravity "lows" .

The length of anomaly **A** after isolation , appear 57 km and its width is about 15 Km. with a maximum culmination of 1.8 mGal. Anomaly **B** has a length more than 61 Km and its width is about 13 Km,and has a culminating amplitude of 1.2 mGal. Anomaly **C** is 50 Km long and 16 Km width with a culminating amplitude of **-** 1.4 mGal .



Fig(3) Residual Bouguer anomaly map by linear convolution method



Fig(4) Regional Bouguer anomaly map by linear convolution method

Anomaly D has length of about 50 Km and its width is about 17 Km , with a culminating amplitude of -1 mGal.

Simulation of Data

The axes of the anomalies are clearly Alpine in their trend .They run parallel to the Alpine structures of Therthar at the northwest , Himreen and Samaraa at the northeast of the area of the study. They must involve not only the Tertiary succession but also the older rocks as well.

The following maximum depth rule(Kearey and Brooks,1984) has been applied to the profile **K- L** shown in fig (3).

Z<0.65 (A max/Ã max)

Where **A max** is the maximum anomaly, **Ã max** is the maximum gradient. It shows that the maximum depth ranges from 2.7 to 3.2 Km along **K-L** considering the lithologic and stratigraphic logs of wells Faluja-1 and east Baghdad-1(fig.1). These figures suggested that the source of the anomalies could not lie deeper than the lower part of the Cretaceous. While, in the present study it may be concluded that the continuation of "high" and "low" reflects the source of these local anomalies within the deeper origin .

No continuous density logging has been carried out in the wells surrounding the present area except the Musaiyib well figure (1).It shows a natural increase in density with depth up to Shuaiba Formation (L.Cretaceous) at a depth 2.48 Km (I.NO.C) library. The detailed density study of the Mesozoic rocks of

Musaiyib well (fig.1) reported a positive density contrast of 0.19 g m/cc that occur between the lower/upper Cretaceous boundary(Aziz ,1981). Rocks above this boundary have an average density of 2.46 gm/cc while those below it have an average of 2.65 gm/cc.

Furthermore, Al Shaikh and Al-Mashhadani, (1997) have used a density contrast of 0.19 gm/cc. Such contrast, represented Mesozoic at Shuaiba Formation as a boundary between the overlying and underlying succession.

Examining the subsurface geology from stratigraphic correlation between the three boreholes Faluja-1 , Musaiyib-1 and East Baghdad-1 of the area ,it can be seen that there is a regional gentle dip of the lower Cretaceous formations toward the north east. It is clearly seen a thinning in Nuhr Umr and Zubair Formation, such reduction in thickness may indicate uplifting related to the late Cretaceous movement ,(Buddy,1980) .

Shuaiba Formation, essentially dolomitic limestone, is one of the upper parts of the lower Cretaceous and constituted in the surrounding area as a good seismic reflector as reported , for example, near Balad structure by Alsakini (1984) ,as well as seismic depth map at the top of Shuaiba formation few Km north of Baghdad city . Al-Majed (1992) showed a well defined undulation and faulting within the Shuaiba Formation.

A gravity interpretation of Therthar local anomalies lying north of the studied area showed best models which fit the observed gravity anomaly relating to the faulting within the Shuaiba formation(Al-Shaikh and Al-Mashhadanyi ,1997).To asses these undulation ,two dimensional models constructed using GravCad program (Sheriff, 1997) and their gravity anomalies are compared with observed anomalies A, B, C, D and E .Looking at the residual map of figure(3) it can be observed "highs" and "lows" such as anomaly A, B, C, D and E along profile K-L .

Two cases are considered to give an interpretation of these anomalies:

Case one, suggests the lower/upper Cretaceous boundary represented by the top of Shuaiba formation which assumed to be the main boundary of density contrast. Three alternative models (fig.5) are suggested. The main difficulty in the process of modeling as to achieve a close agreement between the observed and the calculated effects around the peaks of gravity "lows" and "highs" with a density contrast of model 1 that due to anticlines and synclines below there anomalies (A ,C, E, D and B) . Their closures are depicted by the model and they are ranged from 150 to 350 m . On figure (5) , it can be seen the fit between the observed and the calculated effects is more reasonably close for anomalies A and B at limbs , but it is not so for their peaks (C, D and E) .

On model 2, introducing normal faults on the limbs , while keeping the crest at the same positions , these faults should have their down thrown sides toward the synclines , seen slightly improved best fit between the calculated and the observed values with density contrast value 0.17 gm/cc, but it is not so for C and E .

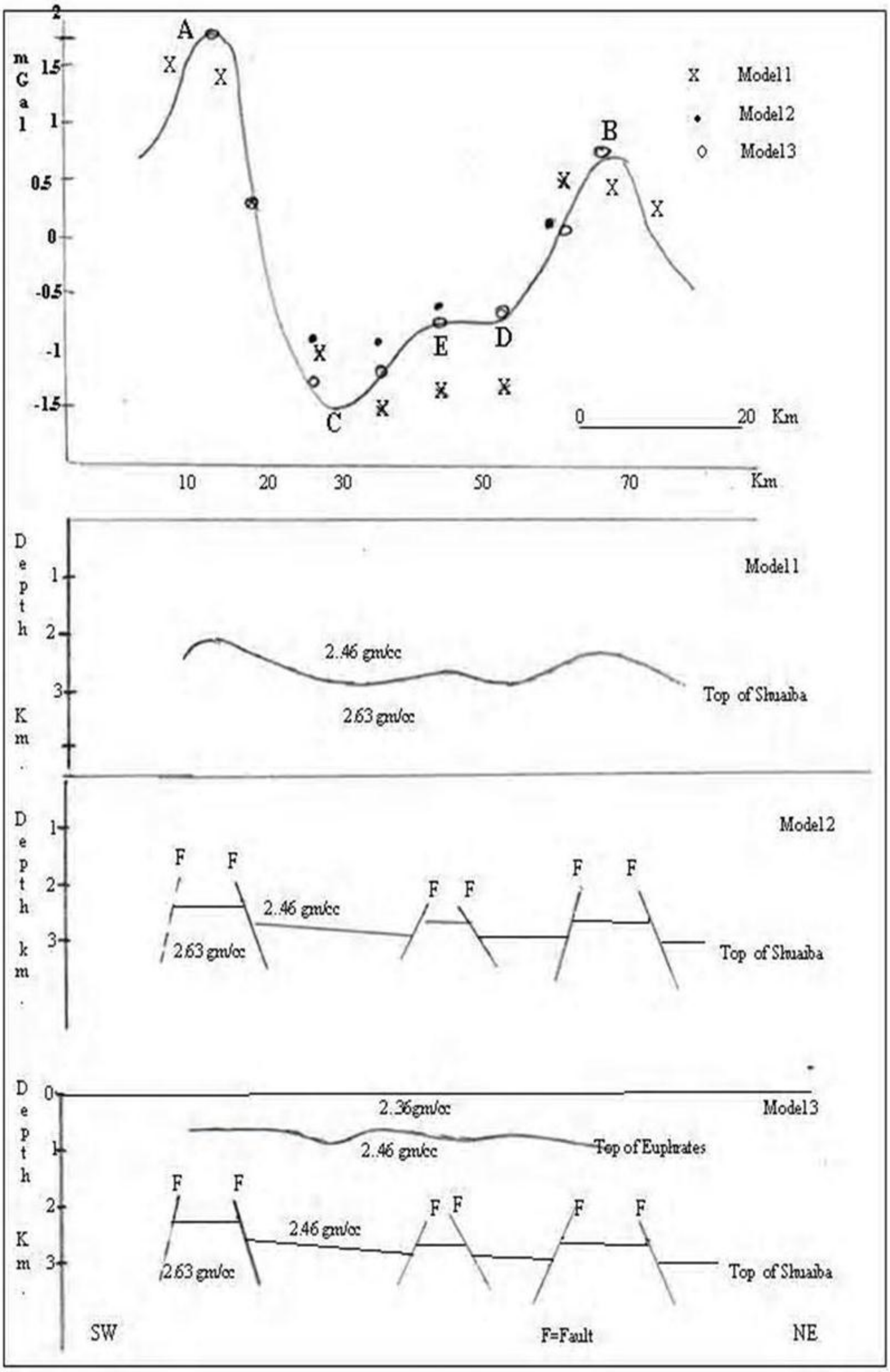
On model 3 . a good agreement with observed anomaly is obtained by introducing a shallow density contrast of 0.1 gm/cc which assumed to occur between the Fat' ha and the overlying Injana Formations on one side and the Euphrates and underlying succession on the other.

Case two, suggests a lower/upper cretaceous boundary representing top of Maudud formation which assumed to be the main boundary of density contrast value 0.19 gm/cc, with two alternative models (figure 6) .

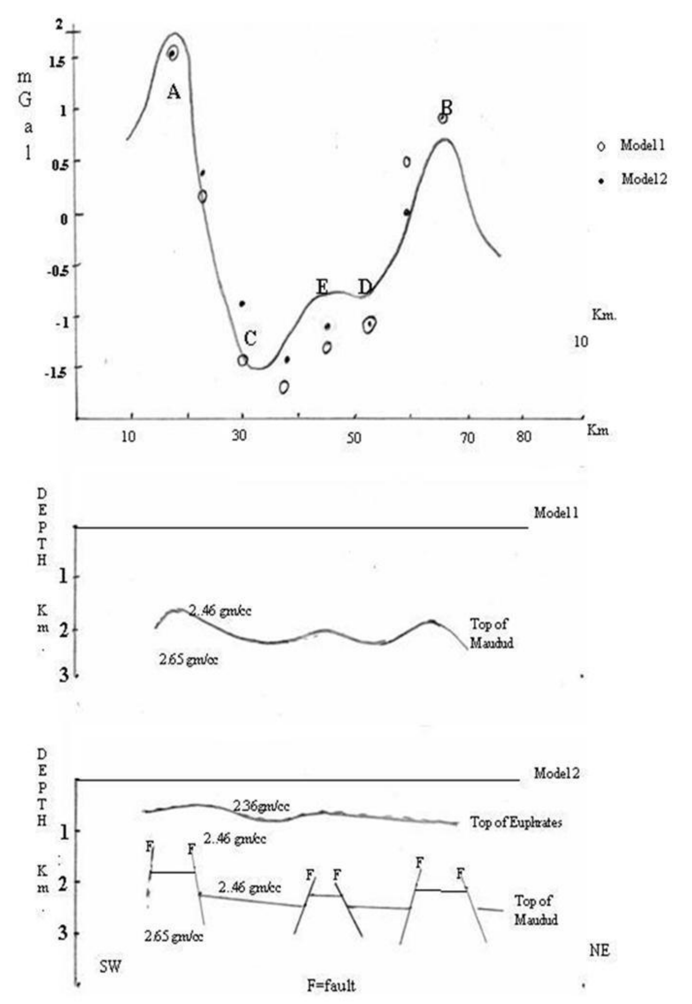
Model 1.represents a section of anticlines and synclines below their anomalies. Their closure as depicted by the model are ranged from 150 to 300 m. in figure (6). It can be seen that a miss fitting all over the anomaly profile between the observed and calculated effects.

On model 2 . Introducing normal faults on the limbs ,while keeping the crest at the same positions with slightly adjusted model, these faults must have their downthrown sides towards the synclines. This model seems slightly better than model 1, but still not fit the observed anomaly .

The boundary contrast, in case one, is reasonable as it separates essentially, sandy and marly succession above from Calcareous succession below, in addition the fit between the observed and the calculated fields has showed much improvement when the top of the undulated Euphrates Formation is added at depth of about 700 m. with closure 75 m. below anomaly C and E. It also shows that the Shuaiba Formation undulated and faulted at a depth between 2400-3100 m.



Fig(5) Two –dimensional representation of gravity sources along line K-L



Fig(6)Two –dimensional representation of gravity sources along line K-L

Discussion and Conclusion

In case one ,model 1, anticlines and synclines associated with Shuaiba Formation and density contrast 0.17 gm/cc would not be sufficient to produce a good fit to the observed anomalies especially at the peaks ("Highs" and "Lows"). In model 2 , introducing the normal faults to the Cretaceous succession has resulted slight improvement on the fitting. Model 3 , where the fit is considerably improved, an undulating boundary or density contrast at the base of Fat' ha Formation as well as the faulted L.Cretaceous rocks have been necessary.

In case two , model 1, anticlines and synclines associated with Maudud Formation with a density contrast 0.19 gm/cc would not produce a good fit to the observed anomalies ,as well as, introducing the normal faults to the Cretaceous succession in model 2 with undulating boundary as a density contrast at the base of Fat' ha formation has resulted in only slight improvement in the fit.

The suggested faults in case 1 model 3, oriented parallel to the axes of the anticlines with Alpine trend .Whether or not these faults penetrate upwards to the Tertiary ,can not be decided from gravity evidence only. If they are projected upwards with their suggested inclinations , they are certainly intersect with the proposed Tertiary undulation especially under the anomaly C and E .If they don’t affect the Tertiary rocks, their locations certainly have influenced the position of the Tertiary undulation during the Alpine orogeny.

Therefore , model 3 in case 1 reflects the reasonable geological structures in compared with the other alternative.

Speculating on the hydrocarbon prospect of the area, it can be pointed out that the proposed Tertiary and Cretaceous folds may in themselves not be good anticlinal trap in view of the present faulting. However, hydrocarbon traps have been found associated with fractured calcareous rocks of Jeribe , Sirikagni and Cretaceous formations in the adjacent structures , They may similarly be oil-bearing in the studied area. while the formations of Zubair and Nahr Umr are oil producer in the southern oil fields of Iraq.

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معالجة ومحاكاة البيانات الجذبية حول مدينة بغداد

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الملخص

خارطة شذوذ بوجير حول منطقة بغداد ذات المقياس 1:000 200 تم فصل المجال ألجذبي لها بطريقة الاحتواء الخطي إلى أجزاء تعود إلى مصدر ضحل ومصدر عميق .يمثل المصدر الضحل شواذ جذبية موجبة وسالبة متتالية تمتد بالاتجاه الالبي الزاكروسي. وفسرت هذه الشواذ بأنها تعود لطيات البيه ضحلة (ثلاثية–وطباشيرية). نوقشت الأدلة المتوفرة التي تشير إلى وجود تراكيب ومجاميع من الفوالق ضمن تكوين الشعيبة شمال وشرق منطقة الدراسة التي هي امتداد التراكيب المشار إليها في هذا البحث والتي تعكس التركيب الجيولوجي الأكثر قبولا .