The Effect of Adjacent Magnetic Sources on the Interpretation of Magnetic Anomalies

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ABSTRACT

A graphical method of determining the possible effect of adjacent igneous bodies on the interpretation of magnetic anomalies caused by a given source is determined. It requires to assume that the given igneous body produces well defined magnetic anomaly and considering contributions of other sources of different depths and widths at different horizontal distances .The method involves taking the ratios of distance between peaks of maximum +ve values of magnetic anomalies of the two adjacent igneous bodies and distance between maximum +ve and -ve values of the main anomaly.

This ratio is plotted against the ratio of(maximum -ve anomaly values, of the two adjacent igneous bodies) to the (maximum -ve anomaly values of the main igneous body). Examples are taken from the Rutba area of the stable shelf of Iraq.

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تأثير الأجسام النارية المجاورة على تفسير الشواذ المغناطيسية

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الملخص

تهدف الدراسة إلى استنباط مخططات قياسية لمعرفة مدى تأثر الشواذ المغناطيسية المراد تفسيرها بالأجسام النارية المجاورة. استندت الدراسة على رسم مخططات لجسمين نموذجين الأول يمثل الجسم الرئيسي والثاني يمثل الجسم المجاور وبأشكال وأعماق ومسافات مختلفة للجسم المجاور .من المخططات المستنتجة وجدت النسبة بين المسافة للقيمة الموجبة لشذوذ للجسم الرئيسي والقيم الموجبة لشواذ الأجسام المجاورة إلى المسافة بين الشذوذ الموجب والسالب لشذوذ الجسم الرئيسي. كذلك النسبة بين القيم السالبة للشذوذ لكلا الجسمين إلى القيمة السالبة للشذوذ الجسم الرئيسي. طبقت هذه الدراسة على الخرائط المغناطيسية لمنطقة الرطبة الواقعة ضمن الجرف المستقر في العراق.

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INTRODUCTION

In interpreting magnetic profiles from the aeromagnetic map of Iraq, it is usually assumed that the observed anomalies are caused by homogeneous magnetic bodies forming the basement that is concealed beneath a thick cover of sediments.

Many unknowns are faced in interpreting magnetic anomalies related to such deep sources. Among these: direction of magnetization in these sources, magnetic susceptibility and the contributions of the adjacent sources are the most important unknowns. Therefore, it is to be assumed that these anomalies are related to igneous bodies within the basement rocks and magnetized by induction only from the present earth's magnetic field. In other word, the study is focused on one of the unknowns mentioned above, which is the effect of contribution of adjacent igneous body at different depths and sizes on the shape of main magnetic anomaly.

Previous studies related to interpretation of aeromagnetic anomalies in Iraq, have assumed that these basement anomalies are not affected by adjacent igneous masses and as such not taken in consideration, (Al Mashhadani, 2000, Najar, 1999, Mohammed 1981, Mahmood, 1981, Aziz, 1981).

In this paper ,the effects of such close magnetic sources will be considered . The suggested method is designed at estimating the amount of change in the -ve part of the anomaly occurring between two igneous sources, which in turn depends on how close the adjacent igneous sources to the main one.

METHODOLOGY

Case one: Adjacent source of similar size and depth at different distances apart.

The magnetic anomalies are calculated over a line running perpendicular to the strike of an hypothetical two dimensional source as shown in fig (1A) . The dimension and depth used for the model is similar to those estimated for igneous sources in the western desert of Iraq,(the stable shelf).(Buday and Jassim,1987)

The magnetic anomalies along the same line over the same source after adding adjacent igneous body of the same volume and properties occurring at a different horizontal distance from the main one are also calculated , Fig (2).
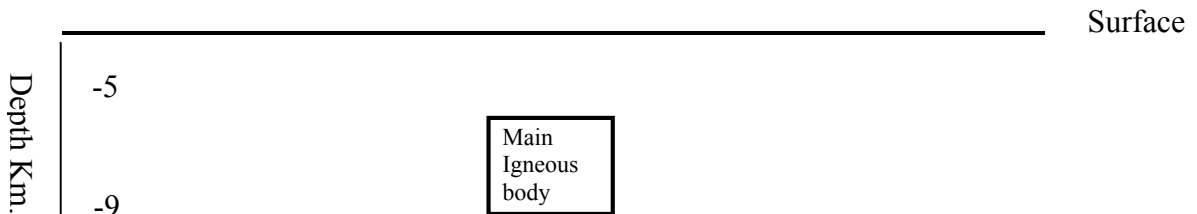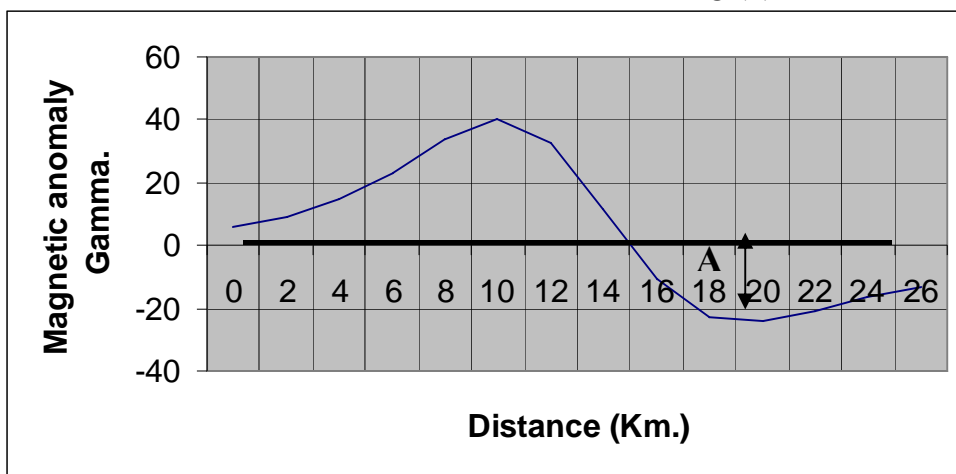

Fig .1A: Calculated anomaly for a hypothetical two dimensional body.

It can be seen that the +ve and -ve peaks of the calculated resultant magnetic anomalies of the two adjacent igneous bodies of fig(2) coincides with +ve and –ve anomaly peaks seen in fig(1A)at large distance apart, but the reverse is true for smaller separating distances. Therefore it is important to measure the distance between the +ve maximum anomaly peaks of the two adjacent magnetic bodies **(D)** (see fig 1B), also to measure the distance between the maximum +ve and -ve anomaly peaks of the main igneous body **(d)**, to show the ratio of the better distance between the +ve peaks of the main magnetic anomaly and adjacent magnetic anomaly to the distance between the +ve and –ve peaks of main magnetic anomaly , that will not affect anomaly shape of the two adjacent igneous bodies. Then for each position the Raito **R=D/d** is calculated.

To show the effect of such close magnetic source to the maximum –ve value of the main anomaly, the magnitude of the theoretical maximum –ve anomaly **(A)** of the main igneous body (fig. 1A) is measured, and also the maximum –ve anomaly **(a)** resulted from the two adjacent igneous bodies(main and adjacent igneous bodies)at each position of the adjacent body is measured too.(fig.1B).
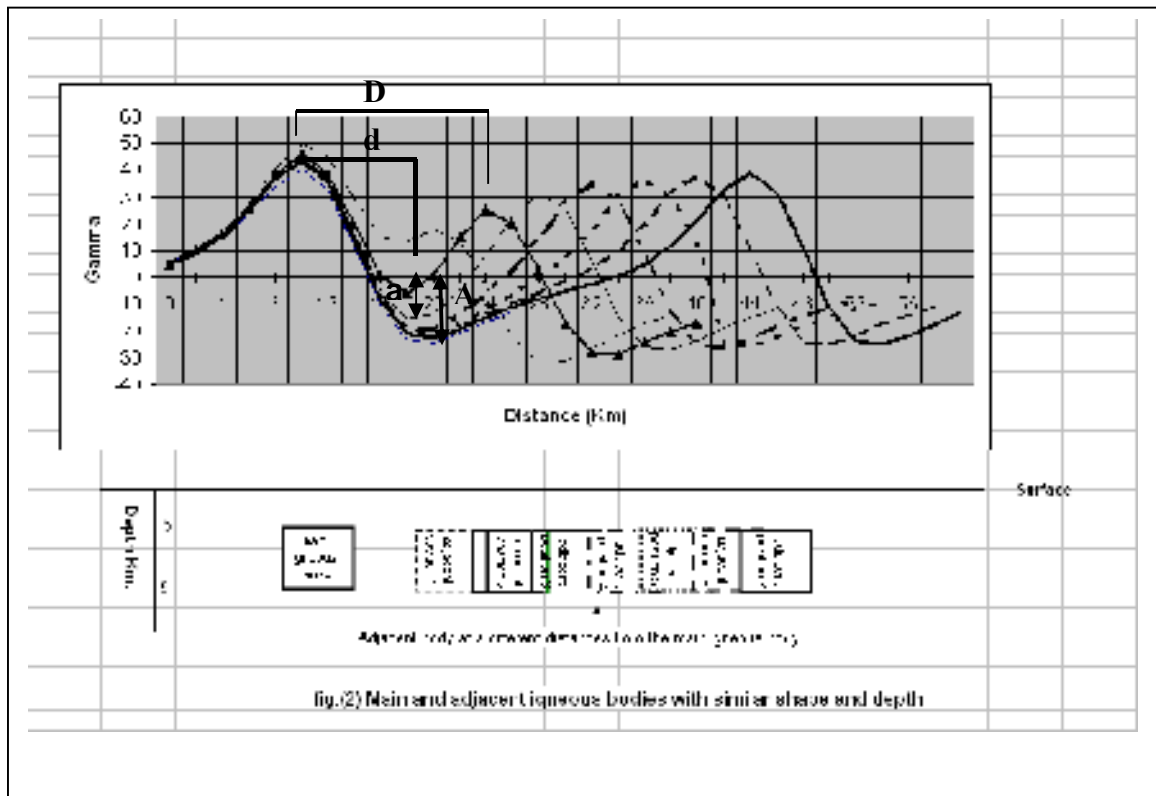

Fig. 1B: Showing the position of **D, d , A** and **a**   parameters

Then the ratio **R1=a/A**   is calculated. A theoretical curve of **R1** against **R** is constructed (fig. (3)), and shows exponential decrease of **R1** as **R** decreases.
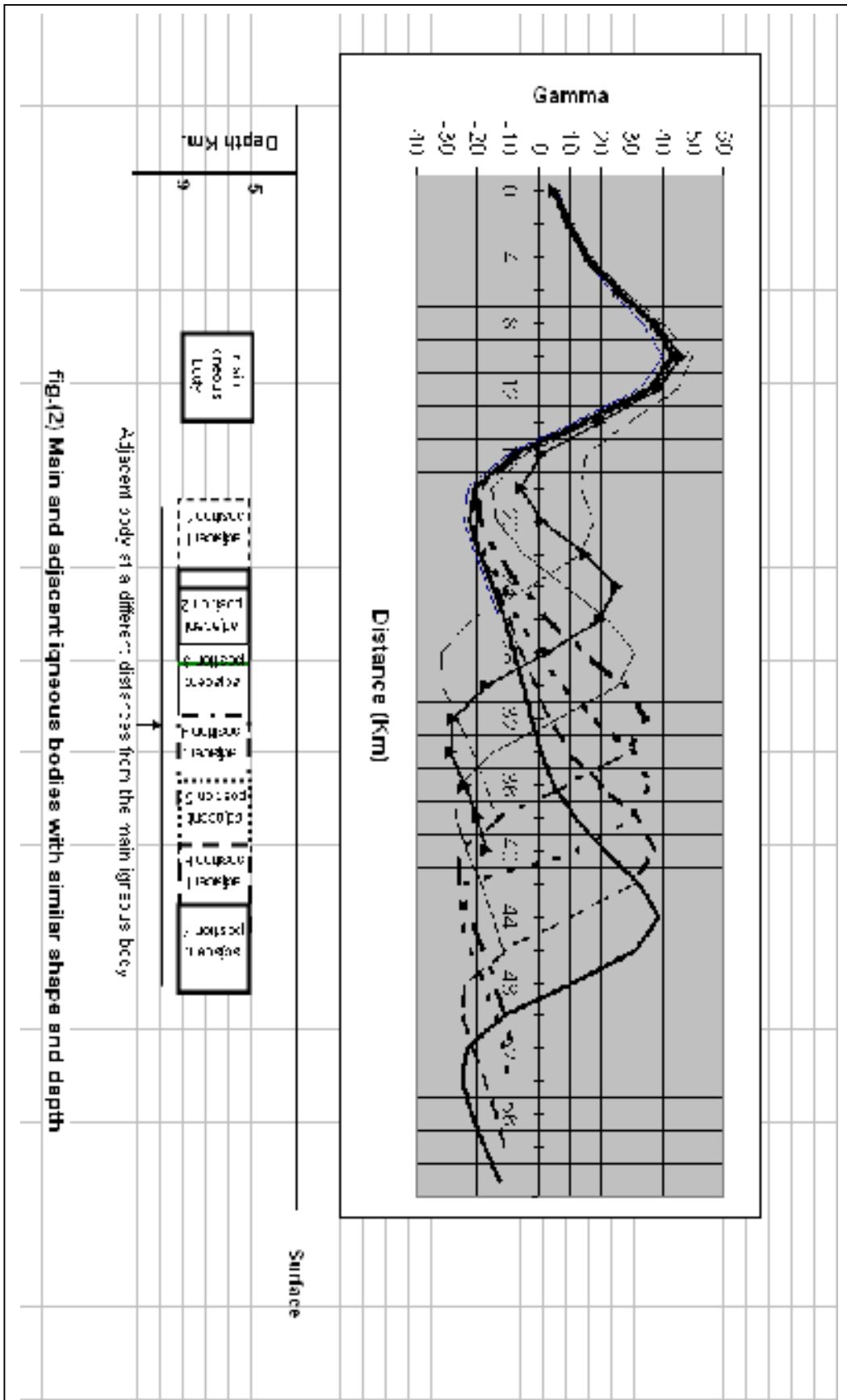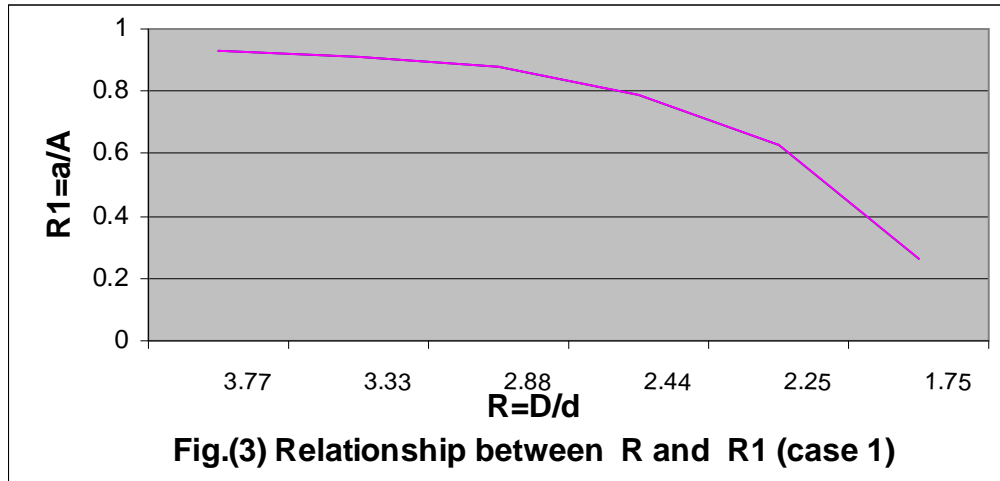
fig.(2) Main and adjacent igneous bodies with similar shape and depth

Fig.(3) Relationship between R and R1 (case 1)

Case two: Wide adjacent sources

Another magnetic anomalies are calculated over the same line as mentioned in the previous case, with only the adjacent source has twice the width of those in fig(2). These anomalies are shown in fig (4), fig (5) shows also exponential decrease of   R1   as R decreases.

fig.(4) Main and adjacent igneous bodies with similar depth and twice width

Fig.(5) Relationship between R and R1 (case2)
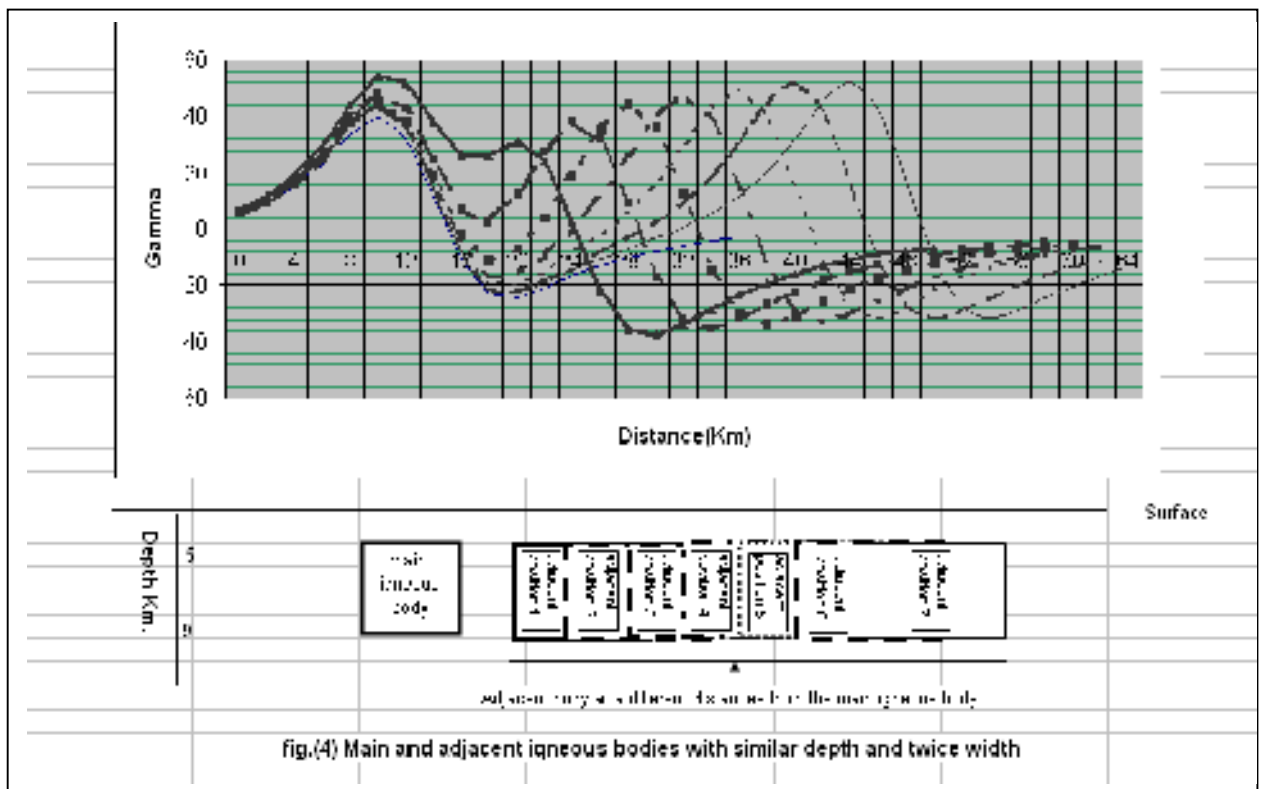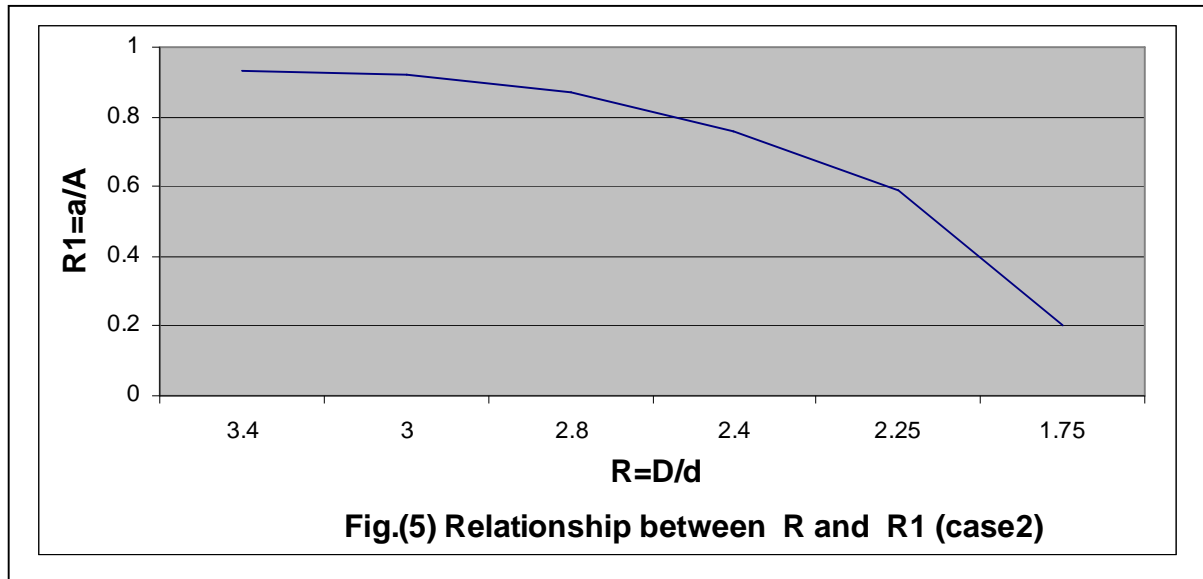
Case three : Deep adjacent source

The adjacent igneous body has the same x-coordinate of the first case but extend deeper than the first case as shown in fig (6). The exponential curve is constructed shows a decrease of **R1** as **R** decreases (fig7).

Therefore ,these three cases show that the magnetic anomalies of the two adjacent magnetic bodies have the same behavior whatever their sizes and depths are.

The anomalies show, the peaks of the +ve magnetic anomalies of the adjacent igneous body are less than it has been when the two adjacent bodies are closer together. The magnetic anomalies regain their real shapes and values when the adjacent body move farther away from the main igneous body. (see (fig(2), fig (4)and fig.(6))) therefor the three cases show the same exponential ratio of **R** and **R1**.

With actual magnetic surveys, **R** can be measured from the observed anomalies , this value gives how much the main magnetic anomaly is affected by adjacent magnetic anomaly of the adjacent igneous body .

Therefore, the safe distance of the adjacent igneous body from the main igneous source so as not to impose appreciable effect, the ratio of **R** should be not less than 2.5 ,and **R1** corresponding to it can be read from the curve of fig (3) or fig (5) or fig (7) ,and also (**a**) (apparent .max.-ve value from the observed -ve anomaly) ,hence the value of the true magnetic anomaly (**A**) obtained from the ratio **(R1= a /A).**

The value (**A)** (true -ve value) can be calculated. According to the value of (**A)** One can determine the true location of the zero line of the observed magnetic anomaly.

Application of the method to the Western Desert .
  In order to illustrate the method described above ,an example of prominent magnetic anomalies have been chosen from the Rutba area of the stable shelf south of the Euphrates river in Iraq,(see fig (8).

The aeromagnetic map shows +ve and -ve magnetic anomalies of different sizes. In the south west area of the map there is a large +ve magnetic anomaly at a value of

5095 γ with east west elongation and -ve magnetic anomaly at about 5015 γ at the north east. This type of anomaly is consistent with induced magnetization from the present earth's magnetic field. This anomaly is called Um Rashif (Alnajar, 1999). Also to the north east of Um Rashif anomaly there is another +ve anomaly at a values of 5050 γ extending east- west which is rather distorted by the Um Rashif anomaly ,and there is also a –ve anomaly at a value of 5010 γ .This type of anomaly is again consistent with induced magnetization from the present earth's magnetic field. This anomaly is called Tillul magnetic anomaly.

To the west of Tillul anomaly there is Ras Al Fahama magnetic anomaly , whose +ve part has a value 5050 γ with an oval shape extending SW-NE , and to the north there is it's –ve part.

Many studies have been carried out by many geophysicists such as Abbas(1972), Al Bdaiwi(1982), Abbas and Al-Khatib (1982)**,** Shaswar(1983), AₒlRawi (1986), Al-Bdaiwi (1992), Al Najar(1999).

All of these studies did not take into consideration the effects of adjacent igneous bodies to the main magnetic anomaly which is affected by the choice of the zero line and also by the true anomalous values of the adjacent igneous bodies.

Therefore, a profile has been taken a long the line **A-B** as show in fig (8). The line starts from the south west at N33^o 45$^-$, E 41° 20$^-$ to the north east of N 34° 25$^-$, E 42° 15. The magnetic profile shows two +ve and –ve peaks. The first +ve peak (Um Rashif) is relatively large with an amplitude of 58 γ trending east-west. To the north there is –ve peak of amplitude 10 γ(fig 9). There is also the +ve peak of Tilul of amplitude 25 γ,occurring to the NE of the profile.

The measured distance between the two +ve peaks of Um Rashef and Tilul **(D)** is about 61.5 km whereas the measured distance between the +ve peak and –ve peak of Um Rashif **(d)** is about 35 km .Thus the ratio **(R=D/d)=1.75** which is equivalent to **R1** = 0.23 using the graphs fig (3),(5),(7).

Therefore, the value **R=1.75** is less than the standard value **R=2.5** that is calculated in the theoretical curve of fig (3).
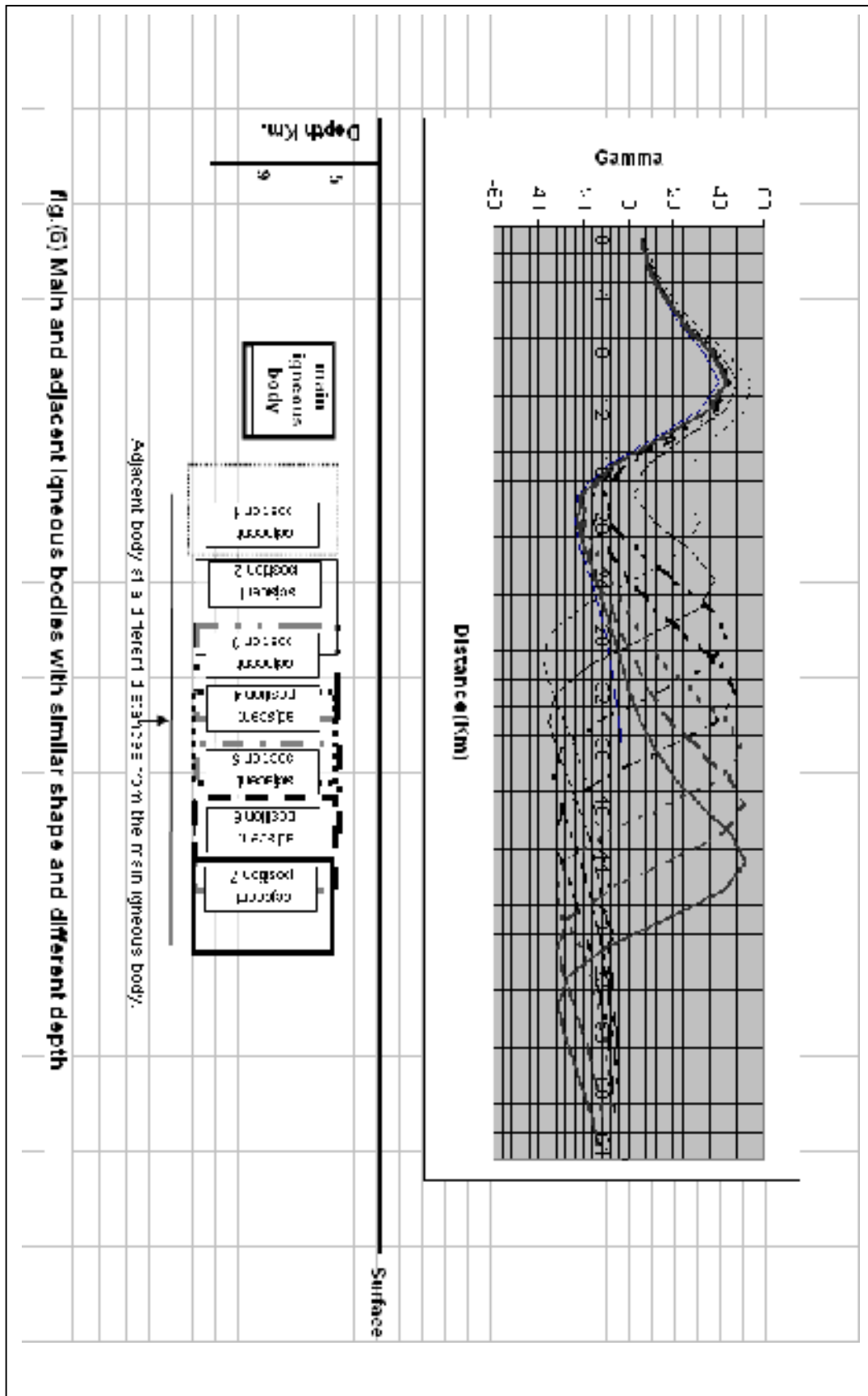

Fig.(7) Relationship between R and R1 (case 3)
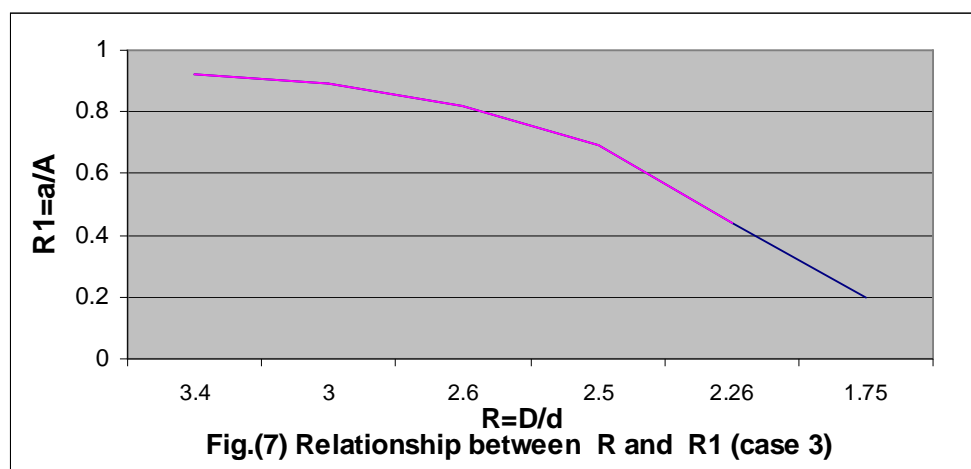
fig.(6) Main and adjacent igneous bodies with similar shape and different depth
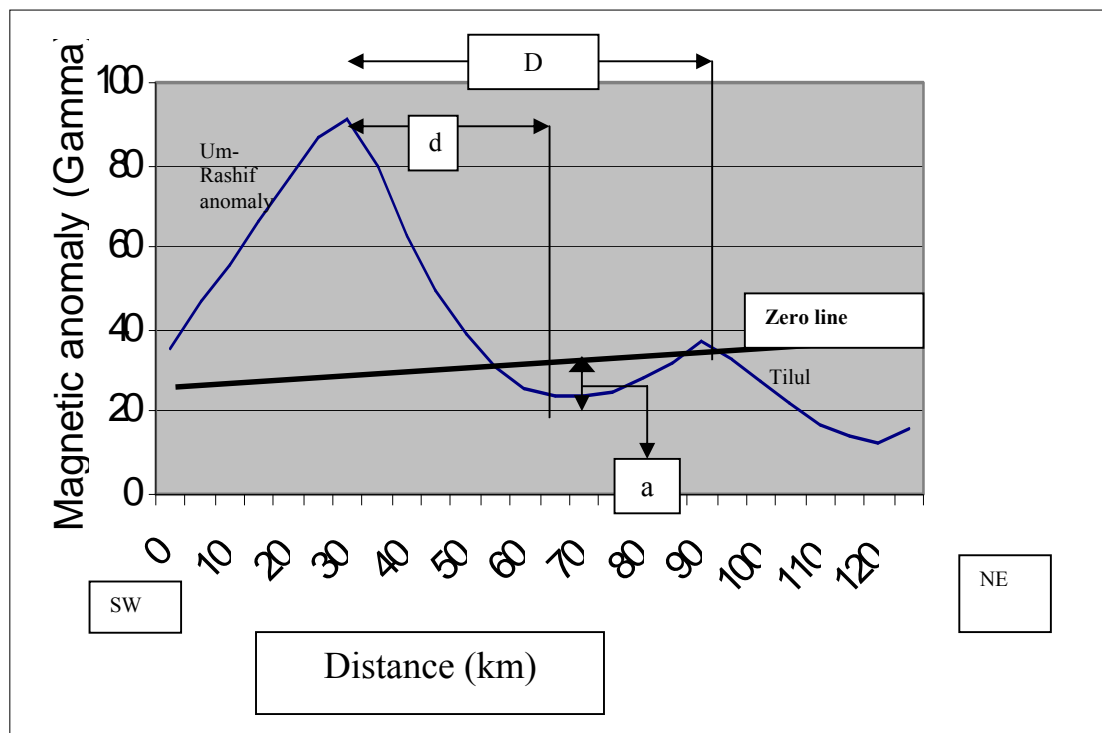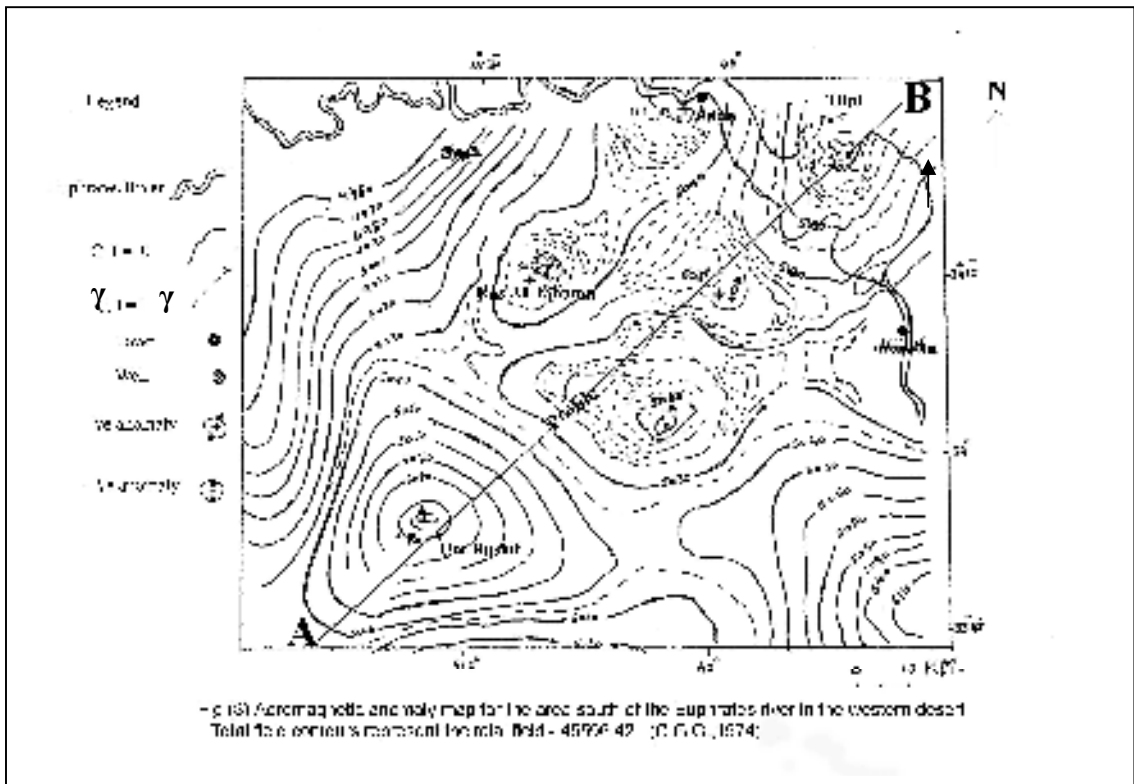
Fig . 9: Observed profile along line A-B

This means that Tilul anomaly is closer to Um Rashef anomaly and the magnetic value of the –ve peaks of Um Rashif and +ve peak of Tilul are less than their true values.

Therefore, the true magnetic values of the –ve peak of Um Rasif **(A)** can be deduced from **R1=a/A** where **R1** and **a** are well known (**R1= 0.23**, **a= 10** γ) hence **A= 43**γ.Then for the best and correct interpretation of the magnetic profile is to choose the correct position of the zero line that depends on the true values of the maximum –ve anomaly of the main body.

CONCLUSIONS

It is hoped that with aeromagnetic anomalies representing deep igneous and metamorphic rocks under condition of induced magnetization, the following steps used in interpretation will lead to some reduction in the many variables involved.

1- when two igneous bodies occurring close together whatever their sizes and shapes, their magnetic profiles show that the +ve peak of the adjacent source and the –ve peak of the main igneous body are less than it has been and it reaches its real values when the adjacent igneous body move away, assuming magnetization by induction.

2- The best distance between two igneous bodies which give minimum effect of one to the other ,is the ratio of R=2.5 or more.

3- The real position of the zero line can be deduced correctly.

REFERENCES

Abbas, M.J., 1972, Gravity and magnetic measurement in the area of Gaara depression GEOSURV Lib.Report No.535, Unpubl.

Abbas, M.J. and Al- Khatib, H.H., 1982, Complex geophysical interpretation of Hit Abu Jir-Shithatha area. GEOSURV Lib.Report No.1274, Unpubl.

Al Bdaiwi, J., 1982, Detailed magnetic survey of Al Walled area Western Desert . GEOSURV Lib.Report No.535, Unpubl.

Al Bdaiwi, J., 1992, Contribution to the analysis of gravity and magnetic field data of Iraq.Iraqi Geol.J.,25(3):50-64.

Al Mashhadani,A.M., 2000. Geophysical evidence for the subsurface structures of the Jezira area, Northern Iraq,Ph.D. Thesis university of Mosul, unpublished

Al Rawi, F.R., 1986,Basement depth estimation in western desert in Iraq using power spectrum techniques. L.Geol.Soc.Iraq,19(2): pp.17-25.

Aziz, N.M., 1981. Interpretation of gravity and magnetic data of western Baghdad area M.Sc. Thesis, university of Mosul, unpublished.

Buday, T. and Jassim, S.Z., 1987, The regional geology of Iraq, vol. 2, Tectonism magmatism and metamorphism. Geosurv. printing dept.Baghdad. 352p.

Compagnei general De-Geophisque (C.G.G), 1974, Aeromagnetic and aerospectro metric survey. GEOSURV.Lib. Unpubl. Report.

Mahmood, S.A., 1981. Interpretation of gravity and magnetic data of Shbicha area western desert ,M.Sc. Thesis, university of Mosul, unpublished.

Mohammed. A.M., 1981. Geophysical study to establish basement configuration in the western desert ,M.Sc. Thesis, university of Mosul, unpublished.

Najar, I.M., 1999. Geophysical evidence for the Mesozoic and Paleozoic sedimentary basins in the northern part of the western desert. Ph.D. Thesis, university of Mosul, unpublished.

Shaswar, O.K., 1983. Analytical study of the geophysical data over Anah area, M.Sc. Thesis, University of Mosul, Unpublished.