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The State of the Main Basement Features of the Western Desert of Iraq, A New Look

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Abstract

The reduction to pole of the aeromagnetic map of the western desert of Iraq has been used to outline the main basement structural features. Three selected magnetic anomalies are used to determine the depths of their magnetic sources. The estimated depths are obtained by using slope half slope method and have been corrected through the application of a published nomogram. These depths are compared with previous published depth values which provide a new look at the basement of the western desert in addition to the thickness map of the Paleozoic formations. The results shed light on the important of the great depths of the basement structures and in turn the sedimentary cover to be considered for future hydrocarbon exploration
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Keywords: Basement depth, main features, magnetic data, corrected depth estimation

عرض لظواهر صخور القاعدة الرئيسية في الصحراء الغربية للعراق – رؤية جديدة

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الخلاصة

استخدم اسلوب تحويل الخارطة المنغاطيسية الجوية للصحراء الغربية من العراق الى القطب في تحديد الظواهر التركيبية الرئيسية لصخور القاعدة. اختيرت ثلاث مقاطع للشواذ المغناطيسية لتقدير اعماق المصادر المسببة لتلك الشواذ. حسبت الاعماق لهذه المصادر عن طريق استخدام طريقة الميل– نصف الميل ومن ثم تم تصحيح الاعماق المحسوبة بأستخدام مخطط رياضي منشور. لقد قورنت هذه الاعماق مع القيم المنشورة سابقا والتي وفرت رؤية جديدة حول صخور القاعدة في الصحراء الغربية بالاضافة الى خارطة سمكية لتتابع الصخور القديمة . ان النتائج القت الضوء على اهمية الاعماق الكبيرة لتراكيب صخور القاعدة وبالتالي الغطاء الرسوبي والتي يجب أن تؤخذ بنظر الأعتبار في الأستكشافات الهيدروكاربونية في المستقبل.

Introduction

The study area represents part of the Iraqi western desert and it is part of the stable shelf that borders the western edge of the Mesopotamia Foreland basin. Surface geology shows Permian to Cretaceous strata outcropping in the center of Ga'ara depression, which attests to the continuity of sedimentation on the Stable Shelf from the Paleozoic to the Cretaceous (1).

The area is relatively simple; the dip of the strata is generally below one degree and cannot be measured directly. The basic structural feature is the Rutba subzone of the stable shelf (2), which

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represents part of a huge regional N-S trending uplift structure. This structure has been observed on the gravity map of the western desert (3).

The depth of the crystalline basement around Rutba area ranges 2-5 km and its highest part occurs in the Ga'ara area (1). The depth value estimated from aeromagnetic interpretation by CGG (4) in the area is about 8 km. This value differs from the depth of 1-4 km given by (5) and (6). Al-Rawi (7) estimated the depths of the basement to be 2.5-5 km through using the power spectral technique across many aeromagnetic profiles. However, (8) estimated the basement depth from gravity and aeromagnetic data to be 6.5 to 10.4 km and 6-10 km respectively in the western desert. The depth varies from 7 km near Rutba to more than12 Km near Haditha area (4). The current study outline the main basement features and provide a new look about the possible basement depth through applying correction to the estimated depth values which can be considered for other magnetic anomalies.

Aeromagnetic Map of the Western Desert

The aeromagnetic map of the western desert Figure-1 is an integral part of the aeromagnetic map of Iraq compiled from a survey carried out by (4). It is characterized mostly by isolated large extent magnetic anomalies of different amplitudes (around 100 Nano tesla). The map also shows no dominant magnetic trends, but the isolated anomalies are varying in direction from ENE-WSW, NWN-SES, NW-SE and some have an E-W trend. These magnetic trends may be related to the structural features of the basement (9). In addition, to the structural interpretation that are depending upon potential data, the outcrop of surface structures interpreted from satellite images and verified with geological maps. It is worth mentioning that the magnetic anomalies have a broad shape extended more than 50 Km in width. These indicated that they must originated from magnetic sources with the basement or deeper. The low amplitudes of these anomalies reflect the supra basement origin, which explain the block-faulted feature of the basement surface (10)

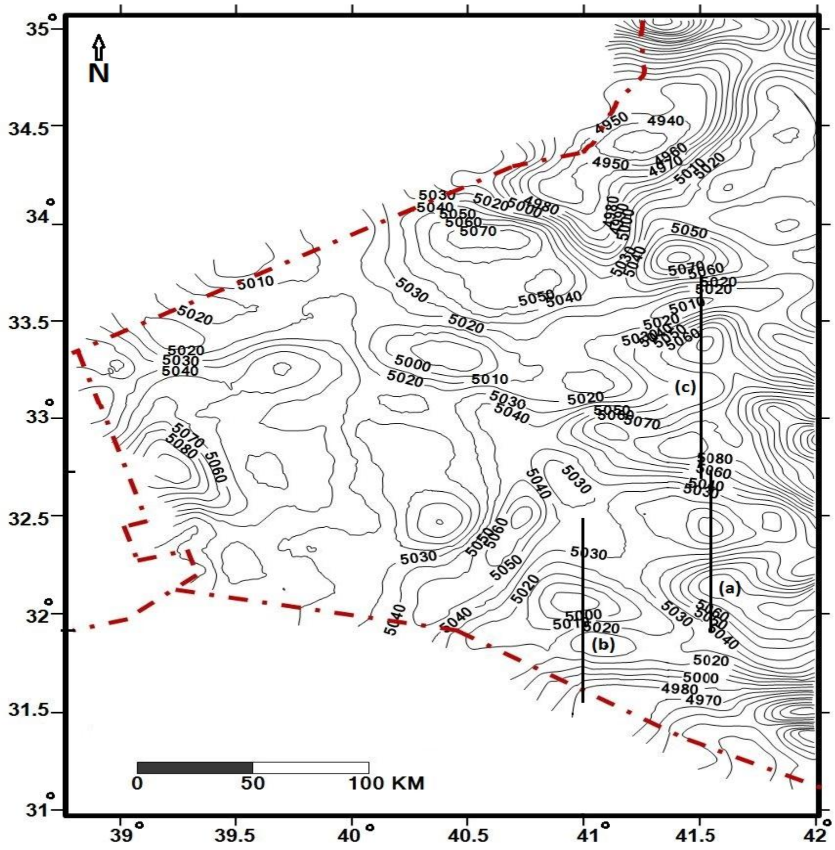

Figure 1- Total magnetic intensity map of the western desert of Iraq (After 4) showing the location of the three selected magnetic profiles a,b and c (straight lines).

The reduction to the pole method of analyzing magnetic field data transforms the total magnetic intensity map to the vertical field situation at the north magnetic pole, so reducing the distortion in the pattern of magnetic anomalies resulting from obliquity of the measured magnetic field and non-vertical polarization vectors in magnetic bodies (11, 12). The magnetic anomaly peak in the transformed map is not necessarily coinciding with the apex of the causal magnetized body because the direction of magnetization is not necessarily in the same direction as that of the present field.

Analysis of the magnetic map

The dominant magnetic anomalies of the aeromagnetic map Figure-1 are mainly closed anomalies with various trends. These anomalies are characterized by the appearance of the dipole effect that represented by positive and negative parts, which is the effect of the inclination angle at this area of about 45^o. Then, the magnetic map is reduced to the pole by utilizing the fast Fourier transform Figure-2, defined the locations of the main basement features. These features are outlined and superimposed on the total magnetic anomaly map Figure-3, which reflect the main interested basement structures in the area to be considered for future investigation.

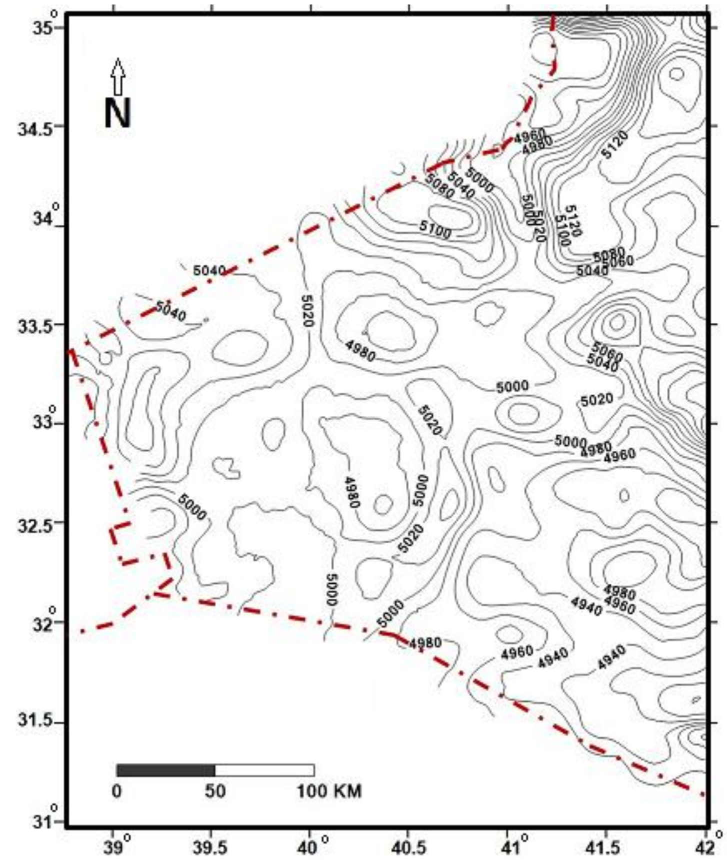

Figure 2-The magnetic data reduced to the pole in order to position the magnetic anomalies symmetrically above the causative sources.

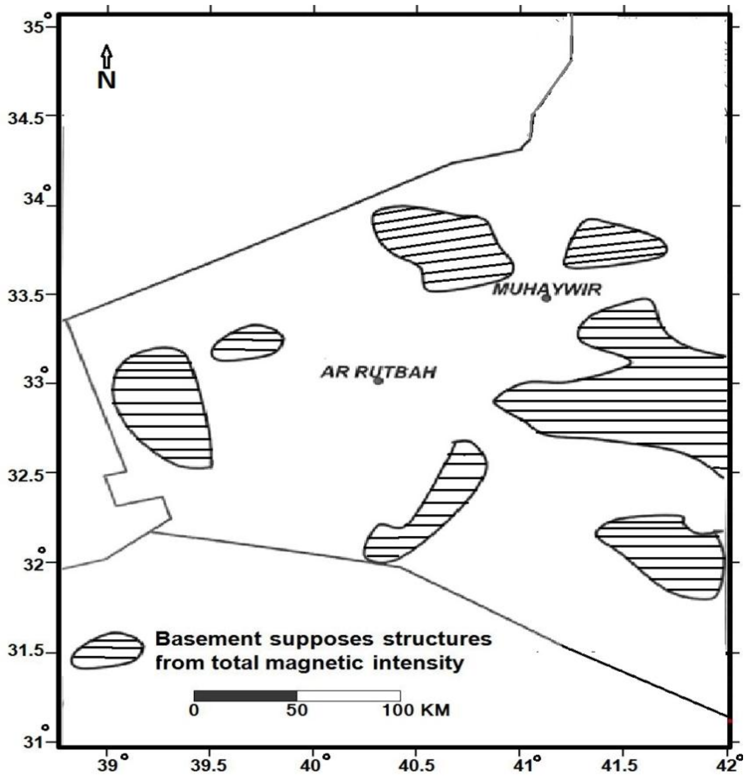

Figure 3-The main basement structures in the area as deduced from the total magnetic intensity map and the reduced to pole map.

The location of the basement features when they are superimposed over the tectonic map of the same area; they have no relation with the surface geologic structural features. The boundaries of the proposed basement structures are crossing the outcropping formations that are illustrated by the surface geology map of the area. These are due to the great extent of the basement features in the western desert.

Basement Depth Estimation

Most of the magnetic anomalies of the western desert cover a large area, which is indicating the great depths of their sources, which are due to basement structures. A simple well known procedure of depth estimation is the slope half-slope method (13) is used to estimate the source depth of magnetic anomalies. Three magnetic anomalies Figure- 4 a, b and c as indicated on the total magnetic intensity map) are selected to determine their source depths and to provide an example of a new procedure to be applied for basement depth estimation. The determined source depths for these anomalies are 16.826, 10.817 and 10.817 km. It is obviously, these depth are too large compared with the published values.

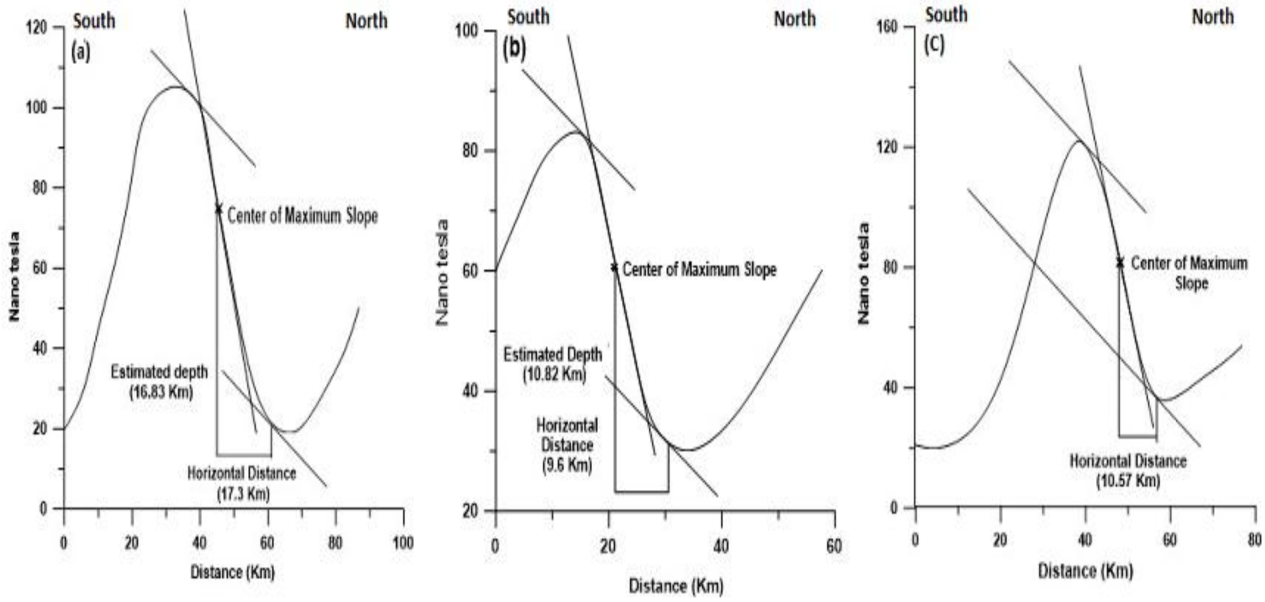

Figure 4-Total magnetic anomaly profiles a, b and c as indicated on the total magnetic map Figure-1 These profiles are used in depth estimation through the application of Peters method and the estimated depths are corrected by using published nomogram.

However, (14) have found that the errors in depth estimations through using Peters method varies according to the inclination of the magnetic field and the errors reached up to 28%. A nomogram has been established as a way to correct the estimated depths for the various inclination angles. The magnetic anomalies in the western desert are located in an area where the inclination angle is around 45. Therefore, the plot of the published nomogram for 45^o is used to correct the estimated depths for the three magnetic anomalies Figure-5. The procedure of depth correction is consisting; estimating the depth by Peters method, then the horizontal distance between the center of maximum slope and the tangent point is determined and the nomogram is applied to find the correction value. The depth values after applying the correction procedure are, 10.700, 6.100 and 6.70 km for anomalies a, b and c respectively.

However, the new depths at the three positions are varying from the previous depths provided by (4), where the previous data concerning the depth estimated is re-drawn Figure- 6 after digitizing the basement depth map established by (4) . Both depth values are also compared with the Paleozoic thickness value at these locations, where the Paleozoic thickness map Figure-7 is drawn depending on the gathered information from the drilled wells in the western desert to depths penetrating the Paleozoic successions. Table -1 exhibited the various depth values of the magnetic sources along the three profiles with the previous depth values of CGG (1974) in addition to the Paleozoic thicknesses. The new values should be considered because the used procedure of depth estimation is dealing with anomaly itself not the average value as in spectral depth estimation.

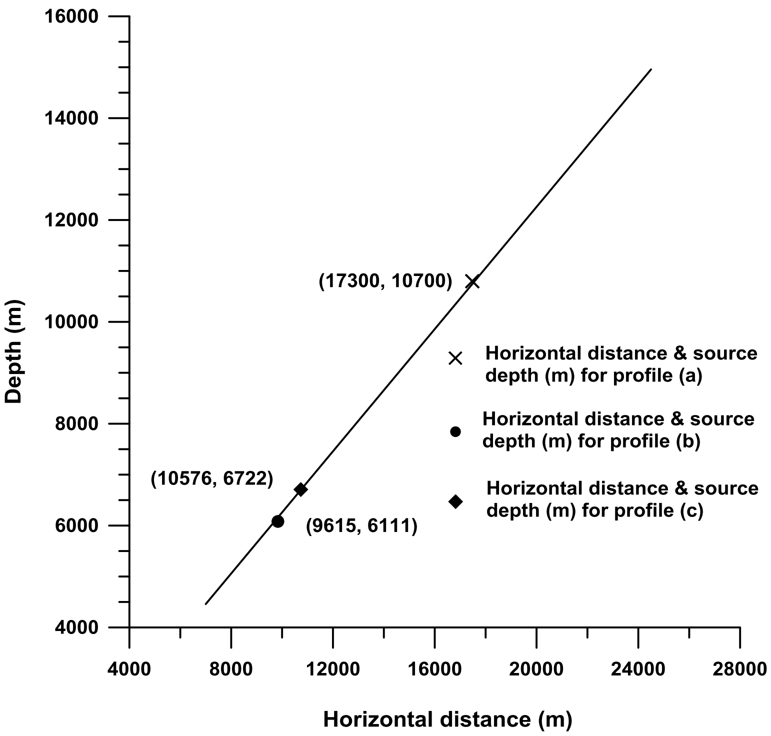

Figure 5-The published nomogram that is established between the relation of the magnetic source depths and the horizontal distances between the centers of maximum slope and tangent points for inclination 45 degree (After 14).

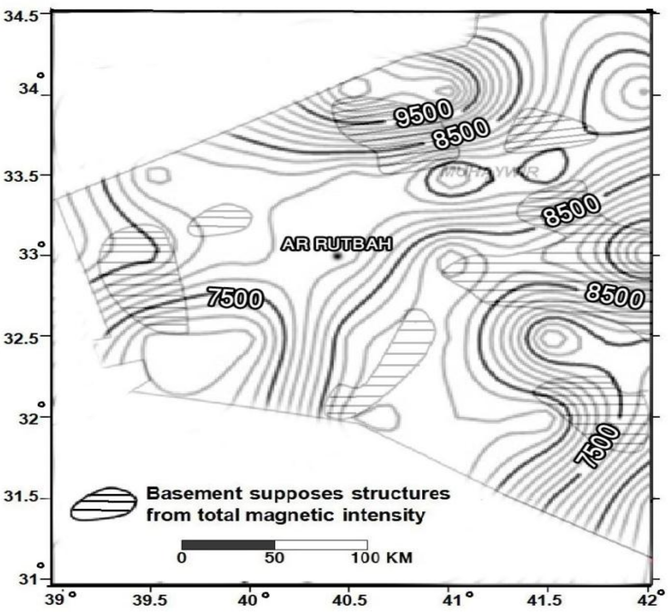

Figure 6-The basement depth map of the western desert of Iraq, depending on the digitized basement depth map estimated from aeromagnetic data (After 4).

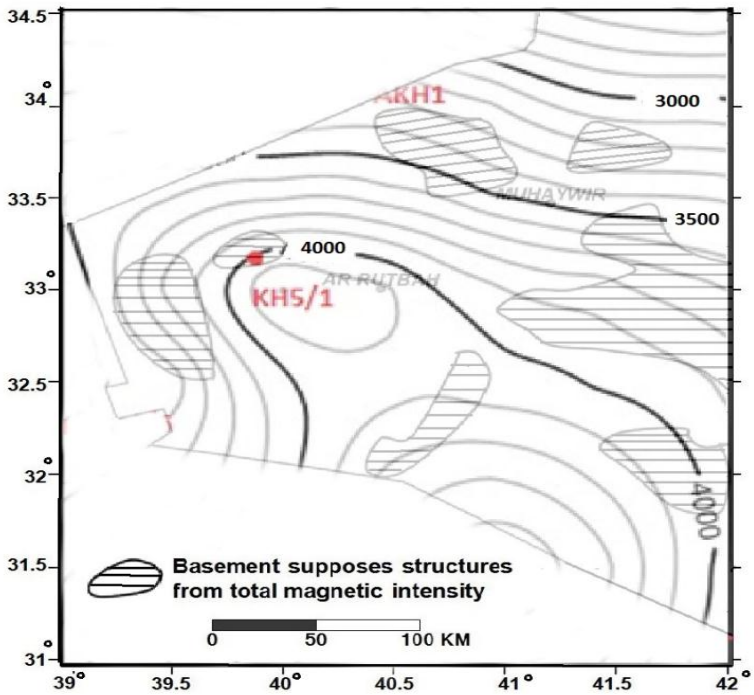

Figure 7-The Paleozoic thickness map of the study area constructed from the available drilled boreholes information of the Paleozoic Formations in the area (C.I. in meter).

Also the difference between the basement depth and the Paleozoic thickness highlights the importance of such differences to be solved. The Paleozoic information about the lower contact of Khabour Formation is missing in Iraq, since well depth did not reach this contact and lower formations. The great difference could be solved only by re-interpretation of the aeromagnetic data, because the magnetic anomalies may represent the effect of many sources reflected at the airborne survey as one anomaly. The large areal coverage of the magnetic anomalies means great depth of the source which may be not true and in turn give errors in depth estimate.

Table 1-The basement depth and the Paleozoic thickness at three selected positions in the western desert, with the difference between the estimated depth of the present study and the published CGG values, in addition to the difference between the basement depth and Paleozoic thickness.

1	2	3	4	5	6	7
Profile Name	Lat. Long. Deg.	Basement depth km (CGG)	Paleozoic thickness km	Difference between 3 and 4 (km)	New depth (km)	Difference between 3 and 6 (km)
A	32.5, 41.5	7.900	3.950	3.950	10.700	2.170
B	32, 41	9.010	4.300	4.710	6.100	2.910
C	33, 41.5	8.900	3.750	5.150	6.700	2.200

Conclusions

The reduction to the pole map outlined the possible main basement magnetic sources in the western desert as an uplifted area of the basement surface. The deduced uplifted features have low amplitude magnetic anomalies and they are considered as supra basement structures. The estimated depths after correction for locations along profiles a, b and c are reasonable if one consider the available thickness of the Paleozoic formations from drilled boreholes in the western desert.

It is recommended to carry analysis to magnetic map to separate the various components of the large anomalies, where many adjacent magnetic sources produce large anomaly and in turn reflects deep depth which is untrue. Such results add complexity to the geologic picture which requires a solution from seismic data.

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