# SOME INTERESTING AEROMAGNETIC ANOMALIES OF THE WESTERN DESERT, IRAQ

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## ABSTRACT

Detailed gravity measurements for some of the relatively impressive short wave magnetic anomalies of the westernmost part of the Western Desert indicate that these anomalies are associated with fracture or fault zones present within the sedimentary cover. One of these anomalies is Al-Waleed anomaly zone present at the cross of regionally extended fault zones over nearly circular cone anomaly. The cone anomaly interpreted as igneous chamber present at a depth of about 2.5 Km within the level of Silurian hot shale. Another anomaly zone (East Traibil anomaly) is followed up by gravity measurements for about 20 Km and shows good correlation with the location of the known regional Amij – Samarra Fault Zone. Nehadain Anomaly Zone, which is with arcuate shape, extends for more than 50 Km. The anomaly source is proved to be a gas trap in its Jordanian part. The aim of the work is to introduce such anomalies for farther studies to clarify their economic importance.

## بعض الشواذ المغناطيسية الجوية المهمة في الصحراء الغربية، العراق

**جاسم محمد البديوي**

**المستخلص**

إن خرائط المسح الجوي المغناطيسية تظهر وجود شواذ ذات مصادر تتواجد ضمن الغطاء الرسوبي وان قياسات جذبية تفصيلية لبعض هذه الشواذ ذات السعة الموجية القصيرة والمنتشرة في الصحراء الغربية أشارت الى ان هذه الشواذ تترافق مع تكسرات أو أنطقة فوالق موجودة ضمن الغطاء الرسوبي. أحد هذه الشواذ (شواذ منطقة الوليد، سطحية) والتي تترافق مع تقاطع خطيات تركيبية ذات امتدادات إقليمية، تعتلي شاذة مغناطيسية عميقة المصدر ذات شكل هرمي. فسرت الشاذة الهرمية الشكل على إنها تعود الى حجرة صخور نارية موجودة على عمق 2.5 كيلومتر ضمن الغطاء الرسوبي مع مستوي صخور الطفل السيلوري الساخن. هناك شواذ مغناطيسية أخرى مثل شواذ شرق طريبيل المغناطيسية تمت متابعتها جذبيا لمسافة 20 كيلومتر وكانت تترافق بشكل جيد مع امتداد نطاق فالق عامج – سامراء ونطاق شواذ منطقة النهيدين ذات الشكل الهلالي ويمتد لأكثر من 50 كيلومتر، وجزء تراكيبه الصخرية الممتدة في الأردن تحوي غاز طبيعي. إن الهدف من هذا العمل يتضمن التنبيه لهذه الشواذ المغناطيسية للتعرف على أهميتها الاقتصادية (ترسبات معدنية، مياه جوفية صالحة للشرب أو ترسبات هيدروكربونية) من خلال التوسع في استكشافها.

## INTRODUCTION

The aeromagnetic map of Iraq (Fig.1, CGG, 1974) shows interesting shallow source anomaly zones. Some of these zones are concentrated in the westernmost part of the Western Desert including H3 area. Since the sedimentary cover in Iraq is considered practically as non magnetic, any short wave magnetic anomaly zone should be dealt with earnestly. Such anomalies could have economic importance. The individual anomalies of the zone surely indicate anomalous concentrations of magnetic minerals believed to be at some level within the sedimentary column. The anomaly zones, not only can give essential information for delineating geological aspects (tracing structures that accommodate the magnetically anomalous mineral concentrations), but also may indicate the possibility of economic ore minerals, fresh water or hydrocarbon accumulation.

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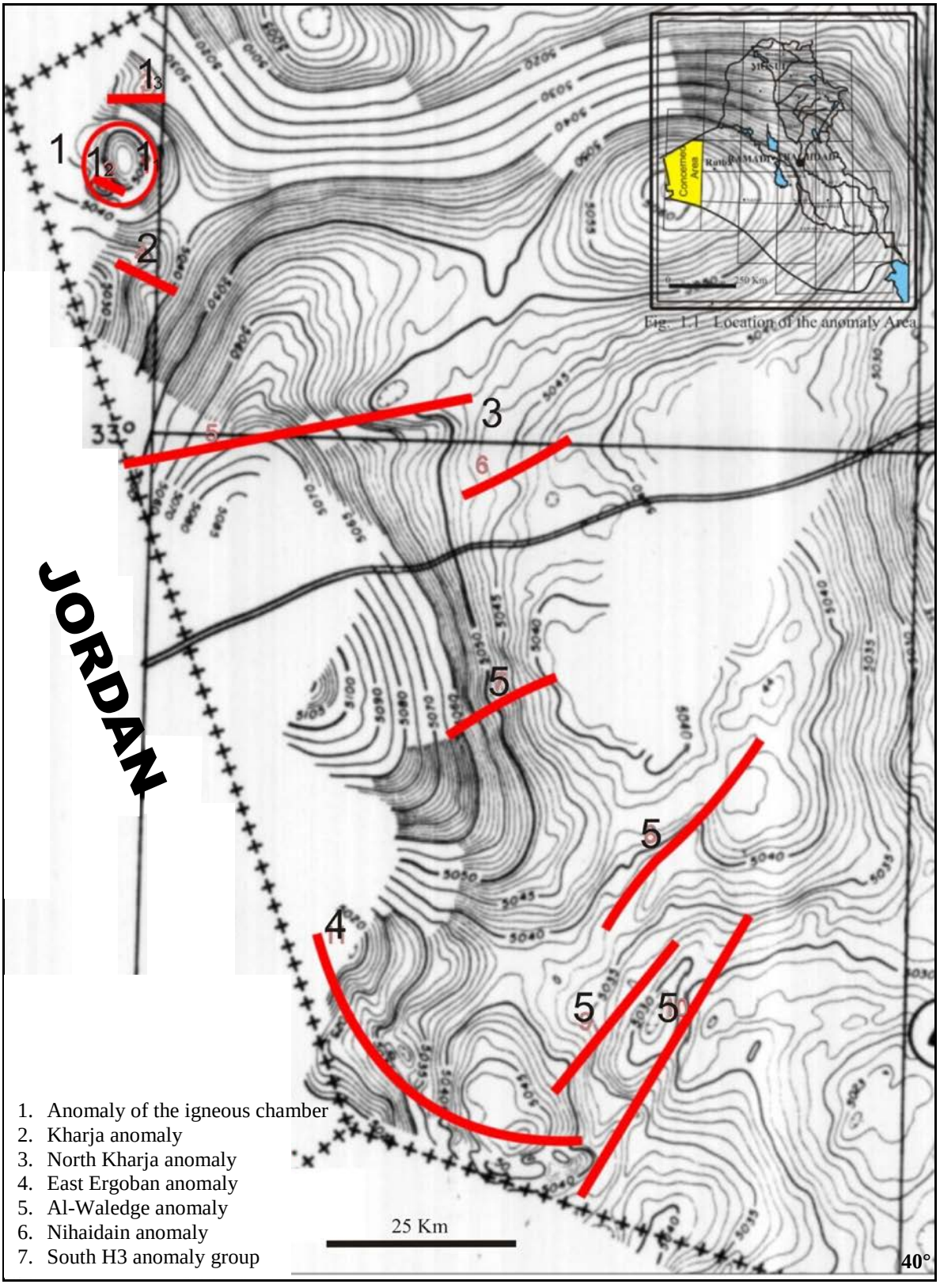


Fig.1: Aeromagnetic anomaly map of the westernmost part of the Western Desert (CGG, 1974)

## THE MAGNETIC ANOMALIES

Five interesting shallow source anomaly locations of the Western Desert could be mention hereinafter:

▪ **Magnetic Anomaly location (1)**

Formed of two anomaly groups, centered at 33º 17' N, 38º 57' E, (Fig.2). The first is of much deeper sources (**Al-Waleed** Anomaly) than the second, which is superimposed on the first and includes **Kharja** and **N – Kharja** anomalies.

– **Al-Waleed Anomaly:** Is a circular cone anomaly with amplitude of about 15 gammas and a diameter of about 15 Km. This anomaly could be interpreted as igneous chamber located at a depth of about 2.5 Km (Al-Waleed **Igneous Chamber**, Al-Bdaiwi, 1982). At this depth, the Silurian Black Shale may exist, a situation which may cause thermal maturation of the organic matter of the shale to develop a hydrocarbon and may proceed to gas (Dr. Rafaa Z. Jassim, personal communication). The chamber exits at the cross of regionally extended fault lineaments (Al-Bdaiwi, 1982), encompassing an area of about 60 $Km^2$.

– **Magnetic Anomalies of Kharja:** are located at the southwestern side of the circular cone anomaly, mentioned above, about 18 Km to the south of Al-Waleed village. It is formed of an outer belt of positive and negative anomalies arranged in a rectangular shape around an area containing main anomaly with reverse polarity adjacent to quiet field area. The magnetic anomalies of Kharja include an area of about (3 – 4) $Km^2$ (Fig.3, Al-Bdaiwi, 1982). The gravity survey over the site, which carried out contemporaneously with the drilling of four bore holes, (Fig.4, Al-Bdaiwi, 2005) shows main gravity minimum surrounded by positive anomaly belts. The drilling insured the presence of anomalous rock body that could be formed through igneous activities and fluidization. The anomalous rock body is encompassed by carbonate rocks of Ratga Formation and contains **zoned lithology**; crushed basaltic rock belt around rock breccia composed of different rock types very rich in black shale with disseminated sulfide minerals sometimes imbedded in basic rock fragments (Bore Holes T1 (196 m without reaching its bottom), T2 (153 m) and T3 (93 m) Al-Bdaiwi, 2005). The rock breccias juckstaposed to gray sand body (Bore Hole T4 (138 m) without reaching its bottom, Al-Bdaiwi, 2005). The **greatest gravity anomaly** of the gravity survey of the site matches well with the position of the 196 m borehole, which cored only the relatively lighter breccea (the country rock is recrystallised carbonates). The lighter breccea relative to the recrystallised carbonates country rock is a conclusive phenomenon for presence of rock body with positive density contrast at depth greater than 196 m. Moreover, the outer magnetic belt is characterized by many points of lightning; one of these points left a magnetic anomaly of about 3500 nt. (Fig.5). The overall discussed geologic picture could be interpreted in terms of **igneous activities and fluidization** that could be connected to the **Igneous Chamber**, mentioned above. All the site of the complex anomalous rock body is covered by about 30 m of alluvium and fine clay; post thermal activity subsidence. Perched fresh water (TDS equal and less than 1000 ppm) is encountered at about 65 m of depth. The topographic map (Fig.6) shows that the site is surrounded by high land, opened only from the southeast. If the southeastern outlet is closed by a soil burier so that the rain water could be spared at some horizons and or to pocket up deeper within the main aquifer.

– **Magnetic Anomaly of North Kharja:** Located on the northern side of the circular cone anomaly mentioned above. This anomaly has an amplitude of few nT, and extends in a NW – SE direction for few kilometers. The anomaly was reconnaissanced by gravity profile measurements (Fig.7, Al-Bdaiwi, 2005), and interpreted as igneous intrusion present at a depth of about 300 m.

- **Orgoban Aeromagnetic Anomaly**

Located to the east of Orgoban Police Station at 33º 10' N, 38º 59' E, with few nT amplitude and extends in a NW – SE direction for about 10 Km. Although this anomaly is not followed up by ground survey, it is believed that it is structurally significant; it should be detected gravimetrically.

- **East Traibeel anomaly (Al-Waledge anomaly**, **Fig.8)**

Extends from inside Jordon and continues within Iraq for more than 30 Km with amplitude of few Nano Tesla. Gravity reconnaissance measurements show that the source of this anomaly could be interpreted in terms of igneous intrusion at a depth of about 300 m (Al-Bdaiwi, 2005). This anomaly is part of the regionally extended Amij – Samarra Fault (Jassim and Goff, 2006). It is worth mentioning that all the recent gravity surveys mentioned above show that the gravity method for such very low amplitude magnetic anomalies is capable in delineating the sources of these magnetic anomalies; the available old gravity map of the Western Desert is proved un capable in the detection of the shallow source structures.

- **Nihaidain Aeromagnetic Anomaly**

Is a major short wave anomaly, located at the Iraqi – Jordanian – Saudi Arabian triangular junction, has arcuate shape and extends for more than 50 Km with amplitude of few nT (Fig.9). Depending on detailed ground magnetic follow up, Sallomy (1980) concluded that the source of this anomaly could be related to near surface igneous dyke. Inside Jordain, the structure proved to contain economic gas. It should be detected gravimetrically.

- **South H3 Anomalies**

These are northeasterly trending, densely distributed from the border with Saudi Arabia to H3 pumping station. These anomalies could be interpreted in terms of basement fault lineaments rather than igneous intrusions. They are correlated with the western flank of Rutbah Gravity Low. The faults have the nature of normal offset.

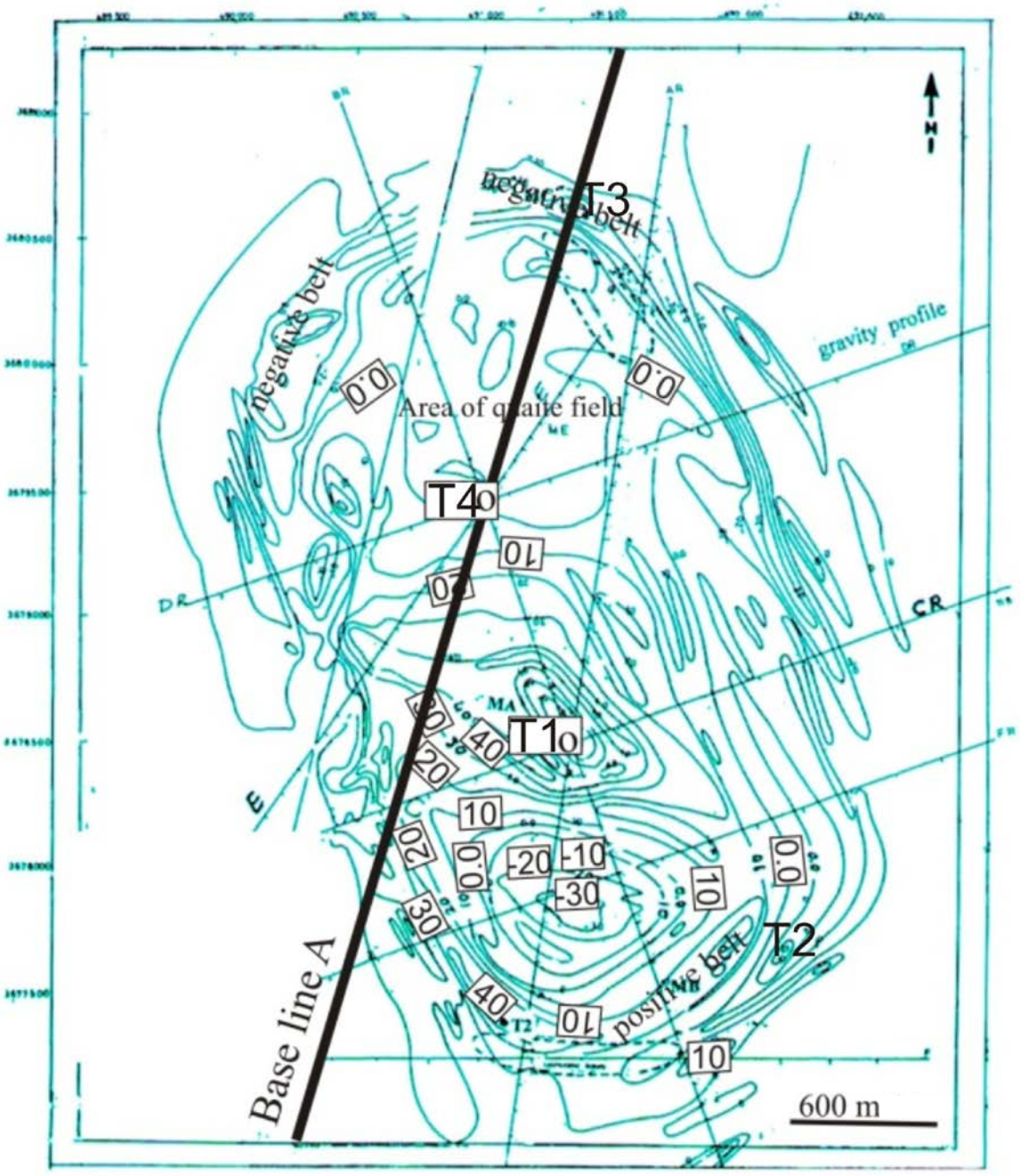


Fig.2: Magnetic anomias of Al-Waleed locality (Kharja locality) contour interval eq. 10 nt., gravity proils added (after Al-Bdaiwi, 1982).
T1 bore hole, 196 m, gray aggrigate, T4 bore hole,138 m, fine sand (after Al-Bdaiwi, 2005)

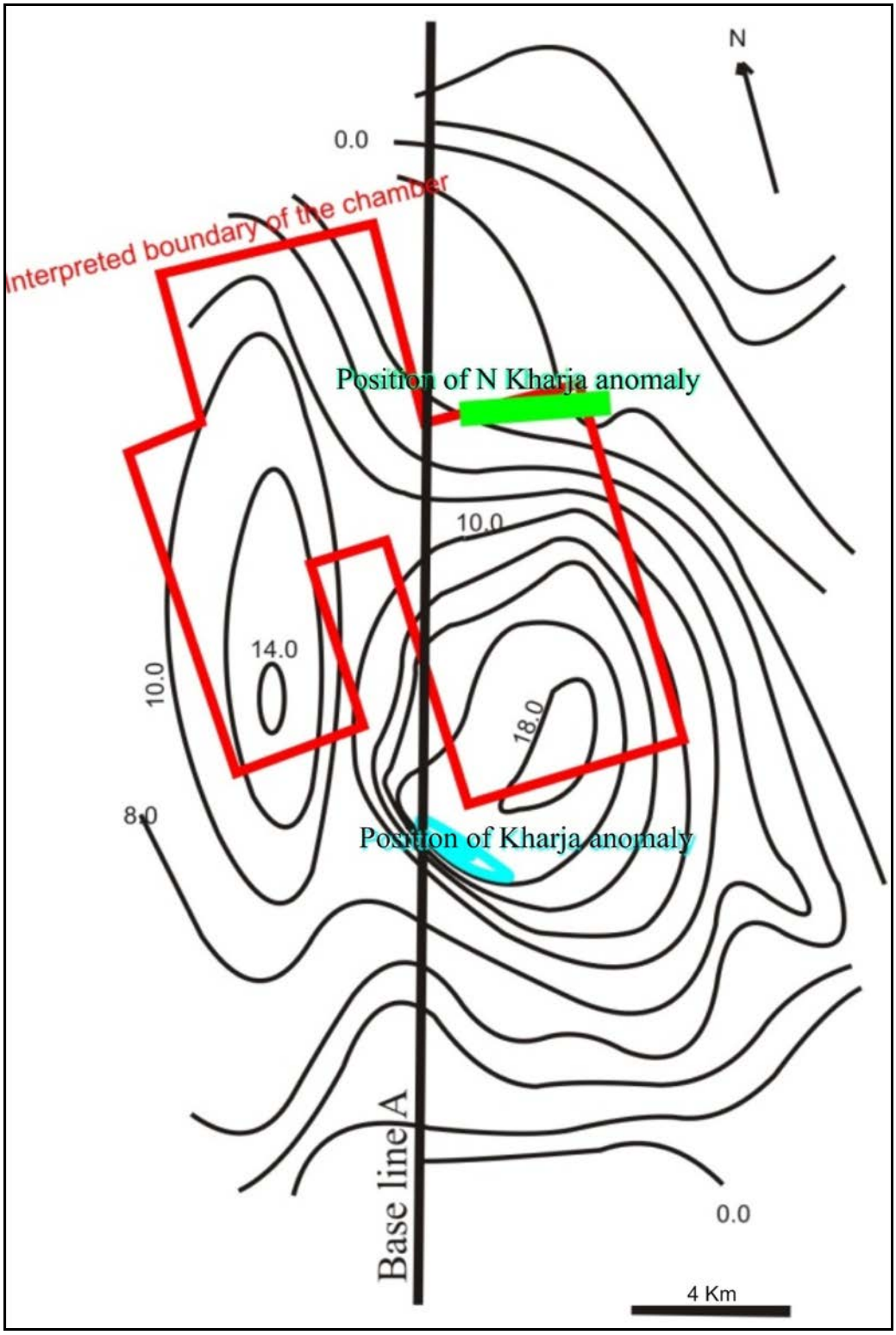


Fig.3: Magnetic anomaly of the igneous chamber, contour interval eq. 2nt., (after Al-Bdaiwi, 1982)

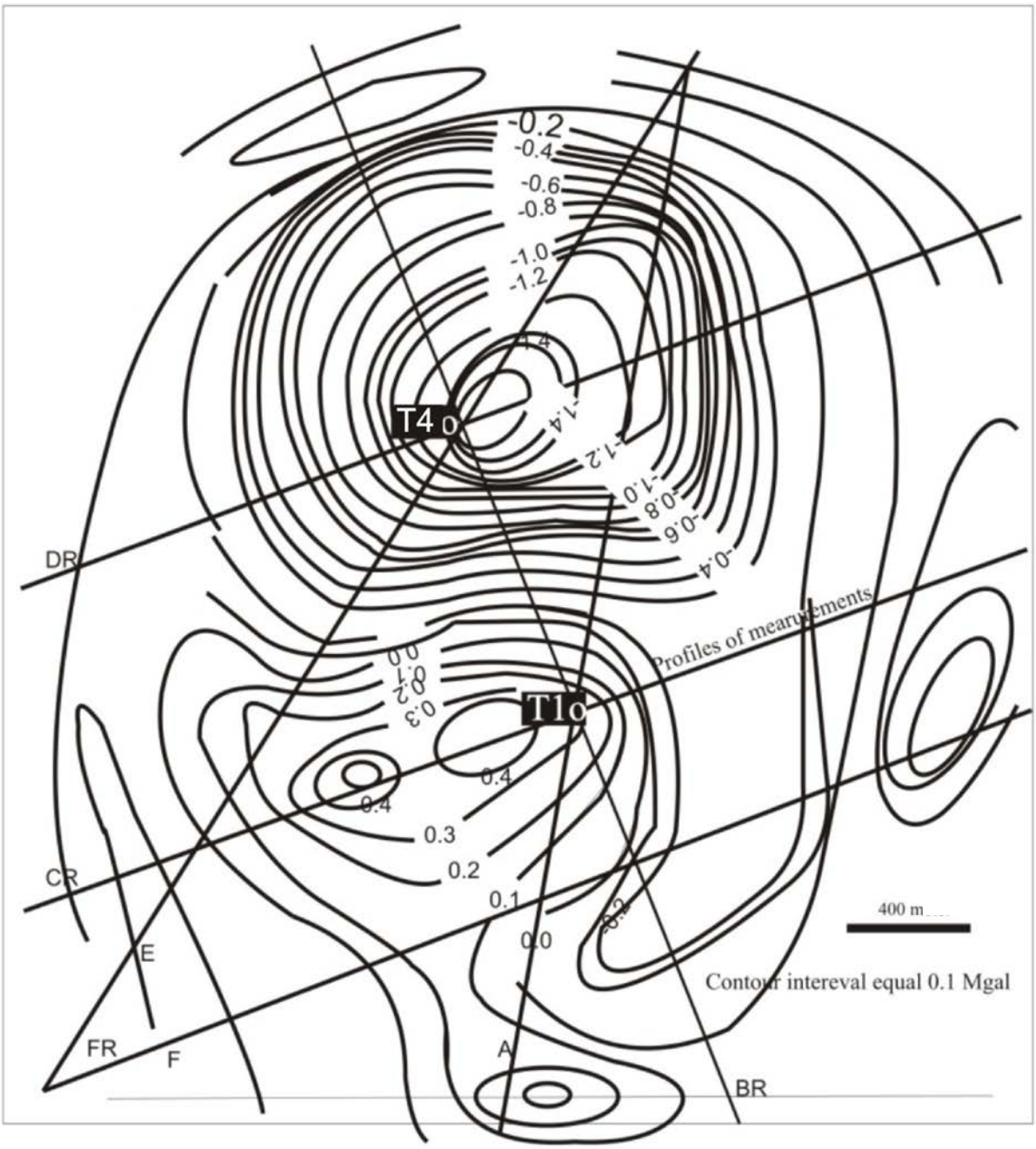


Fig.4: Bouguer gravity map of Al-Waleed locality (Kharja locality),
(after Al-Bdaiwi, 2005)

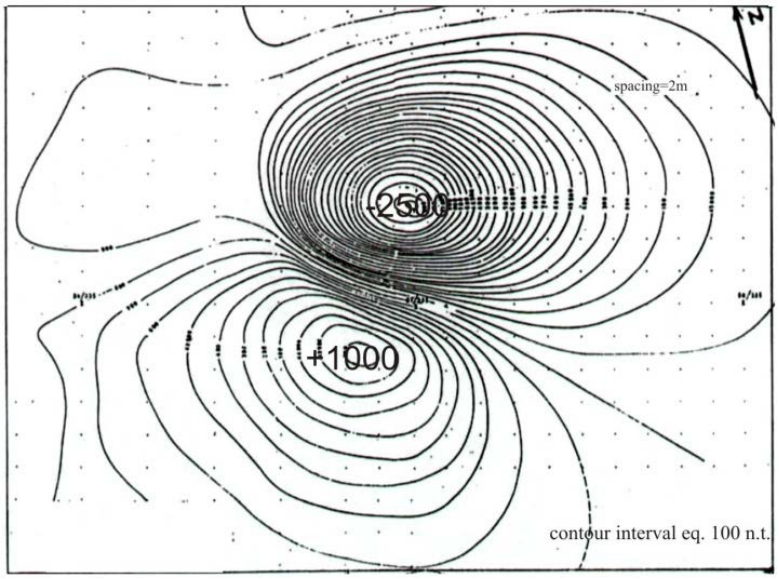


Fig.5: Lightning anomaly (after Al-Bdaiwi, 1982)

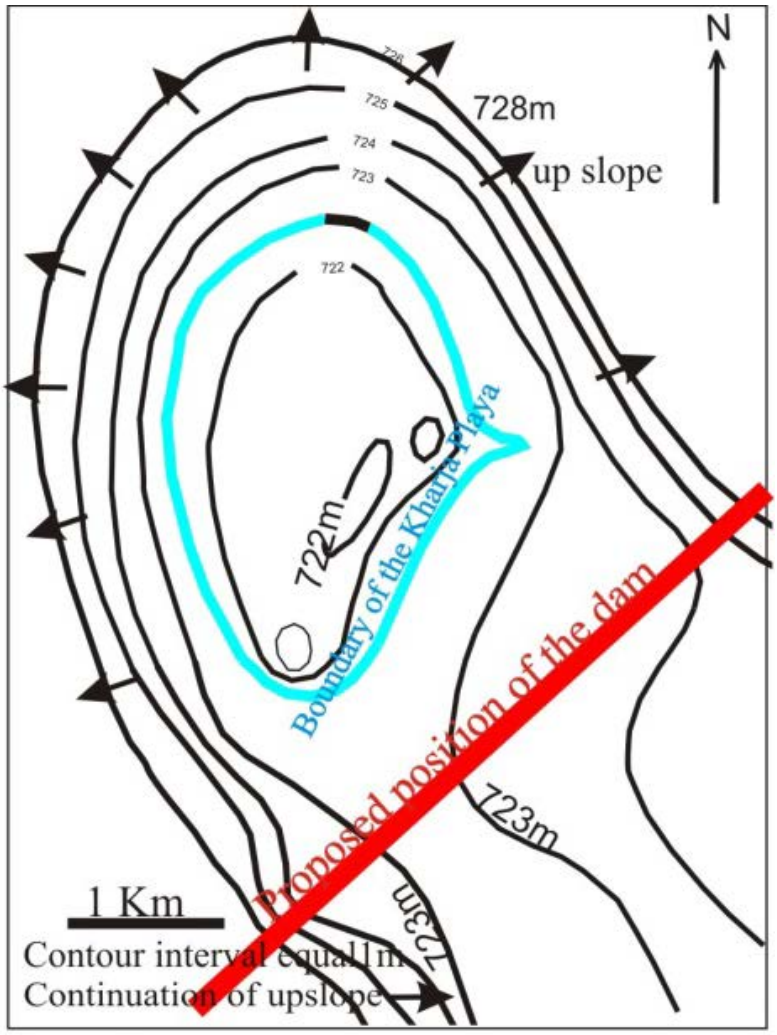


Fig.6: Topographic map of Kharja Area (after Al-Bdaiwi, 2005)

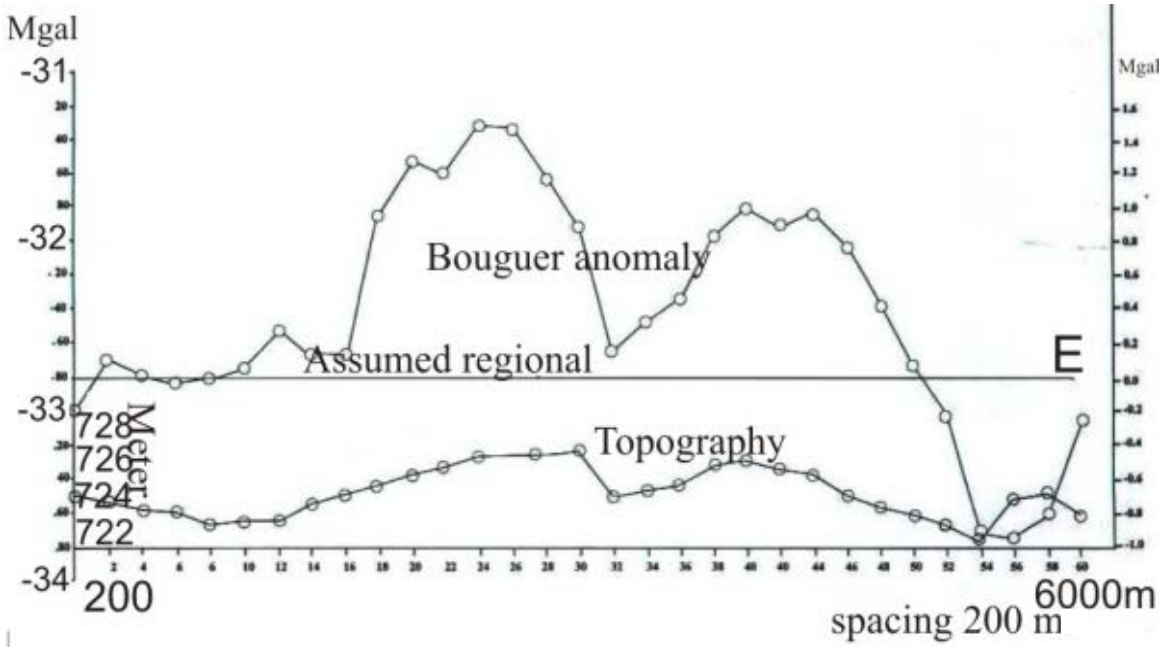


Fig.7: Bouguer gravity anomalies of North Kharja with the topographic profile (after Al-Bdaiwi *et al*., 2007)

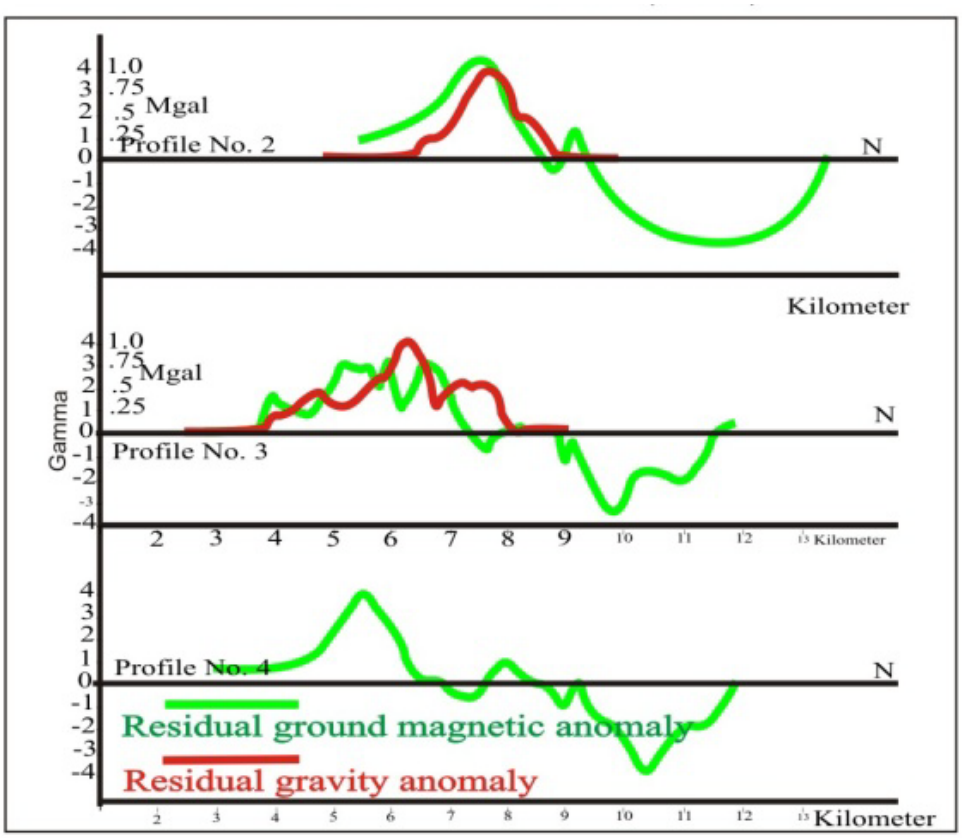


Fig.8: Al-Waladge area, gravity and magnetic residual anomalies (after Al-Bdaiwi *et al*., 2005)

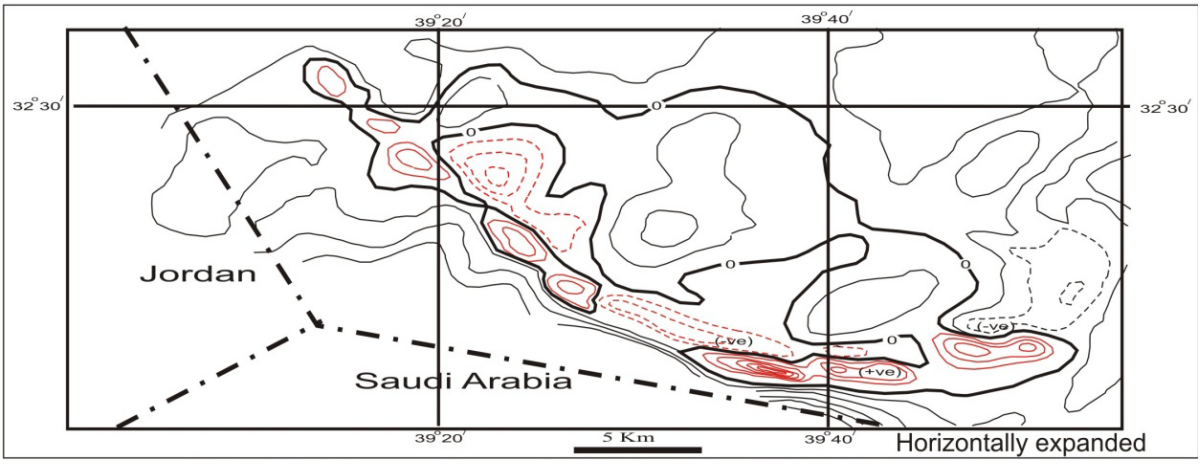


Fig.9: Nihadain magnetic anomaly red color (after CGG, 1974)

## CONCLUSION

In conclusion, the westernmost part of the Western Desert is characterized by numerous shallow source magnetic anomalies. These magnetic anomalies insure the presence of shallow structures that could be of economic interest. Recently executed gravity surveys were very effective in verifying such structures. The surveys also insure absolute incapability of the available old gravity surveys in pointing out such structures; a new, more accurate detailed gravity surveys should be carried out if the Western Desert needs to be seriously developed.

## REFERENCES

Al-Bdaiwi, J.M., 1982. Detailed magnetic survey, Al-Waleed area, Western Desert. GEOSURV, int. rep. no. 1240

Al-Bdaiwi, J.M., 2005. Geophysical studies and preliminary speculations on genesis of pyroclastic rocks in Al-Waleed area. GEOSURV, int. rep. no. 2923.

Al-Bdaiwi, J.M., Musa, A.S. and Jawad, M.B., 2005, Magnetic and gravity measurements and interpretation, Shaeb Al-Waledg. GEOSURV, int. rep. no. 2879.

Al-Bdaiwi, J.M., Omar, S.A., Musa, A.S., Jawad, M.B., Fadhil, G. and Salman, K., 2007. Gravity measurements in north Kharja locality. GEOSURV int. rep. no. 3066.

General De Geophysique, 1974, Aeromagnetic and Aerospectrometric Survey of Iraq.

Sallomy, J., 1980. Magnetic measurements at Nihaidane area. GEOSURV, int. rep. no. 1227.