Magnatic Interpretation of Zaggut Oil Field, Sirt Basin – Libya

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ABSTRACT

The Sirt Basin contains many subsurface geological structures, and we need some techniques to obtain results that can interpret these structures and their trends.

The magnetic method that was used in this study gave results that can be explained by saying that the northern and southern parts have a greater influence compared to the west, and this is due to the influence of the north of the study area in Marada trough and the south due to the influence of Beda platform ,The zaggut oil field requires the use of other techniques to verify the results obtained by the magnetic method

And obtain other magnetic data to continue studying the region on a larger scale.

الملخص

يحتوي حوض سرت على العديد من التراكيب الجيولوجية تحت السطحية، ونحتاج إلى بعض التقنيات للحصول على نتائج يمكنها تفسير هذه التراكيب واتجاهاتها.

الطريقة المغناطيسية التي استخدمت في هذه الدراسة أعطت نتائج يمكن تفسيرها بالقول إن الأجزاء الشمالية والجنوبية لها تأثير أكبر مقارنة بالغرب، وهذا بسبب تأثير شمال منطقة الدراسة في حوض مرادة و الجنوب بسبب تأثير منصة بيدا.

يتطلب حقل الزقوط النفطي استخدام تقنيات أخرى للتحقق من النتائج التي تم الحصول عليها بالطريقة المغناطيسية

والحصول على بيانات مغناطيسية أخرى لمواصلة دراسة المنطقة على نطاق أوسع.

Intraduction:

Libya, situated on the Mediterranean foreland of the African Shield, extends over a platform of cratonic basins that can be divided into two geologic regions, each of which includes a number of sedimentary basins (Figure 1) . The northern part of the country is situated on a tectonically active subsiding margin (Gumati, et al., 1991), and includes from west to east the Sabratah Basin, Sirt Basin ,Benghazi Basin and Cyrenaica Platform. The southern part of Libya, which lies within a stable cratonic area, includes the Ghadamis and Murzuq Basins to the west, separated by the Tibisti crystalline basement massif from AI Kufra Basin in the east. (Figure 1) .As a result of their position at the edge of the African Plate, these basins were affected by successive phases of continental collision and plate divergence (Pickford, 1992). Major hydrocarbon discoveries have been made in the Paleozoic sequence of the Ghadamis and Murzuq Basins, and in the Mesozoic and Cenozoic sequence of the Sirt and Sabratah Basins.

Sirt Basin (Figure. 1) in north central Libya is one of the youngest sedimentary basins of the African Craton, with an onshore area of approximately 375,000 km² and an estimated sedimentary volume of 1.3 million krn (Abdulbaset.M.A. 2002)., It contains more than 100 oil and gas fields, including several giants.

The basin comprises a broad NW to SE trending embayment. It is bounded to the south by the Tibisti Massif and to the west by AI Gargaf Uplift and the Ghadamis and Murzuq Basins. To the east, it is bounded by the Cyrenaica Platform and AI Bottnan Basin .

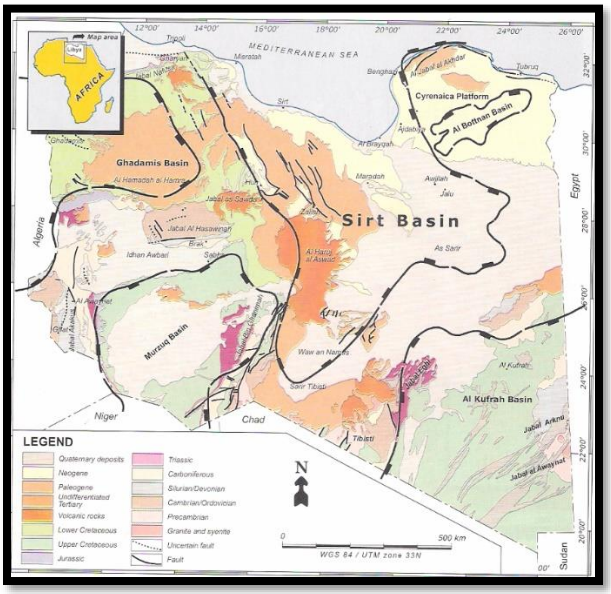


Figure 1. Spread basins in Libya . Modified after Industrial Research Centre 1977

Geological setting .

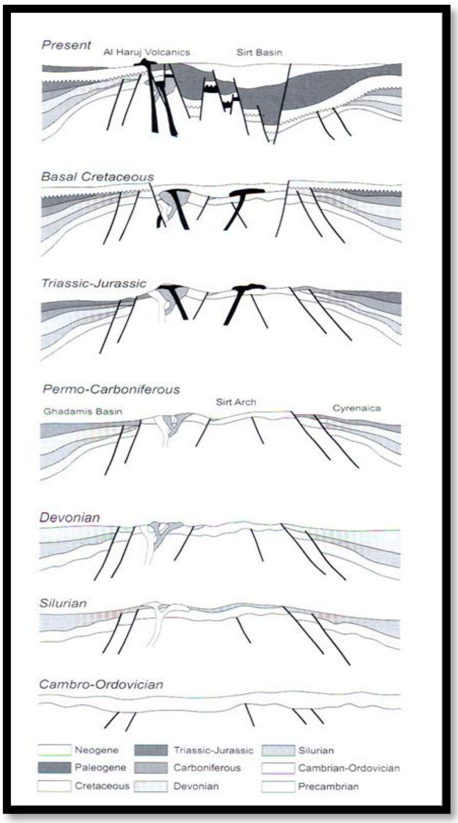
Sirt basin It is bounded to the south by the Tibisti Massif and to the west by Al Gargaf Uplift and the Ghadamis and Murzuq Basins. To the east, it is bounded by the Cyrenaica Platform and Al Bottnan Basin. Sirt Basin comprises four major NW-SE grabens with intervening horsts. Hun Graben, Waddan Uplift, Dor El Abid Trough and Zallah Trough, Dahra Platform and Beda Platform, Al Hagfa Trough, Zelten Platform and Al Jahamah Platform, Agedabia Trough and Rakb High. In the southeast, the Agedabia Trough passes into the E-W trending Hameimat and Sarir Troughs . In the southwest, the Dor El Abid Trough continues into the Zallah Trough before swinging 5 to SSW into the Bu Tumaym Trough. Another important SSW-NNE trending structure is the Kotla Graben, which separates the Beda Platform in the southeast from the Dahra Platform to its northwest. In general, the Sirt Basin displays an asymmetric half-graben style with gentle ENE dipping platforms and steep WSW facing footwalls, so that overall the basin deepens to the ENE (Abdulbaset.M.A. 2002).

The geologic history and the major structural elements of the region (Figure 2) were first clearly elucidated by Conant and Goudarzi (1967) and Klitzsch (1970), and further clarified by Massa and Delorte (1984) , early in the geologic history, a long period of erosion prevailed throughout

Sirt Basin is a major intracratonic rift system on the north central African Plate and comprises a complex of horsts and grabens that began to develop in Latest Jurassic time. This complex structure evolved as a rifted embayment on the northern margin of the African Plate. The tectonic evolution of the Sirt Basin includes thermal arching and repeated phases of rifting that culminated in the Late Cretaceous and Paleocene to Early Eocene, and were followed from Late Eocene onward by thermal subsidence. The sedimentary succession of Sirt Basin reflects its tectonic and structural evolution, which is closely related to the opening of the Atlantic Ocean and the convergence of Tethys in Mesozoic and Tertiary times (Gras and Thusu, 1998).

Sirt Basin developed following a sequence of tectonic events that led to the break-up of the supercontinent Pangaea. The break-up history of the Gondwana part of Pangaea commenced with the Late Carboniferous and Permian development of the so-called Neo- Tethys and the development of rift system in Gondwana (Ziegler et al., 2001). These events were marked by opening of the Neo- Tethys in the central and east Mediterranean domain during Permian - Triassic (Stampfli, 2000; Ziegler et al., 2001) and rifting along the present north-western margin of Africa from Middle Triassic onward. Crustal separation commenced in the Early Jurassic, creating the central Atlantic between Northwest Africa and North America (Gumati and Kanes, 1985; Gumati and Nairn, 1991; Van Der Meer and Cloetingh, 1993a, 1993b; Guiraud and Bellion, 1995; Baird et al., 1996), followed by transtenstional opening of the Atlantic-Alpine Tethys during the Middle and Late Jurassic. At the same time, Laurasia was sinistrally translated with respect to AfricaArabia (Ziegler et al., 2001).

Sirt Basin area experienced stretching and down faulting during Cretaceous time. Large-scale subsidence and block faulting began in the Latest Jurassicj Early Cretaceous. The basin underwent reactivation both in the Late Cretaceous (Van Houten, 1983) and Paleocene time and continued into Early Eocene (Gumati and Kanes, 1985; Van Der Meer and Cloetingh, 1993a, 1993b).



. Structural development of sirt basin region lower2Figure

Paleozoic to present after (Massa and delorte 1984.).

Tectonic Evolution of Sirt Basin ;

The tectonic evolution of sirt basin describes by Baird et al 1996 is divided in to four tectonic phases :

Tectonic phase I.

(pre-graben) represent the langer phase, extends from Precambrin to early Cretaceous (Cenomanian), sediments of this phase are more important. They include Triassic, Jurassic, and early cretaceous continental sandstone and shales
(Nubian sandstone and related sediment) .

Tectonic phase II.

(Rifting and graben fill) precisely represents significant tectonic character of the Late Cretaceous to the Tertiary sirt basin complex. As well this phase and it is sedimentary and economic product are characterized by homogeneity. The timing of phase II extends from about the beginning of Cenomanian to the maastrichtian, meanwhile tectonic activity was associated with crustal rifting, graben development and the initial stages of macrobasinal subsidence.

Tectonic phase III.

(Macrobasinal subsidence) which covers much longer time interval than phase II, is more specific and precise. The phase extends from maastrichan to the end of Eocene. Tectonic activity is represented by macrobasinal subsidence, and the downwarp of the intire sirt basin. Both tectonic activity and the sedimentary result of this phase continue to have a characteristic homogeneity and clear genetic relationship to the development of the sirt basin complex and represents petroleum system .

Tectonic phase IV.

Accupies the closing period of geohistory significant to sedimentary, structural and petroleum system characteristics of the entire sirt basin complex. It extends from earliest Oligocene to Recent, meanwhile tectonic activity occurred with further macrobasinal subsidence, which centered on a combination of Ajdabiya Paleograben and as Sarir – Abu Attiffel basin together with northward tilting.

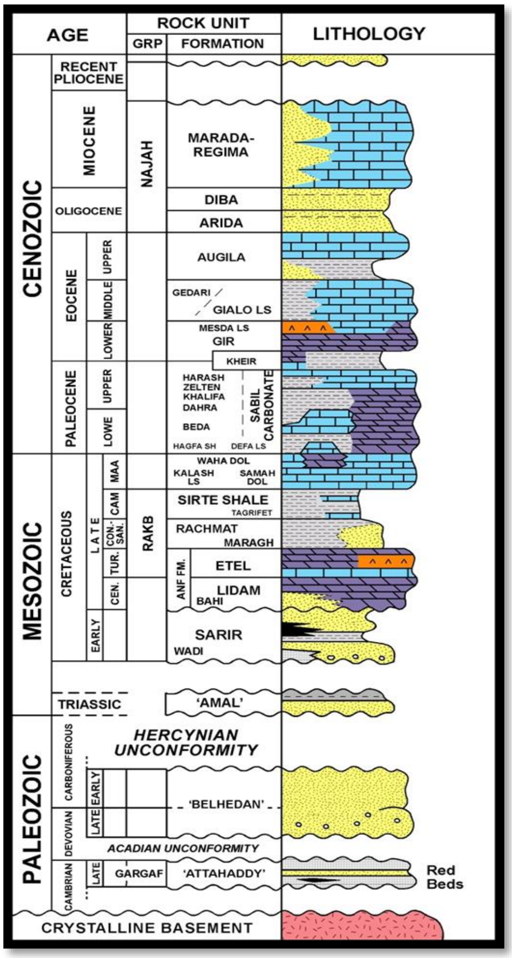


Figure.3. Stratigraphic section (Zaggut oil field. 2007) located at the Beda Platform to the Marada trough on the east (Waha oil company) .

Location of study area.

The study area is Located in Sirt basin Libya between Longitude 19.2000° degree and 19.4000° degree West and latitude 28.16° degree and 28.35° degree North .

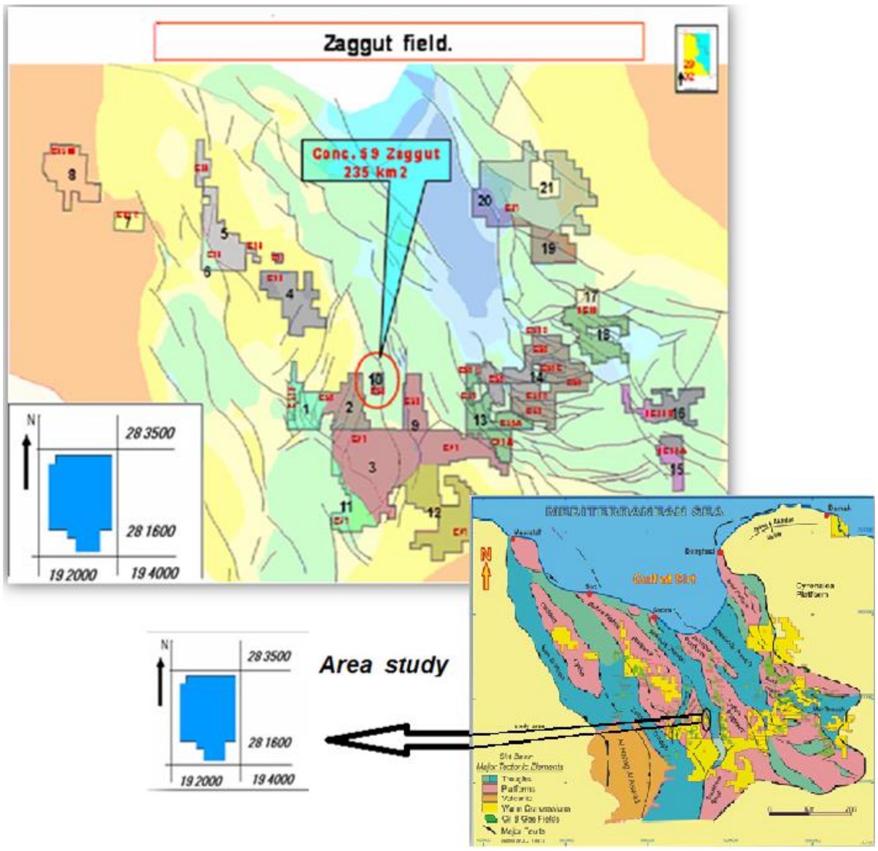


Figure 4 location map of the study area .

Objective of study.

This study aims to identify the geological structures and details of the Zaggut oil field using the magnetic method and the extent of the influence of Marada trough and Beda platform in the study area.

Magnatic Method.

In general, the magnetic susceptibility of the rocks is very variable depending on the type of the rocks. Usually the magnetic anomalies, that have high value, which causes by dykes, faults and lava flows where the rocks have high magnetic susceptibility. Sedimentary rocks usually have a very small magnetic susceptibility compared with igneous or metamorphic rocks that have much higher magnetite content. Normally, magnetic anomalies give better definition of shallow buried features such as buried pipes and drums, but are less useful for investigating large geological features.

We will use Geosoft Oasis Montage software to obtain magnetism maps, For the magnetic interpretation nowadays, the magnetic data is displayed as color maps rather than the contour map, where the color presents the different magnetic anomaly from high to low within magnetic maps.

4.1 Total Magnetic Intensity Map (TMI).

The Total Magnetic intensity (TMI) has vertical component (Z) and Horizontal component (H) in the direction of the magnetic north. The TMI varies in strength from about 25000 nT in the equatorial regions to about 70000 nT at the poles, TMI2 = Z2 + H2...... (Lowrie, 2007).

The magnetic field can be described by Inclination (I), declination (D), and total magnetic field (TMI) (figure 5).

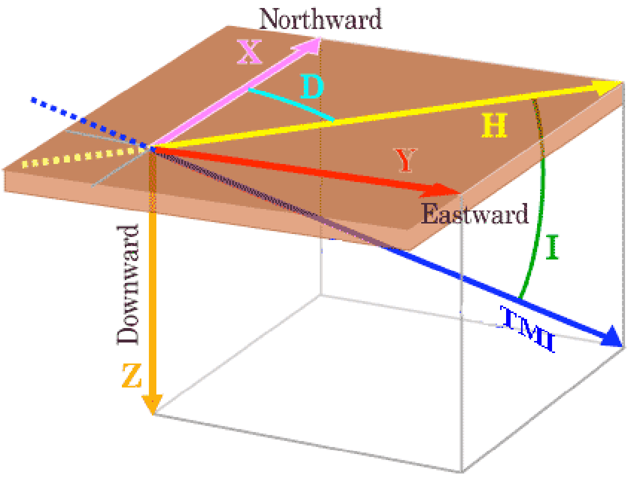


Figure 5: Elements of the magnetic field

The total magnetic intensity map (TMI) of the zaggut oil field 6 was calculated in an attempt to define its subsurface structure (figure 6).

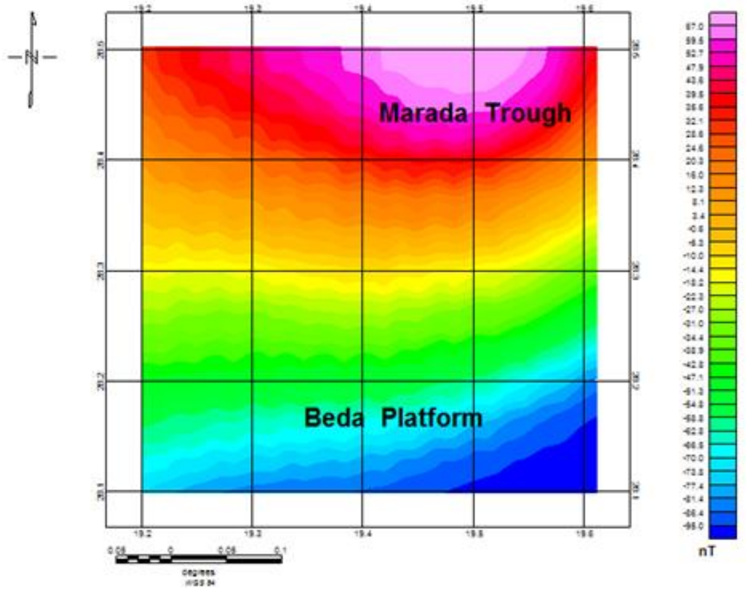


Figure 6: Total Magnatic Intensity Map

The change in magnetism values between north and south reflects the difference in subsurface structures, as it reaches 67 nT in the north high magnetic anomaly and -96 nT low magnetic anomaly in the south. This difference is due to the study area being located between the Marada Trough and Beda plate form, the upper zone a high magnetic anomaly effected by Marada trough but the lower zone low magnetic anomaly effected by Beda platform.. with NW-SE trend structure, which is related to the Late Cretaceous structures of the Sirt basin.

4.2 Reduction to the Pole (RTP) Map

The reduction to the pole operation is a data processing technique that recalculates the total magnetic intensity data as if the inducing magnetic field had a 90o inclination. Reduction to the pole makes the simplifying assumption that the rocks in the survey area are all magnetized parallel to the earth's magnetic field. The Reduction-to-pole filter (Grant and Dodds, 1972) is

$$R_{TP}(\theta) = \frac{1}{[\sin(I) + i\cos(I)\cos(D-\theta)]^2}$$

Where: i , Θ , I , and D are the imaginary unit, wave number direction, magnetic inclination and magnetic declination of the magnetic anomaly respectively.

The total magnetic intensity was reduced to the magnetic pole in Fourier domain by using the Geosoft package software, in order to remove magnetic anomaly distortion which caused by varying magnetization inclination and azimuth. RTP grids were easier to interpret than the TMI because it replaced the anomalies directly above the source of the magnetic field. The inclination and declination in the study area which used for the RTP transformation were taken in the center of the map respectively 28.166°, 7.455° by using geosoft oasis montaj software. (figure 7) , It was noted that in the southwest, values range between -74 and 102, this is centered in the area affected a Beda platform as for the north, the values are between 74 and 60, and this effect results from Marada trough, Referring to (Figure 6), there is a slight change in the values of the anomalies, and the effect of subsurface structures is more clear..

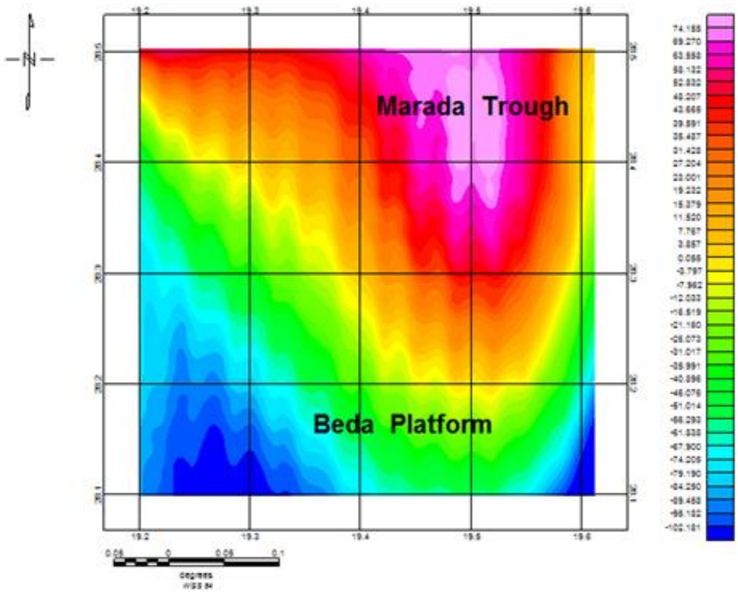
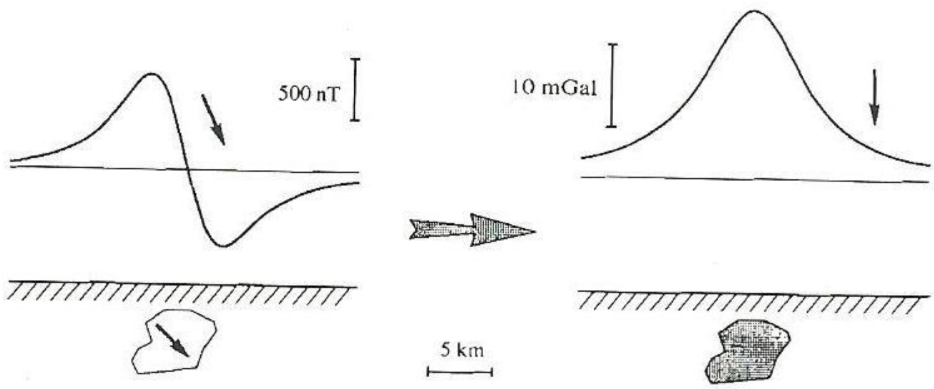


Figure 7: RTP map of study area.

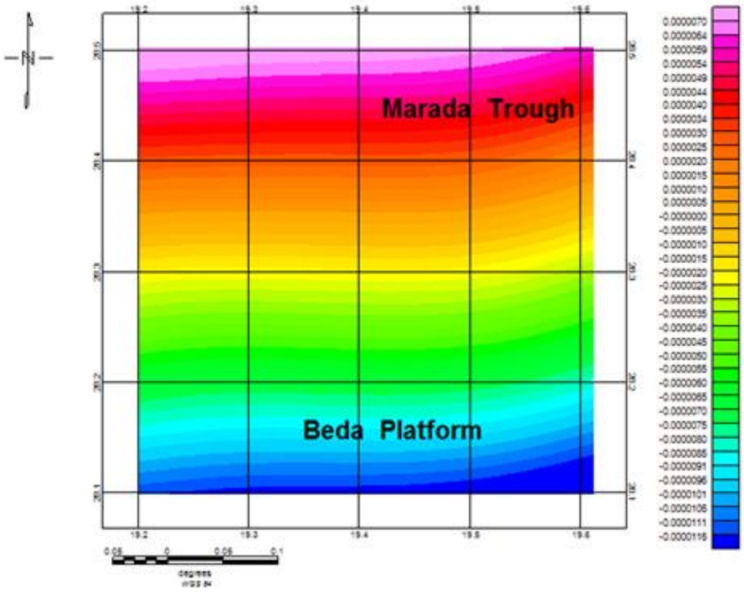
4.3 Pseudogravity Map

The magnetic anomaly is converted into the gravity anomaly with respect to Poisson's relation (Baranov, 1957), that would be observed if the magnetization distribution were to be replaced with an identical density distribution (figure 8) , Baranov (1957) called the resulting quantity a pseudogravity anomaly, and the transformation itself is generally referred to as a pseudogravity transformation. The transformation relates total magnetic intensity to vertical component of the gravity field gz.



: Magnetic anomaly and its pseudogravity transform (after Blakely 1995).8Figure

Total magnetic intensity map was transformed into a pseudogravity map by using Fourier transformation in Geosoft package software, such that transformation makes the total magnetic intensity which behaves like gravity data. After a pseudogravity transformation, broad wavelengths anomalies (regional anomalies) are amplified while short anomalies are attenuated (figure 9).



: Pseudogravity map of study area9Figure

5. Results.

The results obtained from this study are:

- The study area is located between the Marada trough and the Beda platform, and this gave a very large difference in the values of magnetic anomalies between the north and the south, which reached a difference of up to 160 nT.
- The northeast and southeast are affected by the mejor fault, while the northwest and southwest are less affected.
- The Total Magnetic Intensity map (TMI) shows that the Beda Platforms are reflected low magnetic anomaly with value -96 nT .

- The northern part of Maradah Trough shows high magnetic anomalies with approximated value 67nT .
- Both RTP and Pseudogravity anomalies maps are confirmed the fault trending N-S of the structural features within the study area.

6. Recommendation.

- The results achieved in this study has to be verified using other methods such as well logging, seismic, etc.
- magnetic modeling can be performed later to improve our current knowledge of the subsurface geology of zaggut oil field.

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