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The Initial Determining of Hydrocarbon Areas by World Magnetic Model WMM at Al Zubair City, South Iraq

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Abstract: *The area of this study is one of the important places in Iraq, which contains many important oil fields. In this work numerical simulation of the Earth magnetic field in theAl-Zubair city- Iraq have been developed using WMM15 model. This region located at south of Iraq (lat. 30º29`N –30º 25`N), (lon. 47º 34`E – 47º 36`E).The components of the geomagnetic field(total intensity(F),the east component(Y),down component(Z), horizontal intensity (H),north component (X),declination (D) and inclination (I) were found by using(WMM 15) software. Contour mapping of the above seven components were drawn by using surfer 11softawr,magnetic anomaly was found in the area confined betweenlongitudes (47.605°-- 47.612°) and latitudes (30.445° -- 30.45°), and especially in the contour lines of (F,Y,Z,D,I).*
Keywords: *Hydrocarbon Areas, Geomagnetic field anomaly, Magnetic Susceptibility, WMM2015*

I. Introduction

Magnetic methods have been used in oil and gas exploration since the 1920s but, for most of that period, only to investigate major fault zones and map basement rocks. However, recent advances imply that now, under favorable conditions (and especially in combination with other geophysical and geochemical methods), magnetic techniques can play a bigger role in locating oil and gas fields [1].The earth's magnetic field varies due to either static or dynamic anomalies (effects), so that magnetic anomalies can be classify into two types :(a) static anomalies (b) dynamic anomalies. If the earth were composed of uniform materials, the magnetic lines of force would be evenly distributed between the poles. The magnetic lines in a small area would be parallel. However, since various materials have different magnetic susceptibilities due to their composition, the earth's magnetic lines of force are distorted. The local disturbances of the global magnetic field are called magnetic anomalies [2].The anomalies from natural rocks and minerals are due chiefly to the presence of the most common magnetic mineral, magnetite, FeO_2, Fe_2O_3, or its related minerals. All rocks contain some magnetite, ranging from very small fractions of a percent to several percent [2].Magnetic susceptibility is the ease with which a substance is magnetized by the Earth's magnetic field. The variations in magnetic susceptibility between different kinds of mineral affect the Earth's field locally [2].The magnetic susceptibility is one of the most informative fundamental magnetic parameter; therefore the mass magnetic susceptibility is defined as the ratio of the mass magnetization to the magnetic field.[3].The magnetic contrast between sedimentary rocks of normally low magnetic susceptibility and those locally enriched with this epigenetic magnetite results in distinctive magnetic signatures resulting in characteristic "Magnetically enhanced zones" which have proven invaluable in hydrocarbon exploration[4].Because magnetic minerals may directly indicate the presence of oil and gas deposits, magnetic methods are applied to hydrocarbon exploration in oil bearing sedimentary basins. The basic problem in applying these methods is isolation of weak magnetic anomalies caused by underlying magnetic rocks and/or by rocks in the basin sediments [5]. The study area lies in Al-Zubair city in Al-Basrahgovernorate, southern Iraq approximately between (47°34'E - 47°36'E) longitude and (30°29'N -30°25'N) latitude as shown in Fig.(1).MitaRagaran(2008),presented global examples of the different types of surveys and the resultant improvement in magnetic data interpretation related to hydrocarbon exploration[4].Vujic and Verbanac (2008) and Giuliana(2011) performed a ground survey of total magnetic field intensity and the behavior of geomagnetic field in Croatia [6,7].A.perez-perez et al.(2011), measured the magnetic susceptibility of 5425 drill cuttings, coming from 20 oil wells distributed in eight fields of the Petroliferous Barinas-Apure Basin(Barinas, Venezuela),seeking evidence of magnetic anomalies associated with the presence of hydrocarbon deposits[8].M.J. Al bermani et al. (2013) discovered high anomaly value in all components of the earth's magnetic field in Al-Jemaablosh region at Kufa city, Iraq[9]. In this paper the region of interest was divided into grid of vertical parallel lines, the interspacing distance between two lines (1km).Each line was divided into several nodes. The space between any two nodes about (0.250 km), the result of above division is obtaining (115 points), the geodetic coordinates of each point were estimated (longitude, latitude and altitude), which they were extracted from Google Earth V.6. Programs, then the components geomagnetic field were calculated using (WMM15) Software.

II. Geomagnetic Field Components

The geomagnetic field vector, **B**m, is described by seven elements. These are the northerly intensity *X*, the easterly intensity *Y*, the vertical intensity *Z* (positive downwards) and the following quantities derived from *X*, *Y* and *Z*: the horizontal intensity *H*, the total intensity *F*, the inclination angle *I*, (also called the dip angle and measured from the horizontal plane to the field vector, positive downwards) and the declination angle *D* (also called the magnetic variation and measured clockwise from true north to the horizontal component of the field vector). In the descriptions of *X*, *Y*, *Z*, *H*, *F*, *I* and *D* above, the vertical direction is perpendicular to the WGS 84 ellipsoid model of the Earth, the horizontal plane is perpendicular to the vertical direction, and the rotational directions clockwise and counter-clockwise are determined by a view from above (see Fig.2) [10].The ranges of these components shows in the Table (1).

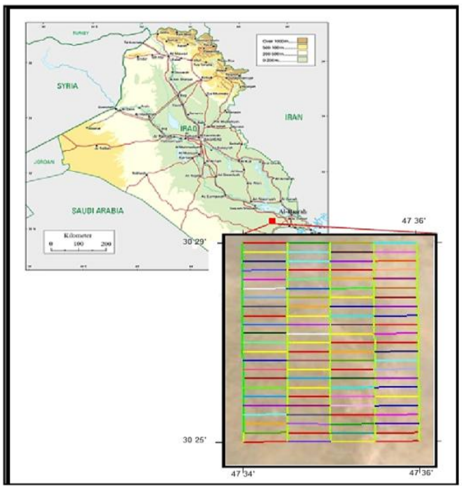

Figure (1):Location map shows the study area

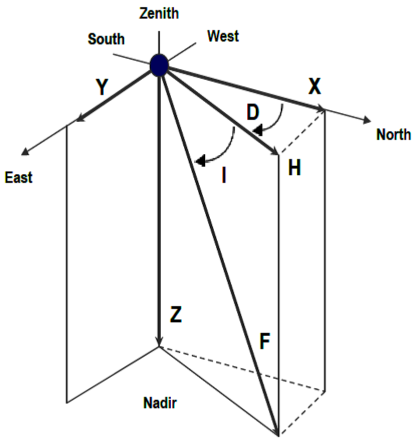

Figure (2):the seven elements of the geomagnetic field vector Bm associated with an arbitrary point in space [10].

Element	Name	Alternative Name	Range at Earth's Surface Min	Max	Unit	Positive Sense
X	North component	Northerly intensity	-17000	42000	nT	North
Y	East component	Easterly intensity	-18000	17000	nT	East
Z	Down component	Vertical intensity	-67000	61000	nT	Down
H	Horizontal intensity		0	42000	nT	
F	Total intensity	Total field	22000	67000	nT	
I	Inclination	Dip	-90	90	Degree	Down
D	Declination	Magnetic variation	-180	180	Degree	East / Clockwise
GV	Grid variation	Grivation	-180	180	Degree	East / Clockwise

Table 1: Ranges of magnetic elements and *GV* at the Earth's surface [10].

III. Theory Model

The study area is surveyed using the World Magnetic Model (WMM). This model can be applied for magnetic survey in air, sea navigation systems, and ground. The WMM is a model of the Earth's magnetic field, that portion of the field generated in the Earth's core. The magnetic field is modeled as the negative gradient of a scalar potential V, which represented by

$$V(r,\theta,\emptyset,t) = a\sum_{n=1}^{N}\sum_{m=0}^{n}(\frac{a}{r})^{n+1}[g_n^m(t)\cos m\,\emptyset + h_n^m(t)\sin m\emptyset]\times p_n^m(cos\theta) \dots\dots 1$$

Where a = 6371.2 km is a reference radius, $(r,\theta,\emptyset)$are geographic coordinates where *r*= the distance from the center of the Earth in Km, θ denotes the co-latitude while $\emptyset$ denotes the longitude, P_n^m are the Schmidt quasi-normalized associated Legendre functions of degree *n* and order *m*, the coefficients g_n^m and h_n^m

are the Gauss coefficients at time , and N is the maximum degree and order of the internal expansion, which is taken here to N = 50 [11][12].

$$g_n^m(\mathrm{t}) = g_n^m + \dot{g}_n^m \times (t - t_\circ) + \frac{1}{2}\ddot{g}_n^m\ (t\ -\ t_\circ)^2 \ldots.. (2)$$

$$h_n^m(\mathrm{t}) = h_n^m + \dot{h}_n^m \times (t - t_\circ) + \frac{1}{2}\ddot{h}_n^m\ (t\ -\ t_\circ)^2 \ldots. (3)$$

Where and represent the Gauss coefficients for the secular variation, the time is given in year and t0 = the epoch of the main-field model, and t = the required time (t0 ≤ t ≤ t0 +5) [13].

IV. Results and Discussion.

The WMM 2015 program used to calculate the magnetic field parameters total intensity, horizontal field strength, north, east, downward components, declination and inclination with the coordinates (longitude, latitude(in degree) and altitude in meters with respect to mean sea level and the local time of Al-Zubair city. The results were explained as a contour map for each component of the earth's magnetic field by using surfer 11 software. Fig. (3) shows the total component(F),its values increase from SW – NE ,while the anomaly behavior in the contour map limit in the area (long. 47.607° - 47.61° E, lat.30.4458° - 30.448° N). Another anomaly appears clearly in fig.(4) for east component (Y) at nearly the same area (long.47.605° - 47.612° E, lat. 30.444° - 30.449° N),while it's values increase from SE –NW . Fig.(5) explain the down component (Z) where its values increase from S-N, and the anomaly limits are nearly the same in the above area (long. 47.607° - 47.61°E, lat. 30.445° - 30.449° N). Figures (6) and (7) show the horizontal component (H) and north component (X) respectively, where their values increase from N-S and noticed that there is no noticeable change in the line of force. Fig.(8) shows the declination component (D) of the geomagnetic field , it can be noticed that the values of (D) increases from SE – NW ,the anomaly appears in the nearly same location (Long. 47.605° - 47.612° E ,Lat. 30.445 – 30.449° N). It can be seen from fig. (9) the values of inclination component (I), which they increase from S-N and the anomaly limits nearly in the same area (long. 47.607° - 47.610° E, lat. 30.446° - 30.450° N).

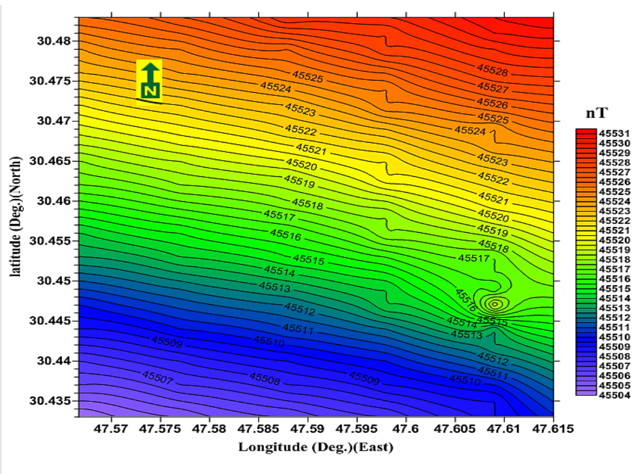

Figure (3): Total Component (F)

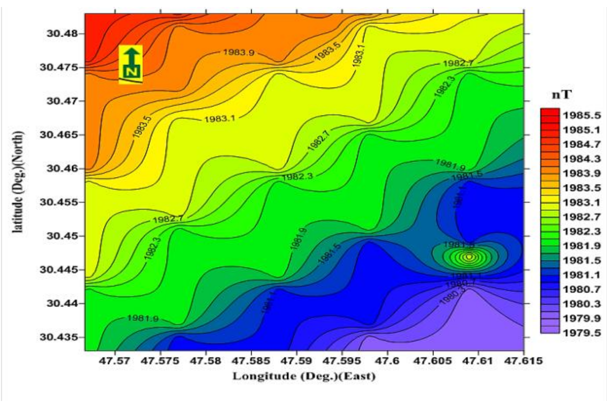

Figure (4): East Component (Y)

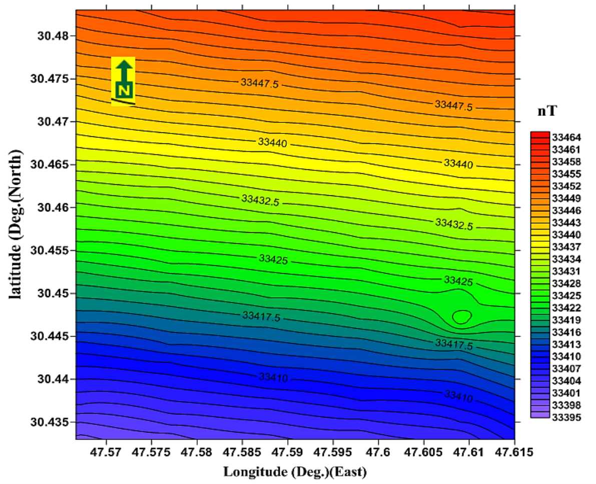

Figure (5): Down Component (Z)

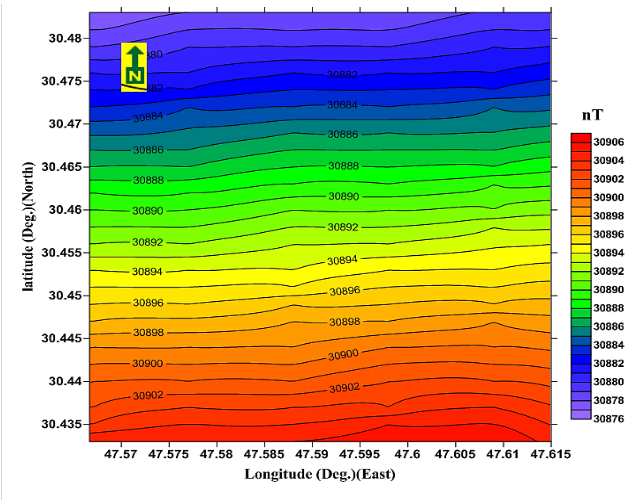

Figure (6): Horizontal Component (H)

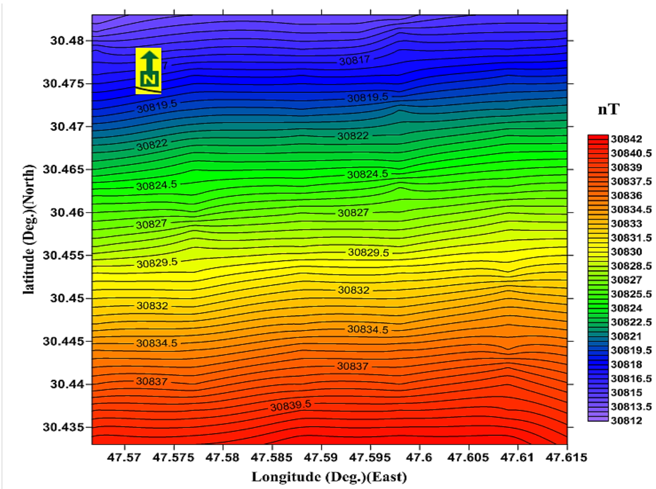

Figure (7):North Component (X)

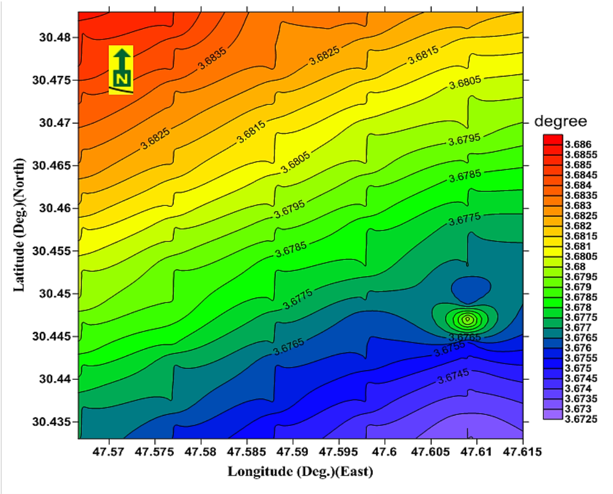

Figure (8): Declination Component (D).

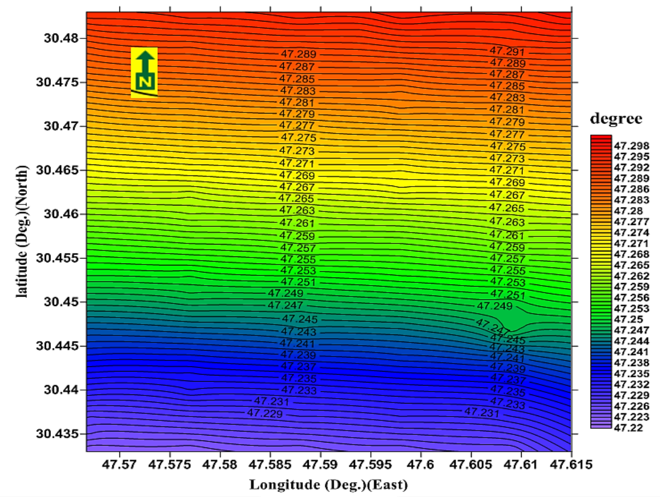

Figure (9): Inclination Component (I).

V. Conclusions

The magnetic anomaly at Al- Zubair city southern Iraq was investigated, especially in contour lines of (F) ,(Y) ,(Z),(D) and (I) .These anomalies are as a result of hydrocarbons in subsurface , accordingly WMM15 model provides a reliable description to determine the hydrocarbon areas by initial stage for exploration methods.

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