GEOMAGNETIC TREND ANALYSIS IN THE FAYUM DISTRICT, WESTERN DESERT, EGYPT

By

M.M. EL-AWADY*,   H. EL-ETR   and A. BAKRAH
Faculty of Science   *Faculty of Science*   *Water Supplies*
Qatar University,   *Ain Shams University,*   *Dept., Tanta, Egypt.*
State of Qatar   *Egypt*

ABSTRACT

The present paper contains brief results of the trend analysis of the aeromagnetic survey in the Fayum District, Western Desert, Egypt. The trend analysis was the constructed magnetic maps which included the total magnetic intensity anomalies, the residual magnetic anomalies, the second vertical derivative magnetic anomalies and the downward continuation magnetic anomalies in depth of two kms to 5 kms. The trend patterns of the anomalies and their distribution were plotted in azimuth-frequency diagrams.

Results show that the trends of the anomalies are characterized by a degree of preference in orientation; specially the pattern is dominated by WNW and ENE orientations at both the Poisson's 95% and 99% significance levels.

INTRODUCTION

The present study is essentially devoted to the evaluation of the subsurface structural and tectonic set-up of El-Fayum district using the available magnetic data. A total area of approximately 3528 km², extending between maximum Lat. 29^0 10′ N to 29^0 50′ and Long. 30^0 20′ E to 31^0 10′ E, is covered (Fig. 1).

The study of the character of the magnetic anomalies is considered as a common quantitative approach to magnetic interpretations. The character of magnetic anomalies is based on the amplitude, the wave length, the grouping of the anomalies and their trend orientation patterns. It has been shown that trend patterns and their distribution can be used to define magnetic provinces which reflect structural or tectonic lines in the area under study (Afflec K., 1963).

The purpose of this work is to define the tectonic trends of the near surface component and the regional component and to check their relation in the studied area.

Trend analysis was carried out for the constructed magnetic anomaly maps in the area under

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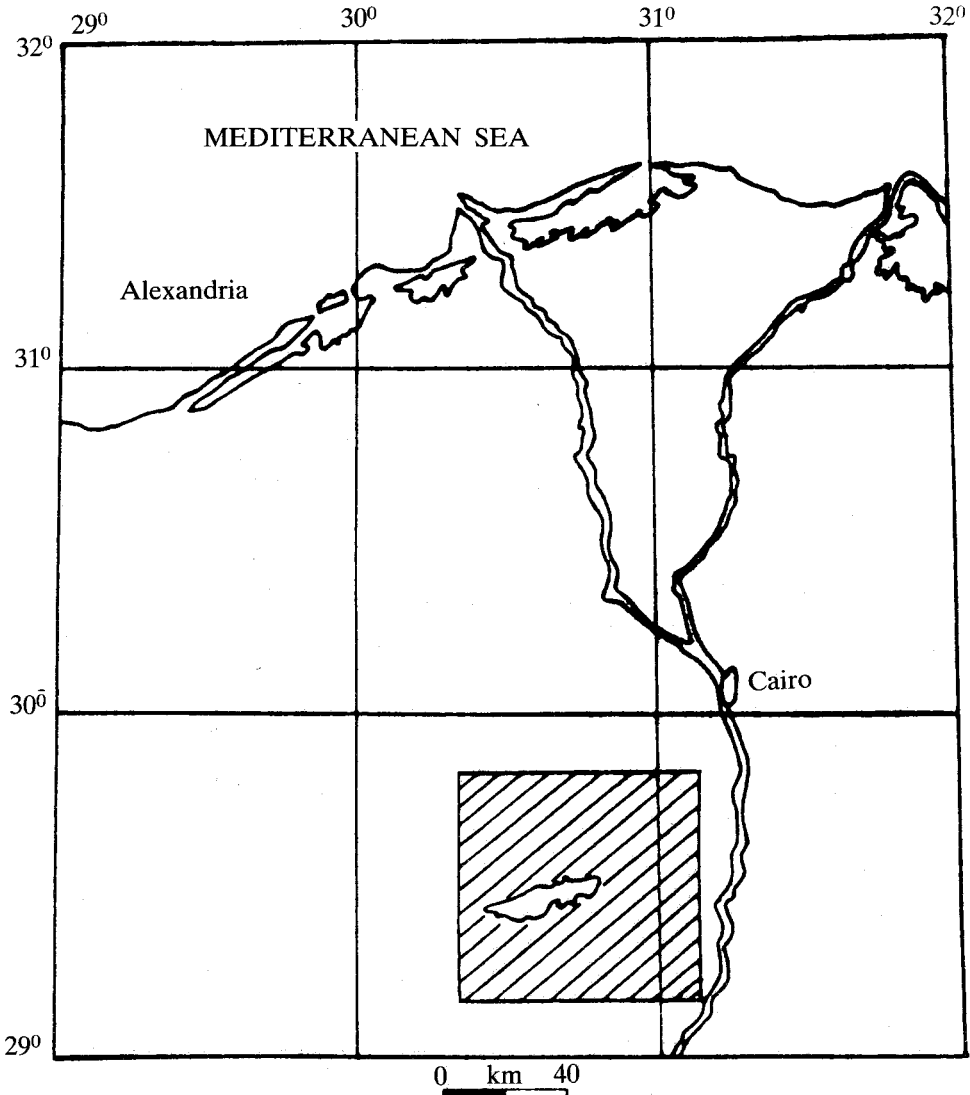*Present address: Faculty of Science, Tanta University, Tanta, Egypt.

Figure 1: Location map of the area under investigation

investigation; namely the total magnetic intensity anomalies, the residual magnetic anomalies, the second vertical derivative magnetic anomalies and the downward continuation magnetic anomalies for a depth of two kms to five kms.

METHOD OF ANALYSIS

The magnetic anomalies align themselves along definite preferred directions forming "trends". The trends of the magnetic anomalies were traced out and marked on the respective maps. A simple and standard method for illustrating the two-dimensional trend patterns is to construct azimuth-frequency diagrams showing the number of elements lying in various direction ranges (Miller and Khan, 1962).

The positions, orientations and lengths of the trends were exactly determined. The lengths of the trends depend upon the length of the long axes of the innermost closure of the anomalies. The direction of the trends is measured as an azimuth, clockwise from north. The number of magnetic trends in each 10 degrees azimuth class is tabulated and their frequency percentages are calculated and shown in Table 1.

The trends of the total intensity, residual, second derivative, downward continuation and summation of the magnetic continuation maps are prepared depending on the exact positions, orientations and lengths of the trends of the anomalies.

The trends of the anomalies are characterized by a degree of preferred orientation, and in order to summarize quantitatively such trends, a total of five azimuth-frequency diagrams are plotted. Such diagrams are based on the number in percent and length in percent of the trends of the anomalies. The total numbers on which each diagram is based as well as the average lengths of the trends of the anomalies are shown in Table 1. No orientation diagrams are plotted for the area that contains less than 25 trends.

In order to simplify comparison between adjacent plots, an attempt is carried out to cut down the number of peaks in the frequency plots on statistical reliability basis. The Poisson's frequency distribution at the 95% and the 99% significance levels are applied (Abdel-Rahman and Hay, 1978).

DISCUSSION

Figure 2 shows the trends of the total magnetic intensity anomalies. The total number of the trends is 10. The main trends present are oriented east northeast, east-west and northwest.

Figure 3 shows the trends of the residual magnetic anomalies. The total number of recognized lines is 30. Their main orientations are east northeast and west northwest. Details are illustrated in histograms 6 of Figures 10 and 11. The data on which the diagrams of these figures are based, are exhibited in Table 1.
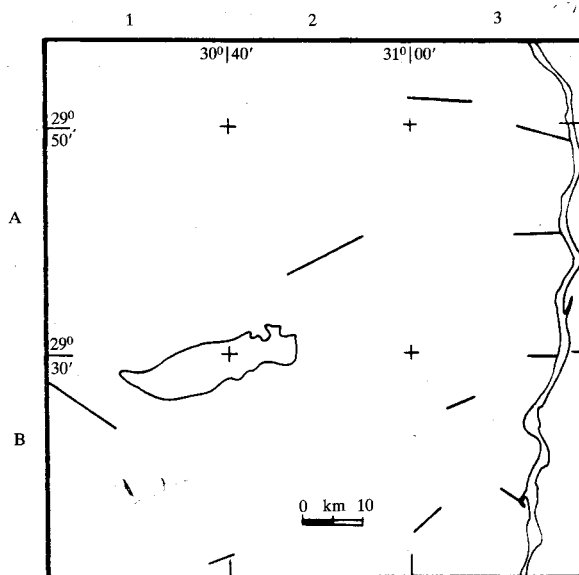
Figure 4 shows the trends of the second vertical derivative magnetic anomalies. The total number of lines is 25. The main orientations are east northeast, east-west, and west northwest. Details are plotted in histograms 7 of Figure 10 and 11.

Figure 5 shows the trends of the total intensity magnetic anomalies at two kilometers depth (1.5 km below datum). The total number of trends is 11. The main apparent orientations are west

Table 1: Number and length of magnetic trends and their frequency percentages. Letters refer to: N: number of magnetic trends in each 10 degrees of azimuth and L: length of magnetic trends of the anomalies.

	2 km				3 km				4 km				5 km								Total Mag. Int.				Residual				2nd drv.			
	N	N%	L_{km}	L%	N	N%	L_{km}	L%	N	N%	L_{km}	L%	N	N%	L_{km}	L%	N	N%	L_{km}	L%	N	N%	L_{km}	L%	N	N%	L_{km}	L%	N	N%	L_{km}	L%
N 0-10 E					3	9.7	18.7	9.7	3	8.8	9.2	5.8	3	7.9	7.8	3.8	9	7.6	35.7	4.9									1	4	0.4	1
-20																													1	4	1.0	3
-30									2	5.9	11.8	7.5					2	1.7	11.8	1.6												
-40									1	2.9	4.4	2.8	2	5.3	8.7	4.2	3	2.5	13.1	1.8					1	3.5	0.7	2.3				
-50									3	8.8	13.4	8.5	4	10.5	12.9	6.2	5	4.2	26.3	3.6	1	14.3	2.4	10.7	1	3.5	1.0	3.2				
-60					1	3.2	4.8	2.5	1	2.9	1.7	1.1	1	2.6	2.6	1.3	3	2.5	9.1	1.2					3	10.4	3.3	10.5	9	30	13.3	40
-70	2	18.2	6.4	5.3	1	3.2	2.3	1.2	2	5.9	2.8	1.8	4	10.5	46.4	22.4	9	7.6	77.9	10.6	2	28.6	7.9	39.1	2	6.9	1.9	6.1				
-80	1	9.1	15.9	13.2	2	6.5	9.6	4.9	1	5.9	6.0	3.8	2	5.3	32.0	15.5	7	5.7	63.5	8.6	1	14.3	2.2	9.8	2	6.9	2.1	6.8				
-90	1	9.1	11.4	9.5					5	14.7	18.3	11.6	3	7.9	9.1	4.4	9	7.6	38.8	5.3	1	14.3	3.2	14.2	6	20.7	8.9	28.6				
N 0-10 W					3	9.7	13.3	6.9	1	2.9	4.8	3.0	4	10.5	21.8	10.5	8	6.8	39.9	5.4	2	28.6	7.8	39	2	6.9	1.5	4.7	2	8	3.3	10
-20	2	18.2	16.4	13.6	1	3.2	3.2	1.7	2	5.9	6.5	4.1	3	7.9	10.9	5.3	8	4.8	37.0	2.8	1	14.3	2.1	38.7	1	3.5	0.6	1.9				
-30									2	5.9	7.0	4.4					3	2.5	7.0	3.2												
-40	1	9.1	26.8	22.3	1	3.2	7.7	3.9	3	8.8	18.2	11.5	1	2.6	1.5	0.7	6	5.1	54.2	3.7												
-50					4	12.9	48.3	25.0	2	5.9	6.5	4.1	3	7.9	13.1	6.3	7	5.9	67.9	12.9					2	6.9	2.4	7.7				
-60									2	5.9	4.8	3.0	3	7.9	9.1	4.4	5	4.2	13.9	1.9	2	28.6	6.8	30.2	4	13.8	2.8	8.9	5	20	6.2	18
-70					3	9.7	11.8	6.1	1	2.9	3.0	1.9	2	5.3	9.3	4.5	7	5.9	24.1	3.3									2	8	1.6	4
-80	2	18.2	15.5	12.9	4	12.9	18.8	9.7	2	5.9	8.7	5.5	2	5.3	12.6	6.1	11	9.3	77.0	10.5					4	13.8	5.2	16.8				
-90	2	18.2	27.8	23.1	8	25.8	54.6	28.3	5	14.7	30.8	19.5	3	7.9	9.1	4.4	19	16.1	139.6	18.9					2	6.9	1.6	4.8	5	20	7.0	21
Total	11		120.2		31		193.1		39		157.9		40		206.9		121		736.8		10		32.4		30		32.6		25		32.8	

Figure 2: Trends of the total magnetic intensity anomalies
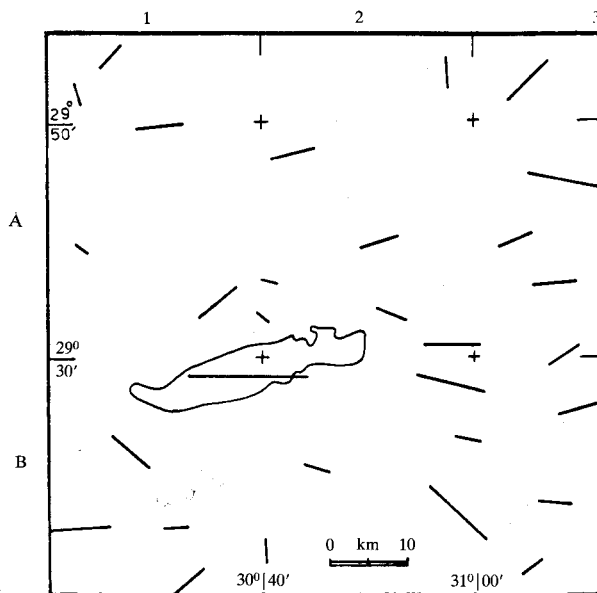
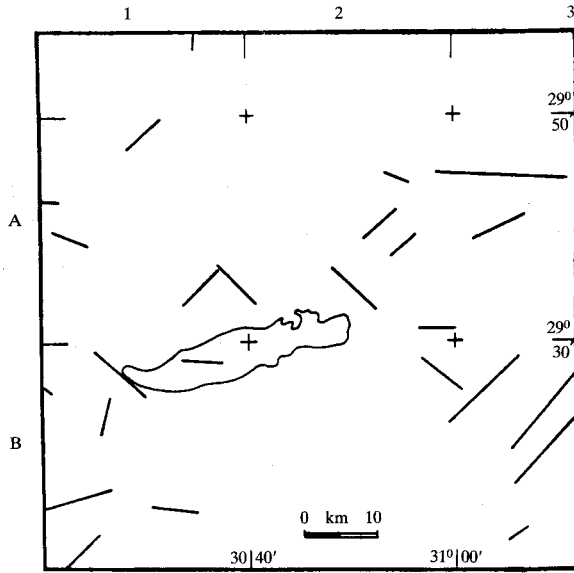**Figure 3: Trends of the residual magnetic anomalies**

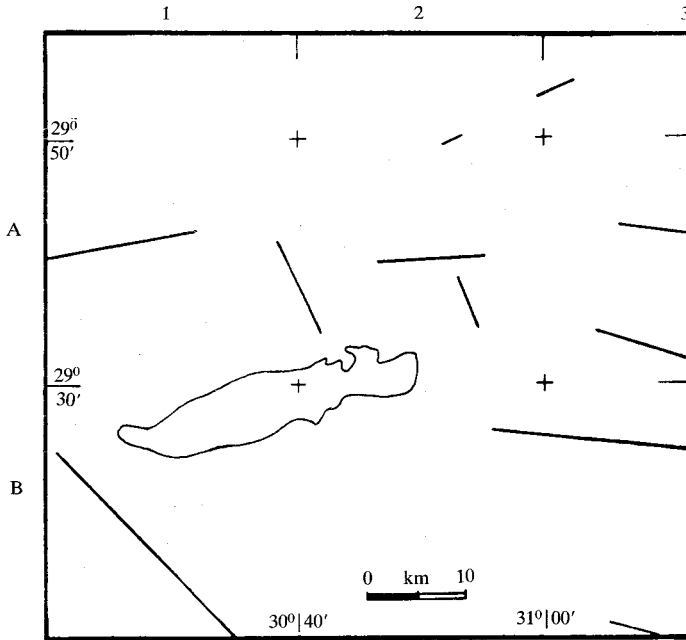**Figure 4: Trends of second vertical derivative magnetic anomalies.**

Figure 5: Trends of magnetic continuation anomalies of the total intensity at a depth of two km (1.5 km below datum).

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northwest, north northwest, and northeast. Details are shown in histogram 1 of figure 10.

Figure 6 shows the trends of the total intensity magnetic anomalies at a depth of 3 kilometers (2.5 km below datum). The total number of linear trends identified is 31. The main apparent orientations are west northwest, northwest, and northsouth. Details are exhibited in histograms 2 of Figures 10 and 11. The west northwest peak is the only significant peak at the Poisson's 95% and 99% reliability levels.

Figure 7 shows the trends of the total intensity magnetic anomalies at a depth of 4 kilometers (3.5 km below datum). The total number of lines identified is 39. The main apparent orientations are east-west to west northwest, northwest, and north-south. Details are shown in histograms 3 of Figures 10 and 11.

Figure 8 shows the trends of the total intensity magnetic anomalies at a depth of 5 kilometers (4.5 km below datum). The total number of trends is 40. The main apparent orientations are north, northeast and northwest. Details are expressed in histograms 4 of Figures 10 and 11.

Figure 9 shows the summation of the trends of the total intensity magnetic anomalies at depths 2,3,4 and 5 kilometers. The total number of trends is 121. The main apparent orientations are mainly west northwest, north-south, east northeast and northwest. Details are illustrated in the summation histograms designated Σ 1+2+3+4.

Figure 10 gives the frequency curves of the trends of the total magnetic anomalies based on grid unit areas each 20 min. Long X 20 min. Lat. each. The plots show the variations, the percentage number (N%) and the percentage length L%) of the trends of the anomalies.

Visual inspection of these frequency curves reveals that they are, in general, polymodal with four peaks or more in each. In any one plot the size and shape of the individual peaks are variable and commonly one of them exceeds the others in value. Vertical and lateral correlation of individual peaks in adjacent curves indicate that consistency is rather limited. Prominent peaks, however, are oriented WNW, ENE, NNW and NNE. The comparison between the number and length curves of any one plot shows that the length of the anomalies in the different azimuth classes are variable. They are maximum in the NNW peak of plot 1, NW peak of plot 2, and ENE peak of plots 4,5 and 6.

Figure 11 shows the frequency curves of the detected trends of the anomalies as based on the total numbers (T.N.) per unit areas of grid as well as the significant peaks obtained from the Poisson's frequency distribution at the 99% and 95% significance levels (Hay and Abdel-Rahman 1974). Although Poisson method is mainly useful in the statistical treatment of sample data, it is used in the present study of the total field of the anomaly trends Poisson's method is considered as an objective method for the identification of the spatial variation in the relative strength of the previously identified peaks (Fig. 10). It should be emphasized, however, that the obtained significant peaks are mainly a function of the pre-selected class interval of azimuth (10[0] of arc in the present study). Broad peaks, extending over more than one class, may not show up as significant peaks. However, if the azimuth classes are changed, different results may likely be obtained. Accordingly, the method as applied identifies the predominant and relatively narrow peaks of the trends of the anomalies.

At the 99% significance level three peaks are disclosed. These are oriented WNW (in diagram 2) and ENE (in diagrams 6 and 7). If the 95% significance level is considered, a fourth peak is disclosed and is oriented E-W (in diagram 3). The spatial distribution of the significant clusters reflects a general consistency of the "significant" orientations rather distinct inconsistency in the relative prominence of these "significant" peaks in the different parts of the area investigated. The introduction of the summation diagram of figure 11 emphasizes lucidly that
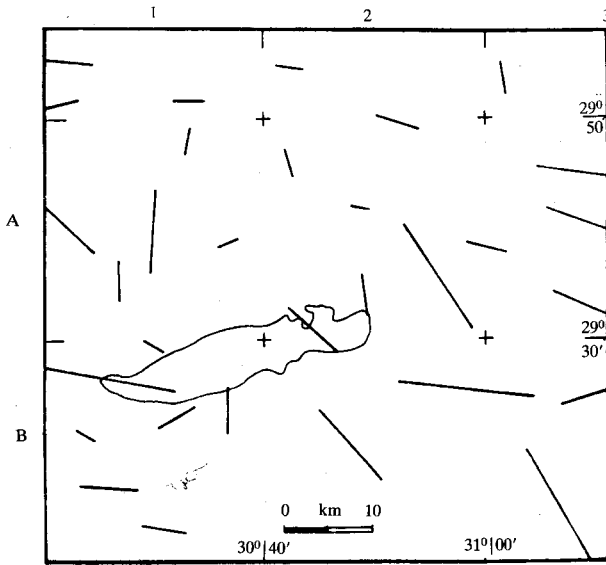
Figure 6: Trends of magnetic continuation anomalies of the total intensity at a depth of three km (2.5 km below datum).
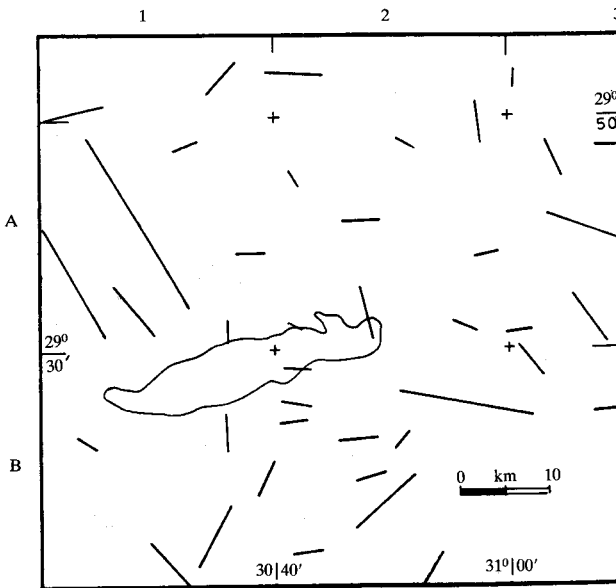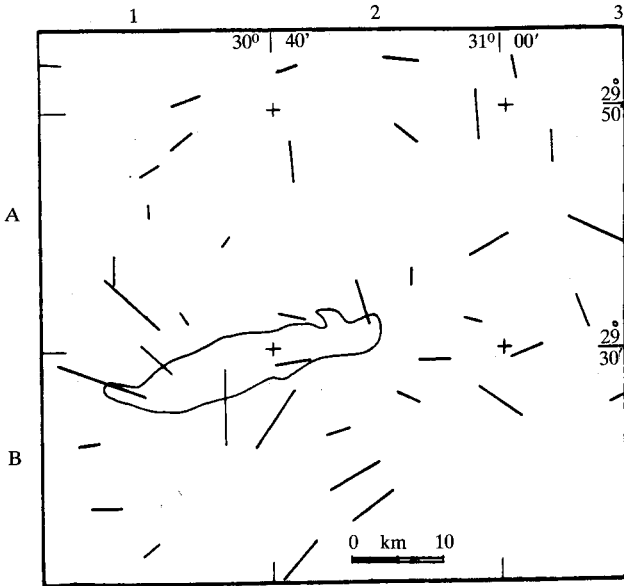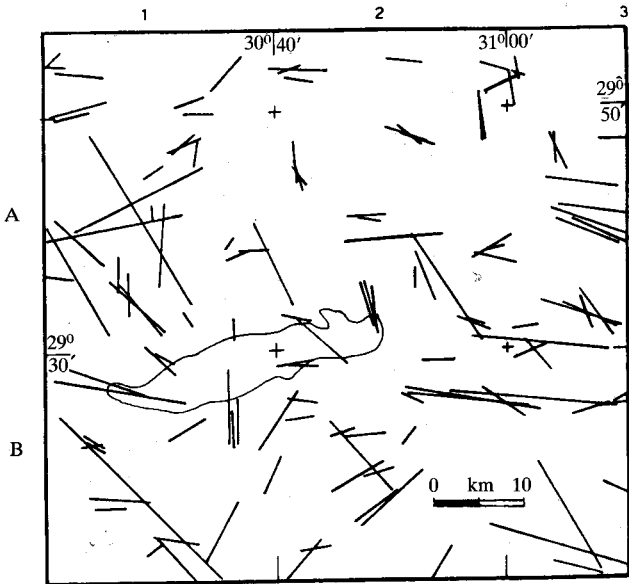

Figure 7: Trends of magnetic continuation anomalies of the total intensity at a depth of four km (3.5 km below datum).
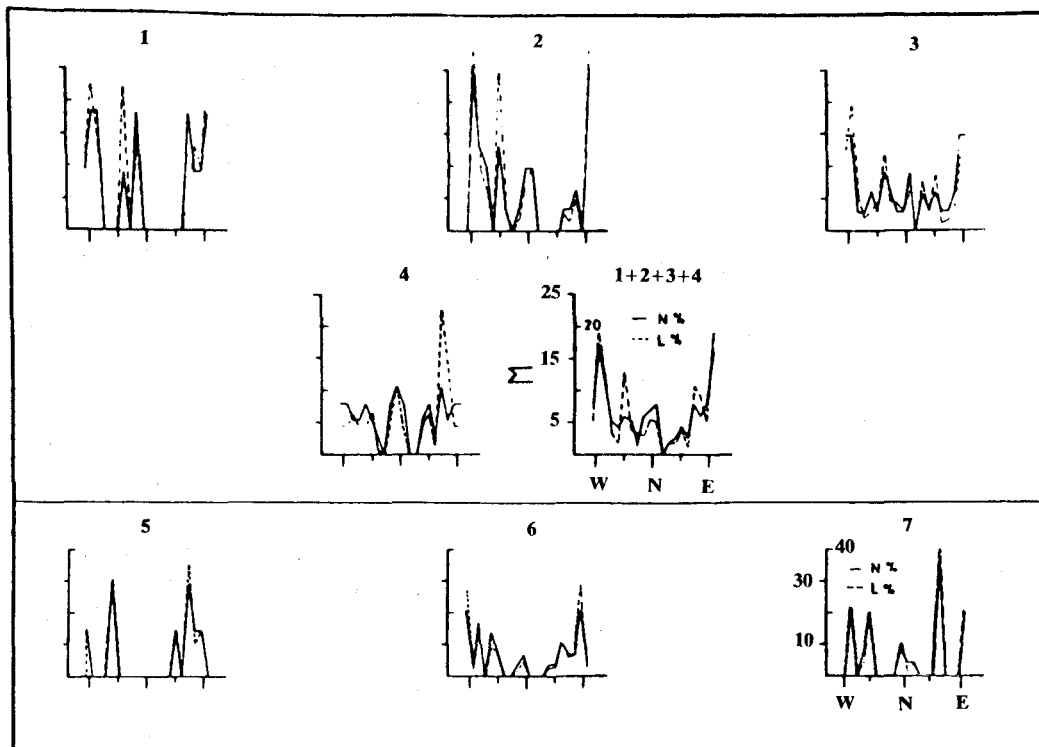
Figure 8: Trends of magnetic continuation anomalies of the total intensity at a depth of five km (4.5 km below datum).
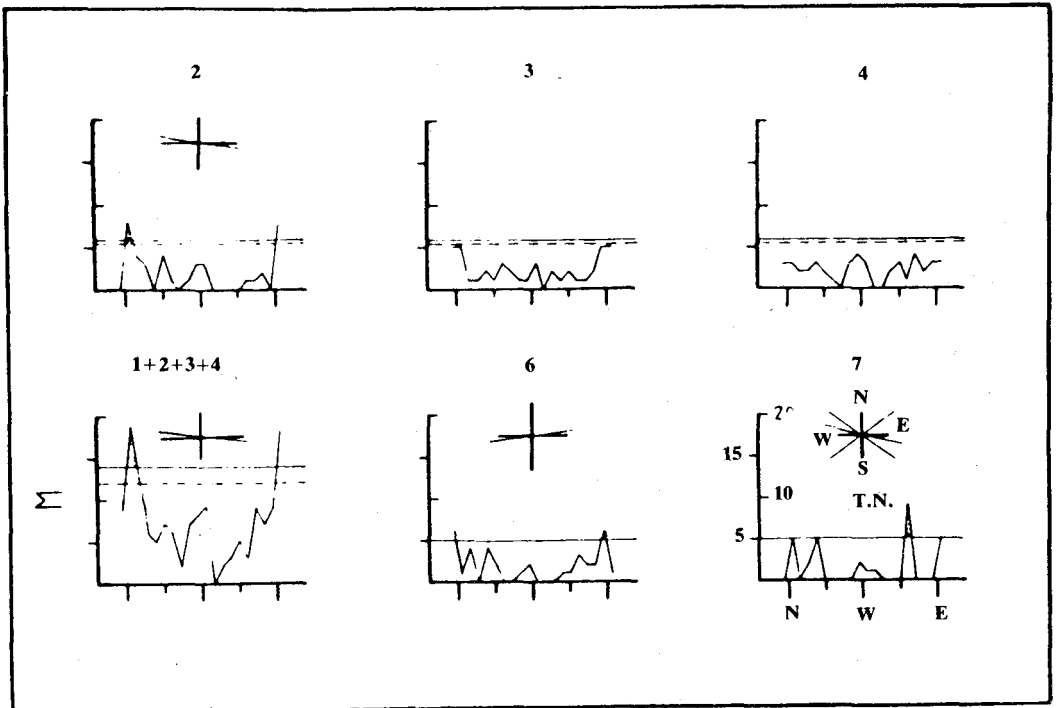

Figure 9: Summations (Σ) of the trends of magnetic continuation anomalies at depths of 2, 3, 4 and 5 kms.

Figure 10: Histograms of the number in percent and length in percent of the trends of the magnetic anomalies in the area, and their summation (>). Numbers designate: (1): Trends of magnetic continuation to a depth of two km (1.5 km below datum), (2) Trends of magnetic continuation to a depth of three km (2.5 km below datum), (3): Trends of magnetic continuation to a depth of four km (3.5 km below datum), (4): Trends of magnetic continuation to a depth of five km (4.5 km below datum), (5): Trends of total magnetic intensity anomalies, (6): Trends of the residual magnetic anomalies, and (7): Trends of second vertical derivative magnetic anomalies.

Figure 11: Histograms of the total number (T.N.) of the trends of the magnetic anomalies in the area under study and their summation (>), showing the significant peaks (stippled) as obtained from the Poisson frequency distribution at the 95% and the 99% significance levels (dashed and solid horizontal lines respectively). Insert orientation plots (roses) show also the significant peaks at the 95% (dashed) and 99% (solid) significance levels. Numbers designate: (2): Trends of magnetic continuation to a depth of three km (2.5 km below datum), (3): Trends of magnetic continuation to a depth of four km (3.5 km below datum), (4): Trends of magnetic continuation to a depth of five km (4.5 km below datum), (5): Trends of total magnetic intensity anomalies, (6): Trends of the residual magnetic anomalies, and (7): Trends of the second vertical derivative magnetic anomalies.

the regional pattern of the magnetic anomaly trends is dominated by WNW and ENE apparent orientations at the 99% and the 95% significance levels.

ACKNOWLEDGEMENTS

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دراسة نوعية لاتجاهات الشواذ المغناطيسية
بمنطقة الفيوم بالصحراء الغربية ـ مصر

محمد محمد العوضى   حسن العتر   أحمد بكره

تقوم هذه الدراسة أساسا على استخدام الخرائط المغناطيسية لمنطقة البحث وقد اثبتت الدراسة النوعية لاتجاهات الشواذ المغناطيسية أن الأتجاهات التركيبية السائدة هى شمال شرق ، شمال غرب ، وشرق غرب ـ وأنها مـرتبطة بتصـدع كلى في صخور القاعدة وبالدراسة الكمية المبنية على استخدام التوزيع البواسيني الأحصائى لدرجة ثقة ٩٥٪ و ٩٩٪ فان الاتجاهات التى سادت هى غرب شمال غرب وشرق شمال شرق .