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A CONTRIBUTION TO THE TECTONIC SETTING OF THE NORTHERN WESTERN DESERT

BY

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ABSTRACT

The main tectonic trends present in the study area are statistically identified and their tectonic significance studied. A graphical numerical technique was applied to the Bouguer anomalies, residual and downward continuation fields. Also, the analysis of the surface structural lineaments; from the landsat satellite images; were carried out.

Seven principal tectonic trends were identified at different levels ranging between shallow sediments, basement surface and deep crust. The area is found to be tectonically related to two stress fields acting during different geologic epochs. The first one was probably as a result of interaction between African and European plates and the other related to the Red sea rifting. These fields resulted in four major (NNW, E-W,ENE, N-S) and three minor (NWW,NNE,NEE) fault systems. They also responsible together with vertical movements, for N-E,N-W and E-W folds detected in the area.

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Such trend analysis shows that the area under study have been subjected to four cycles of tectonism. The first or the oldest cycle belongs to the NNW deformation trend (Pre Cambrian,early paleozoic); the second cycle is found to follow the Mediterranean trend (Mid to late Mesozoic), the third cycle (Eocene to Oligocene) follows the Aualitic arc trend; while the fourth cycle (Quaternary) follows the E- African trend.

In connection with a quantitative interpretation by two-dimensional model bodies a structural map for the basement was constructed.

INTRODUCTION

The area which looks on the surface as a featureless plain covered by tertiary and Quaternary strata was found to have a complex subsurface structure. The surface formations are underlain nuconformably by a sedimentary succession, ranging in age from paleozoic to early Tertiary, that rests on the crystalline basement some 1-6 Km below.

The main target of the present work, is the study of the tectonic trends which are predominant in the tectonic patterns constructed at different levels from the analysis of the Bouguer anomaly map (Fig. 1), and its transformed gravity field including the residual (Fig. 2), and the downward maps as well as the surface structural lineament map using a simple graphical tectniques.

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Set of gravity anomaly maps, continued downward to different levels of approximate 1.25, 2.5, 3.75, 5 and 6.25 Kms have been constructed using the constantinescu method (1961). For illustration, only two of these maps are represented in figures 3 and 4. Besides, isopach maps of the different ages of the sedimentary section were prepared; Figs (5&6).

Comparison results are compared with the previously recognized by geolgist (Said, 1962; Youssef, 1968), from the analysis of linear features obtained by satellite photographs (Halsey and Gardner, 1975), the linear anomalies presented on the geophysical maps (Meshref, 1982; Tealeb, 1979; Sharaf et al, 1989; and others).

Tectonic Patterns

If we consider the minor and major axes of potential anomaly features to be a function of the stresses causing them, then some of the key variables of such features such as magnitude, relief and areal extent may refer to definite characteristics of the causative bodies. For instance, while the longitudinal extent of the anomaly can be interpreted in terms of the individual strain, the potential relief being a comprehensive function of the applied stress is considered as being one of the geotectonic setting of the area. According using Linser's method (1967), the different tectonic maps have been constructed; Figs (7&8) (as examples). They revealed

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the following structural features.

1- Major and Minor faulting of different trend patterns, ages and intensities are probably resulting from deep seated tectonics and rejuvenated through different levels.
2- Horst and graben type of structures, of different magnitudes, striking mainly in NNW, E-W and ENE directions are the major tectonic features affecting the sedimentary cover and the basement complex. They were affected by a secondary NW, N-S and NE faulting tectonics. This may indicate that the area was greatly subjected to different streses during the different geologic times.
3- By careful study of the tectonic patterns, located near the shore line on the gravimetric tectonic map, it can be emphasized that the shore line, in the most of this area, is of tectonic origin.

Trend Analysis

Simple numerical method was used for the analysis of the tectonic maps. A set of azimuth frequency diagrams; showing length and number of the anomalies against the deviations of their major axes from North; have been prepared to illustrate the most dominant structural trends, Figs (9&10).

The general picture of such representation indicates the presences of lateral and vertical deviation of the major axes of the anomalies from North, along four major trends

namely NNW, E-W, ENE and N-S. Such trend pattern, represented from the gravity data, generally help in the detection of the direction and magnitude of the geotectonic forces causing or affecting such gravity anomalies. The "resulting" azimuth-frequency diagrams for some continuation levels in the whole area are shown in figure (11). This figure gives a clue to how far both the direction and magnitude of the tectonic force vary vertically along the various levels through the sedimentary section as well as the basement complex. The predominant tectonic trends show some sort of change at different depth levels. Some tectonic trends are still predominant with increasing depth, but with another frequency distributions. Other tectonic trend directions appeared or disappeared with increasing depth.

Two major trends having N 35°-45°E and N 25°-45°W directions are indicated at the continuation depths 2.5, 3.75 and 6.25 km. While at the continuation depths 1.25 and 5 kms three trends having N-S, E-W, and N20°E directions are obvious. Besides the tectonic trend analysis of the landsat image; (Fig. 12&13) shows the predominant of E-W, and N 60°E directions. This may refer to different phases of tectonic activity that gave rise to structures of varied amplitude and direction to exist at different levels of the Earth's crust within the studied area. Table (1); Fig, (14).

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RESULTS AND DISCUSION

All the tectonic trends which are analyzed can be classified into seven trend. According to the frequency distribution of the hights of the tectonic patterns of these trends, they are mainly predominant in the N 60°E, E-W, N 40°E, N 30°W, N-S, N 20°E, and N 60°W directions.

The tectonic trends which are recognized to be prodominant in N20°E, N-S and E-W directions were recorded in shallow levels. The tectonic trends which are recognized to be predominant in N60°W, N60°E and E-W directions are recorded in both shallow and medium levels, whereas the N 30°W and N 40°E directions are recorded in both medium and deep levels. These results are in a good matching with the results previously recorded in the area and their surrounding by geologists and geophysists. These trends are also named with reference to the previously geological and geophysical literatures. The differences, especially those connected with the analysis of geophysical fields, are only recorded in the frequency distributions of the recognized trends directions. These differences are supposed to be due to the different methods used in the analyses and their accuracies and according to the difference in extensions and locations of areas which are studied. The frequency distribution of these trend directions are changed not only at the different depth levels but also horizontaly through the area, Fig, (15&16). Slight change of some trend directions and appearing or disappearing of others are also obvious with increasing depth. On the basis of these analyses the following may be concluded:-

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1- Tectonic movements are not uniform all over the area.
2- The comparative study on the subsurface geologic conditions described from the continuation maps and different methods of calculation the basement depth indicates that most of the structural features of the basement configuration are represented mainly by the continuation anomalies within the range of spacing 3.75 and 5 kms.
3- The main structural features within the area are in the form of high and low structures as well as faulting Fig. (19). The highs and lows are mainly in the form of uplifted and downfaulted blocks within the basement. The main trends of such structures are NE, NW and E-W.
4- It is evident that the basement surface is characterized by several arching and saggings in the form of ridges, upliftes and structural lows as well as zones of dislocations having different areal extensions, relief, and are oriented either in NE or NW directions; Figs (17&18).
5- Seven principale tectonic trends of N 60°E, E-W, N 40°E, N 30°W, N 20°E and N 60°W directions were identified at diferent levels.
6- Northeast, Northwest and eastwest major anomaly trends of high and low amplitudes are the most effective in the area under study. The northeast trends has mainly the N 50°E (N 40° - 60°E) direction, while the northwest has mainly the N 45°W (N 30° - 60°W) direction. Both trends affect more at the continuation levels of 2.5 and 6.25 kms. The east - west trends has mainly the N 80°E and N 80°W directions and is more obvious at the continuation level of 5 km,

Besides the North - south trend has mainly the N 10°E and N 10°W directions and is more obvious at the continuation level 1.25 km.

7- The detected tectonic trends show that two stress fields may have been acting. The first is the meridional (N-S) stress field acting since early geological times (Pre - cambrian), and is believed to be related to the drifting of the African continent that eventually resulted in the collision between the African and European plates. The second is modified equatorial stress field. Both stress fields have been acting with different intensities through the different levels of the study area.

8- The compressional force affecting a rock in a certain direction (maximum magnitude) will produce its strain (maximum strain) in a direction perpendicular to its maximum stress. Following this argument, one can conclude that the force trending NE-SW (affecting the older formations) will result in a strain trending NW-SE, i.e. parallel to the Gulf of Suez trend; the force trending NS (the second deformation) will result in a strain trending E-W, i.e. parallel to the Mediterrianean trend; the force trending NW-SE (the third deformatin) will result in a strain trending NE-SW, i.e. parallel to the Aualitic trend and the force trend E-W (the forth deformation) will result in a a strain trending N-S, i.e. parallel to the east African trend, Figs. (5,6,11). Therefore, it is believed that the area under study have been affected by four cycles of

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deformations. The oldest cycle was parallel to the Gulf of suez trend and was found to be the deepest one since it is detected at a depth exceeding 6 km (Precambrian to Early paleozoic). It is followed by the Mediterranian deformation trend which detected at a depth range 5 km affecting the sedimentary as well as the basement rocks (occured in Jurassic to Late - Cretaceous), whereas the third deformation represent rejuvenation of the Suez trend as well as the Aullitic trend (occured in Eocene to Oligocene). The most recent was concide with the E-African trend as well as the Aqab trend (pleistocene to Recent). Bayoumi et al. (1977) idenfied five cycles of deformation in the area west of Nile Delta and North Egypt. These cycles agree with the deformation trends of the Gulf of suze, Mediterranean and Gulf of Aqaba which are refered to as the first, second and fourth deformation trend. The third (Late Oligocene - Early Pliocene) and the fifth in the study area (post Pliocenece) represent rejuvenation of the Mediterranean trend.

Table(1) Change in intensity of continuation anomalies with continuation levels.

Continuation Level (Grid Spacing) - Ka.	Main Trend	E - W	N 60 E	N 30 W	N 40 E	N - S	N 20 E	N 60 W
	Range	N80E -N80W	N50-70E	N20-40W	N30-50E	N10E-N10W	N10-30E	N50-70W
	Refernce Name	Tethyan	Qattara	Suez	Aualitic	E-African	Aqaba	——
0.0 (Landsat)		21.94	19.19	10.55	10.47	8.8	15.00	8.79
1.25		3.54	5.99	2.39	17.57	27.52	14.84	3.23
2.5		2.14	10.43	15.80	31.29	6.98	10.47	7.75
3.75		6.03	7.53	13.99	20.02	11.89	11.87	12.75
5		16.67	12.73	12.72	8.83	9.57	14.28	8.99
6.25		7.19	9.13	20.94	13.22	8.57	11.34	7.50

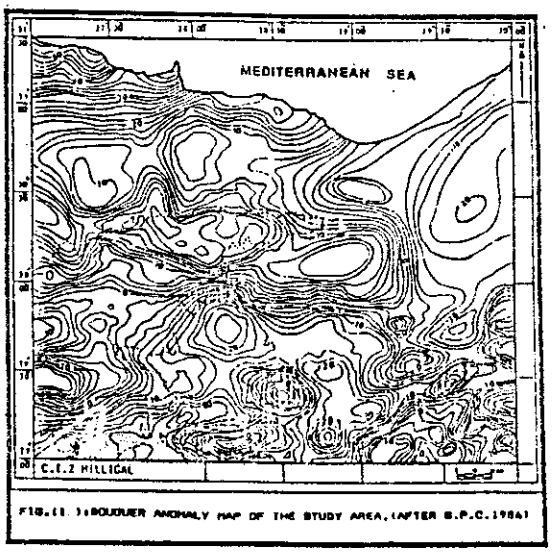

FIG.(1):BOUGUER ANOMALY MAP OF THE STUDY AREA.(AFTER E.P.G.1984)

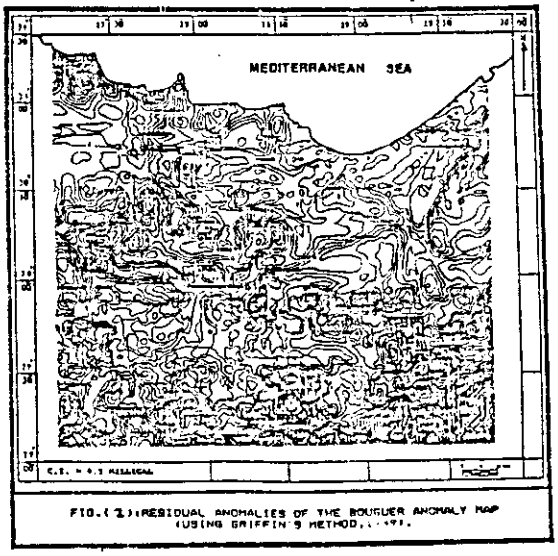

FIG.(2):RESIDUAL ANOMALIES OF THE BOUGUER ANOMALY MAP (USING GRIFFIN'S METHOD,...1991.

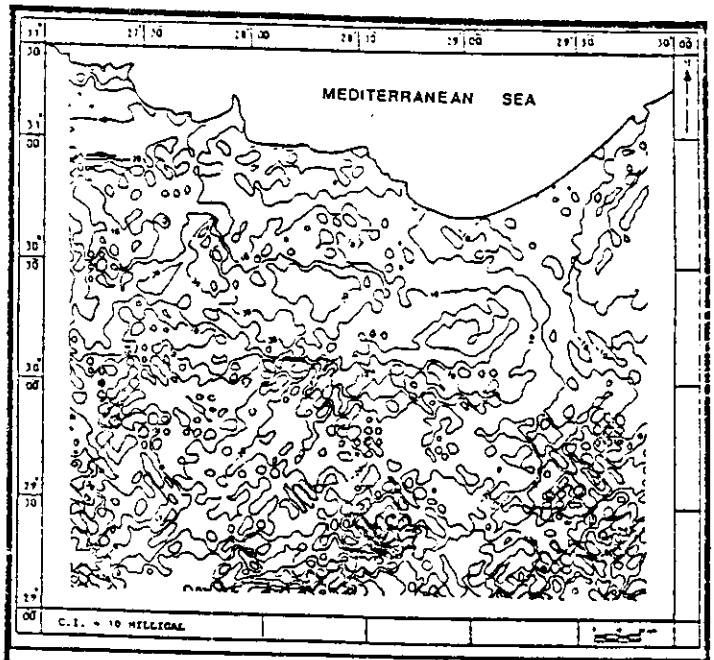

FIG.(3): A MAP SHOWING GRAVITY ANOMALIES CONTINUED DOWNWARD TO A DEPTH 2.5 Km.

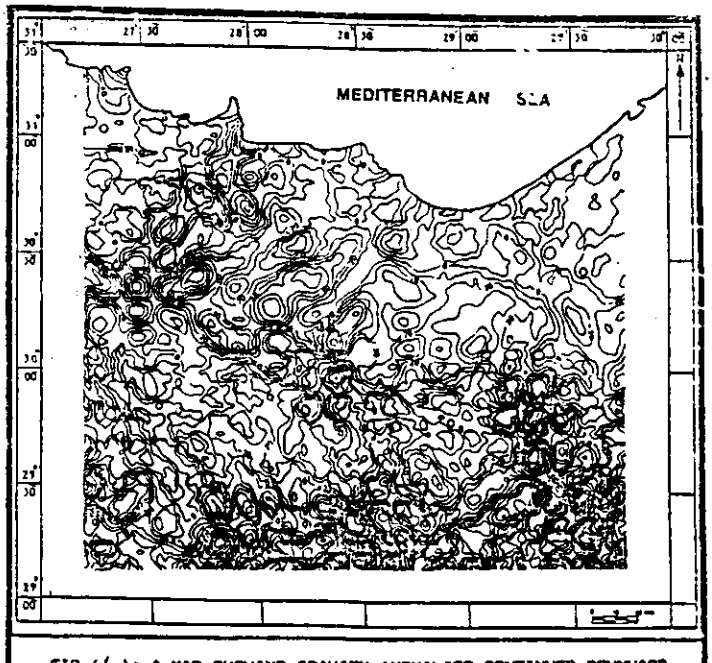

FIG.(4): A MAP SHOWING GRAVITY ANOMALIES CONTINUED DOWNWARD TO A DEPTH 6.25 Km.

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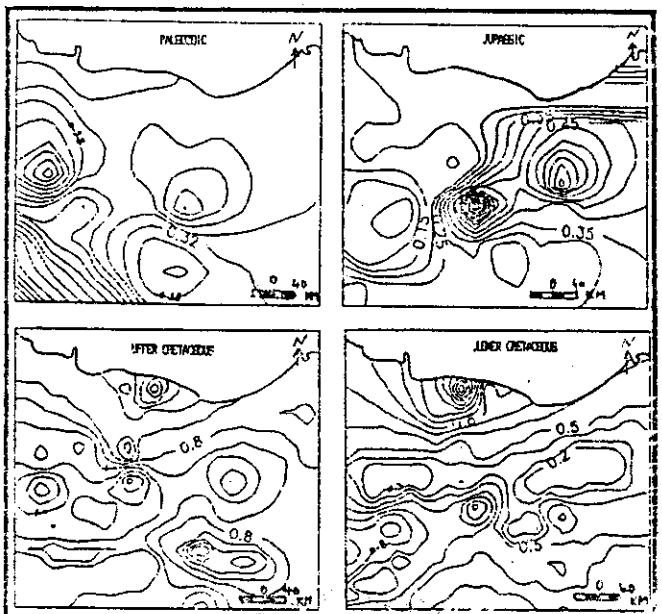

FIG.5: ISOPACH MAPS OF PALEOZOIC, JURASSIC, LOWER AND UPPER CRETACEOUS

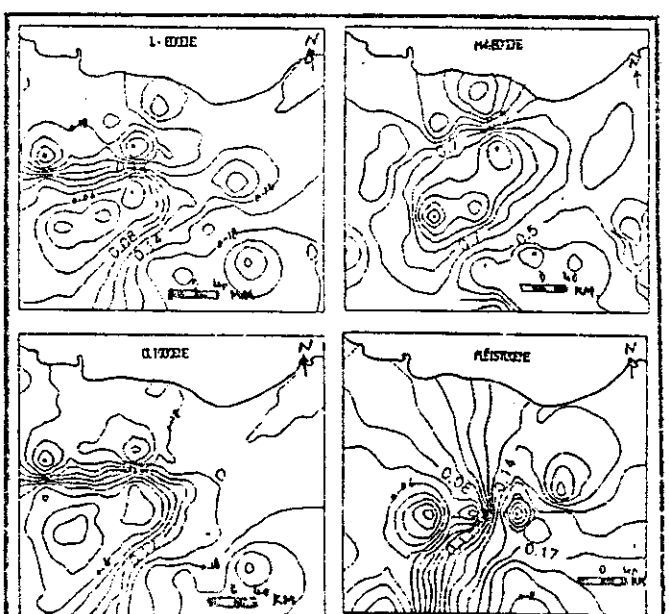

FIG.6: ISOPACH MAPS OF EOCENE, OLIGOCENE AND PLEISTOCENE

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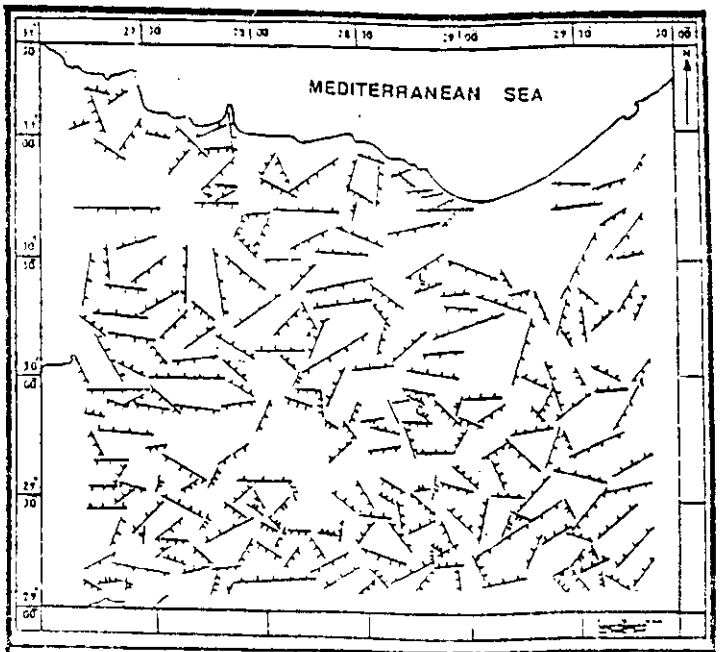

FIG. (7): FAULT SYSTEMS INTERPRETED FROM THE RESIDUAL MAP IN THE BITTER AREA.

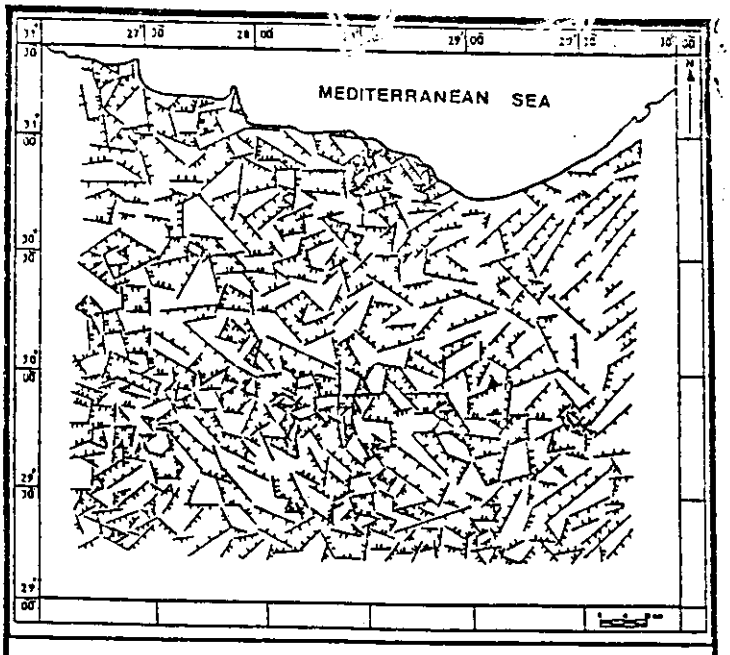

FIG. (8): A MAP SHOWING THE FAULT ELEMENTS BISECTING THE DEPTH RANGE OF 5 km.

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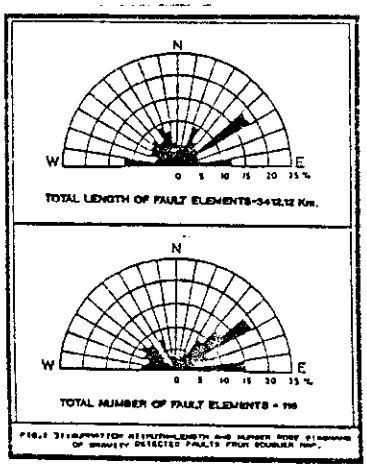

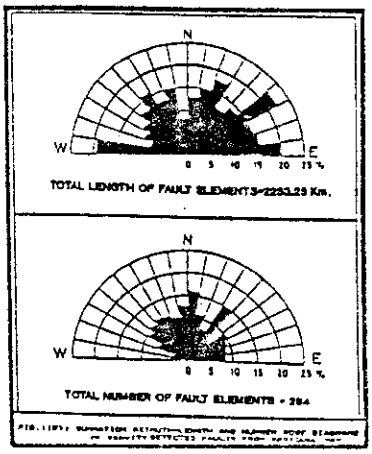

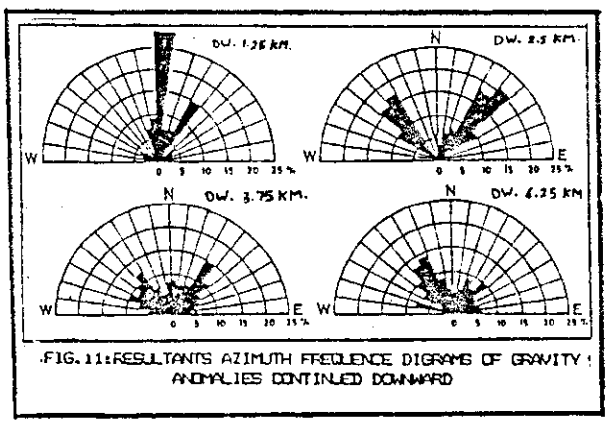

FIG. 11: RESULTANTS AZIMUTH FREQUENCE DIGRAMS OF GRAVITY ANOMALIES CONTINUED DOWNWARD

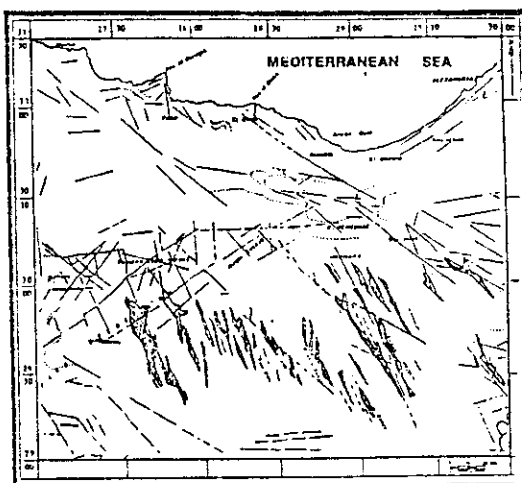

FIG. (12): A STRUCTURAL LINEAMENTS MAP BASED ON LANDSAT-1 IMAGE INTERPRETATION AND FIELD INVESTIGATIONS OF THE STUDY AR (AFTER EL-SHAILY ET. AL., 1980)

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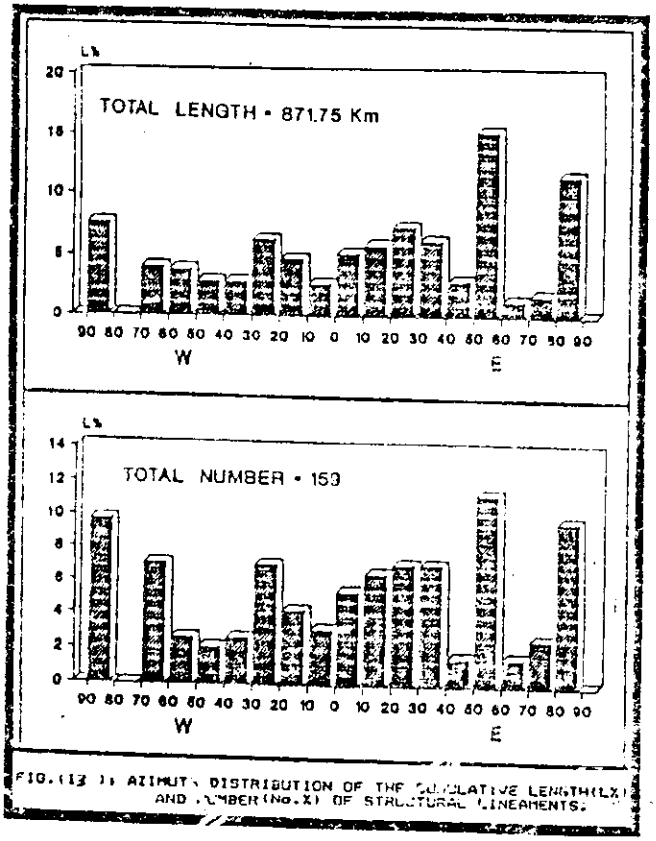

FIG.(13): AZIMUTH DISTRIBUTION OF THE CUMULATIVE LENGTH(LX) AND NUMBER(No.X) OF STRUCTURAL LINEAMENTS.

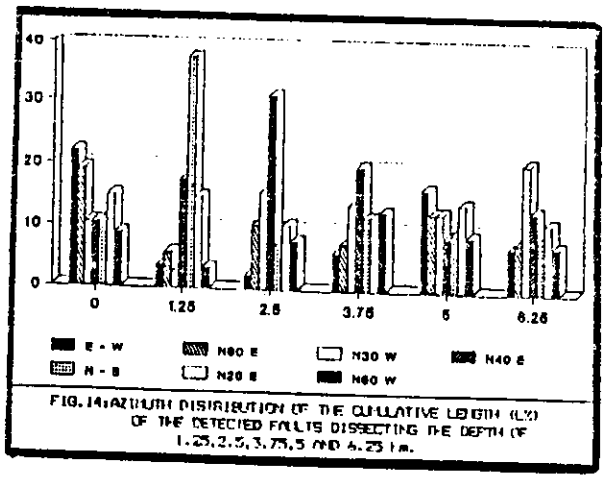

FIG.14:AZIMUTH DISTRIBUTION OF THE CUMULATIVE LENGTH (LX) OF THE DETECTED FAULTS DISSECTING THE DEPTH OF 1.25,2.5,3.75,5 AND 6.25 Km.

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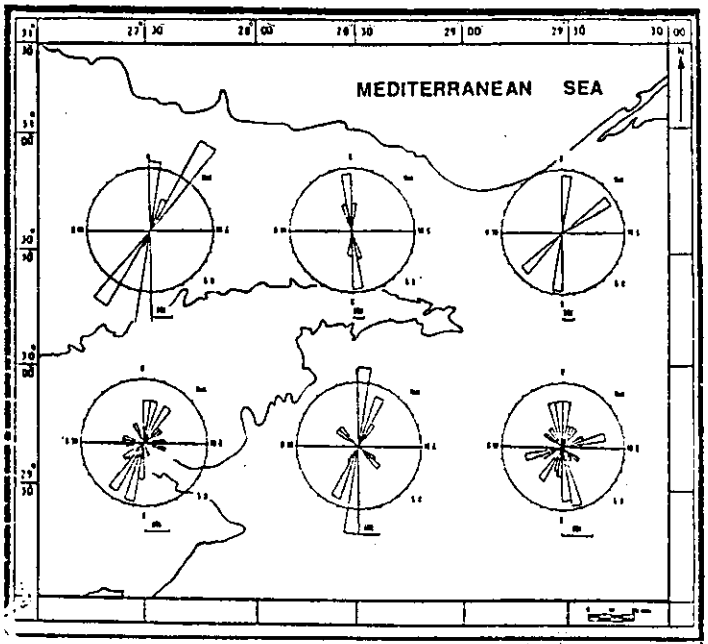

FIG.(15): ROSE DIAGRAMS OF THE CUMULATIVE (LX) AND (NX) OF THE DETECTED FAULTS FROM CONTINUED DOWNWARD TO A DEPTH 1.25 km.

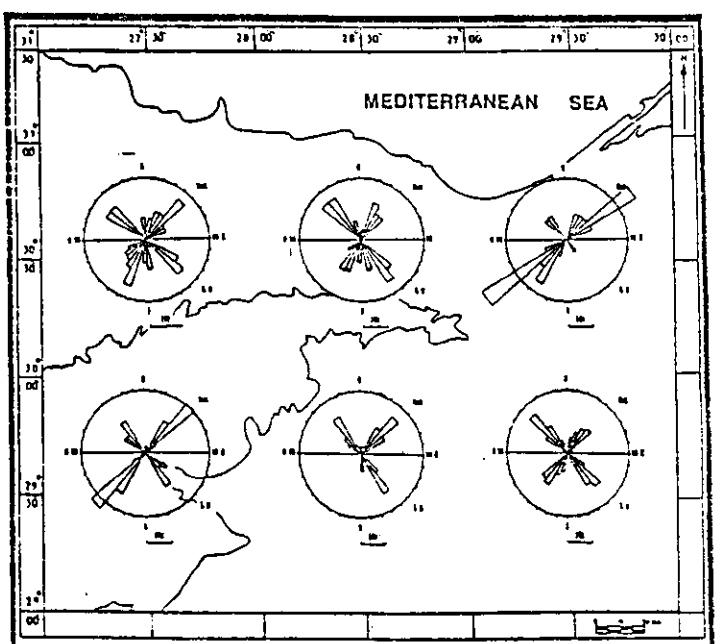

FIG.(16): ROSE DIAGRAMS OF THE CUMULATIVE (LX) AND (NX) OF THE DETECTED FAULTS FROM CONTINUED DOWNWARD TO A DEPTH 2.5 km.

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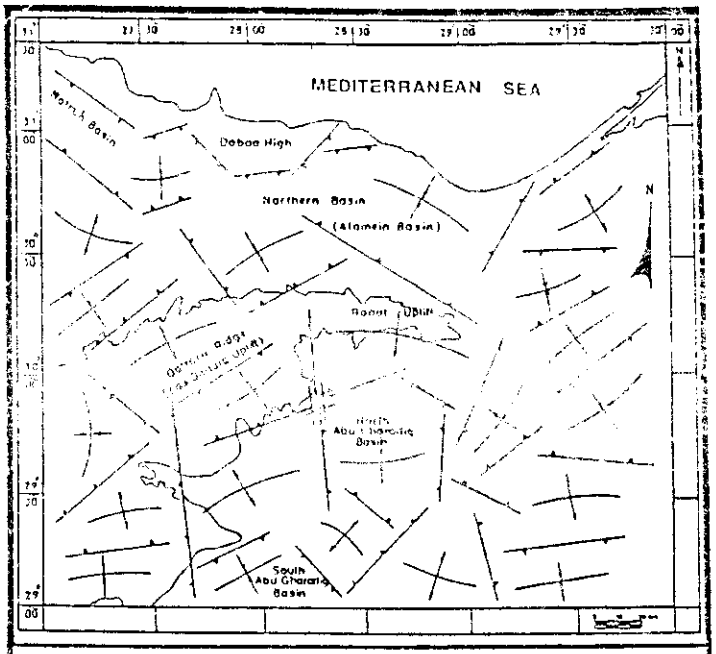

FIG.(17): TECTONIC BASEMENT RELIEF MAP OF THE STUDY AREA.

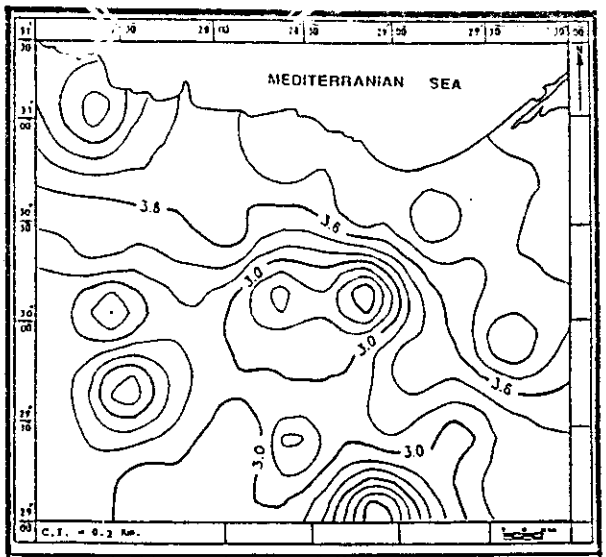

FIG.(18): BASEMENT RELIEF MAP OF THE STUDY AREA.

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اضافات لتكتونيه شمال الصحراء الغربيه

محمد شرف الدين حافظ نعيم
قسم الجيولوجيا ـ كلية العلوم ـ بنها ـ جامعة الزقازيق

بنى البحث على التحليل الاحصائى لتحديد الاتجاهات التكتونيه الرئيسيه الموجوده فى خرائط مجال البوجير والمتبقيات والتواصل التثاقلى التنازلى للجاذبيه الارضيه باستخدام طريقه عدديه بيانيه وأمكن استنتاج سبعه اتجاهات تكتونيه رئيسيه على اعماق مختلفه مابين الرسوبيات والركيزه المعقده وعمق القشره الارضيه وقد تبين أن المنطقه قد تعرضت لمجال قوتين تكتونيتين خلال الاحقاب الجيولوجيه المختلفه احداهما يحتمل حدوثه نتيجه التفاعل بين أفريقيا وأوربا والاخرى يعزى الى تكتونيه البحر الاحمر وأمكن التعرف من خلال خرائط isopach والتواصل التثاقلى التنازلى للجاذبيه على اربع دورات تكتونيه مختلفه تعرضت لها المنطقه وايضا أمكن استنتاج خريطه طوبوغرافيه وأخرى تكتونيه لسطح الركيزه المعقده والاتجاهات التكتونيه المختلفه عليهما.