MAJOR TECTONIC FEATURES IN SOUTHEAST MEDITERRANEAN

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ABSTRACT. — To bring out major tectonic trends, two statistical trend analysis were applied to Bouguer anomalies. First one is a simple graphical-numerical method which is a reliable technique to detect all the tectonic features present. The second method is a two-dimensional autocovariance which is applied to different residual fields in order to detect predominant features at different depths in the crust. By applying the two techniques, authors were able to recognize with a good degree of certainity seven main trend directions: E-W, N60°E-S60°W, N60°W-S60°E, N40°E-S40°W, N30°W-S30°E, N-S, and N20°E-S20°W. Two trend directions, N60°W-S60°E and N20°E-S20°W presumably represent tectonic features that only affect shallow depths, and the rest represent features that affect shallow and deep horizons.

INTRODUCTION

The graphical technique was initiated by Buchheim and Hauterbach (1954) to analyse micromagnetic measurements, developed by Neuman (1959) and Kaspar (1962). Another graphical-numerical method has been proposed by Affleck (1963), and applied by Munde (1969) and Tealeb (1977) statistical techniques are used to analyse large number of discete geophysical values in order to define trends and intersities of trends.

Values to be analysed can either be picked up directly from the map or can be obtained by interpolation. Two methods of analysis have been proposed: The triangle method by Kaspar (1962) which can be applied directly to the measured data, and the method of two-dimensional autocovariance analysis by Horton et al. (1964), to be applied over number of grid-points. The triangle method has been modified by Henkel (1962) using electronic computers. It was concluded by Munde (1969), Marcak (1973) and Tealeb (1977) that the method of two-dimensional autocovariance analysis is suitable to investigate the earth's crust, and to differentiate between the deep (regional) and shallow (local) features.

Main purpose of this work is to estimate predominant features of the investigation area, by analysing Bouguer anomalies, using graphical-numerical Affleck (1963) and two-dimensional autocovariance techniques Horton et al. (1964). To separate different residual fields, methods of trend elimination with polynomaials of first and second orders Agocs (1951) and Zurmuehl (1975) and filter techniques Kertz (1966) were used.

TECHNIQUES OF ANALYSIS

Graphical-numerical technique

Axes of the anomalies on the map is drawn. Length and directions (azimuth measured clockwise from the geodetic north) of the axes are measured. Lengths of the anomaly axes weighted for a fixed azimuth interval (10°) are summed up and the relative frequency distribution are computed. Results of the analysis is represented in polar and cartesian coordinates as rose-diagrams and frequency curves or histograms respectively. High frequencyies of the rose-diagrams or the frequency curves and the common maxima of the histograms represents the predominant trend direction of the anomalies.

Two-dimensional autocovariance technique

For discrete samples $f(X, Y)$ in a -square grid at regular intervals, the autocovariance functions $R(r,s)$ and $R(r,-S)$ has been defined as (Horton et al., 1964).

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$$R(r,s) = \frac{1}{(N-r)(N-s)} \sum_{X=1}^{N-r} \sum_{Y=1}^{N-s} f(X,Y)\, f(X+r,\ Y+S)$$

$$R(r,-S) = \frac{1}{(N-r)(N-s)} \sum_{X=1}^{N-r} \sum_{Y=S+1}^{N} f(X,Y)\, f(X+r, Y-S)$$

$$r, S = 0, 1, 2 \ldots\ldots\ldots\ldots\ldots\ldots m.$$

Where r and S are the possible displacements in X and Y directions respectively. N is the number of samples and m is the maximum permissible pitch of correlation (m1/5 N). According to the symmetrical property of the autocovariance, the function R (-r, -S) and R(-r, S) need not to be computed, because R (-r, -S) = R (r,S) and R (-r, S) = R (r, -S).

The calculated autocovariance values is plotted against the variable (r, S). A contour map is then constructed from these values. Direction of maximum autocovariance, e.g. high correlation, represent the predominant trend direction of the analysed anomalies.

TREND INTERPRETED FROM THE ANALYSIS OF THE BOUGUER ANOMALY MAP

Graphical-numerical technique

The technique applied to a Bouguer anomaly map of the area with 1:500.000 scale and 1 m/S^2 (mGal) contour interval. The map area is divided into ten sectors, with each sector having similar geological and morphological characteristics. The results are presented in Figure 1 on a rose diagram. By examining the results closely, as seen in Table 1, frequency distributions differ from one sector to other. Seven major groups of trends can be recognized, each one within a spectrum of 20° around the main direction. Results of the interpretation are seen to be in agreement with those of Halsey and Gardner (1975) and Tealeb (1977). Table 2 shows the frequency distribution of these results in ten sectors. Figure 2 shows the summary of the distributions, where seven major trends are recognized. In Table 3 it is seen that the frequency distribution.

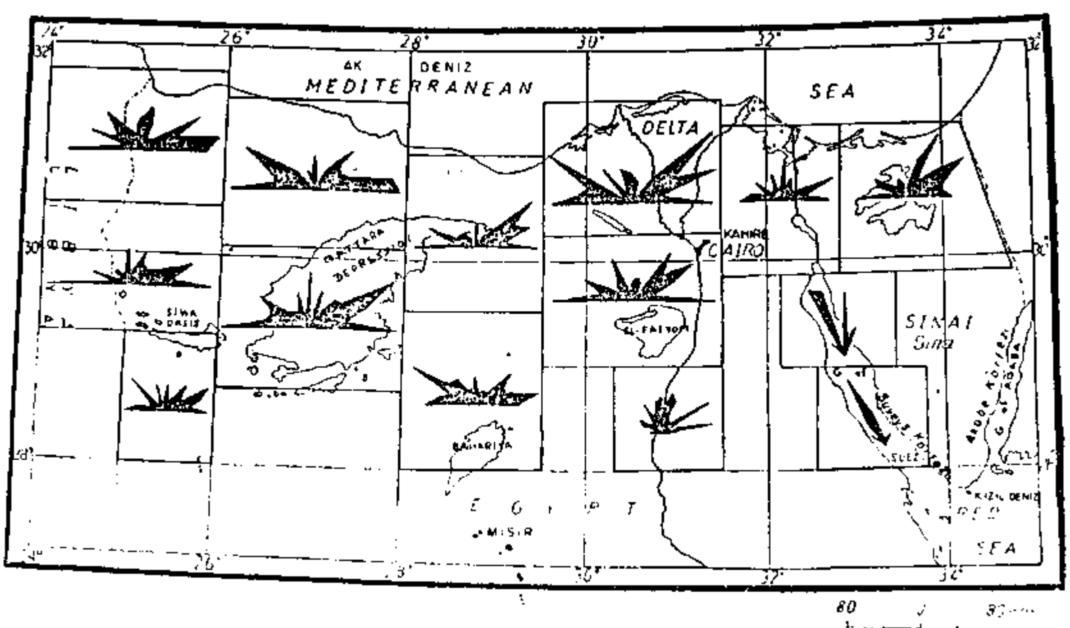

Fig. 1 - Tectonic trends of the Bouguer anomaly of Southeast Mediterranean.

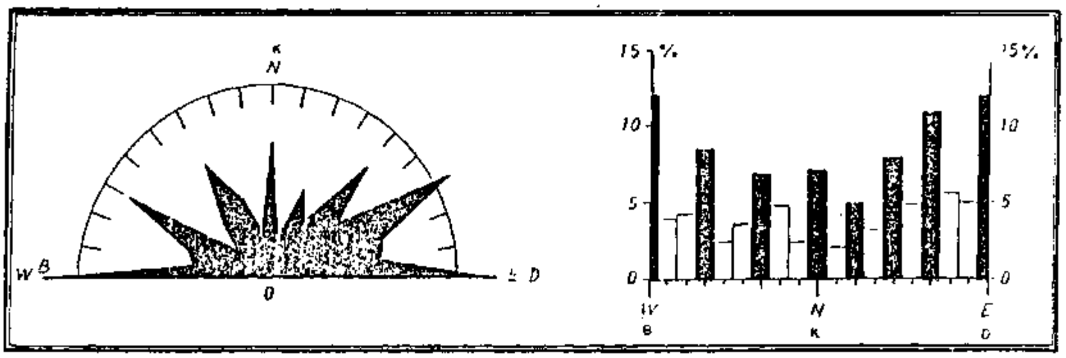

Fig. 2 - Rose-diagram and histogram represent the predominant anomaly trends in Southeast Mediterranean.

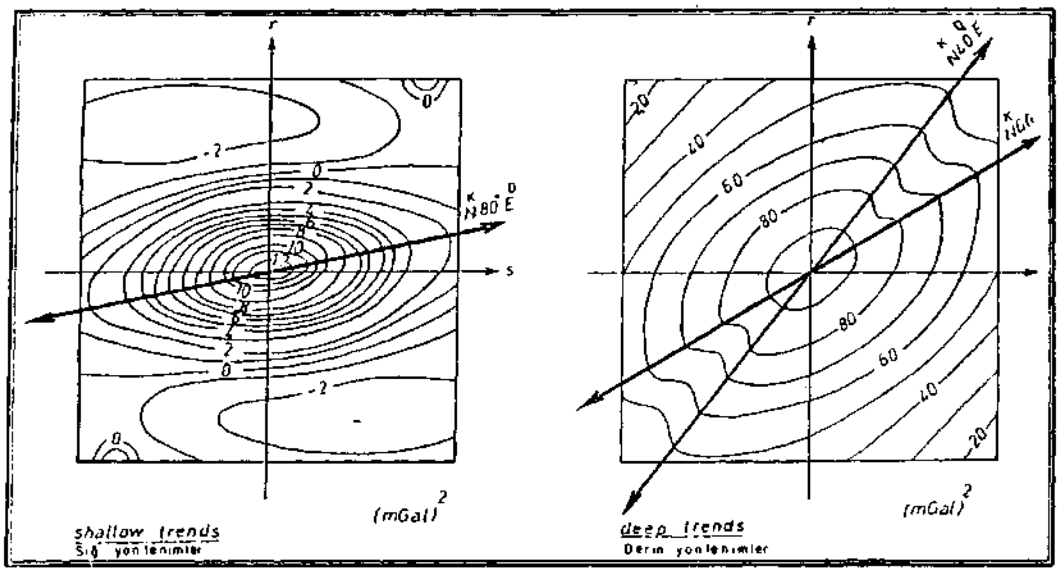

Fig. 3 - Autocorrelation functions of two residual fields represents shallow and deep structures in Southeast Mediterranean.

Trends interpreted from autocovariance

The analysis is carried out on the residual fields of 30 overlaped sectors. It includes two homogeneous residual fields after low-and high-pass filter of Bouguer anomalies Kertz (1966) and Tealeb (1977) and four homogeneous residual fields after elimination of linear and quadratic trend from both Bouguer and its filtered gang, Agocs (1951) and Zurmuehl (1975). The technique is seen to be a helpful tool to delimate trends within sedimentary horizons down to the basement. Figure 3 demonstrates the autocovariance functions of two residuals in Bahariye area; one of which represents shallow zone, the other deep zones trend. Predominant trends at shallow and deep zones are shown in Figure 4 and 5.

Table 1 - Predominate anomaly trends picked in SE Mediterranean

		Subarea									
Mean trends	*Trends limits*	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*
E - W	N80°W - N80°E	E-W	E-W	E-W	E-W	E-W	E-W	E-W	E-W	E-W	
N60°E	N70°E - N50°E	N60°E		N60°E	N60°E	N60°E	N60°E	N60°E	N60°E	N60°E	
				N40°E	N40°E	N40°E				N40°E	
N40°E	N50°E - N30°E		N30°E				N30°E				
N20°E	N30°E - N10°E	N20°E						N20°E		N20°E	N20°E
N-S	N10°E - N10°W			N-S	N-S	N-S	N-S	N-S	N-S	N-S	N-S
			N20°W				N20°W	N20°W			
N30°W	N20°W - N40°W			N30°W		N30°W			N30°W	N30°W	N30°W
		N40°W			N40°W						
			N50°W	N50°W			N50°W	N50°W			
N60°W	N50°W - N70°W				N60°W	N60°W			N60°W		N60°W
		N70°W		N70°W						N70°W	

Table 2 - Distribution of the anomaly trends predominate on the Bouguer anomaly map SE Mediterranean

Trend direction	Reference name	Trend limits	Subarea I	II	III	IV	V	VI	VII	VIII	IX	X	Total area
E-W	Tethyan	N80°W - N80°E	23.5	27.7	22.0	23.0	19.1	24.4	24.0	25.2	19.1	0.0	20.7
N60°E	Qattara	N70°E - N50°E	20.0	17.6	24.0	18.6	24.5	21.6	22.2	19.0	20.5	0.0	18.8
N30°W	Suez	N20°W - N40°W	10.3	7.6	7.4	11.7	11.1	9.6	10.2	8.1	17.0	60.0	15.3
N60°W		N50°W - N70°W	13.2	21.4	10.4	19.0	12.4	12.9	14.0	24.6	12.2	10.9	15.1
N40°E	Aualitic	N50°E - N30°E	7.0	13.5	24.6	17.8	10.3	12.2	11.5	12.6	10.5	0.0	12.0
N-S	E. African	N10°E - N10°W	16.0	4.5	5.5	8.1	10.5	11.5	11.1	5.5	9.8	22.5	10.5
N20°E	Aqaba	N30°E - N10°E	10.0	7.7	6.1	1.8	12.1	8.8	7.0	5.0	10.9	6.6	7.6

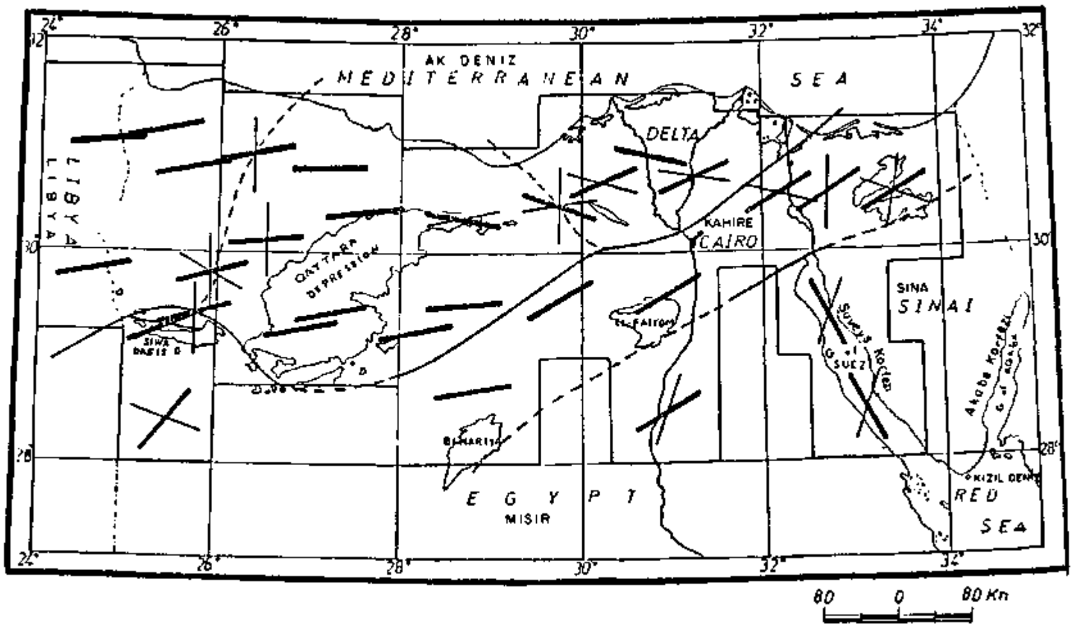

Fig. 4 - Trends of the shallow structures in Southeast Mediterranean.

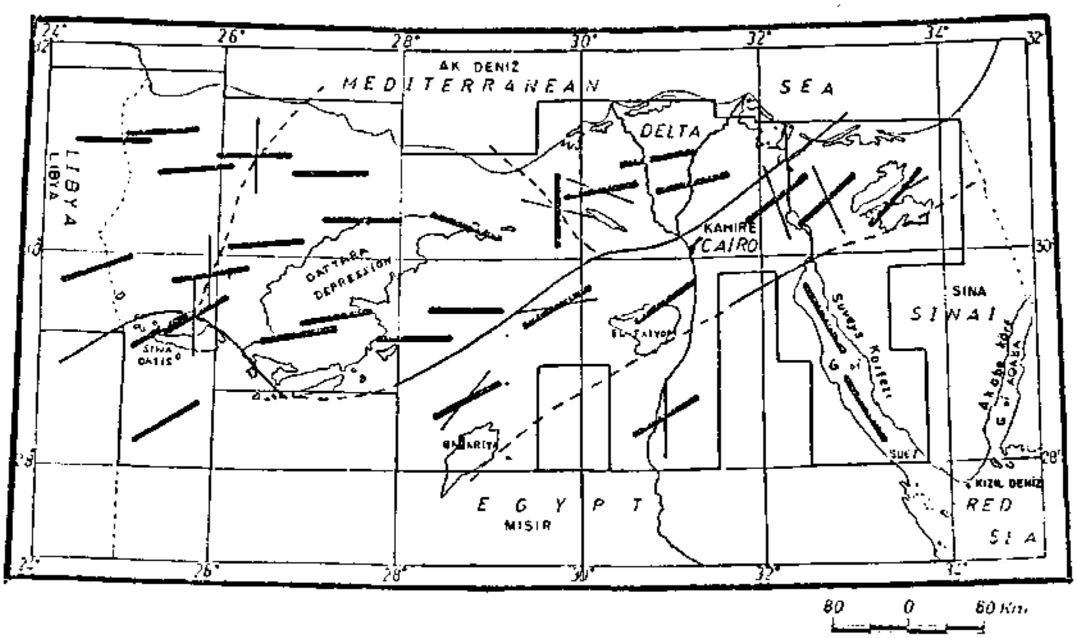

Fig. 5 - Trends of the deep Structures in southeast Mediterranean.

Table 3 - Distribution of the anomaly trends predominate in the Bouguer anomaly map of SE Mediterranean (except X)

Trend direction	*Reference name*	*Trend limits*	*Distribution of the anomaly lengths %*
E-W	Tethyan	N80°W - N80°E	23.0
N60°E	Qattara	N70°E - N50°E	20.9
N60°W		N50°W - N70°W	15.6
N40°E	Aualitic	N50°E - N30°E	13.3
N30°W	Suez	N20°W - N40°W	10.3
N-S	E-African	N10°E - N10°W	9.2
N20°E	Aqaba	N30°E - N10°E	7.7

CONCLUSIONS

The statistical trend analysis presented above provided us with valuable information on the tectonic trends in the area. The graphical-numerical method is useful for determining trends of major and minor extends, where as the second method is helpful in recognising trends at different depths. There are seven major trends differentiated (E-W, N60°E, N60°W, N40°E, N30°W, N-S and N20°E). These trends are noticed to coincide with lineaments extracted from satellite images. Some trends are observed at both deep and shallow zones (E-W, N60°E, N40°E, N-S, and N30°W). They are believed to be developed by tectonic movements initiated possible in Precambrian and rejuvenated later possible Late Tertiary. The N20°E and N60°W trends, however, represent shallow depths. They are believed to be developed in recent geologic times, possibly Late Tertiary.

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