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THE HEAVY MINERAL DISTRIBUTION AND CHANGES IN BOTTOM CONFIGURATION OF LAKE QARUN, WESTERN DESERT, EGYPT

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ABSTRACT

The present work deals with the use of heavy mineral contents as a tool explaining the contemporaenous changes in the bottom cinfiguration of lake Qarun.

For this purpose the heavy mineral analysis was carried on eleven samples out of 39 sediment samples collected from the bottom of lake Qarun in sept. 1986.

On the basis of the heavy mineral distribution, the area under investigation can be divided into 2 main zones, one shallower than 3 meter deep and the other deeper than 3 meter.

The annual rate of deposition varies between 1.3 cm/year in the eastern part of the lake and 2.06 cm/year in the western part.

The contemporaneous changes in the bottom relief in lake Qarun may be attributed to materials delivered to the lake from different sources.

The most important factors affecting these deposits are wind and biological interference in addition to an amount of materials drained to the lake through the drainge pattern and recycled by currents and waves.

INTRODUCTION

Lake Qarun is the lowest portion of El-Faiyum depression. The surface of this depression is almost flat and slopes rapidly westward from + 23 m near Madinet El-Faiyum to -51 m at lake Qarun. The surface of this depression is mainly occupied by fluvial and lacustrine deposits forming a series of terraces at various levels (+25 m, +30 m and +45 m). The depression is bounded by high lands, like Gebel El-Naulun (+ 127 m) and Gebel El-Lahun (+144 m), (fig. 1) which separate it from the Nile valley (Beadnell, 1905).

Southwest lake Qarun there is a conspicuous depression called wadi El-Rayan, which has an area of about 1300 Km2 and altitude ranging between -59 m and zero. The surface of wadi El-Rayan depression is almost occupied by many scattered sand dunes (Sandford & Arkell, 1929).

Lake Qarun is an irregularly closed basin. It lies northwest El-Faiyum depression, at level of about -51 m, it has an area of about 245 km2 with surface water level 43.3 m below sea-level (Dahab, 1988). It is located between latitudes 290 20 N and 290 30 N and longitudes 300 23 E & 300 50 E (Fig. 2).

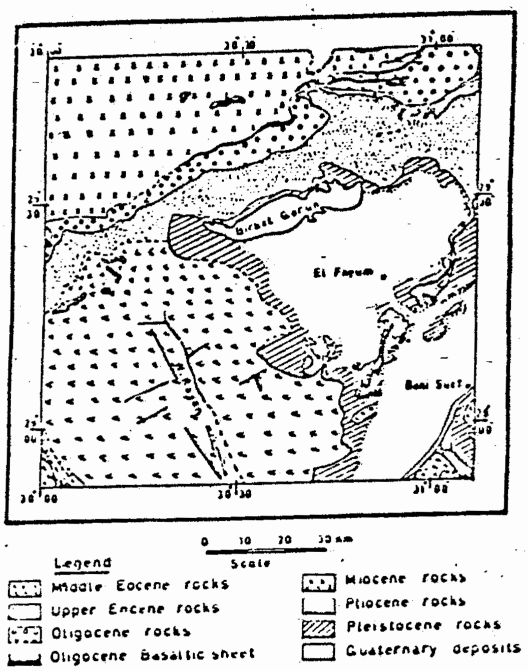
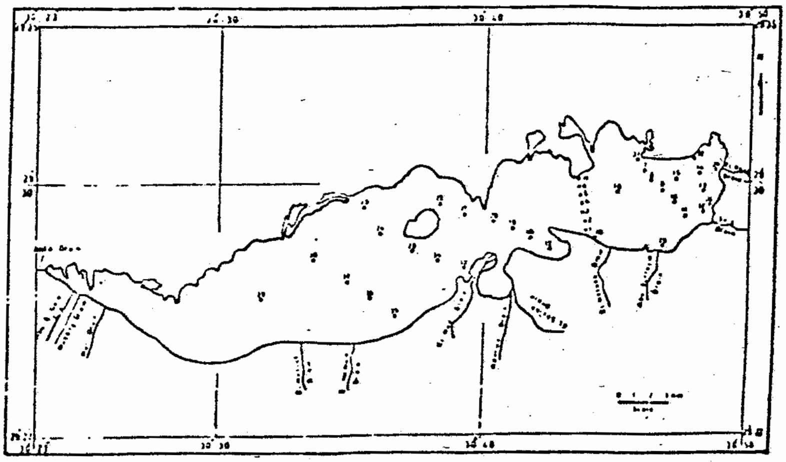


Fig.(1): Geological map of El Faiyum district (after Beadnell, 1905 b, and Sandford and Arkell, 1929).



Fig(2): Station location map showing the distribution of thirty-nine sediment samples collected from Lake Garun.

The Recent bottom sediments studied from lake Qarun varies in lithology from muddy to shelly gravels. Addmixed sediments are also present (Mohamed, 1990). Their carbonate content is moderate and varies from one locality to the other, possibly due to different rates of supply of peolian material (Mohamed and Dahab, 1989).

Samples and Techniques of Study :

Eleven samples out of 39 sediment samples were collected from the bottom of the lake for heavy mineral analysis. The samples collected from a depth varies between 0.3 m and 5.3 m. There sand fractions were separated from each sample through a set of sieves with mesh openings 0.0625 mm, 0.125 mm and 0.25 mm. The fractions obtained were washed with distilled water and ethyl alcohol to dissolve any greasy material present. The heavy and light minerals of each fraction were separated with Bromoform (2.85), and the index figures were determined.

A portion of each heavy mineral fraction was separately mounted using canda balsam and microscopically examined. The relative frequencies of the heavy minerals were determined by counting about 300 grains from each sample. The data obtained is given in Table (1 & 2).

Table [illegible]: The data derived from heavy mineral analysis

Station No	Depth m	Total weight	Light Fraction	Heavy Fraction	Index figur	Sediment Types
2	3.00	35 (gm)	43.994	0.006	0.0018	Silty sandy shell
11	3.20	30	29.67	0.323	0.0108	Sandy Silt
15	3.30	35.37	35.215	0.155	0.004	Shally Silt
20	5.50	33.51	33.488	0.022	0.0006	Sandy shelly silt
26	0.40	31.23	30.99	0.231	0.007	Silty shelly sand
27	0.34	32.35	32.275	0.0745	0.002	Sand
28	0.30	46.08	46,003	0.0764	0.0016	Sandy clayey Silt
29	0.40	44.52	44.309	0.2117	0.004	Sand
33	0.56	49.06	48.689	0.377	0.007	Sand
36	4.25	34.92	34.49	0.021	0.0006	Cleyey Silt
39	5.37	32.50	32.46	0.031	0.00095	Shelly Silt

RESULTS

The mineral constituent composing the heavy fractions are listed in table (2). Illustrations were made showing the frequency distribution of each mineral with depth from water level (Figs. 3 to 12).

The heavy mineral description are given in the same order as listed in Table (2).

1- Rutile :

Rutile is present in reddish brown and yellowish varieties, out of which the reddish brown is the most common. It has a wide relative frequency ranging from 6.68% to 10.40% of the total heavies the relative frequency of rutile with respect to depth from water level is diagramatically shown in figure (3). From this figure, it was found that rutile generally decreases with increasing depth with marked increase at depth 3 meters.

2- Glauconite :

Glauconite is present as rounded grains with olive green colour. Sometimes it occurs within the microshells. The relative frequency of glauconite varies from 2.28% to 18.91%. Its distribution with respect to depth is illustrated in figure (4). From this figure, it is evident that glauconite

Table (2) the mineral percentage composing heavy mineral.

Sample No	Station No	Depth m	Rutile	glauconite	chlorite	staurolite	Garnet	Zircon	Mica	Amphiboles	pyroxine	opaque minerals	Shell + fragment	total heavy. M	Index Figur
1	2	3	7.62	6.77	8.89	3.38	6.35	11.01	5.93	9.74	5.08	11.44	23.72	76.21	0.0018
2	11	3.20	9.90	5.28	4.62	6.93	5.61	7.59	13.53	10.56	5.94	14.85	14.19	84.81	0.0108
3	15	3.30	10.28	11.98	5.99	4.49	4.11	8.98	7.86	8.23	2.99	11.24	23.59	76.15	0.004
4	20	5.50	6.60	13.63	3.57	4.22	2.27	8.76	8.11	6.81	3.89	13.63	14.61	71.49	0.0006
5	26	0.40	8.08	11.78	3.70	5.72	3.03	6.39	11.44	8.08	5.38	17.5	18.85	81.10	0.007
6	27	0.34	9.20	6.80	5.20	4.80	4.80	4.80	7.03	10.00	5.60	14.8	22.80	77.43	0.002
7	28	0.30	8.59	5.41	7.00	7.96	5.73	5.73	10.19	10.50	6.05	16.56	16.24	83.72	0.0012
8	29	0.40	10.40	7.23	5.42	7.23	3.61	6.33	4.42	9.95	6.33	19.00	19.90	80.02	0.004
9	33	0.56	9.25	6.76	4.62	7.82	5.69	6.40	11.03	9.96	7.47	13.52	17.43	82.52	0.007
10	36	4.25	8.10	18.91	10.135	--	--	4.72	12.16	7.43	1.35	13.51	23.64	76.315	0.0006
11	39	5.37	7.58	18.62	9.65	--	--	5.51	11.03	8.27	2.06	14.48	22.75	77.2	0.00098

has no specific trend of variation with depth. However, it increase strongly below 3 meter depth.

3- Chlorite :

Chlorite is present as rounded to subrounded grains with green colour, and diameter ranging between 0.12 mm and 0.25mm Its relative frequency varies from 3.57% to 110.13%. The frequency distribution of chlorite relative to depth is shown in figure (5). It almost increases with increasing depth except at depth 3 meters where it shows sudden decrease.

4- Staurolite :

Staurolite is represented by reddish brown to green yellow pleochroic grains with irregular autline. Its distribution is shown in figure (6). It generally decreases with depth as rutile and its reletive frequency varies from zero % to 7.96%.

5- Garnet :

Garnet is represented by two varieties, a pink dominant variety and a colourless rare one. The distribution of garnet relative to depth is shown in figure (7). From this figure, it is evident that it has a reverse relation with depth greater than 3 meters. However at depth less than 3 meter there is no distinct trend. The frequency distribution of garnet varies from zero % to 6.35%.

6- Zircon :

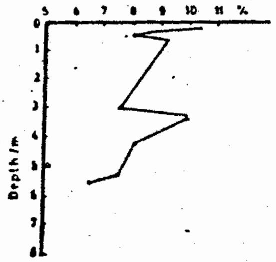
Zircon is mostly represented by small prismatic grains with rounded edges. Few bipyramidal grain or broken crystals with one pyramidal termination are also recorded. Its distribution relative to depth is shown in figure (8). From this figure, it is evident that there is no distinct relation between depth and Zircon percentage. Its frequency distribution varies from 4.72% to 11.01%.

7- Mica :

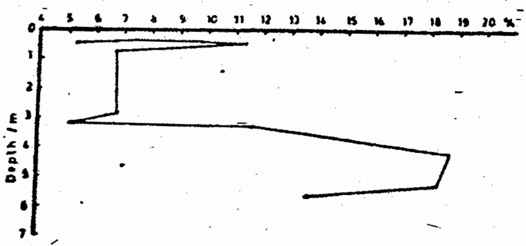
Mica is mainly represented by greenish yellow flakes with oval outlines. Falkes with irregular outline are also common. The relative frequency of mica ranges between 4.42 % and 13.53%. The daimeter of the grains ranges between 0.062 mm to 0.250 mm. The relative frequency variation of mica with depth is shown in figure (9). From this figure it is found that there is no distinct relation noticed between depth and mica contents.

8- Amphiboles :

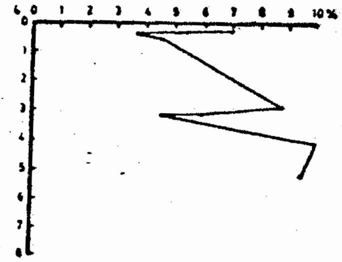
Amphiboles are mainly present as hornblende of green, bluish green and less common brownish green varieties.



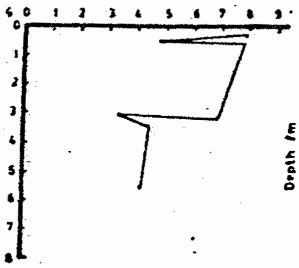
Fig(3) The frequency distribution of rutil with depth.



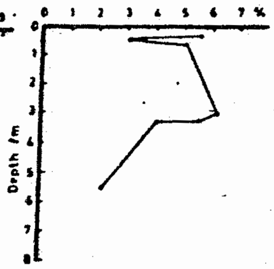
Fig(4) The frequency distribution of Glauconite with depth.



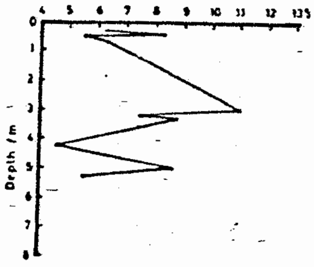
Fig(5) The frequency distribution of Chlorite with depth.



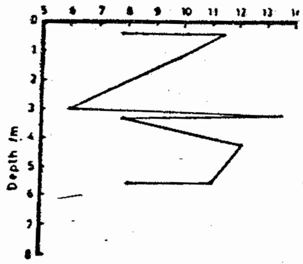
Fig(6) The frequency distribution of Staurolite with depth.



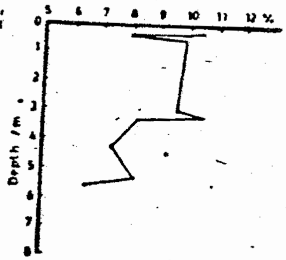
Fig(7) The frequency distribution of Garnet with depth.



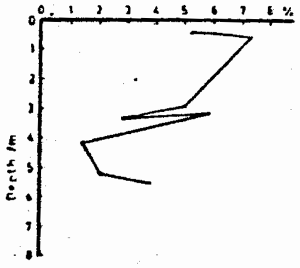
Fig(8) The frequency distribution of Zircon with depth.



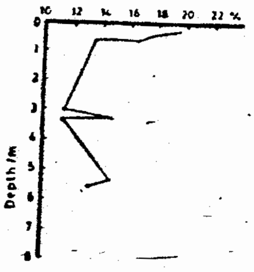
Fig(9) The frequency distribution of Mica with depth.



Fig(10) The frequency distribution of amphiboles with depth.



Fig(11) The frequency distribution of pyroxines with depth.



Fig(12) The frequency distribution of opaque minerals with depth.

Tremolite, actimolite grains are also present but in lower frequency relative to hornblende. The frequency distribution of amphiboles ranges between 6.81% and 10.5%. Their distribution with depth is shown in figure (10). They generally decreases with depth as in case of rutile and staurolite.

9- Pyroxines :

Pyroxines are mostly represented by subangular to subrounded augite grains. The relative frequency distribution of pyroxine ranges between 1.35% and 7.47%. Its distribution with respect to depth is shown in figure (11). This figure indicates that pyroxine generally decreases with depth as in case of rutile staurolite and amphiboles.

10- Opaque Minerals :

Opaque minerals are relatively the most abundant heavy minerals present. They have a relatively wide frequency ranging bewteen 11.24% and 19.99%. They include hematite, ilmenite, magnetite and limonite. These minerals were not counted separately because it is difficult to distinguish between them in transmitted light. These opaque minerals are usually present as irregular individual grains or botroyoidal grains. Hematite may partly occurs as coating on other mineral grains.

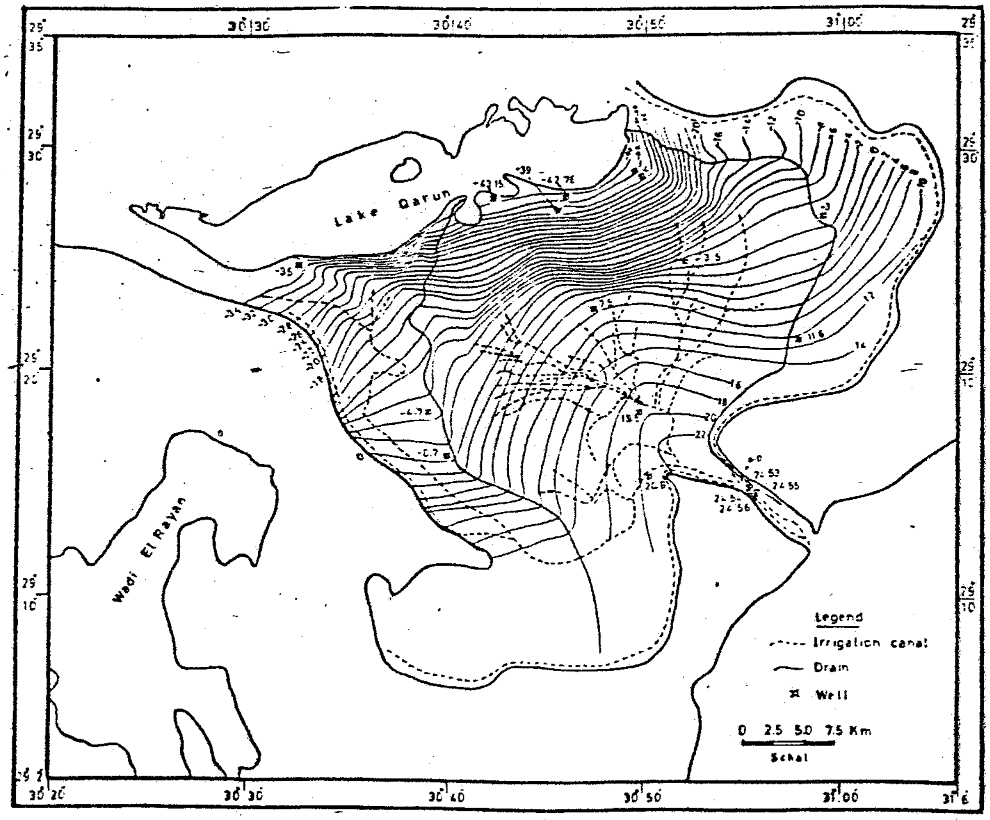
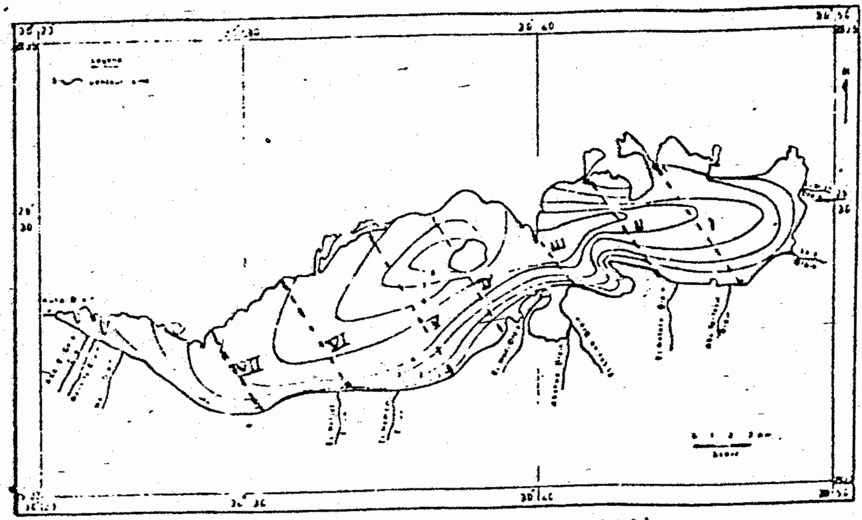
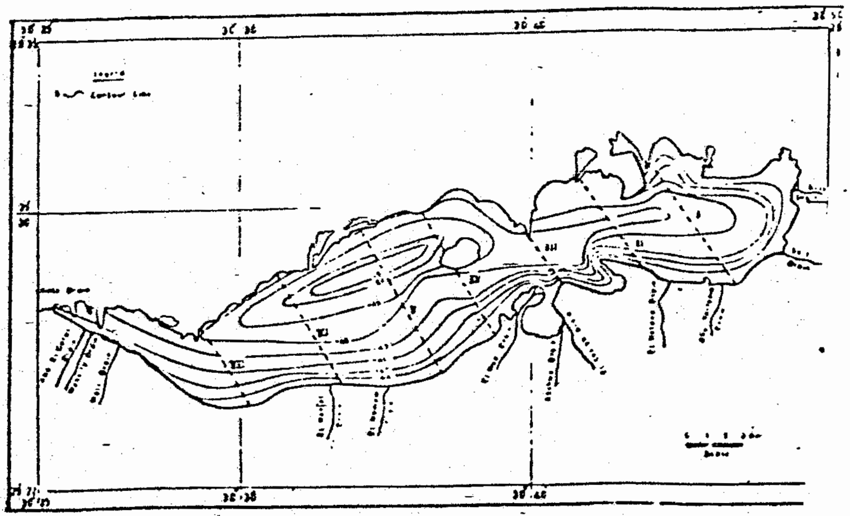


Fig.(13):Woter table mop of El Foiyum depression.



Fig(14) Depth contour map (1986)



Fig(15): Bottom configuration of Lake Qarun and the directions of profiles.
(1957)

The grains generally irregular to well rounded. The well rounded grains are abundant in the samples collected at depth less than 3 meter, whereas the irregular grains are abundant in the samples collected at depth greater than 3 meter. The diameter of these grains varies between 0.06 mm and 0.25 mm. the relative distribution of opaques with respect to depth is graphically shown in figure (12). From this figure, it is observed that above 3 meters depth of water, opoques decreases with depth, whereas at depth greater than 3 meters, opaques increases with depth, Their distribution very similar to that of glauconite.

DISCUSSION

For interpreting the frequency distribution of each mineral, it is necessary to take into account the environmental condition under which the heavy mineral were deposited.

From the frequency distribution curves, it is found that, the area of lake qarun can be tentatively subdivided into 2 main depth zones, ~~one~~ shallower than 3 meters depth and the other deeper than 3 meters. The first zone is characterized by currents which play a great role in the distribution of heavy minerals in the recent sediments.

The elevation of water surface produced by wave drift currents against the shore constitute a normal outward force which inturn is blanced with the inward discharge by waves. Such state of equillibrium exists on the average over a sufficient length of shore (Inman, 1964). In the case where the waves are not perpendicular to the shoreline a local disequillibrium is found. This results in the formation of longshore currents which runs parallel to the shoreline. Consequently, the generated longshore currents are responsible for the lateral transport inside the shallower zone. The lakeward transport is mainly due to the rip currents, generated from the longshore currents. The position of the rip currents are dependent on the bottom configuration & coastal morphology as well as the hight and the period of the waves. Therefore, the areas less than 3 meters depth may be affected with the near surface circulation system of currents. However, the areas of the second zone (deeper than 3 meters) may be affected with the wind generated currents which are dominant through out the year.

The water level of lake Qarun was estimated by Dahab (1988) when he studied El-Faiym depression as -43.3 m (Fig. 13). An atempt was made to find out the contemporaneous

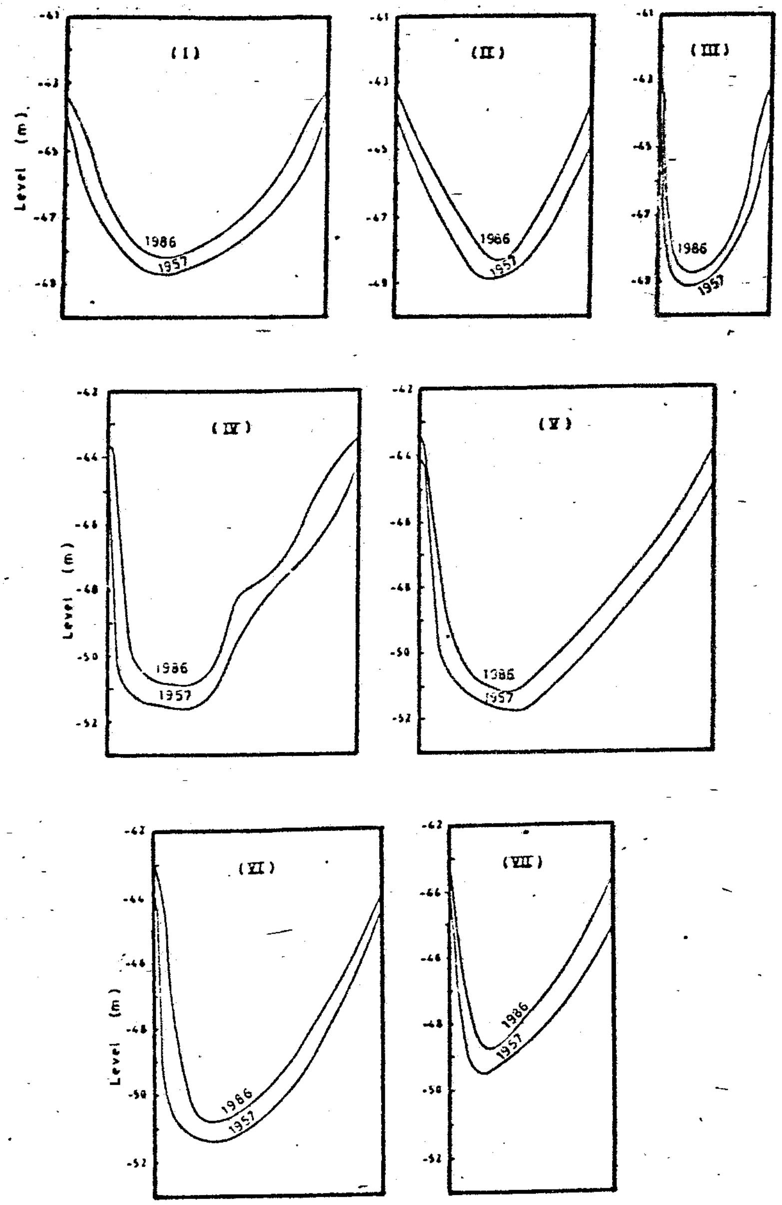


Fig.(6): Profiles show the contemperaneous change in the bottom releif, of Lack Qarun.

changes in the bottom configuration through the last 29 years. For this reason two bathymetric maps are compared, one based on the depth recorded in the year 1957 and the other based on the depth measured by the author (1986). To facilitate the comparison, profiles were made on both maps, which attain the same position (fig. 14,15).

From these figures, it was found that, the average thickness of the deposite is variable. Thus the average thickness of deposits recorded in the eastern portion between 1957-1986 is about 40 cm. (i.e.) about 1.3 cm/year. However, the average thickness of deposits recored in the western portion of the lake between 1957-1986 is about 60 cm. (i.e.) about 2.02 cm/year.(Fig. 16).

In order to know the causes which affected the annua variation in the rate of deposition in the lake, the heav minerals distribution were used to determine the differen sources of material composing lake deposits.

From the frequency distribution of heavy minerals, it wa found that the opaque minerals were delivered from the shor to the inner lake by rip currents and laterally by longshor currents through the zone less than 3 meter depth. Th opaque minerals which are recorded at relatively greate depth (more than 3 meter) are characterized by botoryoidal grains that may be attrributed to the action of bacteria which are able to extract iron from the lake water (Zobell, 1942), Indcate saline water origin.

The mica is present mainly as flaky grains which can be transported in suspeusion as floated grains in the direction of the carrier currents. The mica is deposited when the current attains minimum velocity or oriented through its edge. Thus the relative low abundance of mica nearshore may be due to their hydraulic nature which prevent their settling in the high energy environment (malvina, 1966), Indicating quite energy environments.

Similarly, the pyroxines and amphiboles may be transported with currents due to their cleavable nature and thus able them to float with currents and deposited in an areas characterized by weak currents or eddy currents (Mohamed, 1968), indicating a quite energy environments.

Under the effect of waves and wind induced currents the deposited heavy minerals are sorted and moved across the coastal area by longshore currents (Sverdrup et al., 1970). Thus staurolite and garnet are mainly derived from the shore area to lakeward direction by rip currents from placer deposits on the coast to the area of deposition on the lake bottom, gaves an indcation of terrestrial origin.

The average frequency of zircon in the present study reaches about 7.34%. This average is not in accordance with that given by Shukri (1950), when he studied the Recent Nile sediments, being less than 20% such difference may attributed to :

1- The preferential mechanical concentration of this mineral on account of its high specifie gravity (4.6).
2- Contributed from sources other than the Nile, such as the hinter land where Zircon are relatively more abundance than the Nile (Shukri & Philip, 1959, Emery & Neev, 1960).

The texture of the bottom sediments of lake Qarûn has been shown to include muddy deposits with a relatively high amount of organic matter content in addition to an amount of shelly sand deposits (Mohamed, 1990). Glauconite & chlorite may originate from a number of mother materials such as clayey substances filling cavitlies of shells and tests of organisms. Also, Glauconite may be formed from a diagenetic processes of pyroxines, feldspars and mica by a process of hydration of silica and subsequent absorption of bases and loss of alumina (Zobell., 1942). This indicate a post-deposition environment of saline sedimentay sources.

So, the material composing sediments of lake Qarun attain its sources from an interplay of marine and terrestrial sediments and affected mainly by wind and current in addition to the material from drainage parttern and biological interference.

The variation in the annual rate of deposition between the eastern and the western parts may be refered to the current propogation, variation of load material drained to the lake and salinity which causes a rapid coagulation of the suspended particles thus helping them to settle rapidly, in addition to the affect of wind induced currents.

The material drained from the main drainage pattern may be recirculated with current from eastern portion to western portion. Also, the material derived by NNW wind may be captured by water in suspension and settle rapidly due to the coagulation caused by salinity (average 40% 0). The bioloegical interference which are crowded in the western part relative to the eastern part may add more material to the bottom sediments.

CONCLUSIONS

From the foregoing discussion the following conclusions are reached:

1- The contemporaneous changes in the bottom relief in lake

Qarun may be due to varied terrestrial material delivered to the lake by wind and biological interference which added more material to the sediments, An amount of material may be added from drainage patterns.

2- The material composing sediments of lake Qarun are deposited under quiet energy environment.

3- The sediments of lake Qarun are composed from an interplay of saline water and terrestrial origin.

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