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CORE SEDIMENTS OF LAKE MARIUT, EGYPT

MASSOUD A. H. SAAD

Oceanography Department, Faculty of Science, Alexandria University.

ABSTRACT

Seven short cores were sampled from Lake Mariut to illustrate the vertical variations occurred in the deposits after they have been buried for a long time. The core samples were subjected to some physical and chemical investigations.

The density of dry mud showed a wide range of variations in all cores. The great decrease in water content with depth is due mainly to the change in the nature of the upper sediment samples as a result of the continuous supply of sewage and industrial wastes. The density of wet mud gave a clear inverse correlation with the water content. It increased markedly with depth.

Irregular higher and lower values of organic matter, calcareous substances, allochthonous materials and diatom-silica were found at different depths of all cores, giving a wide range of variations . The quantitative distribution of these components in the core sediments was found to depend mainly upon certain factors wich were discussed.

INTRODUCTION

Lake Mariut, situated along the Mediterranean coast of Egypt, is now divided artificially into four parts (Fig. 1). The lake proper, from which the cores were sampled, has an area of about 6500 feddans (one feddan is equivalent to 4200 m^2). The water depth ranges from 90 to 150 cm. The chlorosity varies form 1.09 to 2.63 g/l (Saad, 1973).

Lake Mariut receives its water from different sources; 1) drainage waters entering into the lake in large amounts via two main drains (Umum Drain transporting the water from Behira Province and Qala Drain carrying the water from the Alexandria drainage system); 2) sewage and industrial wastes discharging into the lake in considerable amounts due to the progressive increase in population and industries around Lake Mariut; 3) rain fall, which is relatively negligable in relation to the other sources, is restricted to

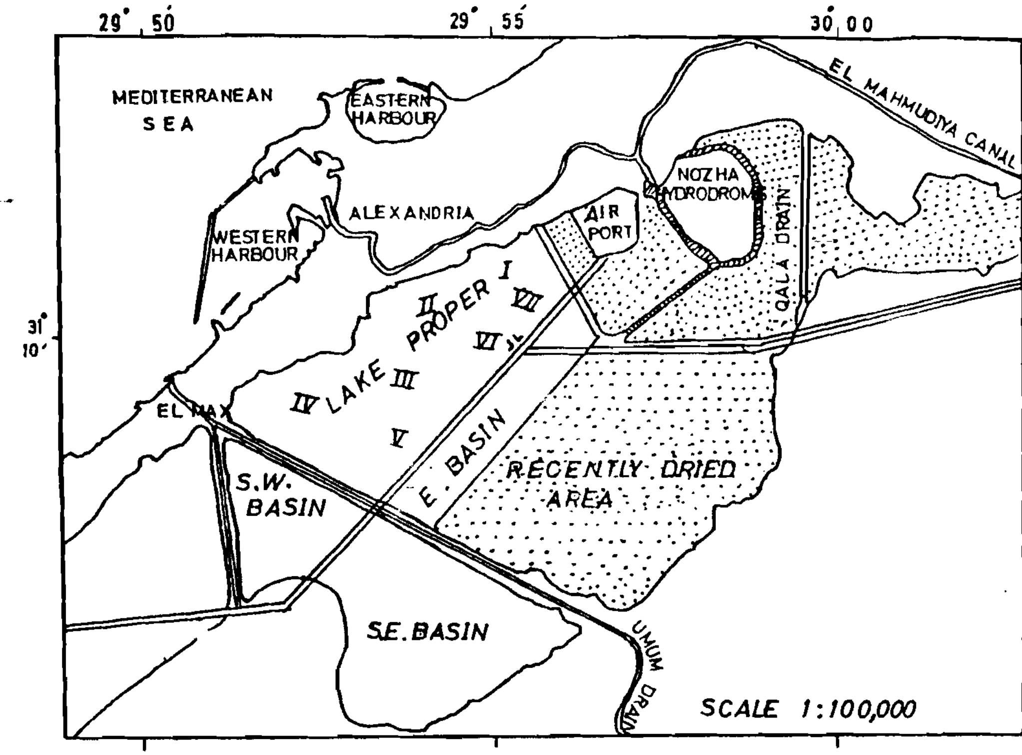

Fig. (1)
Morphometry of Lake Marlut, and position of cores.

the winter months; 4) seepage of the underground water from the surrounding area. Mex-pumps discharge the surplus water from the lake into the sea in order to maintain the lake water level at about 2.8 m below sea level. The drainage and waste waters transport to lake Mariut a considerable amount of allach thonous sediments, which are distributed by currents and water movements throughout most of the lake. These sediments are deposited on the lake bottom and constitute with the Outoch thonous deposit the total rediments of the lake.

Lake Mariut attracted the attention of several investigators, due to the infbuence of acute pollution on its envitonment. the studies corried out on this lake were mainly concentrated on its limnologicel characteristics, with porticuler reference to the problems of pollution, as well as on its fisheries. The investigations on the bottom of lake Maruit were concentrated on the swface sediments. The present work deals with the core sediments of this lake in order to illustrate the vertical variatcons in the quantitatcie compositcon of the sediments after they have been heried and presewed for a long time.

MATERIAL AND METHODS

A core sampler was devised by the author to obtain short cores from the shallow water Egyption lakes (Saad, 1976 a). Seven cores were sampled by this instrument at different regions of lake Mariut (Fig 1).

The density of wet mud was determined (on the same day of collection) by means of a pyknometer. The density of dry mud was calculated from the density of wet mud and the water content (Saad, 1970). The wet sediments were dried in an oven at 105°C to calculate the amount of water content.

The organic matter was determined, as ignition loss, by igniting about 500 mg dry mud in muffel furnace at 525°C from 4 to 5 hours (Ungemach, 1960).

The HCI soluble and insoluble fractions of the sediments were determined by adding 12.5 % HCI to the remaining inorganic parts of the deposits in conical flasks, which were heated for one hour on an electric plate. The solutions were filtered using ashless filter paper. The undissolved parts of the sediments represented the allochthonous materials plus diatom shells and the dissolved fractions were considered as calcareaus substances.

The carbonate-soluble (diatom)-silica was determined photometrically, using the method described by Mullin and Riley (1955) and modified by Tessenow (1964).

RESULTS

The values of the different components in the cores are represented as percentages per dry mud in order to give a good picture for comparing these percentages at various depths of each core and with those at the corresponding depths of the other cores (Fig. 2). These values were also calculated in Kg / m^2 wet mud in order to give a clear idea about their quantitative distribution at different localities and depths of the lake bottom. The silica content was calculated in g / m^2, due to its low value (Table 1). The everage values of the different components for all depths of the cores calculated and presented graphically in Fig. 3.

The density of dry mud showed a wide range of variations in all cores. It veried from 2.71 to 7.00 g/cm^3 in cores V and III, respectively. The surface samples of cores I, II and III gave maximum values, whereas the minimum values of these cores were recorded from the lower samples. The maximum values were found in cores IV and V at 15 and 25 cm, respectively. This condition was reversed in cores VI and VII, where the lowest values were recorded from the upper samples and the highest from the lower deposits. The average values of the dry density varied from 2.88 to 4.12 g/cm^3 in cores V and III, respectively.

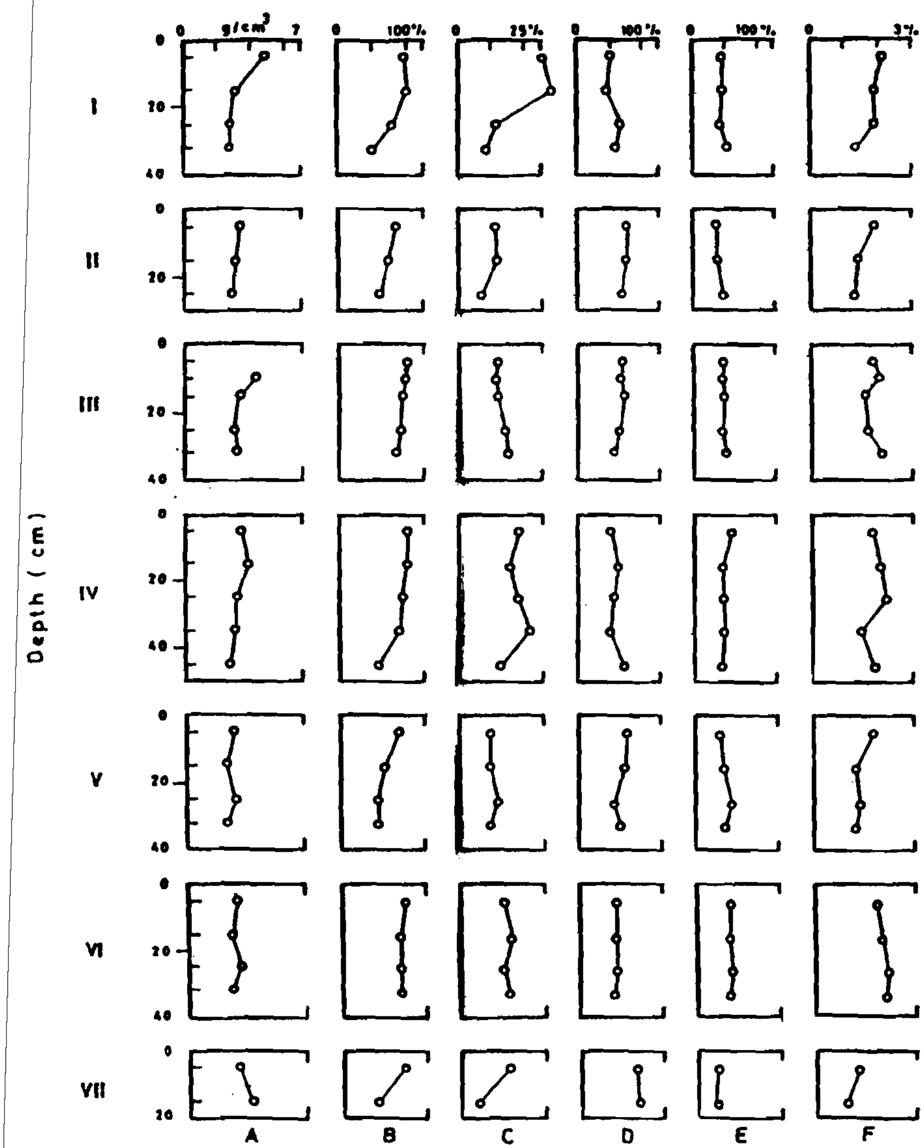

Fig. (2)
Density of dry mud, as well as the percentages of some constituents of Lake Mariut sediments.
A=density of dry mud, B=water content, C=organic matter, D=calcareous substances, E=allochthonous materials, $F=SiO_2$.

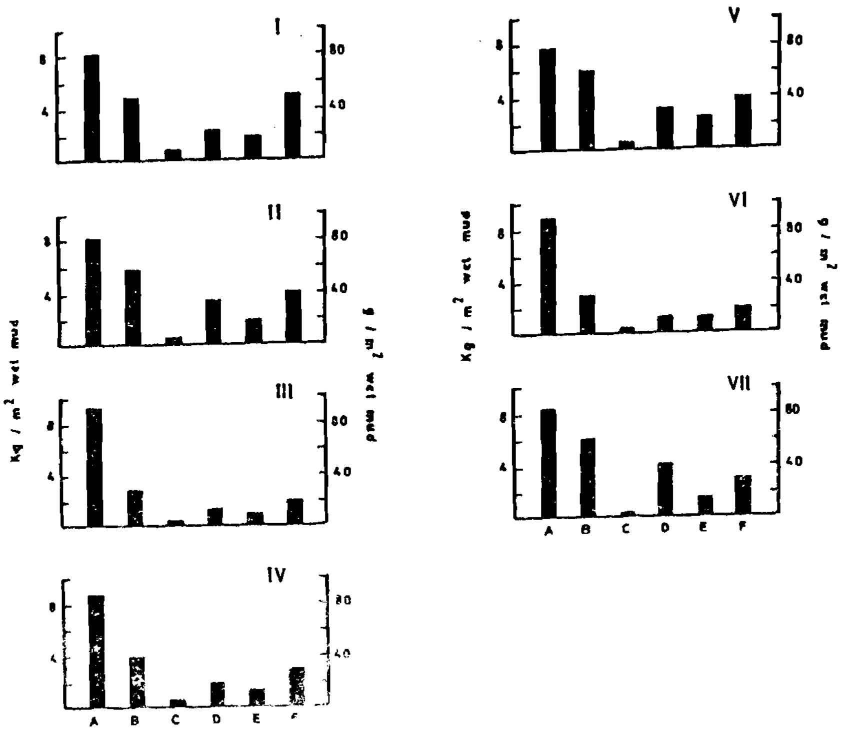

Fig. (3)
Average values of the different components for all depths of the cores.
A=water content, B=dry matter, C=organic matter,
D=calcareous substances, E=allochthonous materials, F=Si.

The minimum values of water content were recorded from the bottom samples of all cores. The maximum values, however, were found in the surface samples. The water content of the cores gave a wide range of variations. It varied from 40.27% (core I) to 82.90 % (core IV). The amount of water decreased with depth in all cores. This decrease was more pronounced in some cores than in the others. This is clear in cores I and IV where the difference in water content between the surface and bottom samples reached 2.9 and 2.4 Kg / m^2, respectively. As shown from Fig. 3, the highest average value of water content (9.2 Kg / m^2) was found in core III, and the lowest (7.8 Kg / m^2) was calculated from core V.

The density of wet mud showed a marked inverse correlation with water content. It increased, in general, on passing downwards in all cores. This increase is much pronounced in cores I and IV, where the differrence between the surface and bottom samples reached 0.39 and 0.41 g/cm^3, respectively.

TABLE 1

Density of wet mud as well as the amount of some constituents deposited in one m^2.

Sample No.	water depth (cm)	sediment depth (cm)	g/cm^3 Density wet mud	Kg/m^2 wet mud Water	Dry matter	Org. matter	Calc. substances	Alloch. materials	g/m^2 wet mud Si	Calculated SiO_2
I_1		5	1.23	9.4	2.9	0.7	1.2	0.97	30	60
I_2	70	15	1.16	9.2	2.4	0.7	0.9	0.78	20	50
I_3		25	1.31	8.4	4.7	0.6	2.5	1.53	70	140
I_4		32	1.62	6.5	9.7	0.9	4.6	4.14	60	130
II_1		5	1.29	8.8	4.1	0.5	2.4	1.16	40	80
II_2		15	1.38	8.2	5.6	0.6	3.4	1.56	40	80
II_3	100	25	1.49	7.4	7.5	0.6	4.0	2.85	50	100
III_1		5	1.18	9.7	2.1	0.3	1.1	0.68	20	40
III_2		10	1.19	9.4	2.5	0.3	1.3	0.88	20	50
III_3	140	15	1.19	9.2	2.7	0.3	1.4	0.98	20	40
III_4		25	1.20	9.0	3.0	0.4	1.5	1.08	20	50
III_5		32	1.25	8.8	3.7	0.6	1.6	1.46	40	80
IV_1		5	1.14	9.4	2.0	0.4	0.8	0.78	20	40
IV_2		15	1.17	9.4	2.3	0.3	1.1	0.88	20	40
IV_3	140	25	1.21	9.0	3.1	0.5	1.4	1.17	30	70
IV_4		35	1.24	8.8	3.6	0.7	1.5	1.38	20	50
IV_5		45	1.55	7.0	8.5	1.1	4.5	2.83	70	150
V_1		5	1.24	8.8	3.6	0.3	2.2	1.07	30	70
V_2		15	1.38	7.8	6.0	0.6	3.2	2.16	40	80
V_3	120	25	1.52	7.5	7.7	0.9	3.4	3.35	50	110
V_4		31	1.48	7.2	7.6	0.7	4.0	2.85	50	100
VI_1		5	1.19	9.1	2.8	0.4	1.2	1.18	20	50
VI_2		15	1.21	8.8	3.3	0.5	1.4	1.37	30	70
VI_3	120	25	1.23	9.0	3.3	0.4	1.5	1.37	30	70
VI_4		32	1.21	8.9	3.2	0.5	1.4	1.28	20	50
VII_1	100	5	1.20	9.1	2.9	0.4	1.8	0.68	20	40
VII_2		15	1.70	7.7	9.3	0.4	6.4	2.46	40	90

This difference is slightly higher in core VII, where an increase of 0.50 g/cm^3 was observed in the upper 10 cm. The average values of the wet density ranged from 1.20 to 1.45 g/cm^3 in cores III and VII, respectively.

Loss of weight on ignition showed a wide range of variations. The organic content ranged from a minimum of 4.69% at the bottom of core VII to a maximum of 27.64% at 15 cm of core I. The curves of organic matter of all cores gave irregular values on passing downwards (Fig.2). Higher and lower values were recorded between the top and bottom samples of the cores. The amounts of organic matter deposited on a unit area at various depths of core IV gave a marked variation than those of the other cores. These values varied from 0.3 to 1.1 Kg/m^2 at 15 and 45 cm, respectively. Figure 3 shows that the lowest average value of organic content (0.4 Kg/m^2) was calculated from cores III, VI and VII, whereas the highest average of 0.7 Kg/m^2 was found in core I.

The curves of calcareous substances gave, similarly, to those of organic matter, irregular values on passing downwards. However, the values of core III showed a decrease from top to bottom. The percentage calcareous substances had a considerable range of variations. They varied from a lowest of 37.33% to a highest of 69.28% at 15 cm depth of cores I and VII, respectively. The amounts of calcareous deposited per m^2 wet mud at various depths of core IV gave noticeable variations than those of the other cores. These values ranged from 0.8 to 4.5 Kg/m^2 in the surface and bottom samples of this core, respectively. Core VII, however, showed a sudden increase of 4.6 Kg/m^2 in the upper 10 cm. The highest average value of calcareous matter (4.1 Kg/m^2) was calculated from this core, whereas the lowest average of 1.3 Kg/m^2 was found in core VI, (Fig.3).

The curves of allochthonous materials run, as shown from Fig. 2, more or less irregular from the top to the bottom. The percentages of these materials of all core samples varied markedly. The ranged from a minimum of 23.04% at 5 cm of core VII to a maximum of 44.22% at 25 cm of core V. The allochthonous materials were deposited in variable amounts at various depths of the cores. The amounts precipitated on a unit area at different depths of core I had a prononunced variation than those of the other cores. They fluctuated between 0.78 and 4.14 Kg/m^2 at 15 and 32 cm, respectively. The calculated average values of allochthonous materials ranged from 1.02 to 2.36 Kg/m^2 in cores III and V, respectively, (Fig. 3).

The SiO_2 percentages in the samples of each core showed a wide range of variations, especially in cores I and IV, where the difference between the minimum and maximum values reached 0.74 and 0.72%, respectively. The silica content of the cores varied from a lowest of 0.96% at 15 cm of core VII to a highest of 2.20% at 25 cm of core IV. The silica content of core I, II and VII decreased markedly on passing downwards. However, the curves of SiO_2 of the other cores run more or less irregular from the top to the bottom, (Fig.2). The amount of carbonate-soluble (diatom)silica deposited at different depths of the cores per m^2 wet mud varied from 20 to 70 g Si. Between these minimum and maximum values, variable amounts of silica were precipitated on one m^2 at various depths of the cores (Table 1). The calculated average values of the diatom silica varied from 20 g Si/m^2 in cores III and VI to 50 g Si/m^2 in core I, (Fig. 3).

DISCUSSION

From the present study, it seems possible to gain sufficient information about the quantitative variations of the materials deposited down at different depths of each core. The data obtained from these depths can also be compared with those corresponding to the same depths of the other cores.

No definte conclusions could be given in the present work regarding the age of the cores. It is hoped always to solve this problem in the future in order to know the age of the Egyptian coastal lakes and to study their developmental history. This can be carried out by taking longer cores from different localities in these lakes. However, Aleem (1958) gave a rough age to the diatomite deposits collected from the Extinct Fayoum Lake (Upper Egypt). He stated that the deeper strata in this deposit (170 cm) could be tentatively dated back to the late Paleolithic or early Neolithic.

The external and internal events are greatly responsible to determine the quality and quantity of the materials deposited on the lake bottom (Saad and Arlt, 1977). In case of lake Mariut, the external events have since the last years a considerable influence on the nature composition and distribution of the lake sediments (Saad, 1976 b, 1978). The great amounts of sewage and industrial wastes entering into. Lake Mariut changed the nature of the lake bottom from its original condition (Saad, 1972c).

The studied components of the sediments showed closed curves in all cores. They were found in all sediment samples, ranging from very low to very high values. This is attributed mainly to the type and nature of the sediments reached the lake bottom.

The great decrease in water content with depth, which was noticeable in some cores than in the others, is due mainly to the change in the nature of the upper sediment samples. These deposits were soft and rich in water content, due to the continuous supply of sewage and industrial wastes (Saad, 1972c). The bottom samples of cores I, II, IV, V and VII were hard and characterized by very low values of water. This condition, however, was not found in cores III and VI, where all samples from the top to the bottom were soft with a slight decrease of water content on passing downwards. The relatively high average values of water content in these two cores are due to the enrichment of all samples with water.

The results indicate that waters content showed a clear inverse relation with the density of wet mud. The relation was observed by the author in some core sediments sampled from lake Burullus (Saad, 1966) and also in the bottom deposits of lake Nasser (Saad, 1984). The wet density increased markedly with depth in all cores. The differences in the values of water and wet density btween the surface and bottom samples were relatively higher in cores I and IV than in the other cores. This is due to the kind of bottom samples in these two cores. These samples were very hard and characterized by low water content and high values of wet density. Since all samples of core III were soft and had more or less similer low values of wet density, a minimm average value was given by this core. The maximum average value of wet density calculated from core VII is due to the absolute maximum value of 1.70 g/cm^3 found at the bottom of this core, as a result of the increase in the amount of the dry matter at this depth.

No definite correlation can be given between the curves of organic matter and water content of all cores. However, this is not in agreement with the results obtained by the author from the short cores of the Schohsee (Germany), where the curves of water and organic content run parallel (Saad, 1970). The same relation was also found by Damas (1956) for the sediments in Ruanda (East Africa), and by Ungemach (1960), for the surface sediments of many European lakes.

Irregular higher and lower values of organic matter were found at different depths of all cores, giving a considerable wide range of variations. The minimum value of 4.69% recorded from the bottom of core VII can be attributed mainly to the abundance of calcareous materials at this depth, where they reached an absolute maximum. The relatively higher values recorded from the upper two samples of core I may be due principally to the location of this core near the wastes outfalls. The relatively higher data of this core increased its average value to reach a maximum of 0.7 kg/m^2.

The quantitative distribution of organic content in the sediments of Lake Mariut depends principally upon some factors:
1) the allochthonous organic load entering into the lake with sewage and industrial wastes;
2) the autochthonous organic production of the lake;
3) intensity of decomposition of organic matter;
4) particle composition of the sediments.

The great quantities of organic materials introduced into Lake Mariut as a result of intensive pollution increased markedly the organic content of the lake. Saad (1972c) observed a thick layer of green phytoplankton covering the surface of Lake Mariut, especially in summer. This condition was also observed by Ohle (1954) in some German lakes. After death, the added autochthonous organic matter increased also the organic content of the lake. It would be expected that the high organic content of Lake Mariut must be followed by somewhat similer high organic values of its sediments. However the values of organic matter found in the sediments were, in general, relatively low. This can be attributed mainly to the high intensity of decomposition of organic matter favoured by the special environmental conditions in the region (El-Wakeel, 1964; Saad, 1972c). The decrease in the organic content of the sediments may be also due to the increase in the rate of sedimentation of mineralogenic matter in the lake (Saad, 1972a). The rate of aerobic mineralization of organic matter was found to increase in localities rich with mineral materials (Saad, 1970). The relatively higher values of organic content found in some samples can be attributed mainly to the great amounts of allochthonous and autochthonous organic materials reached these samples (Saad, 1984). It must be also assumed that the rate of decomposition of organic matter of these samples was relativly low.

Generally, the calcareous substances gave irregular higher and lower values with a wide range of variations on passing downwards. The bottom of Lake Mariut is characterized by the great accumulations of calcareous shells and shell fragments of dead bivalves, specially Cardium species and empty calcareous tubes of the serpulid worm Mercierella enugmatica (Saad, 1978). This observation was also found in Lake Mariut by Aleem and Samaan (1969) and EL-Wakeel and Wahby (1970).

The abundance of calcareous shells increased markedly the amount of calcareous substances in the sediments (El-Wakeel, 1964b; Saad, 1974b 1976b, 1984, Saad and Aolt 1977). This evidence is very clear in cores IV and VII, where the bottom samples enriched with calcareous shells gave considerably higher values than the upper samples. The maximum average value calculated from core VII is attributed to the absolute maximum value of 6.4 kg/m^2 found at the bottom of this core. The minimum average value found in core VI is related to the great decrease in the amount of calcareous shells in the vertical samples of this core.

The scarcity of calcareous shells in certain samples depends mainly upon some factors;

1) the unfavourable ecological conditions necessary for the growth of calcareous organisms;.

2) the increase in the rate of supply of noncalcareous materials via drains, sewage and industrial wastes;

3) the solution of calcium carbonate which may occur after death of the organisms.

Lake Mariut recieives its allochthonous materials mainly from Umum and Qala drains. The irregular higher and lower values of allochthonous materials found in the core sediments might be attributed principally to the variations in the amounts of these materials introduced into the lake via drains.

The allochthonous mineral substances entered into the lake were distributed on the lake bottom and covered the autochthonous organic sediments or mixed with them. Ohle (1960, 1962, 1964), Ungemach (1960) and Saad (1970, 1976b, 1984) stated that the exchange of elements between the sediments and the free water is greatly reduced under this condition.

The amount of cabonate-soluble (diatom)-silica in the sediments of Lake Mariut gave different values with an observed wide range of variations. The low values of diatom-silica were found in sediment samples poor in diatom frustules. The scarcity of diatom shells in these samples might be attributed mainly to the presence of unfavourable ecological conditions for the growth of the diatoms or to the richness of these samples with mineral matter which destroyed the diatom frustules (Saad, 1970, 1971, 1972b). The high rate of release of silica from these sediments must be also considered. On the other hand, the high amounts of silica found in certain sediment samples reflect the richness of these sediments with diatom shells (Saad, 1971, 1976b, 1978, 1984). It may be concluded that the environmental conditions for diatoms abundance were favourable at the time of deposition. In addition, the degree of preservation of diatom frustules in these sediments must be high. Also the condition might be unfavourable to accelerate the release of silica from these sediments into the free water.

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