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BIOSTRATIGRAPHY AND SEDIMENTATION OF SOME SUBSURFACE QUATERNARY BOREHOLE SECTIONS IN BALTIM AREA, MEDITERRANEAN COASTAL PLAIN OF EGYPT.

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ABSTRACT

The subsurface Nile Delta successions encountered in some boreholes in Baltim area comprise sediments of sand, silt and clay sizes. The sediments east of Lake Burullus outlet are mostly of sand sizes while those west of the outlet and south of the Lake are mostly of silt and clay sizes. Marked vertical as well as lateral variations in grain size textural parameters, carbonate and organic matter contents are recorded among the sediments of different grade sizes. The recorded faunal assemblages are of Quaternary affinities and represent marine and brackish water environments. The results of grain size analysis and faunal characteristics indicate that the sediments are of mixed environments.

INTRODUCTION

The present study is mainly concerned with the biostratigraphy and sedimentation of some subsurface Quaternary sections in Baltim area. The data were obtained from five bore holes drilled in the northern part of the Nile Delta. Four bore holes are located in the northern limit of Lake (Lagoon) Burullus and one bore hole is located at the southern extermity of the Lake (Fig. 1).

One hundred and fifty samples were collected at 1 m vertical interval down to 30 m depth. These samples are subjected to grain size analysis. The sediments of sand grade sizes are seived using mechanical shaker. The finer sediments are analysed by the pipette method described by Krumbien and Pettijohn (1938). The textural parameters, mean diameter, standard deviation, skewness, and Kurtosis are calculated following Folk and Ward (1957). The relationship between textural parameter combinations has been discussed for environmental analysis. The carbonate and organic matter contents are determined in some selected samples following Herrin et al. (1957) and El-Wakeel and Riley (1958) respectively. The faunal asseblages recorded in these sediments were collected and identified, particularly foraminifers and ostracode. The significance of these faunal assemblages as environmental indicators is discussed.

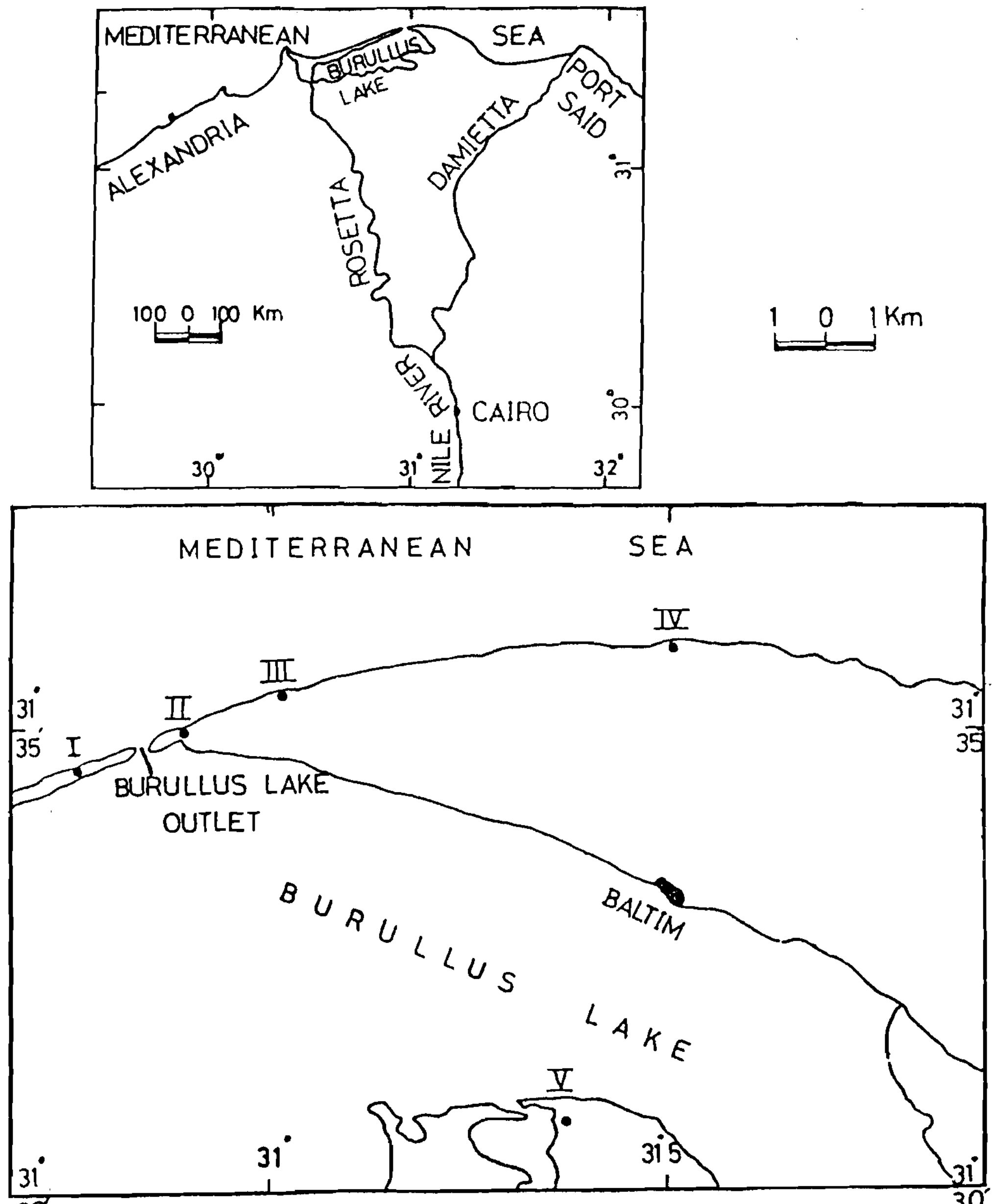

Fig. (1)
Index map showing location of boreholes.

Previous Studies :

Subsurface geologic information dealing with the lithology and biostratigraphy of the Nile Delta sediments are scanty. Fourtau (1915) recognised two layers of Pleistocene sediments forming a part of the Nile Delta namely, an upper layer of Nile mud and clay, and a lower sand-gravel layer. The central and northern parts of the Nile Delta sediments are littoral marine and belong to the Pleistocene. In this regard, Sandford (1934) and Sandford and Arkell (1939) assigned a Pleistocene age to the upper layers and a Plio-Pleistocene or nearly Pleistocene to the lower layers recognised by Fourtau (1915). Said and Yousri (1963) stated that the Pleistocene started in its lower part by clay deposits of estuarine environment in some places and of brackish water environment in others indicating eustatic changes in sea level and influx of drained fresh water.Viotti and Mansour (1969) and Rizzini et al (1976) recognised different biostratigraphic zones ranging in age from Lower-Middle Pliocene to Miocene. Zaghloul et al, (1979) reported that the subsurface Nile Delta sediments comprise different zones ranging in age from Oligocene to Pliocene to Recent. Samir (1980) recorded the presence of subsurface Miocene and Pliocene marine sediments in the Nile Delta and discussed the prevailing paleoenivronmental conditions.

Grain size analysis was carried out on some subsurface Nile Delta sediments (Ahmed; 1970 and El-Bouseily and Frihy; 1975, etc.). According to Ahmed (1970), the middle of the Nile Delta is formed of sediments finer than both the west and the east Delta sediments. El-Bouseily and Frihy (1975) concluded that the sediments encountered in bore holes north and south of Lake Idku as being formed of river sands.

RESULTS OF GRAIN SIZE ANALYSIS

The recorded sediments within the five bore holes are mainly formed of sand, silt, and clay size fractions which vary in percentages and distribution from one bore hole to the other. The sediments of bore hole I and V are dominated by silt and clay size fraction which account for about 64% and 67% of the total successions respectively. The other bore holes are dominated by sand sizes which account for about 62%, 81% and 70% in bore holes II, III, and IV respectively. There is no clear trend for vetical distribution of the sediments of different grade sizes among the bore holes.

The variation of textural parameters as well as the carbonate and organic matter contents against vertical size distribution (Fig. 2) showed that the silt-clay size fraction sediments exhibit more prominent variation than the sediments of sand size fraction in all bore holes. It appears that some pairs of the textural parameters are more significant in some bore holes sediments than in others such as mean diameter: standard deviation and skewness: kurtosis.

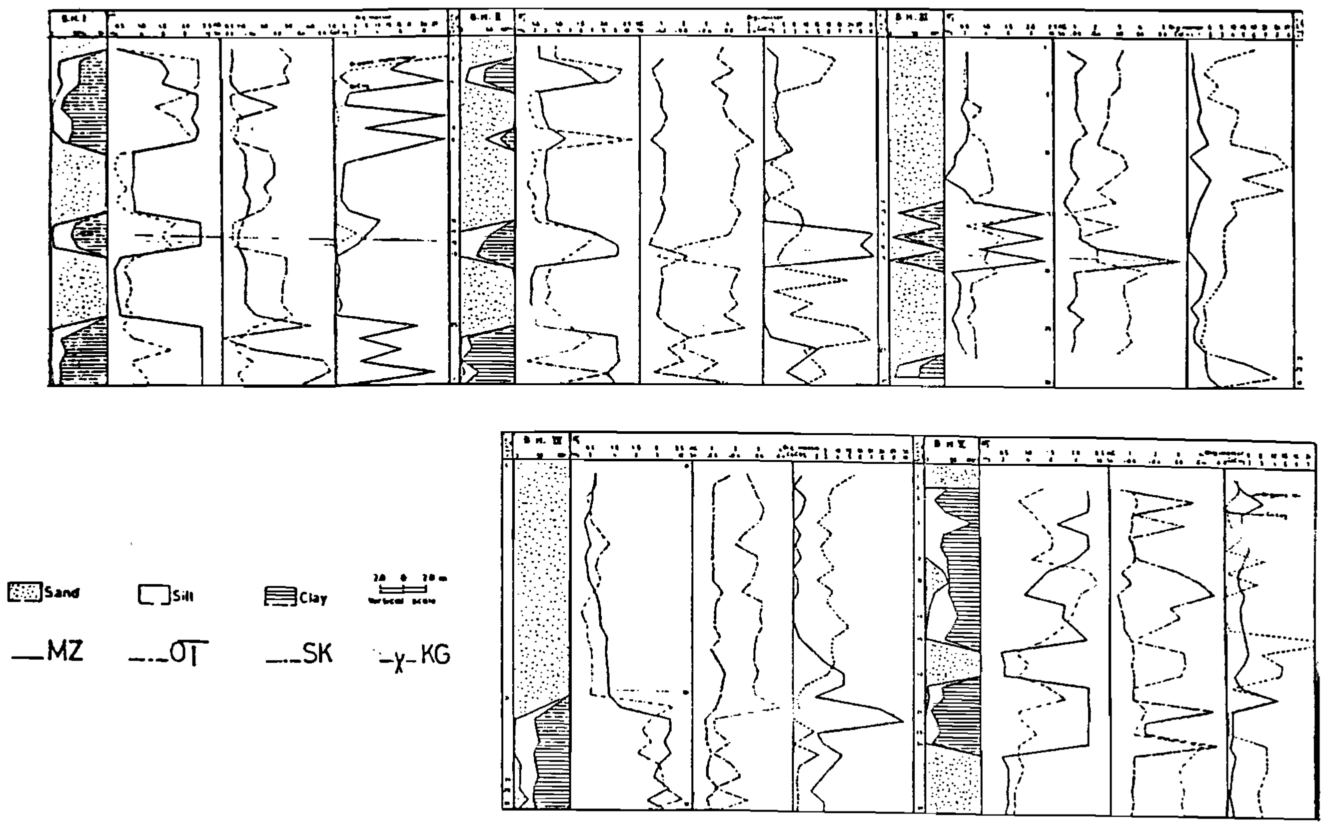

Fig. (2)
Variation of textural parameters against vertical size distribution of sediments in the five boreholes.

The carbonate and organic matter contents exhibit a peculiar behaviour. Carbonate percentages appear to decrease with decrease in grain size. The highest values are found in sandy samples and lowest values in silty and clayey samples. This trend seems to be related to the distribution of calcareous skeletal grains where appreciable amounts of these grains are found in the sand size fractions. Moreover, sediments of silt and clay size fractions are not suitable for flourishing of benthonic fauna. On the other hand, the organic matter exhibits an opposite trend, where it increases from the sand size fractions to the silt-clay size fractions. The equality of size and pencontemporaneous settling might explain such trend (Trask, 1939).

Cumulative curves: Figures 3 and 4 show the cumulative curves of the sand and silt-caly size fractions of the five bore holes. Table 1 gives the angle of slope of the central part of the cumulative curves as well as the cumulative percent and value of the coarse and fine truncations. The sands of the five bore holes possess different angles of slope indicating difference in their sorting. The eastern bore hole sands (IV) are better sorted than the western ones (I, II and III) while sands of the southern bore hole (V) are poorly sorted. The silt-clay fraction cumulative curves (Fig. 4) reflect poor sorting and are characterised by poorly defined central parts.

The two types of sediment size fractions reflect pronounced difference with respect to the coarse and fine tails. The sand size fraction cumulative curves are characterised by less pronounced to absent coarse tails and by the presence of pronounced fine tails (Fig. 3) except for sands of bore hole III which show no fine tails and less pronounced coarse tails. On the other hand, the cumulative curves of the silt-clay size fractions are characterised by the presence of more pronounced coarse and fine tails. A common feature to all the cumulative curves of the bore hole samples particularly those of the silt-clay size fraction, is their distinction into two or more groups. This feature is obvious in the fine tails, except for sands of bore hole III. It could be related to the presence of sediments of different grads sizes which indicate special environmental conditions.

Grain Size Textural Parameters:

The results of grain size textural parameters, mean diameter, standard deviation, skewness and kurtosis for sands and silt-clay size fractions indicate marked differences (Tables 2 and 3).

The majority of sands are fine, moderately sorted, symmetrically skewed and leptokurtic. Some sands, however, are medium, moderately sorted, coarsely skewed and mesokurtic. The silt-clay size fractions, on the other hand, range in size from fine silt to medium clay, but are predominantly of clay sizes. They are poorly sorted, strongly coarse skewed and leptokurtic to very leptokurtic. Only, the silt-clay size fractions of bore hole IV are platykurtic.

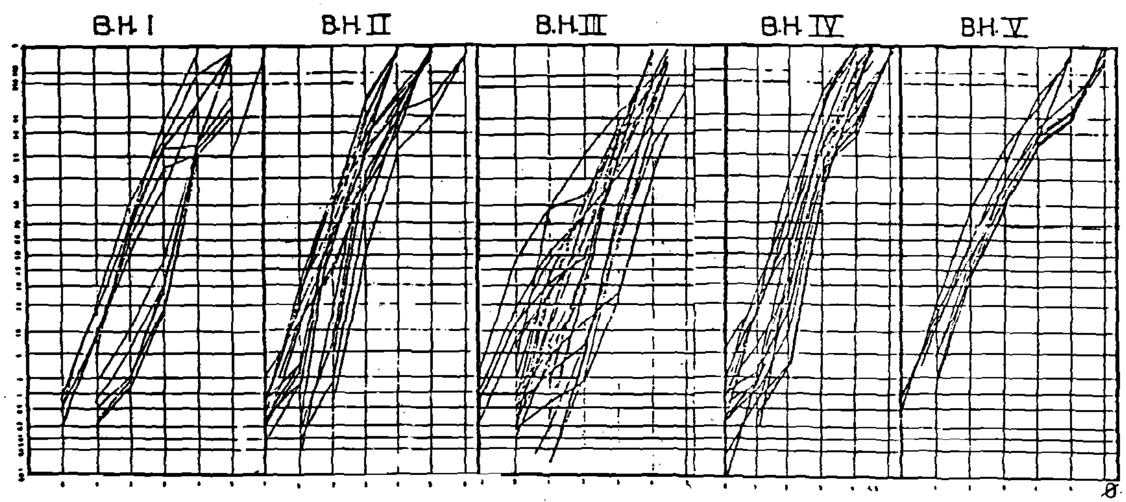

Fig. (3)
Cumulative curves of the sand size fractions of the five boreholes.

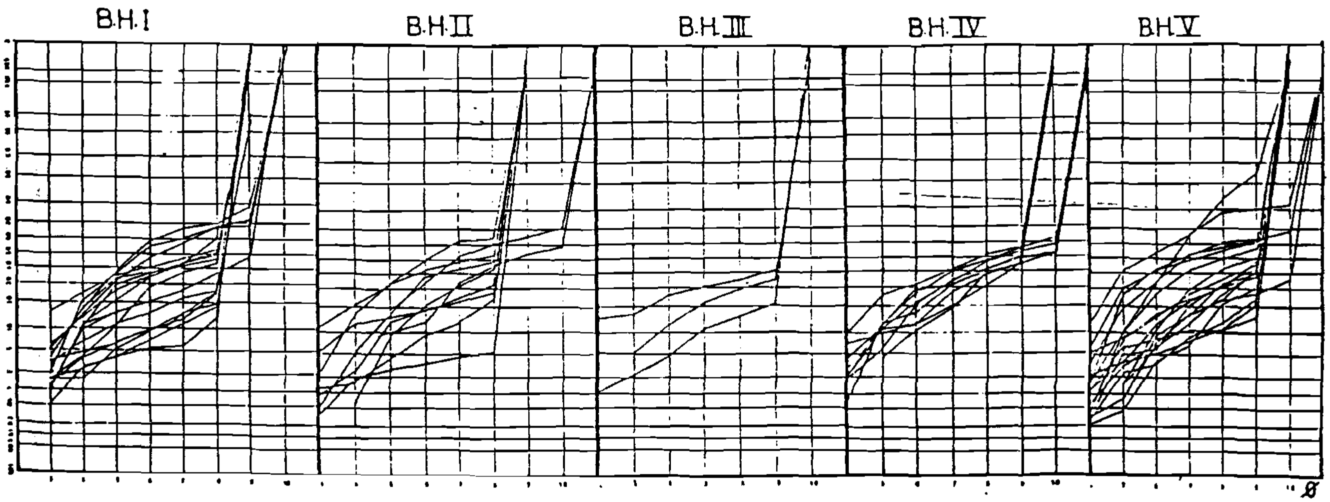

Fig. (4)
Cumulative curves of the silt and clay size fractions of the five boreholes.

Table (1)

Average values of the angle of slope and the cumulative percent and o values of the coarse and fine tails.

Bore hole No.	Angle Of Slope	Sand Size Fraction: Coarse Trun. Cumu. %	Sand Size Fraction: Coarse Trun. ø value	Sand Size Fraction: Fine Trunc. Cumu. %	Sand Size Fraction: Fine Trunc. ø value	Angle Of Slope	Silt - Clay Size Fraction: Coarse Trun. Cumu.	Silt - Clay Size Fraction: Coarse Trun. ø value	Silt - Clay Size Fraction: Fine Truncat. Cumu.	Silt - Clay Size Fraction: Fine Truncat. ø value
I	75°	25.00	3.00	95.00	3.80	--	40.00	8.30	45.00	8.50
II	75°	-	-	97.80	3.00	--	45.00	7.40	42.50	8.75
III	75°	-	-	-	-	--	30.00	9.00	30.00	9.00
IV	80°	20.00	2.00	95.30	3.60	--	50.00	9.50	49.00	9.50
V	64°	-	-	98.50	4.00	--	45.00	9.00	43.00	9.50

Table (2)

Average and range values of the textural parameters of the five bore hole sand size fractions.

Bore Hole No.		Mean Diameter Mz ø	Standard Deviation σI ø	Skewness Sk	Kurtosis KG
I	Range average	1.45 - 3.35 2.42	0.41 - 0.81 0.61	-0.28 - +0.20 -0.03	2.97 - 1.45 1.14
II	Range average	1.35 - 2.90 2.28	0.34 - 1.16 0.60	-0.22 - + 0.22 +0.05	0.63 - 1.29 1.10
III	Range average	0.73 - 3.35 1.78	0.45 - 1.18 0.73	+ 0.50 - - 0.44 -0.04	0.46 - 1.45 1.03
IV	Range average	1.40 - 3.50 2.43	0.32 - 0.87 0.53	+ 0.08 - - 0.04 -0.14	0.85 - 1.87 1.14
V	Range average	1.55 - 2.35 2.40	0.67 - 0.97 0.97	+ 0.01 - + 0.19 +0.08	0.81 - 1.02 0.98

TABLE (3)

Average and range values of the textural parameters of the five bore hole silt-clay size fractions.

Bore hole No.		Mean Diameter Mz ø	Standard Deviation σ I ø	Skewness SK	Kurtosis KG
I	Range Average	5.60-9.25 8.48	0.54-2.72 1.60	-0.82 - +0.25 -0.57	0.53 - 4.80 1.62
II	Range Average	4.50-9.30 7.99	0.29-2.44 1.63	+0.46 - -1.33 -0.45	0.48 - 4.71 1.48
III	Range Average	9.10-9.20 9.13	0.88-2.18 1.55	-0.43 - -0.87 -0.70	0.77 - 5.70 2.54
IV	Range Average	6.90-9.05 8.42	1.57-2.48 1.88	-0.23 - -0.83 -0.62	0.59 - 1.16 0.74
V	Range Average	4.70-9.20 8.23	0.77-2.50 1.43	+0.33 - -0.87 -0.45	0.49 - 7.87 1.60

About 18 % of the bore hole samples (standard deviation values from 0.35 to 0.50) represent, beach and dune environments, 29 % (standard deviation values from 0.5 to 0.8) represent Paleoenvironmental river conditions, 24 % represent river environment (standard deviation values from 0.8 to 1.4), and 29 % mostly of silt and clay size fractions (standard deviation values more than 1.4) are also probably of river environment (Friedman, 1962).

Relationship Between Grain Size Textural Parameters :

The plot of skewness vs. mean diameter can be significant in the separation between dune and beach sands (Friedman, 1961). The application of Friedman's argument to the sediments under study does not appear to be effective in the separation between sands. All sand size sediments are scattered in a narrow range of both mean diameter and skewness while sediments of silt-clay size fractions indicate that the two parameters are clearly related (Fig. 5 A). The coarser sediments tend to be negatively skewed while the finer ones tend to be positively skewed.

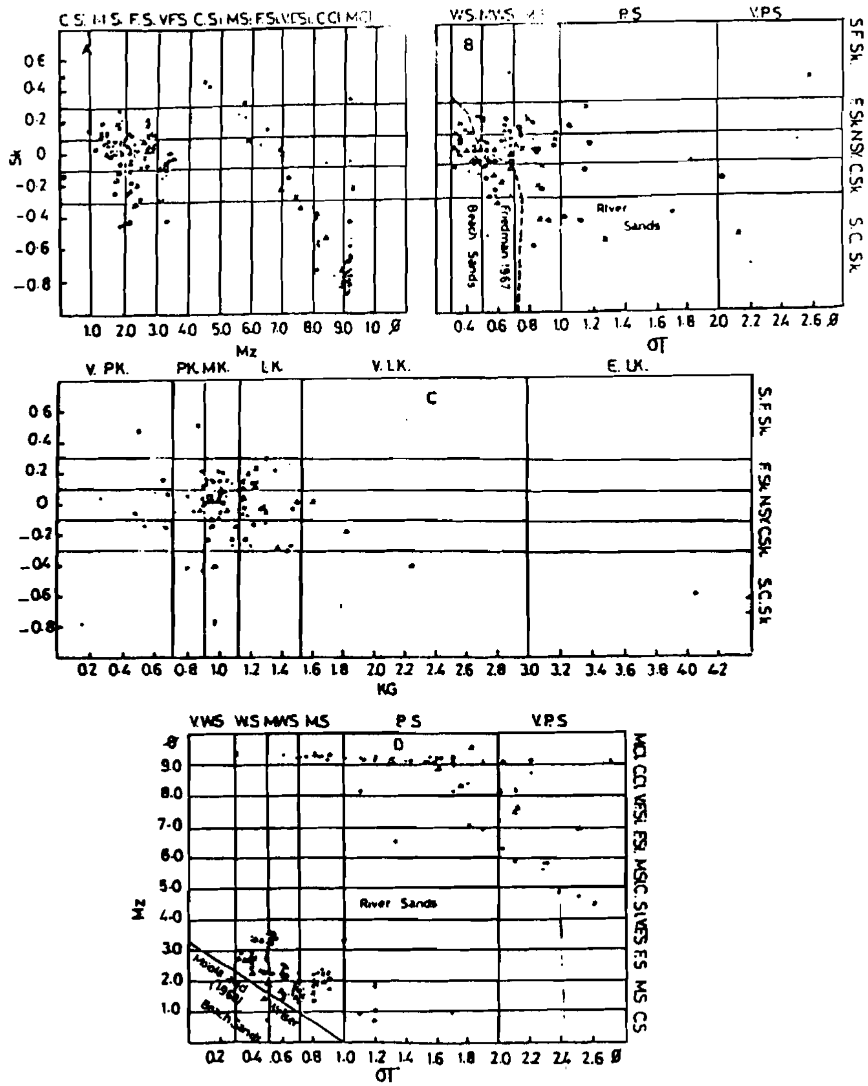

Fig. (5)

Plots of textural parameter combinations:

A=Sk vs Mz, B=Sk vs OT, C=Skvs KG and D=Mz vs OT.

° BHS NO I X BHS NO II ° BHS NO III BHS NO IV ° BHS NO V

S = sand Si = silt Cl = clay.

The plot of skewness vs. standard deviation (Fig. 5 B) shows that the sediments under study are of mixed origin; beach and river, where they fall on both sides of the boundary suggested by Friedman (1967). This result is consistent with the above conclusions based on standard deviation only (Friedman, 1961).

The plot of skewness vs. kurtosis (Fig. 5 C) indicates incomplete separation between samples of the different bore holes. In this respect, Mason and Folk (1958) and Martins (1965) stressed the significance of such relation in the differentiation between beach sands and those of coastal dunes.

Moiola and Weiser (1968) used the relation between mean size and standard deviation for the differentiation between river and beach sands. The plot of such relation for the sediments under study (Fig. 5 D) shows that most of the samples fall within the field of river environment.

The plot of percentile 5 vs. standard deviation (Fig. 6 A) shows a pronounced negative correlation for the silt-clay size fractions and a more or less negative correlation for the sand size fractions. The silt-clay size fractions have a wider range of 05 than the sand size fractions and subsequently have a more pronounced coarser tail than the sand size fractions. The same feature is observed in the plot of percentile 5 vs. percentile 95 (Fig. 6 B). In this respect Passega (1957) and Friedman (1967) mentioned that the tails of grain size distribution curves are significant in environmental interpretation. Friedman (1967) suggested that beach sands lack fine grained tails and less commonly have coarse grained tails, while river sands have fine grained tails and commonly possess coarse grained tails. The sediments of siltclay sizes under study are characterised by pronounced coarse and fine tails while those of sand sizes have less pronounced coarse and fine tails. It can be therefore, concluded that the sediments under study represent; beach, dune, and river environments.

BIOSTRATIGRAPHY

The present part is mainly concerned with the biostratigraphic studies of the sediment successions encountered in the five bore holes in order to get more information about the environmental conditions. Moreover, it is a trial at corroborating the previous environmental conclusions arrived at through grain size analysis.

The faunal contents recorded in these sediments are mainly composed of foraminifers and ostracods. The stratigraphic level as well as the type of sediments incorporating the faunal assemblages vary from one bore hole to another. The foraminifers and ostracods are of limited distribution within the sediments of bore hole I (west of the lake Burullus outlet) where they characterise the topmost part of the succession (0-4 m). On the other hand, they show a longer range of distribution in the other bore holes where

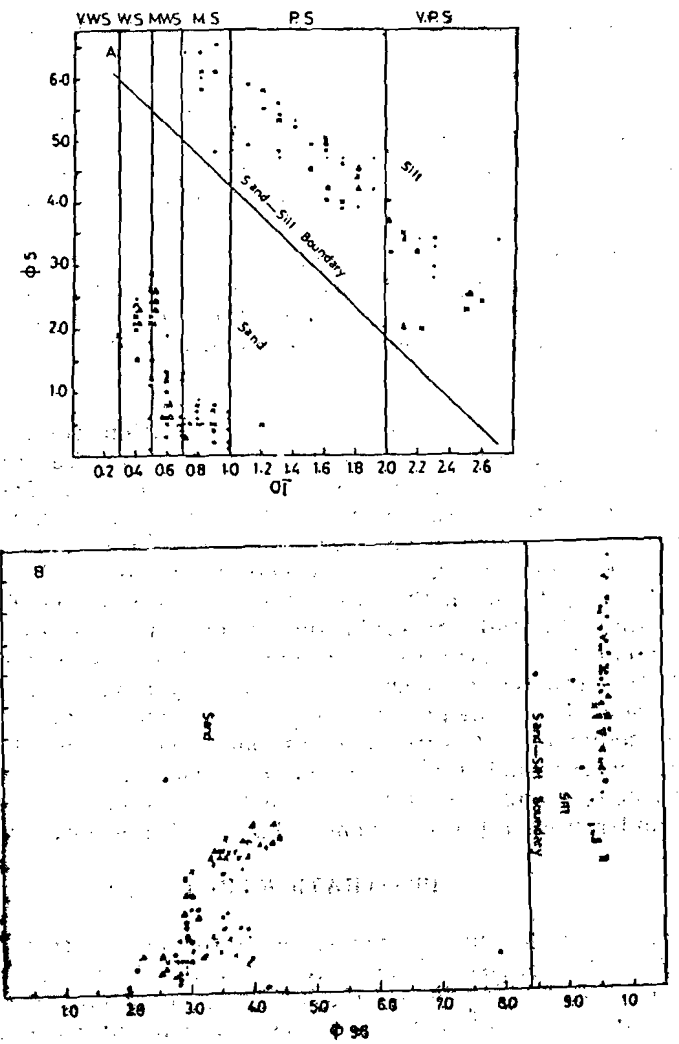

Fig. (6)

Plots of textural parameter combinations:

A= 5 vs. OT and B= 5 vs. 95.

° BHS NO I x BHS NO II ° BHS NO III BHS NO IV ° BHS NO V they characterise about half or more of the succession (Fig. 7). Regarding the type of associated sediments, the faunal assemblages are encountered in sediments of different grade sizes in bore holes I and II, sand size fractions in bore holes III and IV, and sediments of silt-clay size fractions in the southern bore hole (V).

The identified faunal assemblages include the following :

Marine Foraminiferal Assemblage :

Textularia agglutinatus D'Orbigny, **Spiroloculina antillarum** D'Orbigny, **Spiroloculina cymabium** D'Orbigny, **Spiroloculina depressa** D'Orbigny, **Cribrolinoides curta** (Cushman), **Quinqueloculina adeliadensis** D'Orbigny, **Quinqueloculina elleptica** D'Orbigny, **Quinqueloculina phoenicia** Martinotti, **Quinqueloculina (Pseudotriloculina) reticulata** (Soldani), **Triloculina bermudesi** Acosta, **Triloculina linneiana** D'Orbigny, **Triloculina longirostra** D'Orbigny, **Triloculina pseudo-hemispherica** Le Calvey, **Triloculina tricarinata** D'Orbigny, **Triloculina trigonula** (Lamarck), **Guttulina problema** D'Orbigny, **Discorbis giobularis** (D'Orbigny), **Elphidium advenum** Cushman, **Elphidium clavatum** (Cushman), **Elphidium crispum** (Linne), **Globigerinoides ruber** D'Orbigny, **Cibicides lobatus** (Walker and Jacob).

Marine Ostracodal Assemblage :

Cytheretta mediocostata (Moyes), **Cytheropteron crossipinatum** (Brady and Norman), **Semicytherura arcachonensis** Yassini, **Semicytherura acuticostata** (Sars), **Aurila convexa oblonga** (Baird), **Aurila emarginata** (Sars), **Urocythereis oblonga** (Brady), **Callistocythere pallida** (G.W. Muller), **Calistocythere** cf. **Canaliculata** Norman, **Loxoconcha rhomboidea** (Fisher), **Cytheromorpha fuscata** Norman, **Cytherois fisheri** (Sars), **Trachyleberis dunelemensis** (Norman), **Carinocythereis quadridentata** (Baird), **Costa edwardii** (Roeme), **Xestoleberis aurantia** (Baird).

Brackish Water Foraminifers :

Ammonia becarrii (Linne) Var. **tepida** (Cushman)

Brackish Water Ostracods :

Cyprideis torosa (Jones).

Detailed paleontological and ecological studies will be dealt with elsewhere by the present writers.

The above recorded faunal assemblages represent both marine and brackish water environments. The marine forms are recorded only within the sediments of sand sizes in bore holes east of Lake Burullus (II,III and IV). In this regard, Rizzini et al. (1976, p. 39) stated that "the new marine ingression of the Holocene brought lagoons and coastal deposits on the whole area of the Delta also much further to the north". Such conditions seem to have prevailed during the deposition of the sediments under study where brackish water foraminifers and ostracods occur in all the bore holes. Oscillation of sea level occurred at intervals, as indicated by the presence

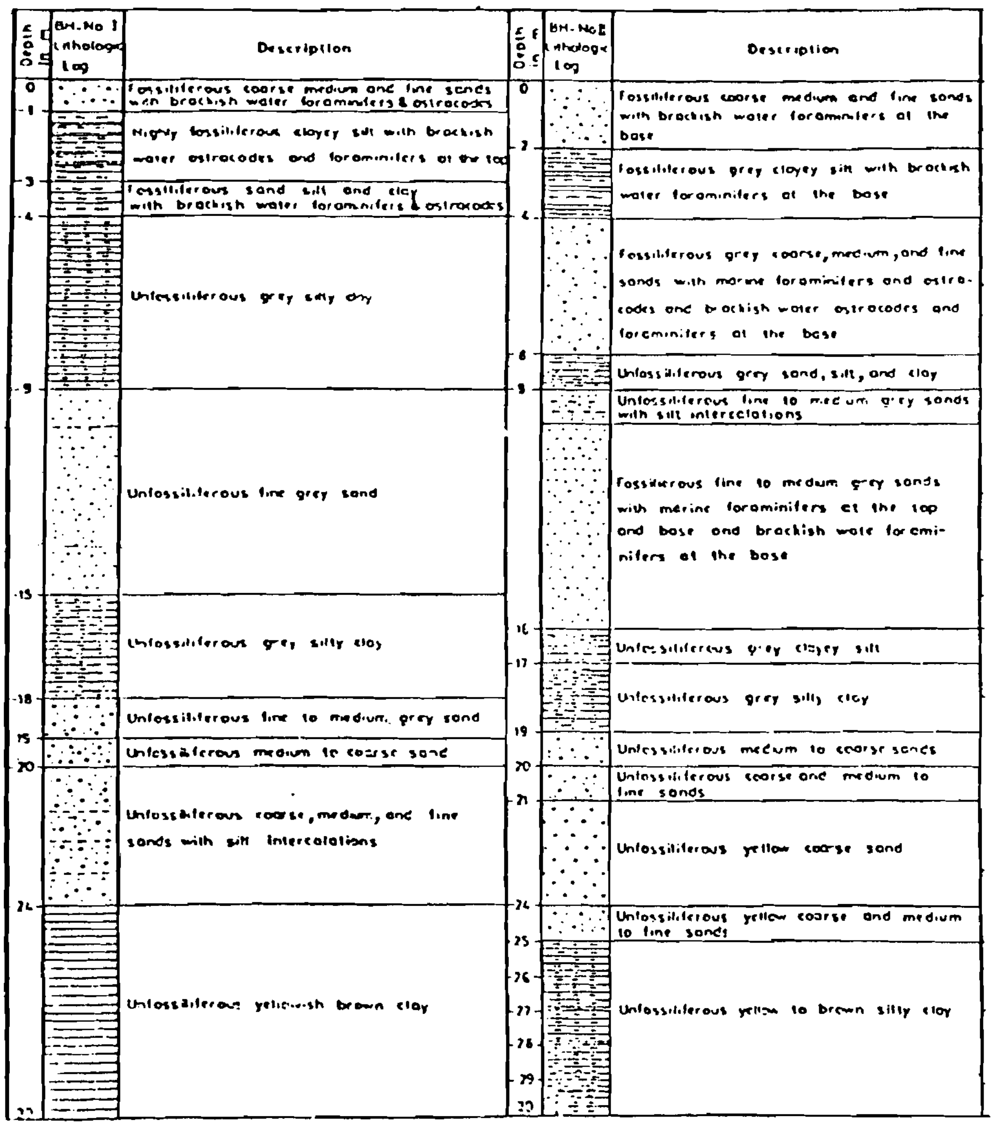

Fig. (7)
Lithobiostratigraphic logs of the five boreholes.

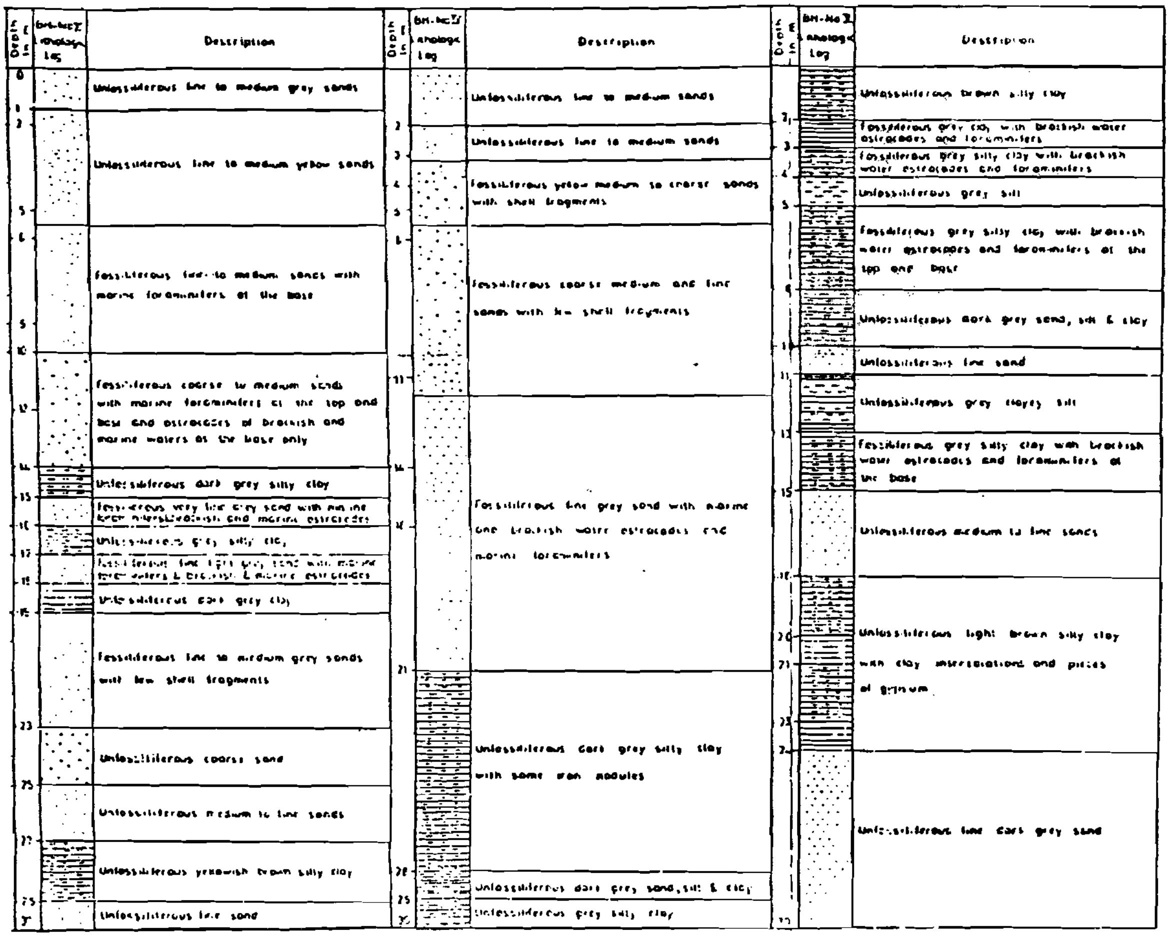

Fig. (7 - continued).

or absence of marine faunal assemblages in some bore hole sediments. Moreover, the fresh water flowing into the lagoon through the ancient Nile branches would have changed the salinity of the marine waters at certain episodes causing brackish water environmental conditions.

SUMMARY AND CONCLUSIONS

The subsurface Nile Delta sediments encountered in some bore holes, north and south of Lake Burullus, in Baltim area, are of sand, silt and clay sizes. Sediments of sand sizes form the marjority of succession in bore holes east of the Lake Burullus outlet, while sediments of silt and clay sizes dominate the successions in bore holes west of the outlet and south of the lake.

The sediments of sand sizes show more prominent variations in textural parameters than those of the silt and clay sizes. Sorting improves from west to east along the northern bore holes. On the other hand sediments of the southern bore hole are poorly sorted relative to the northern ones. The grain size textural parameters indicate that these sediments represent; beach, dune, and river environments. The organic matter content is inversly proportional with the carbonate content. The organic matter increases with decrease in grain size while the carbonate decreases with decrease in grain size.

The recorded faunal assemblages of forminifers and ostracods are of Quaternary affinities and represent marine and brackish water environments. Brackish water assemblages occur in all bore hole sediments while the marione assemblages are restricted to some stratigraphic horizons.

The results of grain size analysis and the biostratigraphic studies indicate that coastal and lagoonal to brackish water conditions seem to have prevailed during the deposition of the sediments in Baltim area. Signs of marine ingressions are indicated by the presence of marine forms in some bore hole sediments.

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