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SEDIMENTOLOGICAL CHARACTERISTICS OF SUBSURFACE SEDIMENTS IN BURG EL-ARAB REGION, NORTHWESTERN COAST OF EGYPT.

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Key Words: Geology, Sedimentology, Mediterranean Sea.

ABSTRACT

A 125-m borehole was studied in order to determine its sedimentological and mineralogical characteristics. To achieve this aim, grain size-, x-ray diffraction-, heavy mineral- analyses, micropaleontological and palyonological studies were conducted in the sediment samples.

The grain size analysis indicates the presence of two different depositional environments and hydrodynamic conditions characterizing the upper and lower parts of the investigated borehole. The depositional differentiation shows that, the upper layers were formed under marine environmental conditions whereas, the lower layers seemed to deposit under fluvial or lagoonal conditions.

The mineralogical analysis illustrates marked decrease of carbonate minerals downward with the predominance of silisiclastic minerals in the lower part of the borehole.

The heavy mineral analysis reveals that, the sediments of the lower part of the borehole are almost of alluvial origin.

Micropaleontological analysis reveals that, the lower part is characterized by the scarcity of the foramineferal individuals and shows abraded and destroyed tests. This deformation could be

explained on the basis that, these individuals are allogenic transported from other area, so they are not related to the environment of deposition. The upper calcareous layers are enriched with the foramineferal tests.

Paleopalynological analysis indicates that, the depositional environment was a shallow marine (inner shelf) as deduced from the abundance of dinoflagellate cyst. Also, the influence of fresh – water is observed from the weak input of ***pediastrum*** *(fresh water algae).*

The lower part might be covered by the fluvially- influenced portion of Mariotes lagoon which was fed by one or more minor branches of the old Canopic channel that flowed into the southeastern portion of the lagoon.

INTRODUCTION

During the few past decades, the region north of the western desert of Egypt receives special attention due to the increasing requirements for ground water resources and soil potentials for the expansion of agricultural projects and constructions of new communities.

The northern zone of the western Desert of Egypt occupies the northern extremity of the great Marmicean homoclinical plateau extending between Alexandria and El-sallum. This zone could be distinguished into two physiographic regions (GUINDY, 1974). The first is the eastern region, which extends between Alexandria and Ras El-Hekma. This region is strongly affected by the presence of the Arab's Gulf which coincides with regional synclinal basin oriented in NNW- SSE direction (Figs. 1& 2). The second region extends from Ras-EL-Hekma to EL-Sallum

The Study area:

The area of study is located in the northwestern coast of Egypt and located at Burg El-Arab area between long 28 24 E& 28 34 E and Lat. 30 48 'N & 31° 00 N (Fig.2). A 125-m borehole was drilled in order to determine the sedimentological and mineralogical characteristics of the sediments.

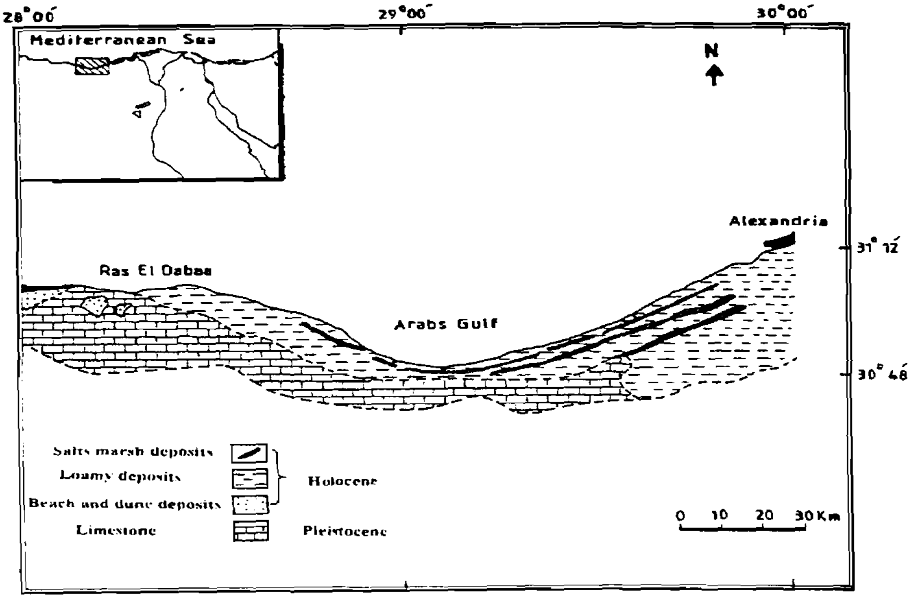

Fig. (1): Geological map of the coast off Arabs Gulf.

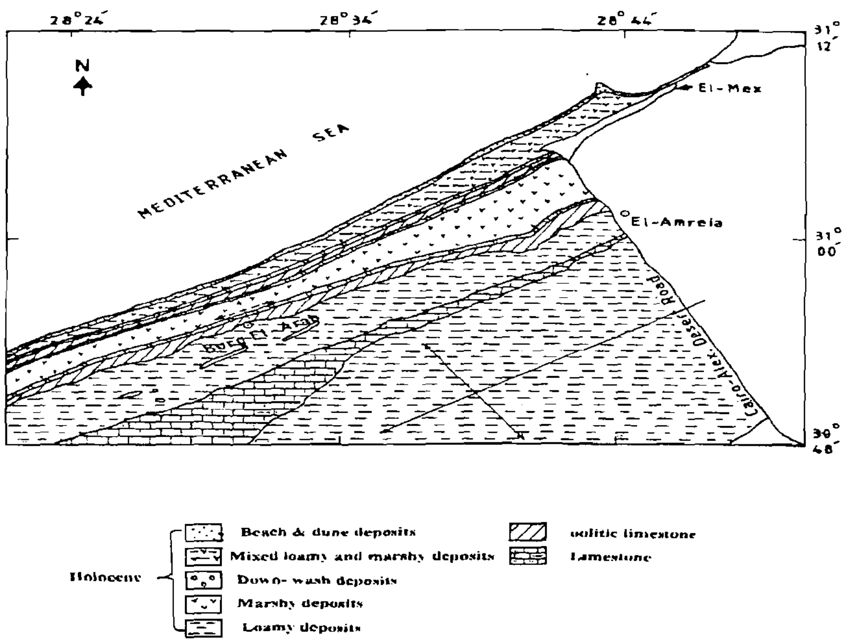

Fig. (2): Geological map of Burg El- Arab area (Abdel Mogheeth, 1968).

Geological Structure:

According to ABDEL- MOGHEETH (1968), the main local geological structure in Burg EL-Arab area could be described as follows; the geophysical studies revealed the presence of two subsurface anticlines. One of these is the Burg EL-Arab anticline faulted on its southern flank with its upthrown side towards the sea. The other anticline lies in the south and is covered by Abu Mina basin. Both anticlines have a NE-SW direction and are nearly parallel to the Mediterranean shoreline and to the different physiographic units in the area.

In another study made by MESHRIF *ET. AL.* (1990) in Burg El-Arab area, the study reveals the presence of four groups of variable causative sources and depth .ranges. The first group of anomalies that of shallow sedimentary sources, vary in depth from 0.8 to 1.25 km. The second group is of shallower intermediate sedimentary sources ranging in depth from 1.5 to 2.4 km.; the third group is of deeper intermediate depth varying from 2.5 to 3.4 km. Meanwhile the fourth group is of deep basement source and range in depth from 4.0 to 6.5 km. The shallowest gravity source is correlated with the top of Qatrani Formation, the second correlates with Abu Roash Formation, while the third is correlated with the top of Alamein Formation. On the other hand, magnetic analysis indicated that the deeper source is lying within the depth range of the basement surface.

Geomorphologic features:

The region west of the Nile Delta reveals mild topography and low relief of the surface, rarely exceeding + 100 ms with irregular coastal line. The land is developed into an almost flat plain, slopping northward (Fig.1).

Stratigraphic characteristics:

The Miocene sediments consist of Moghra and Marmarica Formations. The lower rock unit represents Moghra Formation. It is comprised of sediments belonging to Lower Miocene. In coastal zone, surface exposures of this formation are very rare. The Moghra Formation consists of a thick clastic section. It is thought to have been deposited in a fluviomarine environment connected with the Mediterranean Sea (SAID, 1965; MARZOUK, 1970; HILMY *ET AL.* 1976; SALEM, 1976; AND HASSOUBA, 1980). In subsurface, the Moghra Formation has been encountered with a thickness of about 575-m in Burg El-Arab Well (ATWA, 1979; Fig.3)

The Pleistocene sediments are distinct into;

a) **Pink Limestone rock unit;** with thickness ranging between 0.25-1 m.

b) **Oolitic Limestone;** represented by the coastal ridges.

c) **Cardium Limestone unit;** it attains a thickness of about 10-m at Burg El-Arab.

The recent deposits are widely distributed in the area of the western Desert of Egypt. They can be distinguished into the following units;

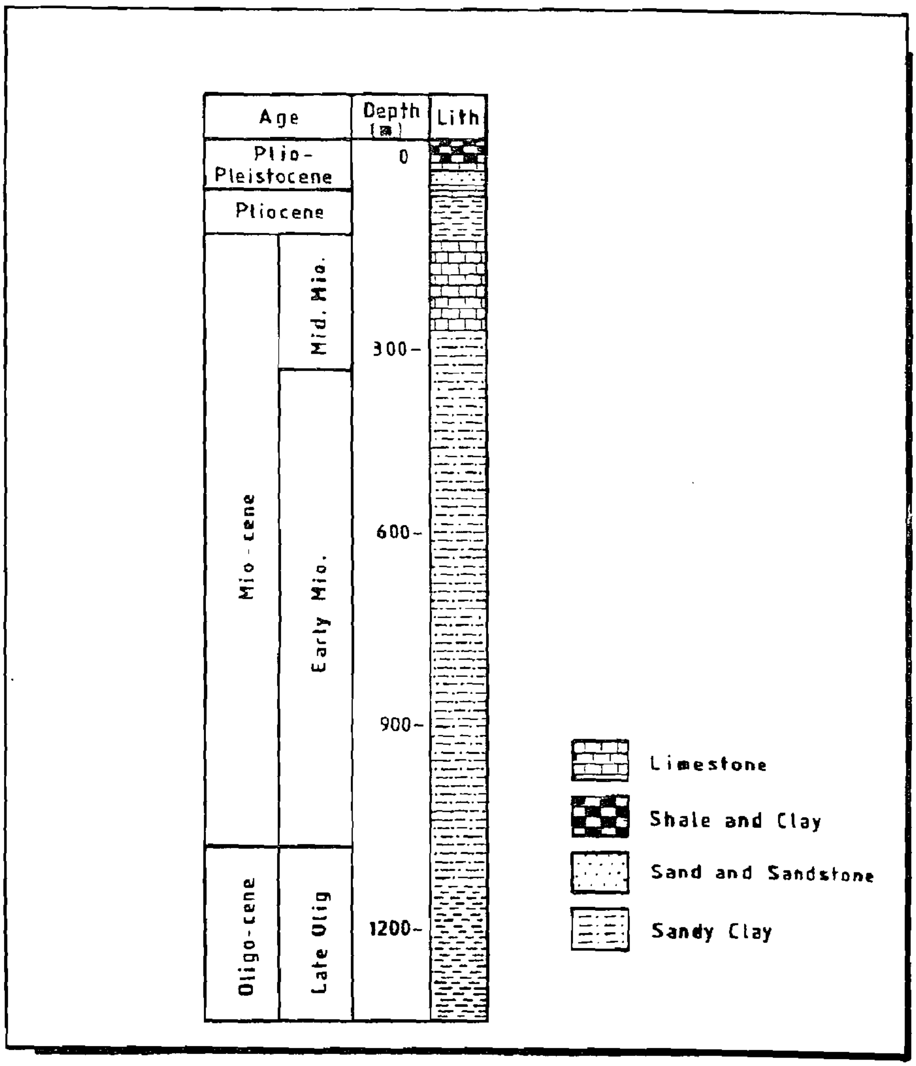

Fig. (3): Composite Long of Burg El- Arab well (Atwa, 1979).

1. **Alluvial deposits** occupy the depressions and the drainage lines and composed of quartz sand, silt and clay rich in carbonate grains in the northern zone and rich in rock fragments in the southern zone. They attain a thickness of about 40 m. Sabkha and salt marshes which are rich in (evaporates, gypsum) are essentially reported in the alluvial deposits particularly in lower lagoonal sites of the depressions (EL- SHAMY, 1968).

2. **Eolian Sand deposits,** developed as coastal sand dunes of carbonate nature or as inland dunes of fine quartz grains and shell fragments (ATWA, 1979).

3. **Beach deposits,** They occupy a narrow strip along the coast and are mainly composed of oolitic sand and carbonate grains with a low quartz sand content (GUINDY, 1974, 1989 & ATWA, 1979). HASSOUBA (1980) studied the Quaternary sediments from the northwestern coastal plain of Egypt from Alexandria to El-Omayed. He revealed that, the rate of dissolution of aragonite from the sediments of the carbonate ridges has been found to increase towards the Nile Delta, whereas to the west, the aragonite survives intensive dissolution.

Climatology: The area of study characterizes with the following;

a) **Air temperature**: The area north of western Desert of Egypt displays a typical Mediterranean climate strongly buffered by the sea. The maximum air temperature recorded in Burg El-Arab area is 30.7 °C, while the minimum is 8.5°C.

b) **Precipitation:** The source of almost all rainfall in the coastal zone of the Mediterranean sea and the precipitation is the only source of surface and ground water in most of the north of the western Desert of Egypt. The annual mean of the precipitation in Burg El-Arab area is 165.5 mm/y.

c) **Relative humidity:** The relative humidity which recorded in Burg El-Arab area ranges between 75% and 64% with mean value of 70%.

d) **Evaporation:** The rate of evaporation in the investigated area varies from 7.8 ml./d to 3.6 ml./d with mean value of 6.0 ml/d. (The general Meteorological Organization of Egypt during the period 1987-1990 recorded the preceding values).

Current regime: GERGES (1976) suggested that, there is a permanent longshore current flowing in summer from west to east in the southeastern Mediterranean, whereas in winter there is an indication of westward current north of 32°.

Sea level variation and coast migration:

According to EL- MAGHRABY (1997) the coast in Alexandria region migrated seaward from near its present location to as much as 20 km to the northwest during the latest Pleistocene lowstand (≈ 20.000-18000 y. BP) and then landward (southeastward) to about the present day midshelf. During this period the area was subaerially exposed coastal and alluvial plain. A NNW-trending, primarily braided river channel system (pre-Canopic) flowed across the alluvial plain to the present- day shelf edge. The major river channel was periodically inundurated by brackish water during intermittent sea –level rises (CHEN ET. AL., 1992).

From ≈ 11000 to 8000 y. BP., the coast migrated from the present -day midshelf landward (southeastward) as sea level continued to rise rapidly. At ≈ 7500 y. BP., the rate of sea-level rise began to decelerate, and brackish water bay and lagoon mud accumulated in the investigated area.

By ≈ 6000 y. BP., much of the area was covered by brackish and fresh water. The fluvially- influenced portion of Mariotes lagoon was fed by one or more minor branches of the Canopic channel that flowed into the southeastern portion of the lagoon. By ≈ 4000-3000 y. BP., sea level steadily rose ≈ 3-4 m below its present level. During this time, the Canopic branch migrated westward as far as the eastern margin of Abu Qir lagoon just east of Abu Sir Ridge II. By ≈ 2000 y. BP., the Canopic branch was diminishing as a significant Nile distributor. By ≈ 800 y. BP., the Canopic branch was filled up with silt so that the fresh water supply to Alexandria region was markedly diminished.

EL-ASMAR (1998) suggested the presence of four major climatic periods in close relationship to the change in marine level. Each climatic period consists of a warm- wet phase followed by a cold arid one. The warm – wet phases are characterized by negative oxygen and carbon isotopes, the deposition of marine sediments with a high frequency of benthic foraminifera and /or the development of paleosols with high content of organic carbon. The cold- arid phases are characterized by positive oxygen and carbon isotopes and Eolian sedimentation, with a low benthonic foraminifera and organic carbon in the Nile-Delta sediments

METHODS OF ANALYSES

The boring was made using rotary type drilling; subsurface samples were obtained with split spoon sampler till a depth of about 125m. After field description and visual classification, all samples were transferred in airtight containers to the laboratory and prepared for further analyses. The examined samples were air-dried, then splited to ensure that representative samples will be examined. About 50 g of each sample was washed thoroughly by distilled water and dried at 50° C (then kept in clean stoppered jars), ready for grain size and mineralogical analyses. The statistical parameters were calculated according to FOLK (1974) and the depositional environments were determined with respect to SAHU'S equations (1964). These equations are applied to determine the different depositional mechanisms that took place in the area of investigation. The depositional conditions were determined using C-M pattern diagram after PASSEGA AND BYRAMJEE (1969). For the mineralogical analysis, the samples were ground in mortar to pass through a 44 μ-mesh sieve (nominal diameter) then sprinkled on Vaseline on a glass slide to ensure random orientation. A Philips X-ray diffractometer Model 1060/80 with copper target tube and nickel filter was used. Diffraction was made at 40 Kv, 25 M.A., chart speed 1°/min in the range of 20°~60° (2 θ), the operating sensitivity was 4x100 counts/sec and the chart speed at 1cm/min. The relative abundance of the minerals was determined by peak height analysis (GRIFFIN, 1971). An infrared analysis has been done to define the different reactive groups of the studied minerals. The analysis was made using Perkin Elmer (1430) ratio recording infrared spectrophotometer. Heavy mineral analysis is performed in order to help in the environmental interpretation. Representative samples were processed using standard palyonological technique (KHOLEIF, 1998). The samples were treated with dil. HCl, HF and con. HCl to remove carbonates silicates and fluorides respectively. After that, the residue was split into two portions. The first one was used to prepare kerogen slides. The second portion was filtered using wet sieving with 10 and 15 μm polyester sieves. Kaiser's Glycerol Jelly is used as a mounting medium. All slides were microscopically examined with Zeiss standard-25 microscope (400x, 630x and 1000x, oil immersion).

RESULTS AND DISCUSSION

Vertical variation of grain size parameters:

The vertical variation of the grain size parameters and their descriptive nomenclature is presented in (Figs. 4a-d). Considering the grain size distribution, it has been found that, sediments ranging from coarse sand and very coarse sand to medium sand in an alternative manner occupy the upper part of the investigated borehole. Moreover the uppermost layers till depth of about 35m were occupied by coarse sand. This was followed by medium sand sediments till the depth of about 40m.An another layer of coarse sand sediments extends about 15m to about 55m. This layer was followed by one of medium sand till depth of about 60m.A coarse sand layer continues without interruption to a depth of about 110m. Up depth of 111m a layer of sediment ranges in size from fine sand to muddy sand including sandy clay sediments extends to the end of boring. It is interesting to define the origin of this layer and determine its depositional environment.

The investigated subsurface sediments reveal the presence of both poorly sorted and moderately sorted sediments, whereas the coarse sand layers tend to be poorly sorted while the medium sand ones reflect moderately sorted and vise versa. The sediments of lower part which extend between- 110 m to -. 125m are very poorly sorted sediments (Fig.4_a). The variation in sorting values from poorly sorted at the bottom to moderately sorted in the overlying layers may reflect variation in the kinetic energy and / or the depositional environmental conditions as proposed by WILGEY (1961).

Skewness distribution throughout the investigated borehole reveals wide range from coarse skewed to fine skewed including nearly symmetrical skewed value. The tendency to the negatively skewed values in the lower muddy part (Fig.4_c) could be attributed to the cemented grains.

The sand facies characterizing the upper part of the investigated sediments (coarse and medium sand) have mesokurtic to leptokurtic distribution whereas the lower one comprising from both silty- and muddy- sand tend to be either platykurtic or leptokurtic (Fig.4_d).

Fig. (4a, b, c & 4d)

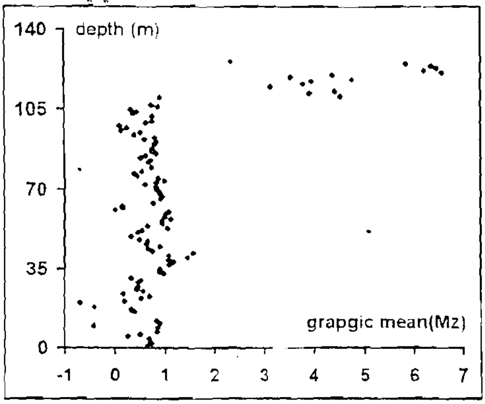

Fig.(4a) :graphic mean-depth relationship in the study area.

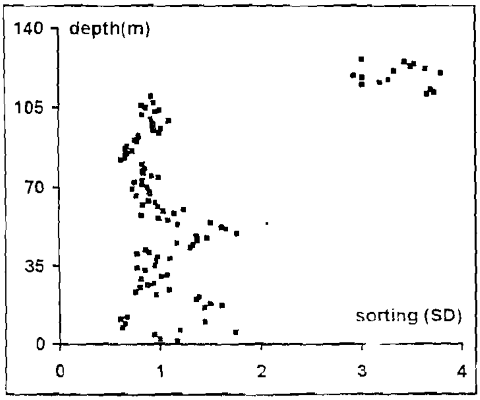

Fig.(4b) :Sorting-depth relationship in the study area.

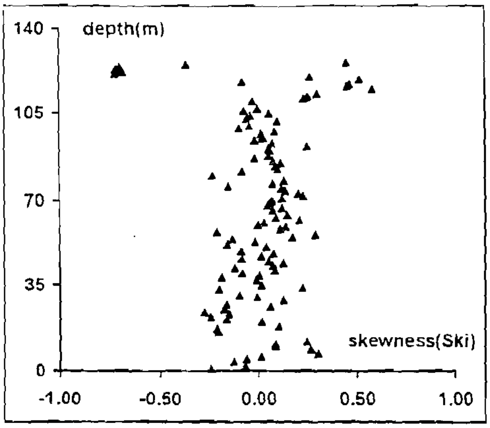

Fig.(4c) :Skewness-depth relationship in the study area.

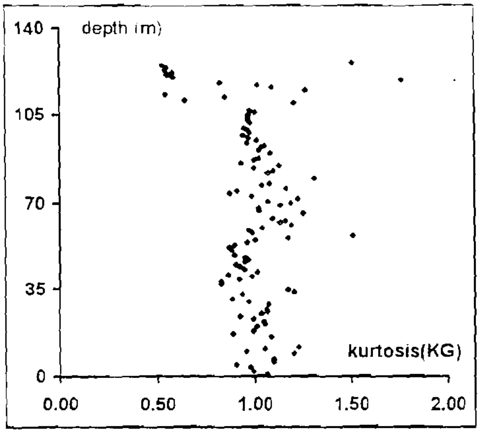

Fig.(4d) :Kurtosis-depth relationship in the study area.

Sedimentological characteristics and the depositional environments:

The distribution curves of the upper part of the investigated subsurface sediments till a depth of about 110m are illustrated in (Fig.5). They are generally similar in their central part, whereas the average angle of the central part was found to be between 60-65.° The curves are being more or less parallel or overlapped indicating almost similar sorting ranging from moderately sorted to poorly sorted. They have similar amount of suspension population (Fig. 5) being about 2-5% of the distribution at 3-4Φ. They differ in the position of the coarse truncation; some have coarse truncation at 2-3.5 Φ with variable amounts of distribution, while other curves show no clear traction population. The curves without traction population could be related to wind blown deposits (VISHER;1969, EL-BOUSELY and FRIHY ;1975 and ANWAR *ET AL.*1981). Those with traction population could be related to wave zone sands as indicated by VISHER (1969).

The lower part of the investigated borehole was subjected to intensive study to determine its origin, its depositional environment, and the hydrodynamic conditions under which the sediment deposited. Table (1) illustrates the sediment components of this layer, whereas table (2) reveals the characteristics of the distribution curves.

Table (1) shows the presence of three main sedimentary units comprised of clayey sand, muddy sand and sandy clay, with general trend of increasing the clay % downward. Table (2) presents the main characteristics of the distribution curves of the lower part of the investigated sediments. The average of the angle of the central part in the distribution curves is lower in the muddy layer (42°) than that of the overlying layers (65°) indicating lower degree of sorting. Moreover the mud deposit's distribution curves (Fig.6) generally have two distribution populations; saltation and suspension. The coarse traction (rolling) population is represented in some samples, while a well-developed suspension population comprised of up to about 60%. These values are comparable to those of the upper part of the studied borehole, which do not exceed 5% (Figs.5 and 6). The slope of the saltation population is less steep (42) reflecting least sorting than the other sedimentary units i.e. coarse and medium sand units. The truncation between suspension and saltation occurs mostly at 8.0 ϕ. Generally no fine truncation point was detected in the distribution curves of the upper sedimentary units of the studied sediments. VISHER (1969) showed that, the

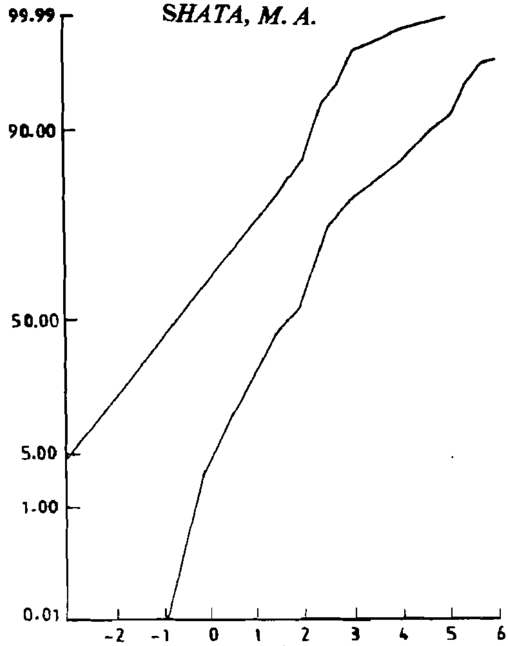

Fig. (5): **Outline of grain size distribution curves of the upper part of the studied.**

Fig. (6): Outline of grain size distribution curves of the lower part of the studied borehole.

Table (1): Sedimentological components of the lower part of the Subsurface sediments in the study area.

Sample No.	Depth (m)	Sand %	Silt %	Clay %	Sediment type
111	111	55.9	5.68	38.43	Clayey sand
112	112	72.22	3.32	24.46	Clayey sand
113	113	52.36	4.10	43.54	Clayey sand
115	115	75.59	8.55	15.86	Muddy sand
116	116	72.2	8.52	19.29	Muddy sand
117	117	72.11	7.81	20.8	Muddy sand
118	118	38.45	34.45	27.38	Muddy sand
119	119	81.03	2.82	16.15	Very fine sand
120	120	56.96	4.94	38.10	Clayey sand
121	121	30.29	1.07	68.63	Sandy clay
122	122	35.63	8.17	56.21	Sandy clay
123	123	30.18	5.20	64.62	Sandy clay
124	124	36.18	4.07	59.57	Sandy clay
125	125	43.86	6.54	49.6	Sandy clay

Table (2): the characteristics of the distribution curves of the lower part of the subsurface sediments in the study area.

S.N	Depth (m)	Angle central part	Coarse truncation (ϕ)	Coarse truncation %	Fine truncation ϕ	Fine truncation %
111	111	30	0.0	20.0	8.0	64.5
112	112	50	0.0	16.0	8.0	77.0
113	113	10	1.0	22.0	8.0	79.0
115	115	37	1.0	26.0	8.0	87.0
116	116	40	1.0	19.0	8.0	85.0
117	117	40	1.0	19.0	7.0	72.0
118	118	35	1.0	14.0	9.0	91.0
119	119	45	4.0	18.0	8.0	85.0
120	120	12	0.0	13.0	8.0	64.0
121	121	60	2.0	20.0	8.0	66.5
122	122	55	0.0	9.0	8.0	46.5
123	123	65	2.0	25.5	7.0	36.0
124	124	70	0.0	5.0	8.0	42.0
125	125	45	2.0	30.0	8.0	53.0

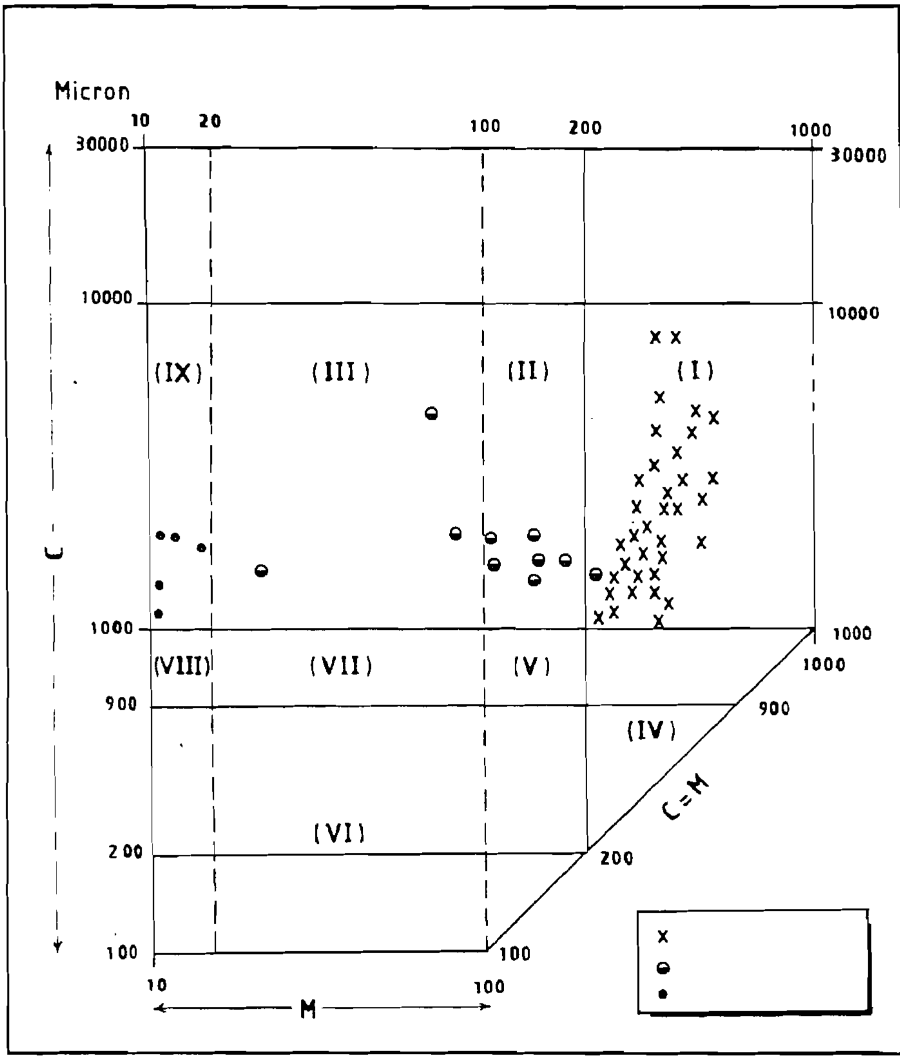

Fig. (7): C-M pattern for the investigated subsurface sample of the area.

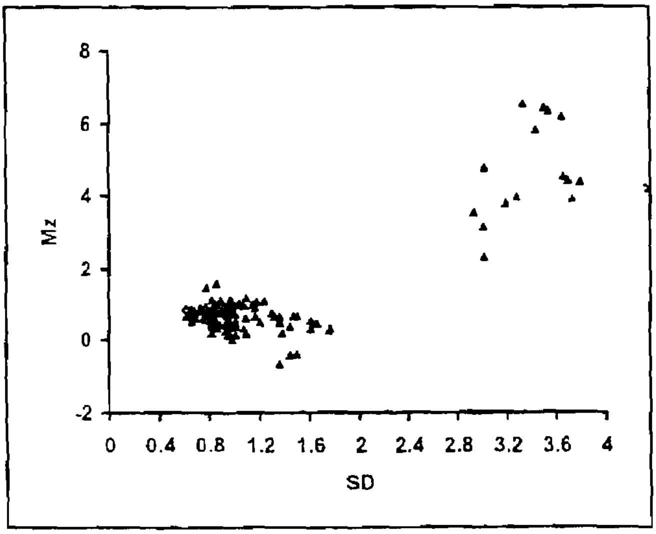

Fig. (8): SD-MZ digram showing different depositional environments in the investigated area.

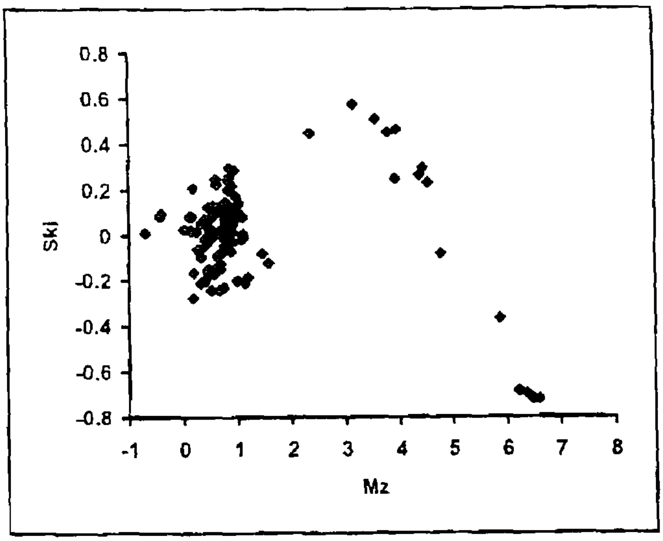

Fig. (9): SKI-Mz digram showing different depositional environments in the investigated area.

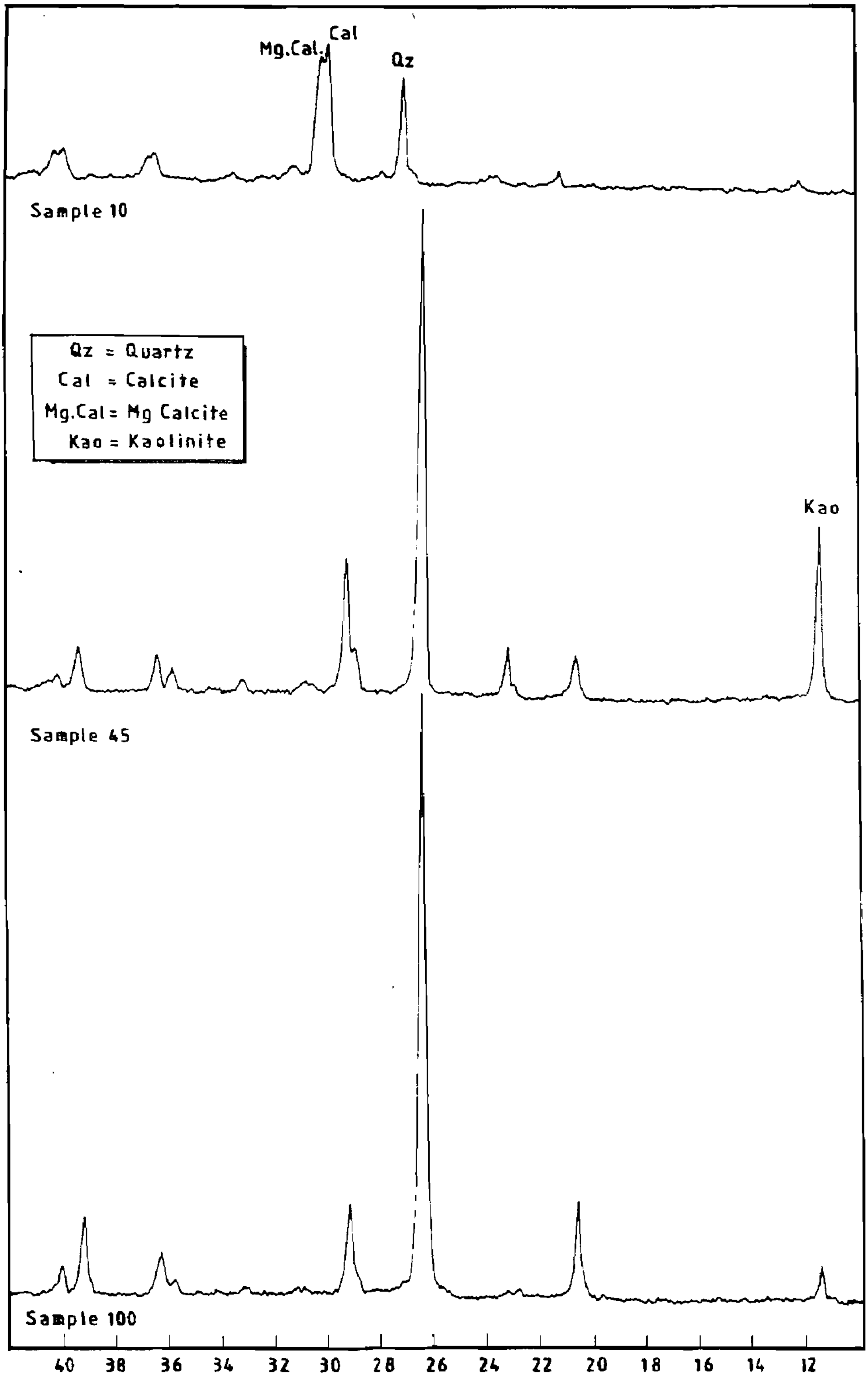

Fig. (10): X-ray diffraction patterns of the subsurface sediments of the upper part of the studied borehole.

position of the fine truncation might reflect turbulent energy at the depositional interface, whereas low turbulent energy produces truncation at a fine point and high turbulent energy at coarse truncation. This indicates that the upper and lower sedimentary units might be probably deposited under different depositional conditions.

PASSEGA and BYRAMJEE, 1969 (Fig.7) predicted the hydrodynamic conditions, under which the sediments deposited. Using C-M diagram, the majority of the studied sample falls in class I & II and III indicating deposition by rolling. From depth of about 120 m the samples fall in class IX indicating deposition by pelagic suspension mechanism that suits the nature of the sediments, which is mainly sandy clay.

The discrimination of the depositional environments under which the subsurface sediments were deposited was determined by drawing scatter diagrams between the different parameters. These are standard deviation versus mean size (Fig. 8) and Skewness virsus mean size (Fig.9). The diagrams showed that, upper part of the borehole was deposited under a different depositional environment from that of the lower part.

SAHU'S equations (1964) revealed that, the upper part of the sediments in the borehole was deposited in beach environments while the lower part was sedimented under fluvial depositional conditions.

Mineralogical characteristics of the investigated subsurface sediments:

The mineralogical characteristics of the sediments were determined using two techniques. The X-ray diffraction was made to determine the different mineral association and its variability throughout the investigated borehole. Infrared technique has been used to define the mineralogical reactive groups. X-ray diffraction patterns indicated well-crystallized mineral matrices in all analyzed samples (Figs. 10&11). At depth of 10m, the carbonate minerals dominate the mineralogical composition ($CaCO_3$ %=71). They are represented by calcite and Mg- calcite. At depth of 45m, the silisiclastic minerals dominate the carbonate ones ($CaCO_3$ %= 19). It is interesting to note that, diagenetic processes have been taken by the partial transformation of calcite into Mg-calcite. Based on Graf (1960) and Goldsmith & Graf and Heard (1961), it was found that the existing Mg-Calcite with *d* (104) of 2.9721 suits Ca-Mg (80-20).

The silicates include quartz and kaolinite. Marked deficiencies in carbonate components have been observed at depth of 100m ($CaCO_3$ %=9). . Moreover, the transformation of calcite into Mg-calcite becomes more intensive.

The silicate minerals become the principle part of the muddy layer that extends from depth 111m ($CaCO_3$ %= 3) to the end of boring i.e. 125m. Traceable amounts of the carbonate components have been determined ($CaCO_3$ %=3.7,Fig.11). The dominance of silicate and the marked deficiency of the carbonate may suggest the fluviomarine origin of this layer.

Infrared analysis reveals presence of quartz at the wave band 797-800 cm^{-1}, calcite at 712 cm^{-1} whereas the carbonate group is recorded at 870 cm^{-1}. On the other hand, Kaolinite is determined at 3700 cm^{-1} (Fig. 12).

Heavy mineral analysis:

Opaques (magnetite and ilimenite), amphiboles (mainly dark green hornblende) and pyroxene are the dominant heavy minerals in the lower part of the investigated borehole (table 3). In addition, there are accessory minerals such as biotite, chlorite, epidote, garnet, tourmaline and staurolite. Heavy mineral ratios are ofently used as criteria for sediment dispersal pattern. Stanley (1989) used the ratio of pyroxene and epidote to study the regional pattern of transport between Nile Delta and Israel.

The average content of the heavy minerals determined in the lower part of the investigated borehole is as follows;

Opaques (Iron oxide minerals):

Opaques are the main heavy mineral in the lower part of the studied borehole. It varies between 9.9 to 40% with average value of 24.71%.

Non –Opaque minerals:

Amphiboles;

They are represented by green hornblende and reveal wide range of variation, whereas it varies from 3.03 to 47.52% with an average value of 20.85%. The higher value of amphiboles may be correlated with the significant increase of the clay fraction and accompanied with the observed decrease of the opaques constituents.

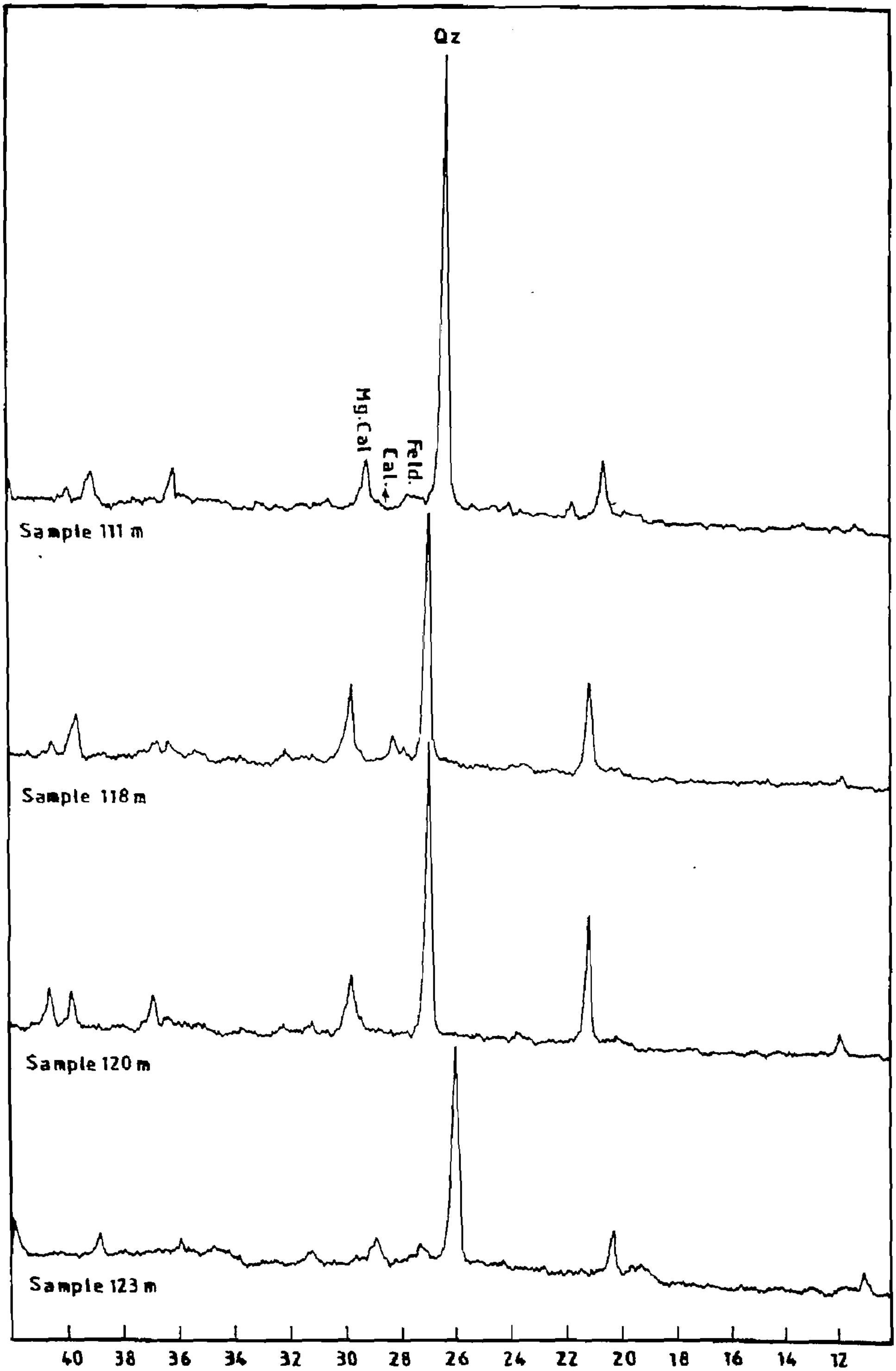

Fig. (11): X-ray diffraction patterns of the subsurface sediments of the lower part of the studied borehole.

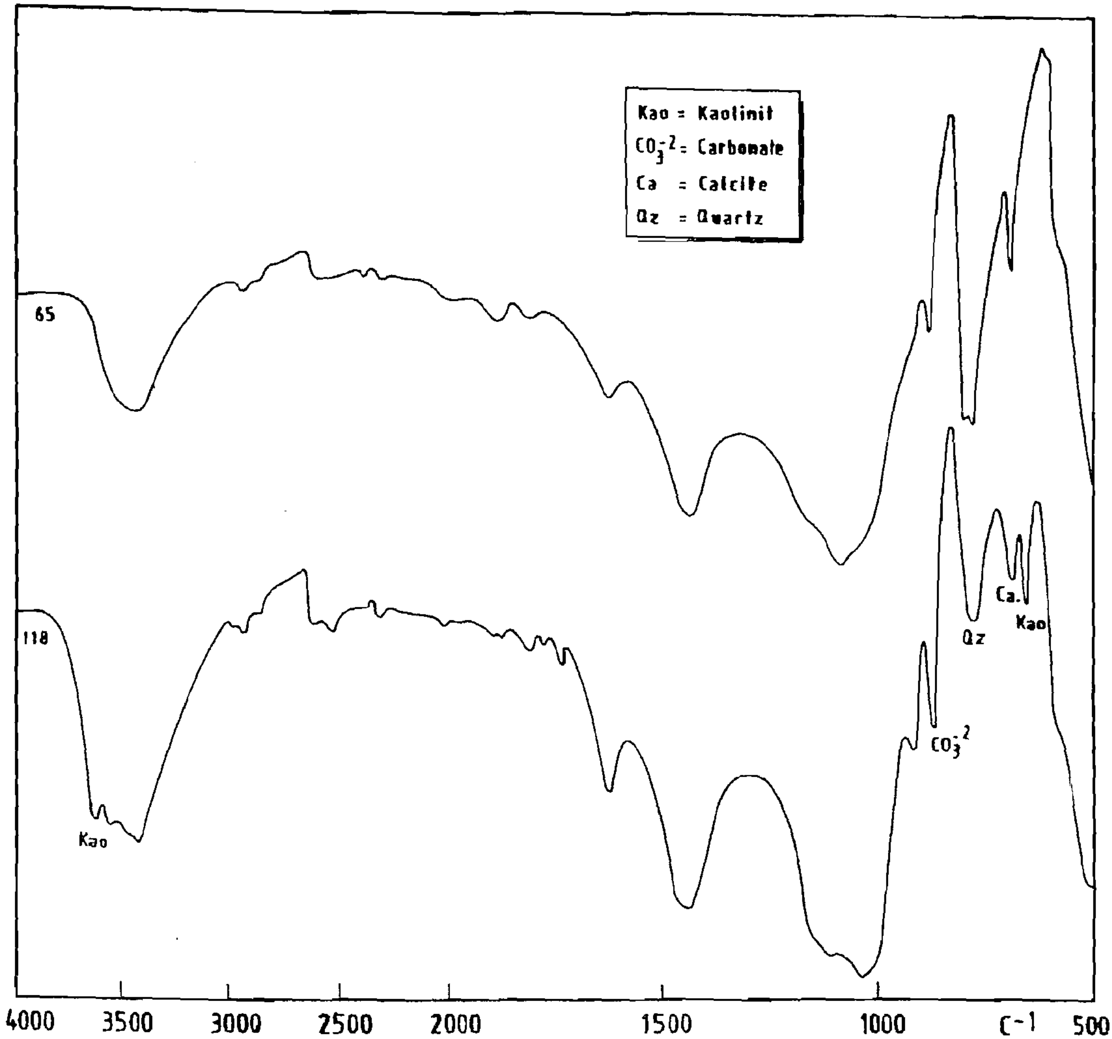

Fig. (12): Infrared spectra for the minerals of the investigated subsurface sediments.

Table (3): Heavy mineral constituents of the lower part of the investigated borehole.

	Heavy mineral %		
Heavy minerals	S.N.111	S.N.113	S.N.115
Opaques	24.24	9.9	40.0
Amphiboles	3.03	47.52	12.0
Pyroxenes	16.67	14.85	14.0
Epidote	7.58	7.92	10.0
Garnet	3.03	1.98	4.0
Monazite	--	--	--
Staurolite	1.52	0.99	2.0
Zircon	--	--	--
Tourmaline	6.06	1.98	2.0
Rutile	--	--	--
Biotite + Chlorite	37.88	14.85	16.0
Heavy mineral %	1.5625	1.9068	0.95108
Index figure	0.0159	0.0194	0.00960
Sand %	55.9	52.36	75.59
Silt %	5.68	4.10	8.55
Clay %	38.43	43.54	15.86
Sediment type	Clayey sand	Clayey sand	Clayey sand

N.B. S.N= sample number = sample depth (m)

Pyroxenes:

They are represented by common greenish yellow augite and less common enstatite and hyperthene varieties. They showed a narrow range of variation from 16.67 to 14% with an average value of 15.17%.

Epidote:

Yellow and greenish yellow grains represent epidote minerals. The average frequency is 8.5%.

Garnet:

Garnet is represented by pink and colorless varieties with an average value of 3%. It is interesting to note that this value is comparable with that obtained by El Nozahy and Badr (1986) in their study on the continental shelf sediments of Abu Qir Bay, northern coast of Egypt.

Micas:

Micas include brown to greenish yellow biotite and colorless chlorite. They varied from 37.88 to 14.85%.

The heavy mineral analysis reveals that, the sediments of the lower part of the investigated borehole are almost derived from alluvial materials.

CONCLUSIONS

The present study entails with all sedimentological, mineralogical, as well as, other evidences to throw lights on the main characteristics of the subsurface sediments in Burg El-Arab area. The grain size analysis indicates the presence of two different depositional environments characterizing the upper and lower parts of the investigated borehole. It reveals also different hydrodynamic conditions. The depositional differentiation shows that, the upper layers were sedimented under marine environmental conditions whereas the lower seemed to deposit under fluvial conditions.

The mineralogical analysis illustrates marked decrease of carbonates downward with the predominance of silisiclastic minerals in the lower part of the investigated borehole.

The heavy mineral analysis reveals that, the sediments of the lower part of the investigated borehole are almost of alluvial origin.

Micropaleontological analysis reveals that, the lower part, in contrast to the upper calcareous layers, is characterized by the scarcity of the foramineferal individuals and shows abraded and destroyed the most tests causing difficulty of specific identification. This deformation could be explained on the basis that these individuals are allogenic transported from other area, so they are not related to the environment of deposition.

Paleopalynological analysis indicates that, The ratio of marine and non-marine palynomorphs reveals that the depositional environment was a shallow marine (inner shelf) as deduced from the abundance of dinoflagellate cyst. Also, the influence of fresh – water connected to the sea is documented as observed from the weak input of ***pediastrum*** (fresh water algae).

The study outlines the origin of the lower fluvial part of the investigated borehole depending on the previously mentioned results and the studies made by different authors to follow up the sea level variations in the study area. It could be concluded that, the lower part might be covered by the fluvially-influenced portion of Mariotes lagoon which was fed by one or more minor branches of the Canopic channel that flowed into the southeastern portion of the lagoon.

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REFERENCES

ABDEL-MOGHEETH, S.M. (1968): Hydrochemical studies of Burg El-Arab and vicinities. M.Sc. Thesis, Ain Shams Uni, 109 pp.

ANWAR, Y.M; GUINDY, A.R.; EL-ASKRY, M.A. and EL-FISHAWI, N.M. (1979): Beach accession and erosion, Burullus-Gamasa coast, Egypt. Mar.Geol.10 M27- M32.

ATWA, S.M.M. (1979): Hydrogeology and hydrochemistry of the northwestern Coast of Egypt. Ph.D. Thesis, Fac. Sci. Alex. Uni.225 pp.

CHEN, Z.; WARNE, A.G. AND STANLEY. D.J. (1992): Late Quaternary evolution of the northwest Nile Delta between Rosetta and Alexandria, Egypt. J. Coast. Res., v.8, pp.527-561.

EL-ASMAR, H. M. (1998): Middle and Late Quaternary paleoclimatic evolution, northern Mediterranean coast of Egypt. Quaternary Desert and Climatic change, Balkema/ Rotterdam/ Brookfield, 1998.pp: 261-271.

EL-MAGHRABY, M.M.S.A. (1997): Geophysical, Hydrogeological and remote sensing studies on the effect of sea level fluctuation on the groundwater reservoir between Alexandria and El-Dabaa, Egypt. Ph. Thesis. Fac. Sci. Alex. Uni.357 pp.

EL- SHAMY, I.Z. (1968): The geology of water and soil resources in El-Dabaa area, western Mediterranean coastal zone, U.A.R. M.Sc. Fac. Sci., Cairo Uni.,112 pp.

EL-BOUSELY, A.M. AND FRIHY, O.E. (1975): Grain size relationship of surface and subsurface sands on the Mediterranean coast between Abu Qir and Rashid, Egypt. Fac. Sci. Bull. Aex. Uni.15.

EL NOZAHY, F.A. and BADR, A. A. (1986): Mineralogy of the continental shelf sediments of Abu – Qir Bay northern coast of Egypt. Geojornal: 13.4, 347-358.

FOLK, R.L. (1974): Petrology of sedimentary rocks. Texas Uni. Hemphill pub. Co., 182p.

GERGES, M.A. (1976): Preliminary results of a numerical model of circulation using the density field in the Eastern Mediterranean. Symposium on the East.Med., Malta . Acta Adriatica, 18(10): 163-176.

GRAF, D. L. (1960): Geochemistry of carbonate sediments and sedimentary carbonate rocks. Div. III. State Geol. Survey Circ. 297, Parts 1-5.

GOLDSMITH, J.R; GRAF. D.L; and HEARD, H. C. (1961): Lattice constants of the calcium – magnesium carbonates. Am. Mineralogist. 43,84-101.

GRIFFEN, G. (1971): "Interpretation of X-ray diffraction data In: Procedures in Sedimentary Petrology" (ed. Carver, R. E), Wiley Interscience, New York: 541-568.

GUINDY, KH.A. (1974): Hydrogeological and Hydrochemical aspects of the Dhabbaa Area, northwestern coastal zone of Egypt. M. Sc. Thesis. Fac. Sci., Cairo Uni., 120 pp.

GUINDY, KH.A. (1989): Hydrogeology of the coastal zone between El-Amereiya and El-Hammam. Ph.D. Thesis, Fac. Sci. Ain Shams Uni. Cairo, 151pp.

HASSOUBA, A.H. 1980): Quaternary sediments for the coastal plain of the northwestern Egypt (from Alexandria to El- Omayed) M.Sc. Thesis, Geol. Dept. Imperial college, Uni. London, London S.W. 7,320 pp

HILMY, M.E.; EL- SHAZLY, M.M. and KORANY, E. A. (1976): Lithostratigraphy and petrology of Miocene and post- Miocene succession in area between Burg El-Arab and El-Dabaa, western Desert. Geol. Soc. Egypt, Cairo. Pp.10-11 (Abs.).

KHOLEIF, S.E.A. (1998): palynostratigraphical studies of Jurassic-lower Cretaceous strata in the subsurface of the northern eastern desert, Egypt. Ph. Thesis , Cairo Uni., 239 pp.

MARZOUK, I. (1970): Rock Stratigraphy and Oil potentialities of the Oligocene and Miocene in the western Desert, U.A.R. 7th Arab Petroleum Congress, Kuwait, v. II, No. 54 (B-3), pp. 1-28.

MESHRIF, W.A., ABU EL-ATA, A. and MANSOUR, H.A. (1990): The use of gravity spectral analysis in defining the mappable seismic horizons of Burg El-Arab area, western desert, Egypt. E.G.S. Proc. Of the 8th Ann.M.1990, pp. 73-94.

MURRAY, J.W. (1991): Ecology and paleoecology of benthic foraminifera. Longman. Essex.394 pp.

PASSEGA, R. and BYRAMJEE (1969): "Grain size image of clastic deposits". Sedimentology, 13: 233-252.

PAVER, G.L. and PRETORIUS, D.A. (1954): Report on Reconnaissance Hydrogeological Investigation in the Western Desert Coastal Zone. Publ. Desert Inst., No.5, Cairo.

SAHU, B.K. (1964). Depositional mechanism from the size analysis of clastic sediments. J. Sed. Petrol. 34: 73-83.

SAID, R. (1965): Notes on the Geology of Egypt. Fac. Sci., Cairo Uni. Press. 90 pp.

SALEM, R. (1976): Evolution of Eocene- Miocene sedimentation patterns in parts of northern Egypt. Am. Assoc. Petrol. Geol. Bull., v 60 pp. 34-64.

STANLEY, D.J. (1989): Sediment transport on the coast and shelf between the Nile Delta and Israel margin as determined by heavy minerals. J.Coast.Res.Vol.5.pp.613-628.

VISHER, G.S. (1969): Grain size distribution and depositional processes. J. Sed. Petrol. 39: 1074- 1106.

WIGLEY, R.L. (1961): Bottom sediments of Georges Bank. Jour. Sed. Petrol. 31(2):165-188