STUDIES ON THE BOTTOM DEPOSITS OF LAKE BROLLUS, A DELTA EGYPTIAN LAKE

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RÉSUMÉ

ÉTUDE DES SÉDIMENTS DU LAC BROLLUS, DELTA DU NIL

Des échantillons de sédiments ont été collectés dans le lac Brollus, un grand lac peu profond d'eau saumâtre du delta du Nil communiquant avec la Méditerranée et qui a fait l'objet d'études physico-chimiques. On a observé une relation inverse entre la densité de la boue humide et la teneur en eau qui dépend surtout de la nature et du type de sédiment. Il existe également une relation inverse entre les quantités d'eau et de matériel allochtone dans la plupart des échantillons de sédiment. L'augmentation des poids de matière sèche dans les échantillons de la partie occidentale (stations I-VII), est due généralement à l'augmentation considérable des poids des différents composants du sédiment (matière organique, matériels allochtones, substances d'origine calcaire, etc.). Les quantités de chacun de ces composants varient beaucoup par m² de boue humide. Leur distribution quantitative dans les échantillons dépend surtout de certains facteurs qui ont été discutés.

ABSTRACT

Sediment samples were collected from Lake Brollus, a large shallow brackish-water Delta lake in Egypt connected to the Mediterranean Sea, and subjected to some physico-chemical investigations. An inverse relation was normally found between the density of wet mud and the water content. The variation of water of the sediments is due mainly to the nature and type of these sediments. An inverse relation existed between the amounts of water and allochthonous materials in most sediment samples. The remarkable increase in the weights of dry matter in the western samples (Stations I-VII) is due generally to the considerable increase in the weights of the different sediment components (organic matter, calcareous substances, allochthonous materials and diatom-silica). The amounts of each of these components deposited on one m² wet mud showed marked variations. The quantitative distribution of these components in the sediment samples was found to depend mainly upon certain factors which were discussed.

INTRODUCTION

Lake Brollus, the second largest Delta lake in Egypt, is situated at the northern part of the Nile Delta, stretching between the two Nile branches. Its area reaches about 146,000 feddans (one feddan is equivalent to 4,200 m²). This lake is separated from the Mediterranean Sea at the North by a strip of land covered with sand bars and sand dunes, and is connected to the sea with Boughaz El-Brollus. The eastern and southern borders of this lake are characterized by their irregularity and surrounded by agricultural lands (fig. 1).

Huge amounts of drainage waters enter into Lake Brollus via several drains. These waters cause the rise in the lake level above sea level, inducing a lake-sea current. Winds are mainly responsible for the rise of sea level, inducing a sea-lake current. The sea water entering into the lake affects mainly the region of the Boughaz. The water depth, ranging from 70-240 cm, increases gradually from east to west and from south to north. Changes in the water

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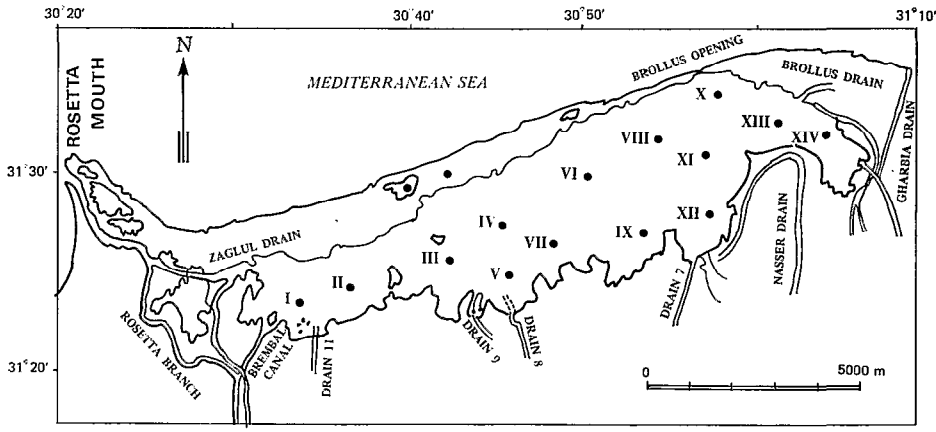

Fig. 1. – Lake Brollus and position of stations.

level expose or flood extensive areas of the lake shores. Chlorosity of the lake water varies markedly according to different localities and seasons. It is, in general, higher in the area of the lake-sea connection and lower in the regions near the drains. The water movement, caused by the effect of the prevailing wind, plays an important role in the distribution of chlorosity in the lake.

The lake bottom shows various structures. It is sandy mixed with silty materials in the region of the lake-sea connection and muddy black to greyish black in colour at the southern part of the lake.

The extensive large area of the shallow water Lake Brollus, its connection to the sea and the huge amounts of the fertile drainage waters entering continuously into it could be considered as main factors responsible for increasing the fish production in this lake. Inspite of the high fish yield from Lake Brollus only a very few limnological studies were carried out on it (DARRAG, 1975; SAAD, 1976a, 1976b). The present work was undertaken to gain some information on the nature and composition of the surface sediments of this lake, in an attempt to throw some light on its fertility.

MATERIAL AND METHODS

A modified Ekman-bottom sampler was used to collect several sediment samples from the lake. Since several samples were more or less similar, only 14 stations were selected to represent different regions of the lake bottom (fig. 1). The density of wet mud was determined, on the same day of collection, using a pyknometer. The density of dry mud was calculated from the density of wet mud and the water content (SAAD, 1970). The amount of water was determined by drying the wet samples in an oven at 105 °C. The organic matter was estimated by igniting about 500 mg dry mud in a Muffel furnace at 525 °C for 4-5 hours (UNGEMACH, 1960). The HCl-soluble and insoluble parts of the sediments were determined by adding 12.5 % HCl to the remaining inorganic fractions of the deposits in conical flasks, which were heated for one hour on an electric plate. Filtration was carried out using ashless filter paper. The dissolved parts of the sediments were considered as calcareous substances and the undissolved parts as allochthonous materials plus diatom frustules. The method described by MULLIN & RILEY (1955) and modified by TESSENOW (1964) was used for the photometric determination of silicate.

RESULTS AND DISCUSSION

The values obtained are represented as weight percentages of dry mud in order to compare the percentage distribution of the different components of the sediments at the selected stations (Table I). These values were also calculated in kg per m^2 wet mud in order to give a good idea about the quantitative distribution of these components on the lake bottom. The silica content was calculated in g per m^2, due to its low value (Table II).

The density of wet mud varied from 1.55-1.21 g/cm^3 at stations II and XIII respectively, with an average of 1.37 g/cm^3. The density of dry mud ranged from 4.33-2.50 g/cm^3 at stations XI and VII respectively, with an average of 3.33 g/cm^3. The wet density gave generally an inverse relation with the water content. The maximum density of wet mud recorded from the western part of the lake was associated with the minimum water content and the maximum value of dry matter. On the other hand, the minimum wet density registered from the eastern side of the lake was associated with a

TABLE I

Percentages of some constituents of Lake Brollus sediments

Stations	Water depth cm	Water	Dry matter	Org. matter	Calc. substances	Alloch. materials	Si	SiO_2
I	170	51.79	48.21	12.55—	45.98	40.88	0.59	1.26
II	145	45.08—	54.92+	12.62	53.16+	33.38	0.84	1.80
III	150	49.17	50.83	16.24	36.24	46.92	0.60	1.28
IV	150	60.18	39.82	16.55	43.19	39.63	0.63	1.35
V	130	48.63	51.37	19.56+	48.84	31.12—	0.48—	1.03—
VI	140	60.17	39.83	12.57	45.20	41.20	1.03+	2.20+
VII	135	50.52	49.48	15.31	49.18	34.87	0.64	1.37
VIII	150	65.21	34.79	16.46	40.21	42.40	0.93	1.99
IX	100	68.15	31.85	19.03	44.41	35.64	0.91	1.95
X	240	68.32	31.68	15.44	31.53—	52.16+	0.88	1.88
XI	110	69.86	30.14	16.77	33.66	48.96	0.62	1.33
XII	105	75.69+	24.31—	19.26	38.04	41.87	0.83	1.77
XIII	110	74.62	25.38	16.72	45.96	36.29	1.03+	2.20+
XIV	70	63.70	36.30	16.03	37.95	45.30	0.73	1.56
Average percentages		60.79	39.21	16.08	42.40	40.76	0.77	1.64

N.B. — The maximum percentages are designated by (+) and the minimum by (—).

TABLE II

Density of the wet and dry mud, as well as the amounts of some constituents deposited on the bottom of Lake Brollus

Stations	Density (g/cm³)		Water kg/m²	Dry matter kg/m²	Org. matter kg/m²	Calc. substances kg/m²	Alloch. materials kg/m²	Si g/m²
	Wet mud	Dry mud						
I	1.47	2.96	7.6	7.1	0.9	3.3	2.86	40
II	1.55—	2.83	7.0—	8.5+	1.1	4.5+	2.83	70+
III	1.53	3.12	7.5	7.8	1.3	2.8	3.65+	50
IV	1.38	3.24	8.3	5.5	1.0	2.4	2.17	30
V	1.54	3.20	7.5	8.0	1.6+	3.9	2.46	40
VI	1.39	3.44	8.4	5.5	0.7	2.5	2.24	60
VII	1.42	2.50—	7.2	7.0	1.0	3.4	2.56	40
VIII	1.32	3.29	8.6	4.6	0.8	1.8	1.96	40
IX	1.30	3.73	8.9	4.1	0.8	1.8	1.46	40
X	1.31	3.82	8.9	4.2	0.6	1.3	2.16	40
XI	1.24	4.33+	8.7	3.7	0.6	1.3	1.78	20—
XII	1.22	3.75	9.2+	3.0—	0.6	1.1—	1.28	20—
XIII	1.21—	3.10	9.0	3.1	0.5—	1.4	1.17—	30
XIV	1.34	3.27	8.5	4.9	0.8	1.9	2.26	40
Average amounts	1.37	3.33	8.2	5.5	0.9	2.4	2.20	40

N.B. — The maximum amounts are designated by (+) and the minimum by (—).

remarkable high value of water and a low value of dry matter.

The percentages of water showed a wide range of variations, fluctuating between 75.69 and 45.08 % at stations XII and II respectively, with an average of 60.79 %. The amounts of water found in one m² varied from 9.2-7.0 kg at these two stations respectively, with an average of 8.2 kg. The variation of water content of the sediments is due mainly to the nature and type of the sediments. The samples collected from the western half of the lake (Stations I-VII) were generally characterized by low water

content and high amounts of allochthonous materials, whereas those obtained from the eastern half (Stations VIII-XIV) had generally high water content and low amounts of allochthonous materials. Accordingly, an inverse relation existed between the amounts of water and allochthonous materials in most sediment samples. The dry matter gave a considerable wide range of variations for both percentages and amounts. The percentages ranged from 54.92-24.31 % at stations II and XII respectively, with an average of 39.21 %. The amounts deposited on one m^2 fluctuated between 8.5 and 3.0 kg at these two stations respectively, with an average of 5.5 kg. The remarkable increase in the weights of dry matter in the sediments of the western half of the lake (Stations I-VII) is due generally to the considerable increase in the weights of the different components in this area; namely, the organic matter, the calcareous substances, the allochthonous materials and diatom-silica. On the other hand, the remarkable lower amounts of dry matter found in the eastern half (Stations VIII-XIV) are attributed generally to the considerable decrease in the amounts of the different sediment constituents in this region.

The percentages of organic matter varied from 19.56-12.55 % at stations V and I respectively, with an average of 16.08 %. The amounts of organic matter deposited on one m^2 showed a marked variation, ranging from 1.6-0.5 kg at stations V and XIII respectively, with an average of 0.9 kg. The relatively higher amounts of organic matter found in the western half of the lake (Stations I-VII) are attributed mainly to the increase in the amounts of autochthonous organic matter produced in this area and also the increase in the quantities of allochthonous organic matter entered this region, mainly via drainage waters.

The percentages of calcareous substances fluctuated between 53.16 and 31.53 % at stations II and X respectively, with an average of 42.40 %. The amounts of these substances deposited on one m^2 gave a pronounced wide range of variations, ranging from 4.5-1.1 kg at stations II and XII respectively, with an average of 2.4 kg. The bottom of Lake Brollus is characterized by great accumulations of calcareous shells and shell fragments of calcareous organisms. The relatively higher amounts of calcareous substances found in the western half of the lake (Stations I-VII) are attributed to the abundance of calcareous shells in this area (El-Wakeel, 1964; Saad, 1974). On the other hand, the lower amounts of calcareous substances obtained from the sediments of the eastern side (Stations VIII-XIV) coincided with the relative decrease in the amounts of calcareous shells in this region of the lake (Saad, 1976a).

The percentages of allochthonous materials fluctuated between 52.16 and 31.12 % at stations X and V respectively, with an average of 40.76 %. The amounts of these materials deposited on one m^2 varied markedly from 3.65-1.17 kg at stations III and XIII respectively, with an average of 2.20 kg. The relatively higher amounts of allochthonous materials found in the western stations (I-VII) are attributed mainly to the considerable amounts of the fine sand particles carried away from the sand dunes adjoining the northern border of the lake by the effect of the prevailing wind. The allochthonous sediments transported to the lake from different sources (sand dunes, drainage and sea waters) are distributed by water movements and currents to reach most of the lake bottom. They may cover the autochthonous organic sediments or mix with them. Consequently, the exchange of materials between the sediments and the free water is greatly reduced under this condition (Ohle, 1960, 1962, 1964; Ungemach, 1960; Saad, 1970).

The SiO_2-percentages ranged from a maximum of 2.20 % (Stations VI and XIII) to a minimum of 1.03 % (Station V), with an average of 1.64 %. The amounts of diatom-silica varied considerably from a maximum of 70 gSi/m^2 at station II to a minimum of 20 g Si/m^2 at stations XI and XII, with an average of 40 g Si/m^2. The relatively higher amounts of diatom-silica found in certain sediment samples reflect the richness of these samples with diatom frustules (Saad, 1971, 1972, 1976a, 1976b). It may be concluded that the environmental conditions necessary for the growth of diatoms were favourable at the time of deposition. The diatom frustules were also subjected to a high degree of preservation in these sediments. Moreover, the conditions might be unfavourable to accelerate the silica release from these sediments into the free water.

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