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Studies of the Factors Affecting the Distribution of Some Metals in Nasser Lake Sediment, Egypt

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Abstract: The present study was carried out to study the factors affecting the distribution of grain size fraction, pH value, carbonate and organic carbon content of Lake Nasser sediments, Also, the distribution of Na, K, Ca and Mg in different grain size fractions (sand, silt, clay). As well as, the concentration of heavy metals Mn, Co, Zn, Ni in different fractions were analyzed using Atomic Absorption Spectrophotometer (AAS) and discussion.The results obtained here indicated that the distribution of grain size fraction of Nasser Lake sediments depend on specific gravity of suspended particles loaded by flood water, speed of water current, depth of location and the amount of aquatic macro and macrophytes decomposition. pH value in sediment has a positive significant with carbonate content. It increases from south to north direction where the carbonate content is high values in medium and northern part of lake. Also, organic matter content is higher value in northern sites of lake than the southern one. From the available data, it could be concluded that the manganese ions is highly accumulated in clay while the cobalt is relatively high in sand fraction. In contrast, the zinc and nickel ions are highly accumulated in silt fraction.

Key word: Lake Nasser Sediment · Grain Size Fraction · Major Metals · Heavy Metals

INTRODUCTION

Lake Nasser formed after Aswan High Dam was completed in 1964. The water of flood Nile carried out 125million tons of suspended particles every year. The bulk of these particles discharged in southern part of Nasser Lake in Egypt and northern area of Nubia Lake in Sudan [1, 2] Flood water is heavily loaded organic detritus and inorganic particles (sand, silt and clay) reaching to southern area of lake [3].

The main natural sources of major and minor metals in Lake Nasser sediment is flood water and environmental condition or chemical weathering. The turbidity of water during flood is function of sedimentation of suspended paSeveral studies have explained the sedimentation and geochemistry of Lake Nasser [4, 5], while the physicochemical of Lake Nasser water studied by Toufeek and Korium [6]

The present study aims to discuss the factor affecting the physical and chemical characteristics of Nasser Lake sediment as grain size fraction, pH value, carbonate and organic matter content. And study the e effect of these factors on the accumulation on the major metals Na, K, Ca & Mg and minor metals Mn, Co, Zn & Ni in different grain size fractions along Lake Nasser.

MATERIALS AND METHODS

Lake Nasser lies in subtropical arid region and extends between latitude 22°00 and 23° 56\ N and longitude 31°19\ & 33°19\ E. The present study was done through eight stations that were selected along the main channel of Lake Nasser. The name of each site, distance from High Dam illustrated in (Fig. 1).

The surface sediment samples were collected using Ekman grab sampler and kept in polyethylene bags into a freezer and transported into laboratory.

The sediment samples were air dried and sieved through 250 µg sieve to separate the graved and coarser fraction.

Weight 100 gm of each sample in 1000 ml beaker and added H_2O_2 (6%) then boiled for 60 minutes [7]. The samples were fractionated into three fractions, first clay less than 2 µm, secondary silt fraction grain size > 2

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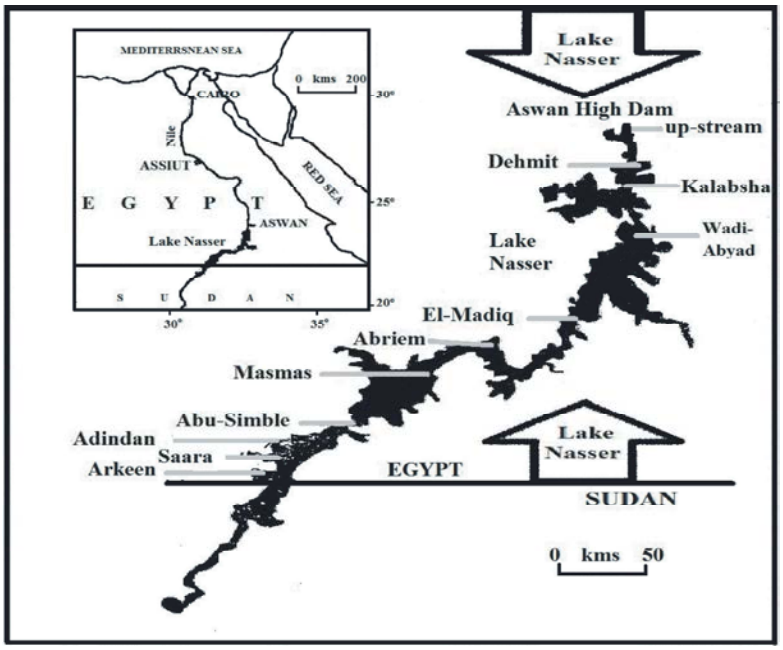

Fig. 1: Map shows the selected stations in the main channel of Lake Nasser.

µm to 63 µm and third sand grain size > 63 µm to 250 µm [8, 9]. Carbonate content, organic matter, pH value in bulk sediment were determined [8].

The prepared fractions for each sample were digestion by mixture acids according to APHA [10]. The concentration of Nam K, Ca, Mg, Mn, Co, Ni where measured using Atomic Absorption Spectrometer Model (Solar 969).

RESULTS AND DISCUSSION

The flood water in the Lake Nasser originated in highland of Ethiopia are very turbid. Since the flood water 1969 no turbid water reaching in northern area of Lake Nasser because all suspended particles sedimentation in southern part of lake where the turbidity of water is function of sedimentation of suspended solids. The total suspended solids, speed of water current and depth of collected samples are determined and listed in Table (1).

Physicochemical Characteristics of Lake Nasser Sediment

Grain Size Fraction: The data obtained are summarized in Table (2). Sand fraction ranged from a maximum value 30.32% at Saara site in southern area of lake and minimum value 8.42% at Abrium site.

Table 1: The speed of water current, depths and suspended solid in Lake Nasser

Code	Site	Dist. from H.D (Km)	Depth	Current speed km/day	Total suspended solids
1	Arkeen	330	33	8.0	41.66
2	Saara	308	36	6.19	36.12
3	Adindan	292	45	6.03	39.16
4	Abo Simple	269	61	5.83	29.63
5	Abrium	235	67	3.3	13.42
6	Masmas	230	65	1.65	8.73
7	El-Madiq	135	76	1.42	6.32
8	Wadi Abyad	75	80	0.99	3.28

Table 2: Grain size fraction of Lake Nasser sediment

Code	Sand	Silt	Clay
1	21.55	22.62	55.83
2	30.22	12.28	57.44
3	25.08	8.53	66.37
4	14.83	11.71	73.46
5	15.7	10.81	73.49
6	8.42	9.91	81.67
7	17.56	12.18	70.26
8	27.80	21.53	50.68

Clay > 2µm, silt > 2µm to 63µm, sand > 63 to 250 µm

As well as, the silt fraction varied between 9.91% at Abrium and 22.62% at Arkeen. Also, the clay fraction in Lake Nasser was varied between the maximum value 81.67% in station 6 as compared with the minimum of 50.68 in station 8 in northern part of lake.

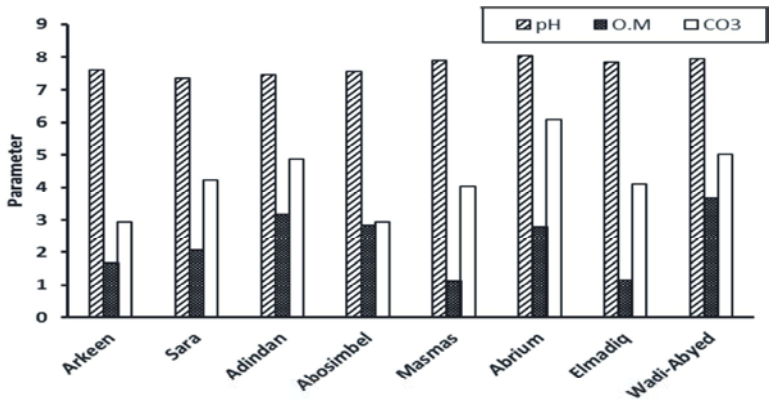

Fig. 2: Concentration of CO_3%, organic matter% and pH value in Lake' sediment

Grain size of Lake Nasser of sediments can indicate spatial in homogeneity. Thus a wide range of different fraction was detected.

The highest sand fraction present in southern area at sites 1, 2, 3 while the low values at sites 4, 5, 6. Generally the sand fraction is decreasing from south to north direction except in northern site at site 8 (Wadi-Abyad). The highest clay fraction was recorded at sites 4, 5, 6 while the lowest value at site 8.

Results shown that the grain size of Lake Nasser sediment differ from one sector to another depending on the material content of grain size which loaded by water flood and on the current velocity of water.

In turn, the grain shape and specific gravity coarser particles having the maximum factors that can be driven by mean traction are thus preferentially transported to highest depth area while high current velocity while smaller particles are moved to lowest depth with reduced current velocity [11].

Hydrogen Ion Concentration (pH): The pH values of sediment samples varying between minimum of 7.35 detected at Saara site 2 in southern area to maximum value 8.05 in northern area (Fig. 2).

The data reveal that the pH value in sediment along the lake lay in alkaline side and it increases from south to north directions. Since most of chemical reactions in aquatic environment are controlled by any change in pH values, where anything either highly acidic or alkaline would kill aquatic life. Thus pH is having primary important in deciding quality of water and sediment effluent [12]

Waters with pH value of to are exceptional and may reflect contamination by strong base such KOH, NaOH and $Ca(OH)_2$ [13]. In contrast, sediment having a pH below 6.0 can be consider hazardous to aquatic life.

Organic Matter: Organic matter content was defined in each fraction at different depths. The concentration of organic matter content ranged between 3.36% and 9.48% in Lake Nasser sediment. The highest value present in Wai-Abyad in northern area of lake while the lowest level recorded in Arkeen in southern part of lake.

The result show that the high organic area of North Lake attributed to low water current velocity.

Also, the high density of phyto and plankton which died and decomposition and settled in bottom sediment [14].

As well as the location has low water current velocity includes living biota mollusca resulted to precipitation all ochtonus material. At low pH value and free oxygen depleted in above water, the organic matter in water decay and discharged to bottom sediment.

From the available data conclude that the distribution of organic matter in sediments does not clearly depend on particle size but it predominantly depends on the environmental condition as temperature, dissolved oxygen and pH value and nature of formation.

Carbonate: The percentage of total carbonate in Lake Nasser sediment ranged between 2.93% and 6.08% (Fig. 2). The lowest value recorded at Arkeen in southern west part of Lake Nasser while the highest value found at Abriem site in middle part of lake.

The lowest CO_3 content found in southern part of lake related to the nature of suspended particles comes with flood which has low carbonate content and the high water current velocity. In contrast the high CO_3^{2-} content in sediment recorded in middle and northern area mainly attributed to the presence high density of different type of phyto and zooplankton, in addition the decay of different organisms especially mollusca and invertebrate. In other hand, the effect of flood water is not found yet in

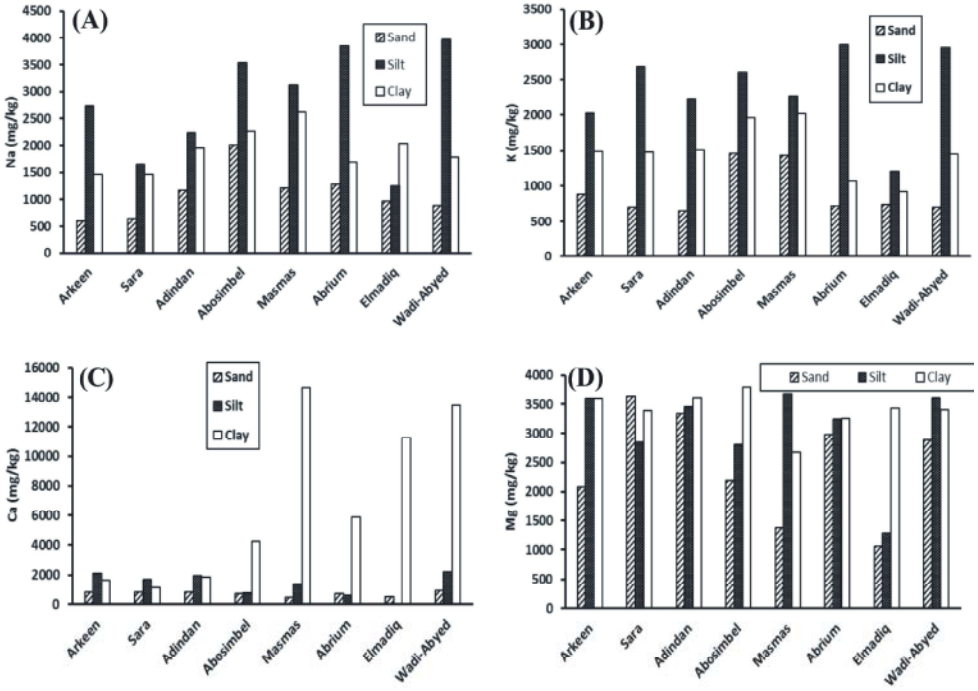

Fig. 3: Concentrations of Major metals in different fractions of Lake Nasser sediment. Sodium (A) Potassium, (B) Calcium (C) and Magnesium (Mg)

northern area of Lake Nasser. The dissolution of $CaCO_3$ from sediment to over layer water is driven by metabolic processes [15] again, dissolution of $CaCO_3$ particles within organism guts may occur independent of the saturation state of the surrounding water [16].

The development and accurate understanding processes controlling the dissolution and precipitation of $CaCO_3$ in the River system remains an important goal for geochemistry [17]. Calcium carbonate dissolution rates from sediments are controlled by solubility and external processes that control the saturation state of the surrounding fluids [18-19].

Two distinctly different geological can be recognized, first carbonate deposited by action of evaporation of surface water of lake as follow:

$$2HCO_3 \rightleftharpoons 2H^+ + CO_3^-$$

Secondary carbonate sedimentation in fresh water in humid regions quantitive based on carbonate content boundary as dominate mineral (calcite).

Distribution of Major Metals in Lake Sediment: The physicochemical condition of sedimentation and climatological are main factors in the process of sediment composition formation. Sediments are multi-phase containing silicates, carbonates, hydroxides/oxides, sulphates and organic substances as major components is a theory that finer sediments contain more heavy metals than coarser ones. The heavy metals concentrations were determination in sand, silt and clay for each sample. The concentration of Na, K, Ca and Mg were represented in Fig. (3).

The highest sodium value 3967.5 mg/kg was recorded in silt fraction at Wadi-Abyad in northern area while the lowest value 608.1 mg/km present in Arkeen in southern part of Lake Nasser in sand fraction, Fig. (3). Generally the sodium ions are accumulated in silt more than other fraction.

Also, the maximum K value 2997.1 was detected in silt fraction at Abrium in median part of lake while the minimum value 652.1 mg/kg was found in sand at Adindan in southern part of Lake Nasser.

On other hand, the highest Ca value 14662.3 mg/kg was found at Masmas in median part of Lake Nasser in clay while the lowest value 123.6 mg/kg recorded at El-Madiq in silt fractions. The obtained data showed that calcium is accumulated with clay fraction especially in median and northern area of Lake Nasser, while sand has low value of calcium salts. The average concentration of calcium in clay is approximately ten times than sand fraction.

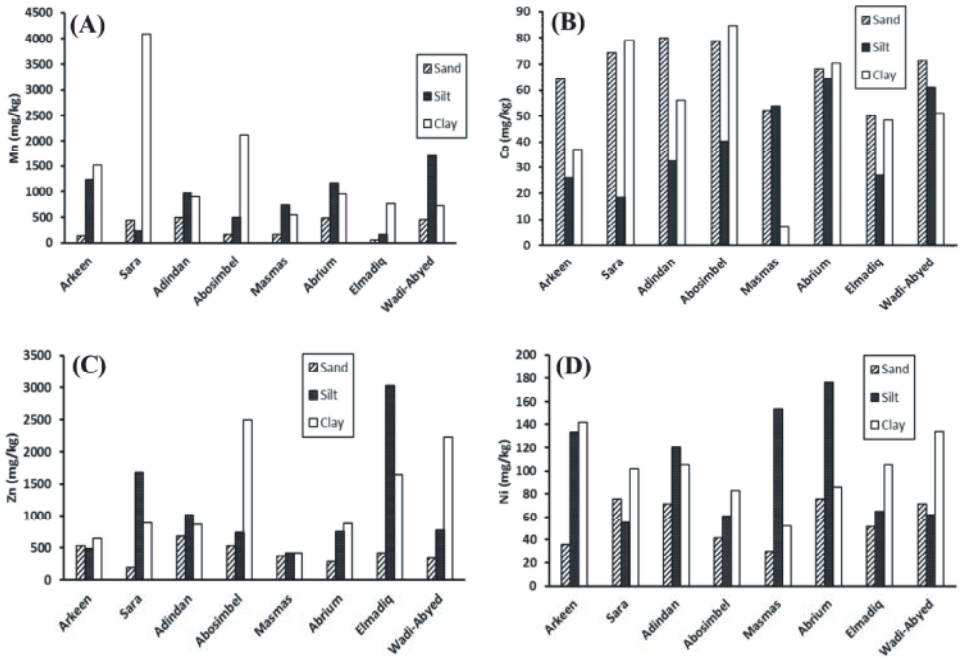

Fig. 4: Concentrations of heavy metals in different fractions of Lake Nasser sediment. Manganese (A), Cobalt (B), Zinc (C) and Nikel (D)

The concentration of Mg ranged from 1056.2 and 3795.3 mg/kg. The lowest values recorded at El-Madiq in sand while higher value found at Abo Simbel in clay fraction.

The data showed that the highest sodium and potassium in median and northern area of lake especially in silt fraction while the lowest value present in sand in southern part of lake. In contrast, the maximum calcium and magnesium present in clay fraction in median and northern areas of lake while the sand is very value by these metals.

Distribution of Heavy Metals in Lake Nasser Sediment: The level of Mn, Co, Zn and Ni is represented in Fig (4). The minimum concentration of Mn was 53.7 mg/kg recorded at El Madiq in sand fraction while the maximum value 4080.2 detected at Saara site in clay fraction.

In turn, the highest cobalt value was 86.0 mg/kg in sand fraction at Adendan compared with the lowest 18.5 mg/kg at Saara in silt fraction.

The concentration of zinc in sediment is ranged from 190.3 to 3036.8 mg/kg, the highest value was detected in silt at El-Madiq in median part of lake while the lowest at Saara in sand fraction.

The data reveals that the highest of zinc found in silt and clay while the lowest present in sand.

The minimum nickel value was 30.0 detected at Masmas site in sand fraction while the maximum 176.4 at Abrium in silt fraction.

Generally, the zinc accumulation in silt and clay fraction in different while sand fraction is poor from Ni salts.

CONCLUSION

The obtained data showed that the distribution of grain size fraction in Lake Nasser depend on the speed water current velocity, flood water, depth and specific gravity of grain size.

The pH value of lake sediment along Lake Nasser lying in the alkaline side and increases from south to north direction and it significant with carbonate content. The distribution of organic matter in sediment does not depend on particles size but it depends on the environmental condition as temperature, dissolved oxygen and pH values.

The concentration of carbonate in lake sediment depends on the nature of sediment silt, density of macro, microorganisms, mollusca and flood effect.

The maximum sodium and potassium levels recorded in median and northern area of lake especially in silt fraction. While the highest value of Ca and Mg clay fraction. This is indicated that Na, K accumulate in the silt and the Ca, Mg are mostly associated with clay mineral.

The data reveal that the Mn was accumulated with clay fraction while the cobalt accumulated in sand fraction. As well as, zinc and nickel ions was accumulated in silt fraction in Lake Nasser.

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