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MINERALOGICAL AND RADIOACTIVE STUDIES FOR UTILIZATION OF LAKE NASSER SEDIMENTS

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ABSTRACT

The present study gives a trial to enhancement the management of Lake Nasser (LN) sediments and presents a demonstration of the sediments assessment process through focusing mainly on the sedimentological, minerlogical and radiometric characteristics of LN and the adjacent beach sediments.

The study revealed that the increasing of sediments accumulation rate at LN cause many challenges and problems which change the morphological features and formation of the flood plains and inner islands. The occurrence of sediment accumulations and heavy mineral placers in LN onshore sediments is known but no systematic attempts has so far been made to management and explore these heavy minerals.

The detailed mineralogical and γ-spectrometric studies for Lake Nasser sediments revealed that the grain size distribution in bottom samples dominant by sandy-silty clay in contrast of silty clayey sand and clayey silty sand in the eastern and western banks, respectively. Heavy fraction in the bottom sediments of LN and the adjacent beach indicates relatively low concentrations of the economic heavy minerals (magnetite, hematite, ilmenite, leucoxene, rutile, zircon, garnet and monazite) that varies between 0.61% and 1.22% for LN offshore sediments and ranged between 1.40% and 1.73% for the eastern beach samples where the western beach samples record 1.30% and 1.73%. It follows that their industrial exploitation is not economically profitable, in spite of previous exploratory studies in the survey zone. The radiometric analysis of all samples showed weak level of radioactivity. Lake Nasser bottom samples showed higher radiometric measurement relative to the adjacent beach samples. This may be attributed to the occurrence of monazite in the LN fine sediments that reach up to 0.0039% and also the presence of some metamict zircon.

The proposed solution for lake sedimentation problems is to prevent eroded particles from entering the lake in the first place by mechanical dredgers. Utilization of economic minerals occurrence in LN can be facilitated by dredging mud into the lake banks. The mud fertility of the reclaimed landin the area. This process also stops sand dunes progression especially in the western bank.

INTRODUCTION

Since the foundation of High Dam, it is one of the largest man-made fresh water reservoirs in the world named Lake Nasser (LN) that extended 500 km in the N-S until Sudan with average width of about 12 km. It is called Lake Nasser in its Egyptian part (350 km long) and Lake Nubia in the Sudanese part (150 km long) (El Gammal, 2010). It is located between lat. 21.8 and 24.0° N and Long. 31.3 and 33.1°E, covering area of about 6,600 Km^2 with total storage of about 162 billion m^3 at water level 182 m (Avakyan and Iakovleva, 1998). It provided a water source of new populations (about 1.0 and 1.2 million people in Egypt and Sudan, respectively).

Lake Nasser has a maximum discharge peak during August and September with maximum sediments accumulation (Fig. 1). Lake Nasser dead zone capacity for sediment deposition is reach up to 31 billion m^3 encountered by sediment transported from the upper reaches (Blue and White Niles), beside sand encroachment from the Western and Eastern Deserts. These sediments decrease the reservoir capacity, increase of bed levels at the reservoir entrance and growing of a new delta. Lake Nasser sediments are comprised mainly of clastic material (clay, silt, and sand sizes), organic debris and chemical precipitates. The relative abundance of each depends on the nature of the local drainage basin and the climate. These sediments were not commercially utilized until now and they were considered as naturally fertilizer for agricultural Nile Delta lands during flood seasons before construction of Aswan High Dam.

Therefore, this paper aims to enhancement management of LN by improving the quality of information about its bed sediments through collecting in-shore core samples from the southern Egyptian portion of the lake (to avoid precipitation effect of High Aswan Dam) using detailed sedimentological, mineralogical and spectrometric studies. Also, survey and monitoring sediments sources using off-shore samples from the western and eastern banks of the lake by mineralogical investigations. Furthermore, the study produces reliable estimates of radioactive and economic minerals of the studied sediments.

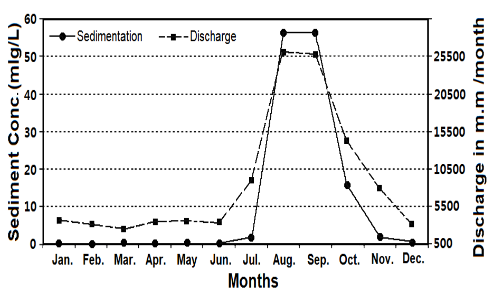

Fig.1: Average monthly precipitation and discharge rates of Lake Nasser (After MWRI, 2010)

The lake was faced with many challenges include sediment accumulation due to form a submerged delta in the Sudanese portion (Fig. 2), bank erosion and failure, sand dunes encroachment, pollution hazard (agriculture, municipal, and industrial) and evaporation losses. A buffer zone of 2 km is established around the LN by Decree 203/2002, where no agricultural, touristic and industrial activities are allowed to take place under law 102/1983 (Zaghloul et al., 2012).

The internal circulation of LN is controlled by the inflowing Nile River which drains a sediments catchment. Basinal deposits of the lake are fed mainly from river plume dispersion involving overflows, interflows, and underflows, and by pelagic settling (Phillips and Nelson, 1981). Occasional the fine sand layers in muds of basinal cores attest to density currents or underflows generated during river flooding flowing the length of the lake along a sublacustrine channel marking the position of the now submerged channel of the Nile River. The submerged delta face has been prograding into the lake in the Sudanese part. Two major proximal to distal sub-environments are defined for the lake on the basis of surficial sediment character and dominant depositional process: riverine and lacustrine (El Kobtan, 2007). The riverine environment represents in the southern part (Sudanese) of the LN and characterized by sand, silty sand, sandy clay silt, clay silt and silty clay sediments, whereas, the lacustrine environment represents north of the borderline N22° and is characterized by silty clay and clay sediments (El Kobtan, 2007). Along the northern part of the lacustrine environment, as the suspended sediments rapidly decreased northward, the bottom sediments tended to be fine grained (fine clay). Helfrich, et al. (2009) studied the effect of sediment load on the biological diverse. El Dardir (1984 and 1994) and Iskaros and El Dardir (2010) mentioned that the maximum sedimentation in LN takes place at the south sector. The study area was

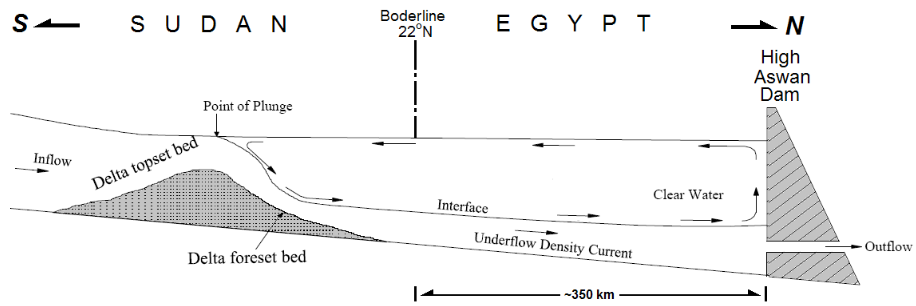

Fig. 2: Model of Lake Nasser floor sediments circulation (After MWRI, 2010).

chosen to reduce the effect of High Dam on circulation and precipitation of the sediments (Fig. 2).

The studied area is characteristics by continental climate. July and August are the hottest months with average minimum/maximum temperatures of 24 and 39.7°C, respectively. In the coolest months of December and January temperatures fall to minimum/maximum temperatures of 10 and 21.7 °C. Khedr, et al. (2013) studied the meteorology of the western bank of LN, they recorded that the prevailing wind direction is north or north-northwest. The average humidity varies between 13% in Summer and 34% in Winter. Rainfall is rare, although rain in the Eastern Desert occasionally causes flash flooding in the wadis on the eastern bank of LN and of the River Nile (Zaghloul, et al., 2012). Sand dunes sedimentation into LN is about 1.5 million m^3/year. Low soil slopes leads to the difficulty of water access to higher land allocated for agriculture on LN. Fish farming, inside embayments (i.e. in floating cages or concrete ponds) transfers dead or alive algae and industrial feed waste used as nutrients that pollute LN water (Salem, 2013).

As high loads of excessive sedimentation transported into lake represents a serious threat to the water lake suspended sediments and begin to settle them; fill in the lake basin making the lake more shallow, reduce the amount of surface area, decrease the water volumes and lake storage capacity, reduce water clarity, increase water temperatures, lower dissolved oxygen levels and promote fish kills,

Geomorphological Features

Based on the significant morphological features, the study area can be subdivided into different geomorphological features which has a great effect on the sedimentation and minerals concentration of the area, these are concluded in;

1.The narrow valley of River Nile incises the Precambrian crystalline rocks.

2.Aswan Hills with elevation ranged between 200 - 400m (a.s.l.) .

3.Lake Nasser (LN); it represents the High Dam reservoir.

4.Embayments (Khors) constitute more than 70% of length of LN shoreline. Khors have considerable effect in evaporation process of LN (El Kobtan, 2007). Their great number in the eastern side of the lake indicates well preservation of drainages coming from Red Sea Mountain, while they are masked by aeolian sand deposits in the western side of the lake (Khedr et al., 2013).

5.Nubia Plain represents an ancient erosional surface defined by Butzer and Hansen (1968). The Nubia Group forms the oldest sedimentary unit in the Nubia Plain that lies over older Paleozoic sediments (Khedr et al., 2008).

6.Border High Land is dominating in the southeastern part of the study area extended to Sudan and composed of sedimentary rocks with elevation reach to 500 m (a.s.l.).

7.Dunes and sand sheets transported and deposited by the prevailing winds in Egypt blow from the NW to the SE (Khedr et al., 2008 and Abd El Aziz, 2012).

8.Islands: there are about 38 islands distributed throughout LN, the largest of them are Abreem Fortress (5 km^2), Neiorol hills (4 km^2) and Sara East (2.5 km^2).

Geologic Setting

The studied area dominated by a sedimentary succession ranging in age from the Post Cambrian to Holocene, with inliers of igneous and metamorphic rocks belonging to the Pre-Cambrian basement complex and Tertiary basalts. The distribution of the stratigraphic units are shown in (Fig. 3). Geology of the study area has been described by several authors, among them Shatta (1962); Issawi (1968, 1971 and 1978); El Shazly, et al. (1977); Entz (1980); Said (1981, 1990 and 1993); Abou Elmagd (2003) and Khedr, et al. (2010 and 2013). The stratigraphic sequence in southern Egypt has classified into three-fold vertical-groups; from base upwards these are, the Pre Late-Jurassic "Infra-Nubia Group", the Late Jurassic-Maastrichtian "Nubia Group" and the Maastrichtian-Paleocene to Recent "Ultra-Nubia Group" (Khedr et al., 2013). Structurally, Issawi (1968 and 1978) mentioned that the LN area is characterized by three main features. The most important one is faulting. The largest of which are Kalabsha and Seiyal faults, trending mainly E-W trend. Faults in the N-S trend are also predominant. Two other systems of subordinate faults, the NW-SE and the NE-SW also exist. The area is affected by up-arching due to uplifting of basement rocks. Folding is less common structure in the study area. Small domes and several basins were created according to the up-arching of the basement.

METHODOLOGY

Sampling

The present work deals with 10 dredged (on-shore) core samples of LN deposits from selected localities starting from Km 170 to 350 at High Dam (Fig. 4). Also, twenty corresponded beach core (off-shore) samples (E1-E10 and W1-W10) were collected from both banks of the lake (Table 1). The dredged sam-

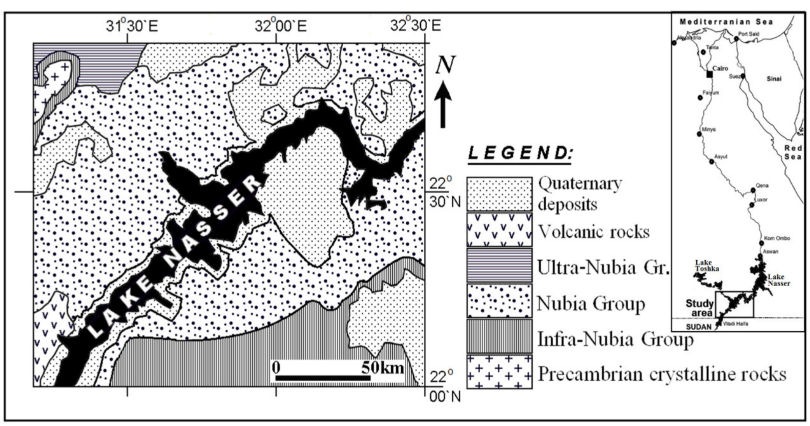

Fig. 3: Geologic map of Lake Nasser and surrounding rocks (Modified after, Khedr et al., 2013)

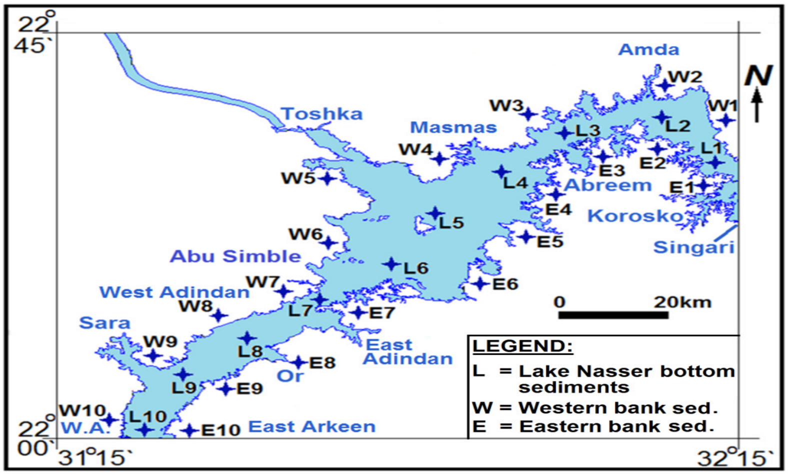

Fig. 4: Location map of the collected samples

Table 1: Locations, depths and weights of the collected core samples.

Distance from HAD (Km)	Locality	Depth a.s.l. (m)	S. No.	Weight of core (gm)	S. No.	Weight of core (gm)	S. No.	Weight of core (gm)
170	Khor Singari	107	L1	8178.85	E1	4191.14	W1	6941.03
190	Khors Korosko & Amda	111	L2	6982.00	E2	5287.34	W2	7050.45
210	Khor Abreem	113	L3	7865.21	E3	5131.72	W3	6821.23
230	Khor Masmas	116	L4	9614.02	E4	4797.40	W4	5910.68
250	Khor Toshka	120	L5	7670.58	E5	6010.27	W5	6449.46
270	North Abu Simble	123	L6	8719.29	E6	4992.55	W6	4861.73
290	East Khor Adindan	131	L7	7897.37	E7	5686.20	W7	5128.47
310	West Adindan & Khor Or	138	L8	8288.41	E8	5130.17	W8	5442.42
330	Khor Sara	147	L9	7815.19	E9	3981.52	W9	6826.15
350	W. & E. Arkeen	162	L10	9027.54	E10	5920.77	W10	7119.85
			Av.	8205.85	Av.	5112.91	Av.	6255.15
			Max.	9614.02	Max.	6010.27	Max.	7119.85
			Min.	6982.00	Min.	3981.52	Min.	4861.73

(L = Lake Nasser, E = eastern bank, W = western bank, a.s.l. = above sea level and HAD = High Aswan Dam).

ples were sun dried. The beach samples were obtained by dug boreholes with a diameter of 10 cm and 50 cm depth after stripping off the surface windblown sand layer. The samples were subjected to preparation procedures in the Nuclear Materials Authority Labs. at Qattamiya and Anshas. The representative core samples were obtained using a rotary Jones Riffle splitter (Fig. 5).

Sedimentation and Grain Size Analysis

In order to have an idea about sedimentological facies of the studied samples, they were subjected to mechanical analysis. About 100g for each representative sample were subjected to dry sieving using standard screens with aperture diameter of 1000, 500, 250, 125, 63 and 40µm.

Mineralogical Investigations

The studied samples were subjected to separation of the economic minerals by physical gravity method using a full size Wilfley wet shaking table after sieve excluding the over size (1000 µm), the organic matter and shell fragments. Then, the weight of rejected tailings was calculated and also, some characteristic statistics have calculated.

The obtained heavy fractions were subjected to magnetic fractionation using a Car-

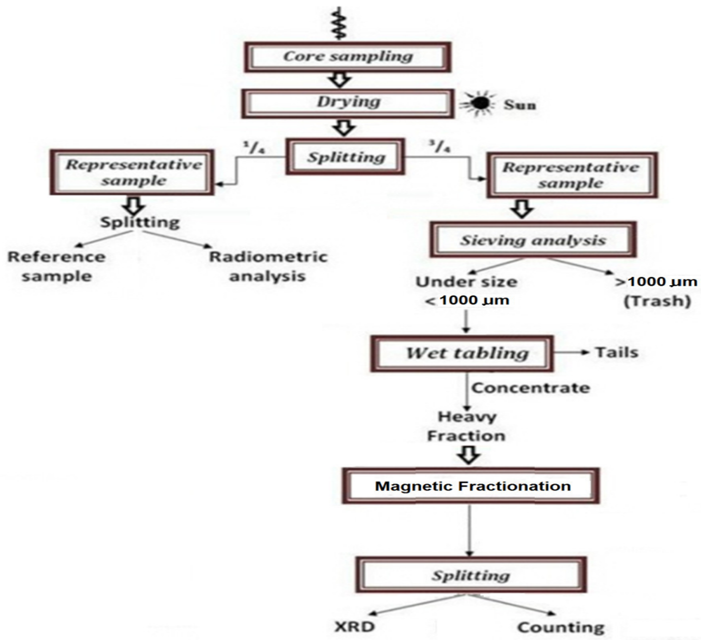

Fig. 5: Flowsheet of the laboratory techniques conducted in the present work

pco MLT 13/111/5 lift type magnetic separator. The used current values were; magnetic 0.07A, 0.8A, 1.0A, 2A and non-magnetic 2A fractions. Each of the obtained magnetic fractions was quartered to obtain small representative samples. Each representative sample was weighed and spreaded on a glass plate for binocular microscopic identification. About 500 grains were counted at different random fields covering the whole glass plate to calculate the frequency of the constituent minerals. The weight percent of each mineral in every subfraction is calculated according to Strakhov, et al. (1957). Some picked grains were measured using X-ray diffraction unit Philips PW-3710 with generator PW-1830, Cu target tube and Ni filter at 40 kV and 30 mA.

Radiometric Measurements

Thirty samples were measured for eU, eTh and K% using multichannel analyzer of γ-ray detector (γ-spectrometer technique). U and Th are measured by using two energy regions representing ^{234}Th and ^{214}Pb isotopes at 93 keV and 238 keV for eU and eTh, respectively.

RESULTS AND DISCUSSION

Sedimentation and Grain Size Analysis

The weight of raw samples is listed in Table (1). The grain size analysis of the studied samples showed that the grain size varying from the very coarse sand size to the clay sizes (Table 2). Figure (6) illustrates the lateral variation in the grain size categories of the LN bed sediments. According to grain size analysis of the studied sediments, it can divide into different sectors (Table 2). The grain size analysis in the offshore sediments of LN revealed that the studied sediments are mainly consisted of sandy silty clay (100%). This is a reflection of decreasing in the following current competency, but some samples

Table 2: Grain size distribution (%) of the studied samples.

Distance Km	S. No.	Sand >1000 µm	1000-500 µm	500-250 µm	250-125 µm	125-63 µm	Silt 63-40 µm	Clay <40 µm	Class.
170	L1	0.89	0.89	1.59	1.13	3.08	43.43	48.99	Sandy silty clay
190	L2	0.92	2.62	2.27	2.74	2.74	38.94	49.77	Sandy silty clay
210	L3	0.54	2.04	1.13	2.06	1.18	40.02	53.03	Sandy silty clay
230	L4	0.90	1.90	1.46	1.88	0.36	31.97	61.53	Sandy silty clay
250	L5	0.83	1.48	0.96	1.67	1.95	30.98	62.13	Sandy silty clay
270	L6	0.43	1.73	1.13	1.73	1.12	25.93	67.93	Sandy silty clay
290	L7	0.38	0.98	0.78	0.96	1.98	28.17	66.75	Sandy silty clay
310	L8	0.56	0.69	0.96	0.36	0.95	24.32	72.16	Sandy silty clay
330	L9	0.35	0.73	1.45	0.55	1.64	21.28	74.00	Sandy silty clay
350	L10	0.25	0.75	0.42	1.34	1.01	20.16	76.07	Sandy silty clay
	Av.	0.61	1.38	1.22	1.44	1.60	30.52	63.24	
	Max.	0.92	2.62	2.27	2.74	3.08	43.43	76.07	
	Min.	0.25	0.69	0.42	0.36	0.36	20.16	48.99	
170	E1	3.12	1.96	3.19	25.76	22.57	28.34	15.06	Clayey silty sand
190	E2	2.51	3.02	13.08	13.02	35.09	15.24	18.04	Silty clayey sand
210	E3	1.15	7.37	17.14	20.60	23.44	20.06	10.24	Clayey silty sand
230	E4	2.76	4.15	14.15	29.15	15.26	18.28	16.25	Clayey silty sand
250	E5	1.56	5.90	15.87	15.97	8.32	30.06	22.32	Clayey silty sand
270	E6	4.36	2.82	20.32	21.00	13.15	28.02	10.33	Clayey silty sand
290	E7	6.74	13.04	11.64	11.44	21.68	17.03	18.43	Silty clayey sand
310	E8	2.02	4.10	31.13	13.37	10.09	20.02	19.27	Clayey silty sand
330	E9	7.68	5.37	8.62	22.20	14.12	17.01	25.00	Silty clayey sand
350	E10	11.31	10.05	16.51	14.55	10.39	21.04	16.15	Clayey silty sand
	Av.	4.32	5.78	15.17	18.71	17.41	21.51	17.11	
	Max.	11.31	13.04	31.13	29.15	35.09	30.06	25.00	
	Min.	1.15	1.96	3.19	11.44	8.32	15.24	10.24	
170	W1	2.62	2.46	26.52	18.36	13.58	19.67	16.79	Clayey silty sand
190	W2	0.16	2.02	30.42	38.34	9.17	10.02	9.87	Clayey silty sand
210	W3	0.68	2.19	34.38	35.28	10.82	9.67	6.98	Clayey silty sand
230	W4	1.44	7.42	23.10	19.51	20.58	11.13	16.82	Silty clayey sand
250	W5	2.26	4.08	30.06	20.26	12.21	10.03	21.10	Silty clayey sand
270	W6	1.42	4.22	24.22	23.11	15.49	13.28	18.26	Silty clayey sand
290	W7	2.2	6.72	31.45	17.34	14.24	11.81	16.24	Silty clayey sand
310	W8	1.88	6.20	28.65	20.64	16.38	8.83	17.42	Silty clayey sand
330	W9	2.26	5.78	22.42	18.31	15.65	16.27	19.31	Silty clayey sand
350	W10	1.22	4.76	25.02	23.64	13.08	14.22	18.06	Silty clayey sand
	Av.	1.61	4.59	27.62	23.48	14.12	12.49	16.09	
	Max.	2.62	7.42	34.38	38.34	20.58	19.67	21.10	
	Min.	0.16	2.02	22.42	17.34	9.17	8.83	6.98	

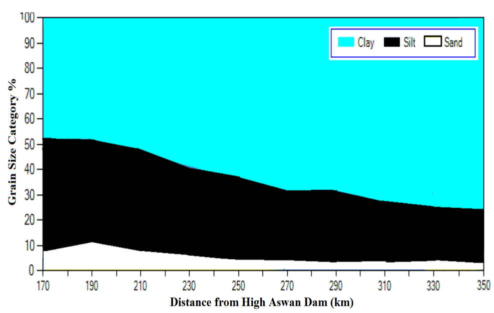

Fig. 6: The lateral variations in grain size category % of bed sediments at southern portion of Lake Nasser

deviate from this pattern.

The silt and clay fractions constitute the main size of the offshore sediments that are ranged between 20.16-43.43% and 48.99-76.07% , respectively. While, the sediments of LN eastern bank were characterized by their abundance of sand facies (60%) followed by silt (30%) and rarely clay (10%). Sand contents were found in high fraction (47.62 and 69.70%) while clay and silt alternating to form low percents. On the other hand, western bank sediments were dominated by sand facies (100%), sand contents were ranged between 63.54 and 83.35%. In the southern part of Lake Nasser, with both banks of the outer lake, the sand deposit facies is the dominant fraction especially in the littoral zone. While the silty-clay and clayey sands sediments are the dominant which occupy the central offshore sediment facies extend into the 10-20 m deep inner shelf which are agreement with dominance of low-energy processes.

The present study showed that the distribution of grain size is controlled by depth of sediments (Tables 1 & 2) where the clay size increased with depth while the silt and sand fractions decreased in the same trend.

The prevailing winds in Egypt blow from NW to SE. This wind direction seams to form the prominent NW-SE trend of mega-dune belts in Egypt. The dominant NW trade wind travelling over the northern part of the Western Desert of Egypt arrives at the eastern bank. The provenance of the blown sand into LN in the southern part of Egypt seems to have a close relationship with the great sand seas and dune sands of the Western Desert (Khedr, et al., 2013).

Water drains into Lake Nasser carrying much of the suspended sediments being transported by river and streams (khors) of the LN basin. Current and wave action along the shoreline is responsible for additional erosion and sediment deposition, and some materials mainly sands may be introduced as a result of wind action. Because dynamic processes that keep materials suspended are generally more active near the shore, lake sediments are usually sorted by size. The very coarse sands occur near shore, but the finer sands, silts and clay are in most cases found offshore. The morphometry of size and shape with depth relationships of LN together with climatic, soils and geology factors play a major role in determining the sediments accumulation and water quality of LN. The morphology of LN is tree-like shape; this provides an extensive amount of beach that is desirable for recreational lake developments and a highly irregular shoreline margin account for a relatively high shoreline development index.

The studied sediment have physicochemical specification where clays exist in a variety of colours, black clays containing large concentrations of organic matter or sulfides and other clays usually containing high concentrations of calcium carbonate. Also clays of the studied samples show other colours, including red and green reflecting particular chemical and biological influences

Mineralogical Investigations

Heavy minerals have been used in sedimentological studies in order to determine the source areas and conditions of erosional grain. They provide useful information about sediment transport trends and longshore drift processes (Hoffman et al., 1999). The content of heavy minerals in modern sediments of LN and the adjacent beach deposits were identified. Their nature and distribution were found to be controlled by the grain size, the petrographic nature of the source areas and the hydrodynamic behaviour of the mineral grains. The heavy minerals are resistant to mechanical and chemical alteration processes; consequently, they are useful as natural tracers, so much for their hydrodynamic behaviour and their potential of preservation (Morton, 1985). The concentration and distribution of heavy minerals in LN sediments is mainly controlled by the rate and the source type of sediment supply, the hydraulic processes, as well as by the grain size and the specific weight (Ergin et al., 2007). Another factor controlling the distribution of the heavy mineral content is their mode of erosion, transport and sedimentation, due to their selective resistance to weathering and hydrodynamic processes (Frihy and Dewidar, 2003). The nature of heavy minerals identified in modern sediments of the LN and the adjacent beachs was found to be related to the petrographic nature of the source areas and to the conditions of erosion-transport-deposition undergone by the mineral grains.

The results of the mineralogical analysis (Table 3) show that the content of the examined economic minerals present in the heavy fraction are ranges between 0.61% and 1.22% for LN samples and 1.40% and 1.73% for the eastern bank samples, where the western bank samples are varies from 1.30% to 1.73%. The economic heavy minerals content of the studied sediments (Table 3) are represented by magnetite, hematite, ilmenite, leucoxene, zircon, rutile, garnet and monazite. Their morphological features are shown on Figs. (7-14) and their percentage contents in Table 4. The rest of heavy minerals appear with contents between 0.19% and

Table 3: Heavy fraction (%) and its constituents of the studied samples

S. No.	Heavy constituents (%)										Total Heavy Fraction (%)	Light Fraction (%)
	Economic heavy minerals (%)								Total economic heavy (%)	Rest of heavies (%)		
	Magnetite	Hematite	Ilmenite	Leucoxene	Rutile	Zircon	Garnet	Monazite				
L1	0.56	0.125	0.06	0.011	0.029	0.123	0.06	0.0016	1.00	0.67	1.67	98.33
L2	0.31	0.043	0.05	0.006	0.030	0.131	0.04	0.0017	0.61	1.00	1.61	98.39
L3	0.79	0.071	0.01	-	0.056	0.228	0.06	0.0028	1.22	0.71	1.93	98.07
L4	0.48	0.075	0.02	0.012	0.048	0.209	0.05	0.0019	0.90	0.79	1.69	98.31
L5	0.41	0.141	0.02	0.010	0.041	0.146	0.01	0.0039	0.78	0.50	1.28	98.72
L6	0.51	0.042	0.05	0.006	0.051	0.131	0.03	-	0.82	0.86	1.68	98.32
L7	0.35	0.082	0.05	-	0.037	0.144	0.03	0.0029	0.70	0.19	0.89	99.11
L8	0.58	0.110	0.17	0.017	0.022	0.232	0.04	-	1.17	0.22	1.39	98.61
L9	0.58	0.078	0.12	-	0.045	0.211	0.07	0.0028	1.11	0.69	1.80	98.20
L10	0.40	0.108	0.19	-	0.051	0.205	0.05	-	1.00	0.63	1.63	98.37
Min.	0.31	0.042	0.01	-	0.022	0.123	0.01	-	0.61	0.19	0.89	98.07
Max.	0.79	0.141	0.19	0.017	0.056	0.232	0.07	0.0039	1.22	1.00	1.93	99.11
E1	0.63	0.12	0.28	0.08	0.09	0.23	0.12	0.0003	1.55	0.45	2.00	98.00
E2	0.56	0.14	0.20	0.08	0.06	0.38	0.08	0.0003	1.48	0.65	2.13	97.87
E3	0.91	0.15	0.14	0.06	0.06	0.23	0.09	0.0002	1.65	0.27	1.92	98.08
E4	0.67	0.25	0.21	0.07	0.10	0.15	0.07	-	1.51	0.65	2.16	97.84
E5	0.58	0.14	0.27	0.04	0.08	0.28	0.11	0.0002	1.50	0.76	2.26	97.74
E6	0.89	0.15	0.11	0.08	0.07	0.30	0.13	0.0003	1.73	0.36	2.09	97.91
E7	0.66	0.12	0.18	0.06	0.08	0.21	0.09	0.0003	1.40	0.16	1.56	98.44
E8	0.59	0.19	0.27	0.07	0.08	0.28	0.07	-	1.56	0.22	1.78	98.22
E9	0.69	0.20	0.10	0.04	0.06	0.22	0.18	0.0002	1.49	0.87	2.36	97.64
E10	0.63	0.12	0.28	0.08	0.09	0.13	0.09	0.0003	1.42	0.68	2.10	97.90
Min.	0.56	0.12	0.10	0.04	0.06	0.13	0.07	-	1.40	0.16	1.56	97.64
Max.	0.91	0.25	0.28	0.08	0.10	0.38	0.18	0.0003	1.73	0.87	2.36	98.44
W1	0.54	0.20	0.27	0.08	0.08	0.29	0.13	0.0003	1.59	0.47	2.06	97.94
W2	0.83	0.12	0.11	0.09	0.07	0.31	0.09	0.0003	1.62	0.48	2.10	97.90
W3	0.64	0.10	0.14	0.07	0.07	0.21	0.07	-	1.30	0.87	2.17	97.83
W4	0.81	0.14	0.15	0.06	0.11	0.37	0.09	0.0002	1.73	0.21	1.94	98.06
W5	0.72	0.15	0.21	0.07	0.10	0.23	0.09	-	1.57	0.56	2.13	97.87
W6	0.55	0.22	0.27	0.07	0.08	0.24	0.12	-	1.55	0.16	1.71	98.29
W7	0.82	0.13	0.27	0.09	0.12	0.13	0.12	0.0002	1.68	0.26	1.94	98.06
W8	0.60	0.16	0.20	0.08	0.10	0.36	0.09	-	1.59	0.27	1.86	98.14
W9	0.56	0.15	0.14	0.06	0.08	0.23	0.14	0.0002	1.36	0.44	1.80	98.20
W10	0.81	0.19	0.21	0.05	0.09	0.15	0.08	-	1.58	0.69	2.27	97.73
Min.	0.54	0.10	0.11	0.05	0.07	0.13	0.07	-	1.30	0.16	1.71	97.73
Max.	0.83	0.22	0.27	0.09	0.12	0.37	014	0.0003	1.73	0.87	2.27	98.29

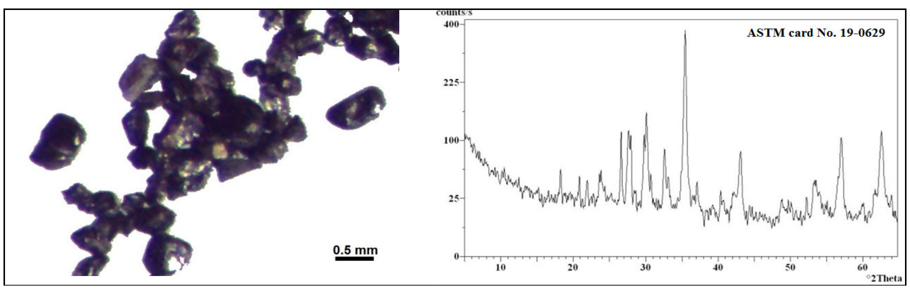

Fig.7:Photomicrograph of magnetite mineral and its X-ray diffractogram

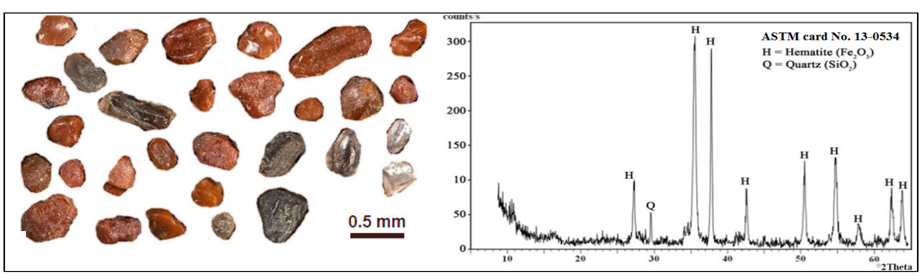

Fig.8: Photomicrograph of hematite mineral and its X-ray diffractogram

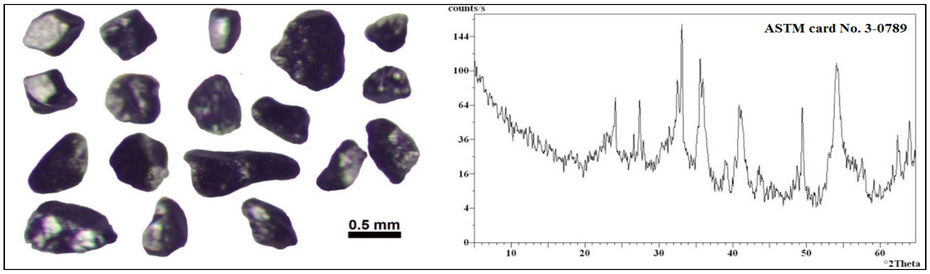

Fig.9: Photomicrograph of ilmenite mineral and its X-ray diffractogram

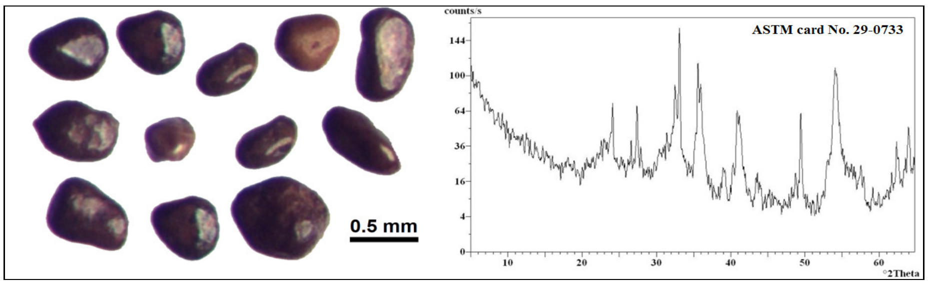

Fig.10: Photomicrograph of leucoxene mineral and its X-ray diffractogram

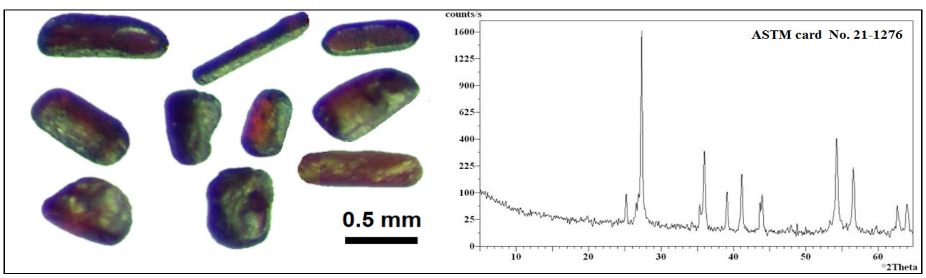

Fig.11: Photomicrograph of rutile mineral and its X-ray diffractogram

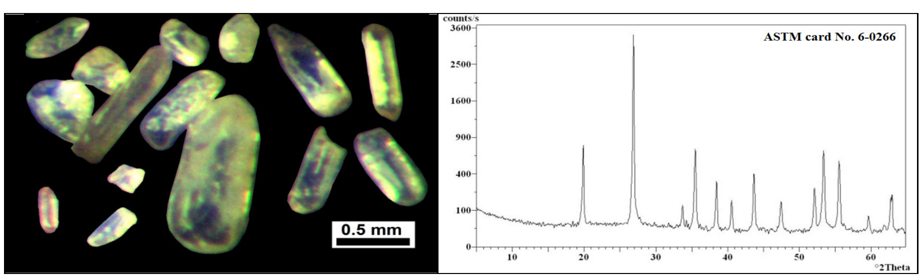

Fig.12:Photomicrograph of zircon mineral and its X-ray diffractogram

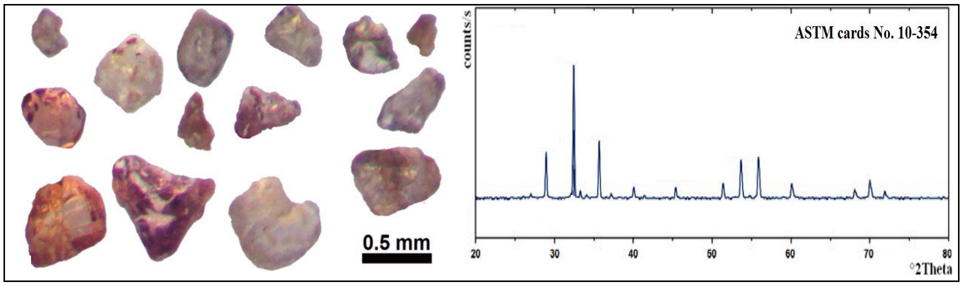

Fig.13:Photomicrograph of garnet (speaaartine) mineral and its X-ray diffractogram

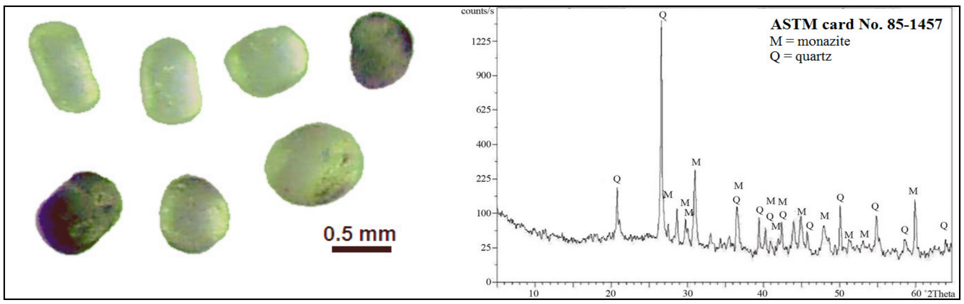

Fig.14: Photomicrograph of monazite mineral and its X-ray diffractogram

1.00% of LN samples and 0.16% and 0.87% of eastern bank samples, where the western bank samples showed 0.16% and 0.87%. The lateral distribution of the different heavy minerals is shown in Table (3) and Figs. (15&16), beside the iron minerals (ilmenite, leucoxene and magnetite), zircon and garnet are the predominant minerals found in the eastern and western beach samples. At the beach samples the ilmenite exposed by leucoxenization process (dissolve of iron and enriched of titanium). On the other hand, the offshore sediment samples of LN characterized by occurrence of metastable minerals with fine grains of monazite. Figure (15&16) showed that heavy mineral contents of LN sediments are lower than that of the both banks. This is may be attributed to the fine grain size of LN sediments comparison to both banks and/or effect of wind precipitation on both banks from the adjacent rock units.

The recorded metastable minerals in the examined samples are pyroxenes and amphiboles that represented by rest of heavies (%) in Table (3). On the other hand, recorded ultrastable minerals representing by economic heavies (%). The relationship between ultrastable and metastable minerals permitted to distinguish sedimentary environments of variable degree of reworking and maturity. The ratios amongst ultrastable and metastable heavy minerals and heavy mineral varieties in different zones of the study area and their distribution patterns are used in order to recognize their nature and behaviour in the environment, source areas and transport agents, as well as their relationship with granulometric and hydrodynamic characteristics (Morton and Hallsworth, 1994). The present study showed low ultrastable (Ult)/metastable (Met) ratio for the offshore minerals (1.5%) indicating a less significant degree of sedi-

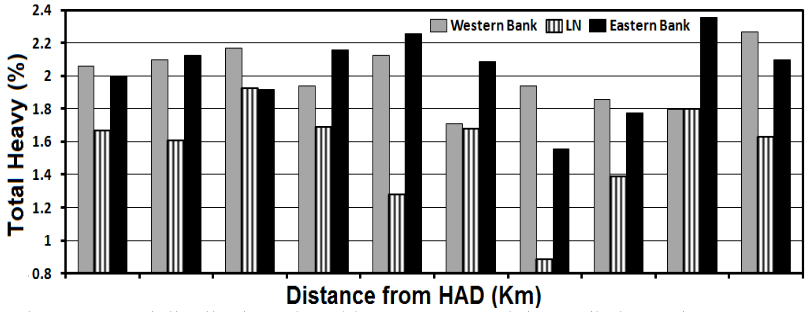

Fig.15: Lateral distribution of total heavy wt % and the studied samples

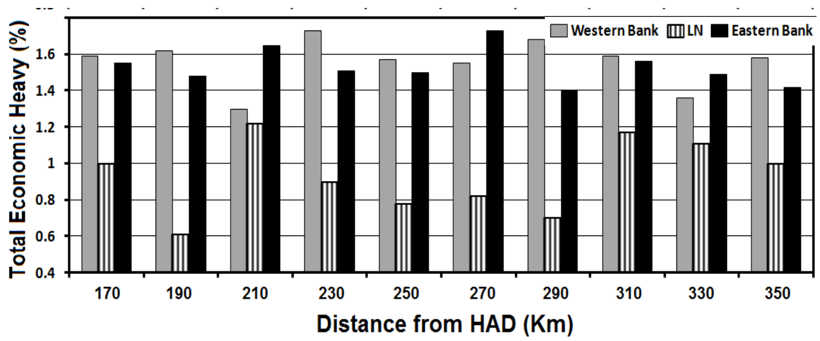

Fig.16: Lateral distribution of total economic heavy wt % (a) and the studied samples

ment maturity, where their occurrence may be related to the proximity of the mother rock or a high sedimentation rate that would prevent from significant alteration (Blatt et al., 1980). On the other hand the adjacent beaches showed relative high (Ult)/(Met) minerals ratio (3.0-3.5%), as a result of the predominance of sandy and sandy-muddy deposits in beach areas indicating the mineralogical maturity of these deposits.

Regarding the origin of heavy minerals, it suggests several sources; the Nile River which supplies mainly reworked rocks and very mature sediments coming from the erosion of upstream mountainous rocks. On the other hand, the drainage and the wind provide eroded sediment from exposed different sources (sandstone, sand accumulations, igneous and metamorphic rocks) which occurred at the eastern and western sides of the LN. These sediments are characterized by low degree of maturity. Another possible source of supplies is related to the material eroded from exposed coastal cliffs and beaches.

Radiometric Analysis

Natural radioactivity levels for the southern part of LN bottom sediments and surrounding rocks have been measured using γ-spectroscopy system (Table 4 and Fig. 17). The results show that their eU, eTh and K (%) are weak level. The inner samples of LN sediment showed higher radiometric values relative to the beach samples. The maximum content for eU, eTh and K are 3 ppm, 8 ppm and 2.54%, respectively. The maximum radiometric measurements of the eastern beach samples showed maximum values of 5 ppm, 5 ppm and 2.19% for eU, eTh and K (%), where the western beach samples showed 4 ppm, 5

Table 4: Spectrometric measurements of the studied samples.

S. No.	eU (ppm)	eTh (ppm)	K (%)
L1	ULD	5	1.36
L2	ULD	4	1.15
L3	ULD	6	1.32
L4	1	4	0.37
L5	ULD	6	0.67
L6	1	7	ULD
L7	2	4	0.32
L8	2	7	0.16
L9	3	8	2.54
L10	1	6	0.35
Minimum	1	4	0.16
Maximum	3	8	2.54
E1	2	2	1.52
E2	1	4	1.94
E3	2	4	1.67
E4	2	2	0.82
E5	1	1	0.51
E6	1	4	1.12
E7	5	5	2.19
E8	4	4	1.34
E9	1	2	1.55
E10	1	3	0.57
Minimum	1	1	0.51
Maximum	5	5	2.19
W1	3	4	1.29
W2	ULD	2	0.79
W3	3	4	1.41
W4	2	3	1.35
W5	1	4	1.14
W6	2	5	1.30
W7	2	4	1.16
W8	3	5	2.54
W9	3	5	2.10
W10	4	4	2.56
Minimum	1	2	0.79
Maximum	4	5	2.56

ULD = under limit of detection

ppm and 2.56%, respectively. These radioactivities are may be attributed to the occurrence of monazite and some metamict zircon in the LN sediments. Figures (18&19) illustrated the lateral distribution of both monazite and zircon in LN and its banks. It is clear that most of LN samples show zircon content lower than that of the adjacent banks except some samples. On the other hand, monazite content was much higher in LN bottom samples in comparison to the adjacent banks.

Lake sediments Management

Lake Nasser is increasingly threatened as a result of increased population growth, intensified use of surface waters, exploitation of shoreline properties, and other human pressures. Soil sediments entering a lake can originate from within the lake itself and from external sources.

The purpose of a lake management survey is to determine hydrographic and morphometric features of the lake watershed with refer to sediment accumulation rate and their effect on the water-quality parameters. One of the most fundamental objectives of inland lake management is land-use practices, which prevent soil erosion and limit the input of both sediments (sedimentation) and nutrients.

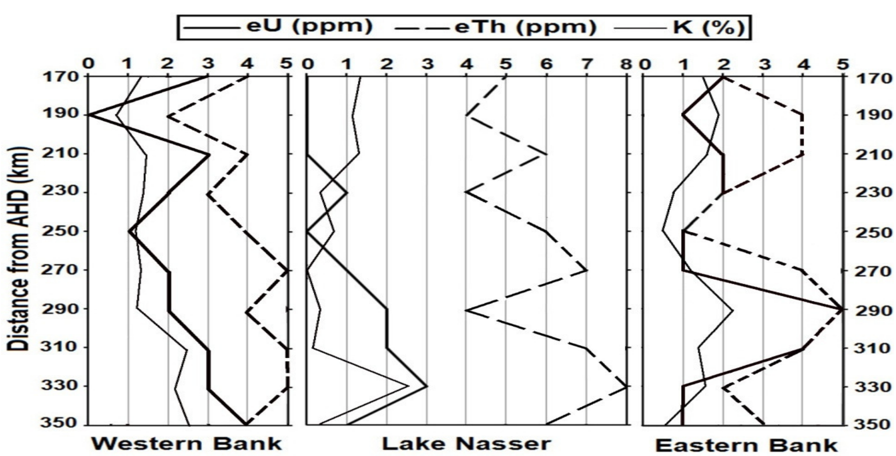

Fig. 17: Lateral distribution of the radioactivity of the studied sediments

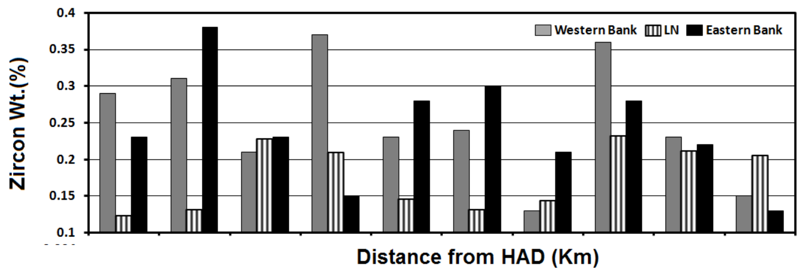

Fig.18: Lateral distribution of zircon wt.% in the studied samples.

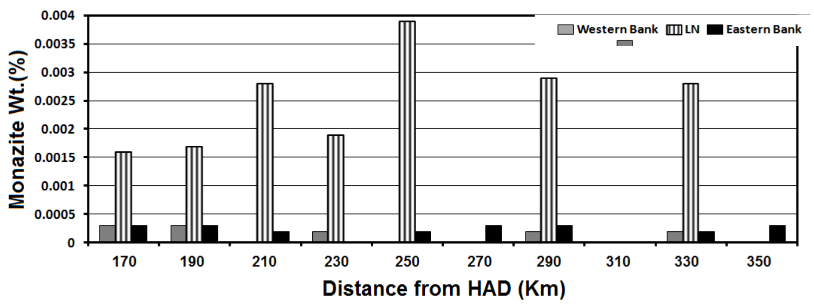

Fig.19: Lateral distribution of monazite wt.% in the studied samples.

Within the lake basin, erosion caused by excavation and deforestation on steep shoreline slopes and wave action cause shoreline erosion, furnishing sediments to be transported and deposited elsewhere in the lake.

Sedimentation makes the lakes shallower, decreasing the volume of water and reducing the amount of surface water available for recreation. Also, sedimentation, promotes water loss and higher evaporation rates, depreciates riparian property values, increases water temperature, depletes oxygen supplies and causes fish kills.

The proposed solution for lake sedimentation problems is to prevent eroded soil particles from entering a lake in the first place. “Preventative” solutions are much easier, more efficient and a lot less costly than “restorative” solutions used to remove sediments after they have reached the lake waters. Dredging, the physical removal of bed lake sediments is the most common method used to deal with excessive deposition of eroded soils and organic matter. Mechanical dredgers can be pumping mud through artificial channels in both banks of the lake. The transported mud increases the fertility of the land and makes it become more suitable for the agriculture projects. This process will be used to stop sand dunes progression in the western bank and used as natural fertilizer of agricultural area.

CONCLUSIONS

The heavy minerals investigation showed that the most important economic minerals present in the heavy fraction are ranged between 0.61% and 1.22% for LN bottom samples and between 1.40% and 1.73% for the eastern bank samples, where the western bank samples are ranged between 1.30% and 1.73%. These values are not considered economically feasible. The radiometric measurement of the bottom samples showed higher radiometric measurement relative to the beach samples. This may be attributed to the occurrence of monazite and some metamict zircon in the LN sediments. The proposed solution for lake sedimentation problems is to prevent eroded particles from entering the lake in the first place by mechanical dredgers. Utilization of economic minerals occurrence in LN can be facilitated by pumping sediments through artificial channels into the lake banks as natural fertilizer of the reclaimed land. This process also stops sand dunes progression especially in the western bank.

Acknowledgements

The authors express many warmest thanks and acknowledge to Prof. El Assy, I. E., former Vice Chairman of NMA, for his critical advices during essential discussions of this work. Also, sincere acknowledgements go Dr. Abd El Aziz, M. H, High Dam Authority for his support and facilities during field trip.

REFERENCES

Abd El Aziz, M.H., 2012. Sedimentary accretion of windblown sand along the western bank of Nasser Lake in Egypt. Unpublished M.Sc. Thesis, Geol. Dept., Fac. Sci. Aswan, South Valley Univ., 269 p.

Abou Elmagd, K., 2003. Sedimentary facies analysis, petrophysics and groundwater possibilities of the sedimentary sequence of Toshka area, south Western Desert, Egypt. Proc. 3rd Intern. Conf. Geol. Afr., Dec. 7-9, Assiut Univ., Egypt, II, 321-339.

Avakyan, A.B., and Iakovleva, V.B., 1998. Status of global reservoirs: The position in the late twentieth century. Lakes and Reservoirs: Research and Management, 3, 45-52.

Blatt, H.; Middleton, G.V., and Murray, R., 1980. Origin of Sedimentary Rocks. 2nd Ed. Prentice-Hall, Englewood Cliffs, N.J., 782 p.

Butzer, K.W., and Hansen, C.L., 1968. Desert and river in Nubia : geomorphology and prehistoric environments at the Aswan Reservoit.. Wiscon Univ. Press.

El Dardir, M., 1984. Geochemical and sedimentological studies on the sediments of Aswan High Dam Reservoir. Unpublished Ph.D. Thesis. Fac. Sci., Al Azhar Univ., Cairo, Egypt, 238 p.

El Dardir, M., 1994. Sedimentation in Nile High Dam Reservoir, 1987–1992, and sedimentary futurologic aspects. Sedimentology of Egypt, 2, 23 – 39.

El Gammal, E.A., 2010. Assessment Lake Nasser Egypt within the climatic change. J. Amer. Sci., 6(7), 305-312.

El Kobtan, H.M.H., 2007. Geological studies on the Recent sediments of Lake Nasser (Southern Part) as a sign reflecting its evolution. Unpublished M.Sc. Thesis, Benha Univ., Fac. Sci., Geol. Depart., 106 p.

El Shazly, E.M.; Abdel Hady, M.A.; El Kassas, I.A.; El Amin, H.; El Shazly, M.M.; Abdel Megid, A.A.; Mansour, S.I., and Tamer, M.A., 1977. Geology and groundwater conditions of Toshka basin area, utilizing Landsat satellite images. Remote Sening Center and Academy Sci. Res. and Tec., Cairo, 75 p, XLII plates.

Entz, B.A.G., 1980. Sedimentation Processes in the Reservoir Lake Nasser-Nubia during 1965-1974 and Future Aspects. Water Sup. & Manag., 4, 63-66.

Ergin, M.; Keskin, E.; Umran Doðan, A.; Kadýoðlu, Y.K., and Karaka, Z., 2007. Grain size and heavy mineral distribution as related to hinterland and environmental conditions for modern beach sediments from the Gulfs of Antalya and Finike, eastern Mediterranean. Mar. Geol., 240, 185–196

Frihy, O.E., and Dewidar, K.M. , 2003. Patterns of erosion/ sedimentation, heavy mineral concentration and grain size to interpret boundaries of littoral sub-cells of the Nile Delta, Egypt. Mar. Geol., 199, 27–43.

Helfrich, L.A.; Parkhurst, J., and Neves, R., 2009. Guide to Understanding and Managing Lakes: Part I (Physical Measurements). Author J., V. , 420-538.

Hoffman, C.W.; Grosz, A.E., and Nickerson, J.G.,

1999. Stratigraphic framework and heavy minerals of the continental shelf of Onslow and Long Bays, North Carolina. Mar. Georesour. Geotechnol., 17, 173–184

Iskaros, I.A., and El Dardir, M., 2010. Factors affecting the distribution and abundance of bottom fauna in Lake Nasser, Egypt. Nature and Science, 8(7), 95-108.

Issawi, B.,1968. The geology of Kurkur-Dungle area. Gener. Egyp. Org. Geol. Resear. and Min., Geol. Surv. Cairo, Egypt, Paper No. 46, 102 p.

Issawi, B., 1971. Geology of Darb El Arbain, Western Desert, Egypt. Ann. Geol. Surv. Egypt, 1, 53-92.

Issawi, B., 1978. Geology of Nubia west area, Western Desert, Egypt. Ann. Geo. Surv., Egypt, 8, 237 – 253.

Khedr, E.S.; Abou Elmagd, K., and Halfawy, M., 2008. Movement and accumulation-budget of windblown sand along the Western side of Lake Nasser: (1) Physiographical and meteorological background. 3rd Intern. Conf. Geol. Tethys. South Valley Univ., Fac. Sci., Geol. Depart., Aswan, Egypt.

Khedr, E.S.; Youssef, A.A.E.; Abou Elmagd, K., and Khozyem, H.M., 2010. Tectono-stratigraphic subdivision of the clastic sequence at Aswan area, southern Egypt. Proc. 5th Intern. Conf. Geol. Tethys Realm, South Valley Univ., 197-216.

Khedr, E.; Abou Elmagd, K., and Halfawy, M.,2013. Factor analysis of meteorological and granulometrical data of aeolian sands in arid area as a geo-environmental clue: a case study from western bank of Lake Nasser, Egypt. IJCEE-IJENS., 13(03), 21-37.

Ministry of Water Resources and Irrigation of Egypt (MWRI), Nile Water Sector, 2010. Presentation on: The sedimentation monitoring at Lake Nasser/Nubia US High Aswan Dam.

Morton, A.C., 1985. Heavy minerals in provenance studies. In: Provenance of Arenites (Zuff,G. G.,Ed.), 249-277.

Morton, A.C., and Hallswort, C., 1994. Identifying provenance specific features of detrital heavy mineral assemblages in sandstones, Sediment. Geol., 90, 241–256

Phillips, C.J., and Nelson, C.S., 1981. Sedimentation in an artificial lake-Lake Matahina, Bay of Plenty. New Zealand J. Marine and Freshwater Research, 75, 459-473.

Said, R., 1981. The geological evolution of the River Nile". Springer, 151 p.

Said, R., 1990. The geology of Egypt". Balkema, Rotterdam, 734 p.

Said, R., 1993. The Nile River: geology, hydrology and utilization. Pergamon Press, Oxford, UK., 320 p.

Salem, M.G., 2013. Investigating the filling scenarios to adapt with climate change impacts (Case study: Qattara Depression, Egypt). Energy Procedia, 36, 200-2010.

Shalash, S., 1982. Effects of sedimentation on the storage capacity of the Aswan High Dam reservoir. Hydrobiologia, 92, 623-639.

Shatta, A., 1962. Remarks on the geomorphology, pedology and groundwater potentialities of the southern entrance of the New Valley. Part I: Lower Nubia area, Egypt, U.A.R. Bull. Soc. Geogr. Egypt, 35, 273-299.

Strakhov, N.M.; Bushinskii, G.I., and Pustovalov, L.V., 1957. Metody izocheniya ocadochnykh porod, tom I" (Methods of studying sedimentary rocks, (I) Moskva, Gosgeoitekhiz dat, 611 p.

Zaghloul, S.S.; Pacini, N.; Schwaiger, K., and de Villeneuve, P.H., 2012. Towards a Lake Nasser management plan: Results of a pilot test on integrated water resources management. Intern. Water Techn. J., I(3), 249-258.

دراسات معدنية وإشعاعية لتعظيم الاستفادة من رواسب بحيرة ناصر

قنديل منشاوي قنديل، جهاد محمد رضا منصور وعاطف حسن عبد العظيم

بالرغم من احتواء رواسب البحيرة وضفتيها على كمية من المعادن الثقيلة الاقتصادية إلا أنه لم تتم محاولات جادة لتقييمها والاستفادة منها، لذا يهدف هذا البحث لتعزيز إدارة رواسب بحيرة ناصر من خلال تقييم رواسبها والتركيز بشكل رئيسي على دراسة الخصائص الرسوبية، المعدنية والإشعاعية لها بتجميع عينات من القاع وكلا الضفتين بالجزء الجنوبي من البحيرة.

تعاني بحيرة ناصر من العديد من التحديات بسبب زيادة معدل الترسيب بها مما نتج عنه ارتفاع مستوى القاع وظهور العديد من التغيرات المورفولوجية كتكون السهول الفيضية على ضفاف البحيرة بالإضافة إلى نشأة الجزر في مسطح البحيرة.

أظهرت الدراسة الرسوبية التباين في السحنات الرسوبية بين رواسب قاع البحيرة (حيث تسود سحنة الطين الغريني الرملي) على النقيض من ضفتيها فتسود سحنتي الرمل الغريني الطيني والرمل الطيني الغريني في الضفة الشرقية والغربية على الترتيب.

من الناحية المعدنية، ظهر عدم الجدوى الاقتصادية للشق المعدني الثقيل المفصول باستخدام الطريقة التثاقلية نتيجة لاحتوائه على نسب ضعيفة من المعادن الاقتصادية (الماجنيتيت، الهيماتيت، الإلمنيت، الليكوزين، الروتيل، الزركون، الجارنت والمونازيت) حيث تراوح مجموعها برواسب البحيرة ما بين ٠,٦١ و ١,٢٢٪ بينما كان ما بين ١,٤٠-١,٧٣٪ و ١,٣٠-١,٧٣٪ في الضفة الشرقية والغربية على الترتيب.

إشعاعياً، كانت جميع العينات المدروسة آمنة حيث أظهرت مستوى ضعيف من الإشعاع لكنه كان أعلى برواسب البحيرة مقارنة بضفتيها. وربما يرجع ذلك لوجود معدن المونازيت بنسب تصل في أعلاها لـ٠,٠٠٣٩٪ بالاضافة لوجود بعض الزركون المشع.

وقد خلصت الدراسة إلى أن الحل الأمثل للاستفادة من النسب الضئيلة للمعادن الاقتصادية الموجودة برواسب البحيرة كذا حل مشكلة تراكم الرواسب بالبحيرة هو تكريكها عند بداية تكونها وإعادة ضخها ميكانيكياً عبر قنوات تصريف بالضفة الغربية للبحيرة حيث تتوفر مساحات واسعة نسبياً قابلة للاستصلاح الزراعي. كما أن هذه العملية ستؤدي إلى وقف زحف الكثبان الرملية على هذه الضفة بالإضافة إلى استخدام هذه الرواسب كسماد ومحسن طبيعي للتربة المستصلحة.