Geochemical studies on the recent bottom sediments in the River Nile from Aswan to Cairo, Egypt

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ABSTRACT

Chemical analysis of the River Nile recent bottom sediments proved that the Upper River Nile is nearly divided into southern middle and northern zones. The southern zone riches in Mn, Pb and Cd and poor in Zn and Cu. The middle area, riches in Fe and poor in Al, Mn, Pb and Cd. The northern zone riches in Al, Zn, Cu and poor in Fe. Large volume of organic matter and mud imputes may be an important factor in this enrichment of trace metals. The carbonate content increases northwards. The distribution of carbonates is mostly controlled by the facies of sediment, i.e. the carbonate increased with high accumulation of mud and decreased with sand. The high accumulation of carbonate contents is occurred in the depth between 2 and 5 m. This accumulation increases towards the beach and tends to decrease gradually towards the deeper zone. The relative order of abundance of carbonates can be summarized as follows: autumn> summer> spring> winter and in north > middle> south zone. the results proved that the highest value of organic matter is occurred in winter at north zone (15.3%). There is tendency to increasing eastwards and westwards concentrated in front of drainage water, bottom of channel and associated with high accumulation of mud. The relative order of seasonal distribution according to abundance of organic matter is; in winter > autumn > summer > spring and south > north zone > middle zone. The source of heavy metals in the River Nile sediments is mostly allocthonous from agricultural drainage waters and industrial materials. The remobilization of metals from water depends on some physio-chemicals changes in the water and sediments; elevated of salt content, changes in the redox condition, lowering of pH, presence of

natural competing agents, sediment facies change, organic matter, mud content and high accumulation of biogenic carbonates. The concentration of elements in the River Nile sediments are Fe> Al> Mn> Zn> Cu> Pb> Cd.

KEY WORDS: Heavy metals, River Nile, Egypt

INTRODUCTION

The area under investigation lies between latitude 31° - 33° E and longitude 23° - 32° N (Fig. 1). Minerals and rocks those are stable in the primary environment and often unstable in the secondary environment. By various processes, primary weathering, elements are released, resulting in the redistribution of chemical elements causing their dispersion in the secondary environment. The chemical and physical weathering can act together simultaneously and lead to the breakdown of rocks and migration of their chemical elements in the form of true solution, colloidal solution and residual particles.

The inorganic debris of weathering, resulting from the action of water and the atmosphere on pre-existing rocks can mix with the organic material, from the life processes of plants and animals. (Krauskopf et.al, 1995). According to Krauskopf (1967), the chemical processes may be analyzed and dispersed chemical elements from the sediment. Thus, the patterns of dispersed chemical elements in the secondary environment can help in the characterization of the secondary formation as well as in understanding their environment of deposition.

In the present work the distribution patterns of the chemical constituents of the sediments of the studied area are investigated in order to give a chemical model of the sediments depositing in fresh water environment. Attention was also paid to explain the effect of fresh, brackish and sewage water discharge on the concentration levels and distribution of the chemical elements in the River Nile bottom sediments and water.

In this respect, the study of chemical characteristics and the distribution patterns of the sediment of the River Nile have been achieved by considering: determining the heavy metals and other chemical constituents in the River Nile bottom sediments. The heavy metals include (Al. %), (Total Iron (Fe %), Manganese (Mn. ppm), Copper (Cu. ppm), Lead (Pb. ppm), Zinc (Zn. ppm) and Cadmium (Cd. ppm), where the other chemical constituents are represented by organic matter (O.M%) and carbonate content (Co_3).

MATERIAL AND METHODS

The recent bottom sediments were collected in winter (February month), spring (April month), summer (Jules month) and autumn (November month) 2007 from 14 stations. 119 samples were collected from middle and channel banks by a grab sampler (Ekhman type). Sampling sites in the River Nile have been subdivided into southern, middle and northern zones (Fig.1). The southern zone contains Aswan, Kema factory, Kom Ombo, Luxor and Kous. The middle zone includes Deshna, Naga Hamadi, Assuit, Minia and Bany swaif). The northern zone is Helwan, Hawamdeia, Shubra and Elwaraq.

Determination of organic matter in sediment was carried out, according to Hanna (1965), by loss on ignition. Part of sediment was dried at 105 $^{\circ}$C in dried oven. 0.5 gm of dried sample was transferred to a weighed porcelain crucible in an electric muffle furnace to about 700 $^{\circ}$C for about 30 minutes, and then removes, cool in desecator, and weighed until constant weight.

Organic Matter % = (A-B) x100/ weight of sample

A= Weight of sample before ignition **B**= Weight of sample after ignition.

Carbonate content in the sediments was determined by the method described by Alexjev, (1971) and Vogel (1982). 0.2 gm of dry sample was mixed with 10 ml of HCl (0.5N) in a clean beaker. The beaker was covered and boiled gently for 5 minutes. After cooling, 50 ml distilled water was added on the sample, then filtered through Whatmann filter paper. Samples were titrated against NaOH 0.25N using phenolphthalein as indicator, blank was made by using 0.2 gm dry pure calcium carbonate. Amount of unused acid was determined.

Carbonate percentage was calculated according to the following equation: Carbonate as $CaCO_3$= (A X M_1 X 100)/ (B X M_2):

A: the amount of unused acid for sediment sample

B : the amount unused acid for blank

M_1: Molecular weight of CO_3 M_2: Molecular weight of $CaCO_3$

The concentrations of Al, Fe, Mn, Cu, Pb, Zn and Cd were measured by Inductively Coupled Argon Plasma Atomic Absorption (ICAP 6500 Duo). The samples are analyzed in the Egyptian Desert Research center, according to the method of Trefry (1987).

RESULTS AND DISCUSSION

Some Chemical Constituents in River Nile Sediments

Carbonates (Co_3^{--} %)

The seasonal changes of carbonate in the recent bottom sediments of river Nile are hardly variable and they fluctuated between 0% and 32.8% (Tables 1) and Figure (2). The lowest value records are observed in the south zone during spring season, the values are tended to increasing gradually towards the middle and north zone. The average of carbonate content decreased during winter and increased gradually during spring, summer and autumn.

The distribution of carbonate contents in the bottom sediments during winter ranged between the highest value (32.8%) found at Shubra middle station and the lower carbonate value (0%) appeared at Bany swaif middle station with average (8.3%). During the spring, the highest value (32.8%) observed at east bank of Alwaraq station and the lowest value (0%) found at east and west bank of Kom umbo stations with average (8.4%). During the summer, the highest carbonate value (25.4%) recorded at main channel of Alwaraq station and the lowest value (1.4%) showed at main channel of Kom umbo station with average (10.1%). Finally, during autumn season the maximum value was (31.4%) recorded at east bank of Shubra station while the minimum value was (2.1%) appeared at Kom umbo middle station with average (11.5%).

Generally, from (Table 1 and Figure 2), the carbonate content increases northwards. The distribution of carbonates is mostly controlled by the facies of sediment, i.e. the carbonate increased with high accumulation of mud and decreased with sand. The high accumulation of carbonate contents is occurred in the depth between 2 and 5 m. This accumulation increases towards the beach and tends to decrease gradually towards the deeper zone. The relative order of abundance of carbonates can be summarized as follows: autumn> summer> spring> winter and in north > middle> south zone.(Figure 2)

Organic Matter (O.M. %)

Organic Material is a production from the life processes of plants and animals and is the source of such fuels and raw materials as cool, petroleum, and natural gas (Engel et.al, 1993). The horizontal distribution of organic matter is shown in Tables (2) and Figure (3). During winter, organic matter content ranged between 0.202% and 16.8% at west bank of Minia and middle channel of Aswan stations, with averaging 3.4%. During spring, organic matter varied from 0.31% to 9.05% at middle channel of Assuit and east bank of Alwaraq stations, with averaging 2.38%. During summer, it ranged between 0.03% and 6.7% at east bank of Alwaraq and middle channel at Kema factory, with averaging 2.41%. Finally, during autumn, the maximum value was 11.19% at middle channel at Aswan station while the minimum value was 0.25% at middle channel at Assuit with average 3.1%.Generally; it can be observed that the winter has the highest value of organic matter averaging 3.4% and decreased during autumn (average 3.1%), spring (2.38%) and summer (2.41%).

Generally, the results proved that the highest value of organic matter is occurred in winter at north zone (15.3%). There is tendency to increasing eastwards and westwards concentrated in front of drainage water, bottom of channel and associated with high accumulation of mud (Table 2 and Figure 3). The relative order of seasonal distribution according to abundance of organic matter is; in winter > autumn > summer > spring and south > north zone > middle zone.

Heavy metals in the River Nile sediments

The heavy metals concentrations in the River Nile sediments are listed in tables 3, 4, 5 and 6 and Fig 4. With regard to the distribution of Al (Figure 4), during spring, aluminum content ranges between 1.39% and

4.59% at southern zone with an average 1.85% and northern zone with an average 3.62% and middle zone, averaging 2.15%. While during autumn, aluminum content varied from 1.93% to 4.63% southern zone with an average 3.17% and northern zone with an average 3.54% and at the middle zone, averaging 2.64%. Finally, the highest values of aluminum are observed at Kema factory (southern zone) and decreasing at middle and north zones.

However, Fe value showed quite regularly distribution between 1.99% at Hawamdeia station (north zone) with an average 2.13% and 2.56% at Aswan station (south zone) with an average 22.28%, while the middle zone average was 2.15% during winter. During spring, total Fe varied from 1.67% to 2.28% at Assuit and Alwaraq stations (middle and north zone), averaging 2.04 and 2.16 %, while the north zone average was 2.2%. Fe content during summer ranged between 3.63% at Kom Ombo (south zone) with an average 4.36% and 4.81% at Hawamdeia (north zone) with an average 4.74% while middle zone was 4.69%. During autumn, the Fe value varied between 2.99% at Helwan (north zone) and 4.69% at Aswan (south zone) with an average 4.29 while the middle zone, the Fe value reached to 3.89%. However, in case of Fe, the river is nearly divided into north rich zone and middle and south poor basins. With respect to stations, the high value of Fe occurred at Shubra and Alwaraq station (Greater Cairo) i.e near the factories in the area and at Aswan (south zone) during autumn, it may be related to the igneous rock in the area and the factories and decreased in the middle zone. Seasonally, the accumulation of iron attained in summer > autumn > during winter > spring. Areal distribution of manganese during winter, the value ranges between 190.72 ppm at Hawamdia station (north zone) and 1775.9 ppm at Aswan station (south zone) with an average 652.01 ppm, while the middle average of Mn 721.55 ppm. During the spring manganese content varies between 163.56 ppm and 1418.8 ppm at Assuit and Aswan stations (middle zone and south zone) with an average 454.95 and 642.81 ppm, while in the north zone, the Mn value was 720.57 ppm. Mn content during summer rangedbetween 192.78 ppm at Kom Ombo and 816.48ppm at Aswan (south zone) with an average 507.58 ppm while in middle and north zone was 728.71 and 693.72 ppm. During autumn season, the lower total Mn (107.73 ppm) recorded at Assuit (middle zone) with an average 339.07 ppm and the higher percent 1027 ppm appeard at Aswan (south zone) with an average 578.79 ppm while in the north zone the average of Mn was 299.09 ppm. (Table 3, 4, 5, 6 and Figure 4). The relative order at abundance of Mn was winter > summer > spring > autumn. The southern zone proved to have a maximum value in all season and decreased towards middle zone and northwards. Areal distribution of Zinc appeared that during winter, zinc value ranged between 14.51 ppm at Hawamdia station (north zone) with an average 36.25 ppm and 88.14 pmm at Assuit station (middle zone) with an averaging 48.25 ppm, while in the south zone was 36.94 pmm. During the spring zinc content varied from 11.86 ppm to 135.53 ppm at Assuit and Kema Factory stations (middle zone and south zone respectively) with an averaging 39 and 62.29 ppm, while in the north zone attained 74.07 pmm. Zn content during summer ranged between 9.56 ppm at Kom Ombo and 93.35 ppm at Naga Hammadi (south and middle zone) with an average 27.64 and 56.15 pmm respectively, while in north zone was 56.96 ppm. During autumn season, the total Zn value recorded 11.03 ppm at Kom Ombo and Assuit (south and middle zone) with an average 35.43 and 29.69 ppm, respectively and 66.98 ppm recorded at Shubra (north zone) with an average 43.92 ppm. (Table 3, 4, 5, 6 and Figure 4).

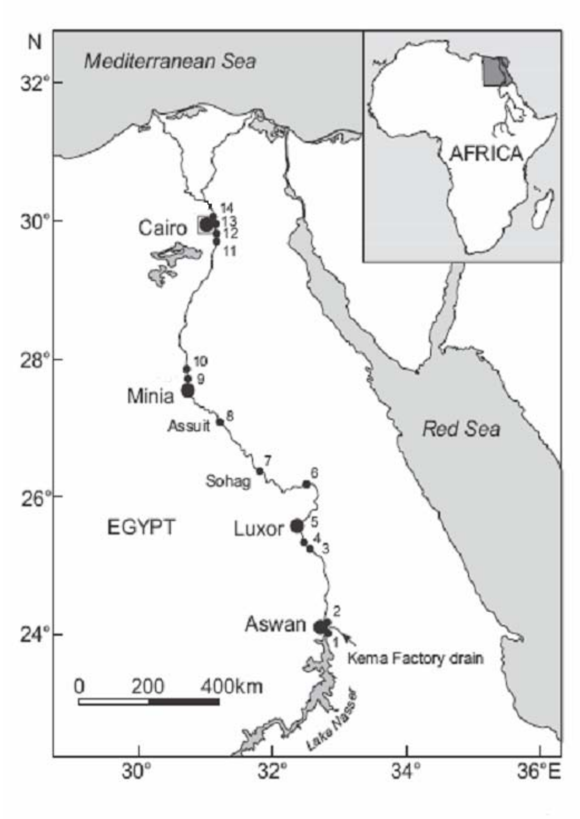

Figure1: Map of sampling sites on the River Nile from Aswan to Shubra, Cairo

Then, the highest values of Zn are observed at Kema factory south zone and decreasing towards middle and increasing northwards.

According to the seasonal variation of zinc contents in bottom sediments of river Nile was spring > autumn > winter > summer seasons. The value increased in front of the factories on river Nile.

The copper content during winter ranged between 1.25 ppm at Hawamdia station (north zone) with an average 9.39 ppm and 30.7 ppm at Assuit station (middle zone) with an averaging 12.86 ppm, while in the south zone was 11.7 ppm. During spring copper content varied from 2.52 to 33.19 ppm at Bany Swaif and Deshna stations (middle zone) with an averaging 10.87 ppm, while the south and north zone was 12.1 ppm and 21.17 ppm, respectively. Cu content during summer ranged between 10ppm at Luxor and 39 ppm at Shubra (south and north zones) 15.2 and 31.75 ppm, respectively while middle zone average of Cu was 26.2 ppm. During autumn season, the low Cu value was 1 ppm at Hawamdeia and Helwan (north zone) with an average 12.25 ppm and the high value appeared 56 pmm at Aswan (south zone) with an average 26 pmm, while the middle zone was 12.07 pmm .(Table 3, 4, 5, 6 and Figure 4).

We can observed that the copper content increased northwards near to the electricity station at Shubra during summer and autumn and turned to decreasing during winter and spring.

In case of lead, during winter, lead value ranged between 1.64 ppm at Kema Factory station (south zone), and 23.33 pmm at Luxor station (south zone) with an averaging 15.61 pmm, while the middle and north average was 13.34 and 12.76 pmm. During spring lead content varied from 2.76 pmm at Assuit and Bany Swaif stations (middle zone) with an average 8.82 pmm to 28.35 pmm at Aswan station (south zone) with an average 15.098 pmm, while the north zone, average of Pb was 13.24pmm. During summer the highest concentration of Pb recorded at Deshna (middle zone), with an average 14 pmm, while in north zone was 12.4 pmm. During autumn, the low Pb concentration appeared at Luxor and Kous stations (south zone) with an average 25.67 pmm and Minia and Bany Swaif (middle zone) with an average 16.67 pmm while the highest value are 35 pmm recorded at Aswan (south zone) with an average 25.67 pmm. In the north zone was 18.25 pmm. (Table 3, 4, 5, 6 and Figure 4).

The lead content at the south zone it is proved to have the highest value and tends decreasing towards the north zones. The increased of lead at this station attached to present of the Kema factory in the south and electricity station at north and the concentration of Pb shown that during summer > autumn > spring > winter.

The cadmium content shown in Table 3, 4, 5, 6 and Figure 4. Generally, the concentration of cadmium in sediment of river Nile increased during winter and spring and decreased during summer and autumn. The lowest value of Cd 9.41 pmm recorded at Bany Swaif at middle zone with an average 10.44 pmm and highest value attained 13.34pmm at Luxor southwards, with an average 11.9 pmm while the north zone was 11.1 pmm. During spring the low concentration of cadmium occurred 9.22 pmm at Bany Swaif (middle zone) with an average 10.87 ppm and the high concentration was 14.16 ppm at Kom Ombo (south zone) with an average 11.82 ppm, while the north zone was 11.99 ppm. The cadmium concentration during summer and autumn attained the lowest value and varied between 0 and 2 ppm. Finally, the concentration of Cadmium appeared that during winter > spring > summer > autumn.

Comparison of heavy metal contents in sediment

The mean trace metals concentrations in sediments from different regions are listed in Table 7. In the River Nile sediments in the present study, all metals showed lower levels than Aswan High Dam reservoir (Zaghloul et. al., 1987and El-Dardir., 1984) and river Nile (Issa et. al., 1997) We can be observed the present data are in the lower range with Gohar (1998) at the River Nile and Farhat, (2010) at two branches of river Nile also the trace metals lower level than Lotfy (2008) except Mn at greater Cairo river Nile and (Onyari & Wandiga., 1989) at lake Victoria, Kenya except Cd. Whereas, the investigated trace metals in sediment of the study area showed higher levels compared with those in river Nile Estuary (Saad & Fahmy.,1985) except Cu and Zn and with (Biney.,1991) at Lower Volta river Ghana except Fe, Cu and Pb and with (Walting & Emmer., 1981) at Swartkops river S. Africa except Pb. The levels of metals in the study area are lower than unpolluted sediments in inland water (Salomons & Forestner,1984) except Cd.

The concentration of element in river Nile sediment was Fe> Al> Mn> Zn> Cu> Co> Pb> Cd

The distribution of heavy metals in the river Nile sediments is mostly controlled by the mineral composition of bottom sediments in addition to pollutants introduced in to the river through agricultural, domestic or industrial wastes discharge Figure 5. These additional source cause some local increase in trace elements, contents of area affected by these input. In general, all metals are enriched in the areas affected by the following factors: Fe, Mn, Cd and Zn et.cl are concentrated near the factories on river Nile and the agriculture drainages the sediments of the north zone are riche in Pb, and the bottom sediments of the west zone in Cu. The chemical analysis of the recent river Nile sediments proved that the upper river Nile is nearly divided into southern zone; rich in Mn, Pb and Cd at the same time poor in Zn, Cu, Co, Bo, Cr, Ni, mud and carbonates and those of the middle area, rich in Fe and poor in Al, Mn, Pb, Cd, Bo, Cu and organic matter, whereas those of the northern zone are rich in Al, Zn, Cu, Co, Bo, Cr, Ni, V, Sr, mud, organic matter and carbonates and poor in Fe. Large volume of organic matter and mud imputes may be an important factor in this enrichment of trace metals. Draz (1983) proved that copper is generally introduced to the aquatic environment and incorporated in mud minerals.

Similarity

By using cluster analysis on the obtained data of physicochemical parameters and the analyses elements (Figure 6) the result in sediment indicate that; there was high similarity between Shubra and Deshna 95% also high similarity between Shubra, Deshna and Helwan 80% while low similarity with other stations.

Table (1): Distribution of carbonate in winter, spring, summer and autumn in river Nile sediment 2007-2008.

Zone	Stations	Winter	Spring	Summer	Autumn
South	Aswan	16.59	4.94	5.63	12.71

	Kema East	19.76	5.29	5.65	28.94
	Kema Middle	0.35	6.35	18.35	21.18
	Kema West	17.29	*	*	*
	Kom Ombo East	1.41	0	1.76	8.47
	Kom Ombo Middle	0.35	3.18	1.41	2.12
	Kom Ombo West	*	0	5.65	3.18
	Luxor East	*	*	7.41	*
	Luxor Middle	1.41	2.12	*	3.53
	Luxor West	4.94	2.82	2.12	9.18
	Kous East	2.12	4.94	9.88	9.53
	Kous Middle	0.35	1.76	3.18	3.88
	Kous West	*	6	*	*
Middle	Deshna East	*	6	20.82	15.18
	Deshna Middle	*	2.82	2.82	3.18
	Deshna West	*	7.76	9.88	9.18
	Naga Hammadi East	*	14.47	14.12	12.35
	Naga Hammadi Middle	*	2.47	*	22.59
	Naga Hammadi West	*	9.53	*	22.59
	Assuit East	5.65	4.59	20.12	*
	Assuit Middle	*	1.76	*	8.47
	Assuit West	28.59	7.41	8.12	9.53
	Minia East	4.24	*	18	*
	Minia Middle	3.53	7.06	*	8.12
	Minia West	2.47	5.65	11.29	8.47
	Bany swaif East	*	3.53	9.88	2.82

	Bany swaif Middle	0	4.59	2.82	2.82
	Bany swaif West	3.53	1.06	2.82	*
North	Helwan East	8.12	20.47	12.35	7.41
	Helwan Middle	2.12	7.06	*	6.35
	Helwan West	*	2.82	10.59	*
	Hawamdia East	6	*	*	7.41
	Hawamdia Middle	3.18	4.59	*	2.82
	Hawamdia West	*	11.65	11.65	5.65
	Shubra East	25.06	18	*	31.41
	Shubra Middle	32.82	30.35	*	19.76
	Shubra West	*	32.47	11.29	12
	Alwaraq East	*	32.82	19.06	13.41
	Alwaraq Middle	*	15.53	25.41	31.06
	Alwaraq West	*	11.29	*	15.53
	Average	8.26	8.42	10.08	11.54

Table (2): Distribution of organic matter in winter, spring, summer and autumn in river Nile sediment 2007-2008.

Zone	Stations	winter	spring	summer	autumn
South	Aswan	16.84	2.52	3.3	11.19
	Kema East	16.42	1.62	2.89	9.15
	Kema Middle	0.32	1.75	6.67	8.06
	Kema West	2.23	*	*	*
	Kom Ombo East	0.78	0.39	0.74	0.40
	Kom Ombo Middle	0.30	0.81	0.38	0.33
	Kom Ombo West	*	0.49	2.64	0.42

	Luxor East	*	*	0.92	*
	Luxor Middle	0.85	0.58	*	0.46
	Luxor West	1.85	0.57	0.51	3.56
	Kous East	0.31	2.62	1.98	3.03
	Kous Middle	0.3	0.41972	0.29	0.57
	Kous West	*	1.71	*	*
Middle	Deshna East	*	1.80	3.33	6.22
	Deshna Middle	*	0.59	0.99	0.74
	Deshna West	*	3.47	3.24	2.42
	Naga Hammadi East	*	5.75	4.44	5.77
	Naga Hammadi Middle	*	0.59	*	1.12
	Naga Hammadi West	*	2.78	*	3.24
	Assuit East	2.89	1.14	4.52	*
	Assuit Middle	*	0.31	*	0.25
	Assuit West	3.40	1.37	2.04	2.36
	Minia East	1.22	*	*	*
	Minia Middle	0.21	0.62	*	2.36
	Minia West	0.20	1.42	3.31	2.09
	Bany swaif East	*	0.53	2.00	0.49
	Bany swaif Middle	0.54	0.46	0.30	0.4
	Bany swaif West	0.31	0.34	0.3	*
North	Helwan East	4.99	4.29	4.11	1.83
	Helwan Middle	0.5	2.61	*	0.42
	Helwan West	*	0.68	3.56	*
	Hawamdia East	2.20	*	*	2.12

	Hawamdia Middle	0.36	0.67	*	0.44
	Hawamdia West	*	2.1	2.55	1.61
	Shubra East	5.77	7.91	*	5.57
	Shubra Middle	15.35	4.74	*	6.03
	Shubra West	*	6.01	6.59	2.27
	Alwaraq East	*	9.05	0.03	2.65
	Alwaraq Middle	*	5.42	1.1	7.81
	Alwaraq West	*	7.47	*	6.79
	Average	3.4	2.38	2.41	3.1

Table (3): The measurements of (Fe %, Mn, Cu, Pb, Zn and Cd ppm) in sediment at different Zone of river Nile during winter.

Zone	Station	Fe	Mn	Zn	Cu	Pb	Cd
South	Aswan	2.56	1775.9	56.16	22.99	16.9	10.99
	Kema	2.39	220.51	16.25	5.11	1.64	13.13
	Kom Ombo	2.1	209.6	21.88	5.88	18.29	11.73
	Luxor	2.21	556.25	51.65	12.21	23.23	13.34
	Kous	2.16	497.77	38.78	12.33	17.97	10.32
Ave		2.28	652.01	36.94	11.7	15.61	11.9
Middle	Deshna	*	*	*	*	*	*
	Naga Hamadi	*	*	*	*	*	*
	Assuit	2.27	1722.6	88.14	30.7	22.32	12.21
	Minia	2.07	206.98	17.04	4.62	8.69	9.7
	Bany swaif	2.12	235.07	39.56	3.25	9	9.41
Ave		2.15	721.55	48.25	12.86	13.34	10.44
North	Helwan	2.17	449.48	31.13	2.76	12.2	11.67
	Hawamdeia	1.99	190.72	14.51	1.52	4.01	10.26
	Shubra	*	*	*	*	*	*
	Alwaraq	2.24	1333.7	63.12	23.89	22.07	11.37
Ave		2.13	657.97	36.25	9.39	12.76	11.1

Table (4): The measurements of Al%, Fe %, Mn, Cu, Pb, Zn and Cd ppm) in sediment at different Zone of river Nile during spring.

Zone	Station	Al	Fe	Mn	Zn	Cu	Pb	Cd
South	Aswan	1.83	2.27	1418.8	85.39	19.66	28.35	11.53
	Kema	2.37	2.27	738.36	135.53	14.34	20.5	13.03
	Kom Ombo	1.73	2.22	414.23	42.63	11.35	10.16	14.16
	Luxor	1.39	2.15	377.09	34.4	9	6.48	9.99
	Kous	1.94	2.1	265.58	13.49	6.16	10	10.41
Ave		1.85	2.2	642.81	62.29	12.1	15.1	11.82
Middle	Deshna	2.56	2.26	1030.2	97	33.19	14.98	11.2
	Naga Hamadi	2.23	2.07	369.75	25.59	8	10.39	10.93
	Assuit	1.96	1.67	163.56	11.86	2.52	2.76	11
	Minia	2.03	2.14	546.67	47.16	8.15	13.22	12
	Bany swaif	1.99	2.04	164.59	13.4	2.5	2.76	9.22
Ave		2.15	2.04	454.95	39	10.87	8.82	10.87
North	Helwan	2.26	2.09	377.64	38.23	6.35	8.08	12.82
	Hawamdeia	3.54	2.01	469.37	51.54	17.27	9.23	10.51
	Shubra	4.09	2.26	945.58	87.9	28.13	15.38	12.71
	Alwaraq	4.59	2.28	1089.7	118.59	32.94	20.26	11.9
Ave		3.62	2.16	720.57	74.07	21.17	13.24	11.99

Table (5): The measurements of (Fe %, Mn, Cu, Pb, Zn and Cd pmm) in sediment at different Zone of river Nile during summer.

Zone	Station	Fe	Mn	Zn	Cu	Pb	Cd
South	Aswan	4.67	816.48	38.96	21.00	17.00	0.00
	Kema	4.5	405.97	24.99	14.00	17.00	1.00
	Kom Ombo	3.63	192.78	9.56	12.00	3.00	1.00
	Luxor	4.34	464.94	27.20	10.00	12.00	1.00
	Kous	4.66	657.72	37.49	19.00	13.00	0.00
Ave		4.36	507.58	27.64	15.2	12.4	0.6
Middle	Deshna	4.65	747.31	44.10	27.00	25.00	0.00
	Naga Hamadi	4.69	747.31	93.35	34.00	nd	1.00
	Assuit	4.79	809.68	54.39	32.00	8.00	2.00
	Minia	4.66	716.69	44.84	19.00	5.00	1.00
	Bany swaif	4.65	622.57	44.10	19.00	18.00	1.00
Ave		4.69	728.71	56.15	26.2	14	1
North	Helwan	4.74	785.86	57.33	33.00	11.00	1.00
	Hawamdeia	4.81	582.88	58.80	31.00	1.00	1.00
	Shubra	4.73	708.75	61.01	39.00	15.00	0.00
	Alwaraq	4.66	697.41	50.72	24.00	12.00	1.00
Ave		4.74	693.72	56.96	31.75	9.75	0.75

Table (6): The measurements of (Al %, Fe %, Mn, Cu, Pb, Zn and Cd ppm) in sediment at different Zone of river Nile during autumn.

Zone	Station	Al	Fe	Mn	Zn	Cu	Pb	Cd
South	Aswan	3.98	4.69	1027.40	53.66	56.00	35.00	1.00
	Kema	4.13	3.97	271.03	17.64	10.00	32.00	2.00
	Kom Ombo	3.14	3.57	393.50	11.03	7.00	10.00	1.00
	Luxor	1.93	4.71	635.04	51.45	31.00	Nd	nd
	Kous	2.69	4.49	567.00	43.37	26.00	Nd	1.00
Ave		3.174	4.29	578.79	35.43	26	25.67	1.25
Middle	Deshna	3.35	4.25	531.85	35.28	21.33	10.00	1.00
	Naga Hamadi	2.87	3.9	341.33	25.73	10.00	8.00	1.00
	Assuit	2.52	3.32	107.73	11.03	4.00	32.00	2.00
	Minia	2.31	4.46	530.71	63.95	23.00	Nd	0.00
	Bany swaif	2.15	3.53	183.71	12.50	2.00	Nd	0.00
Ave		2.64	3.89	339.07	29.69	12.07	16.67	0.8
North	Helwan	2.01	2.99	113.40	44.84	1.00	15.00	1.00
	Hawamdeia	3.34	3.26	163.30	14.70	1.00	4.00	1.00
	Shubra	4.17	3.81	422.98	66.89	31.00	27.00	1.00
	Alwaraq	4.63	3.9	496.69	49.25	16.00	27.00	1.00
Ave		3.54	3.49	299.09	43.92	12.25	18.25	1

Table (7): Mean metal concentration in sediment of some sites in Egypt

Fe	**Mn**	**Zn**	**Cu**	**Pb**	**Cd**	**Area**	**References**
3.3 %	579.6 µg/g	45.9 µg/g	17.4 µg/g	14.04 µg/g	5.9 µg/g	Present study	Present study
8.14-10.7%	2.50%	NA	126ppm	570ppm	30ppm	Aswan High Dam reservoir	Zaghloul et. al., 1987 El-Dardir., 1984
4.74%	1.03%	NA	NA	NA	NA	River Nile	Issa et. al., 1997
$0.5x10^3$ µg/g	387 µg/g	139 µg/g	85.6 µg/g	NA	1.06 µg/g	River Nile Estuary	Saad & Fahmy. ,1985
2.63-8.18 %	601-1728 µg/g	68-564 µg/g	41-903 µg/g	NA	5-56 µg/g	River Nile	Goher., 1998
$55x10^3$ µg/g	295 µg/g	34 µg/g	28.9 µg/g	16.7 µg/g	0.2 µg/g	Lower Volta river Ghana	Biney., 1991
$53x10^3$ µg/g	616 µg/g	165 µg/g	78.6 µg/g	69.4 µg/g	0.55 µg/g	Lake Victoria, Kenya	Onyari & Wandiga., 1989
$16x10^3$ µg/g	177 µg/g	36 µg/g	10.5 µg/g	17.8 µg/g	1 µg/g	Swartkops river S. Africa	Walting & Emmer., 1981
5.2 $x10^3$ µg/g	279 µg/g	141 µg/g	82.9 µg/g	96.04 µg/g	6.45 µg/g	River Nile Greater Cairo	Lotfy., 2008
4.7 -4.9%	46.1-2152 ppm	91.5432.3ppm	22.3-312.2ppm	10-229.4ppm	6.3-10.6ppm	Rosetta Branch	Farhat., 2010

4.7 -4.9%	65.9-2488ppm	80.1-439.5ppm	44.5-148.9ppm	32.8-136.3ppm	7.5-13ppm	Damietta branch	
41 x10^3 g/g	770	95	33	19	0.11	Unpolluted sediment	Salomons & Forestner.,1984

NA: not analysis

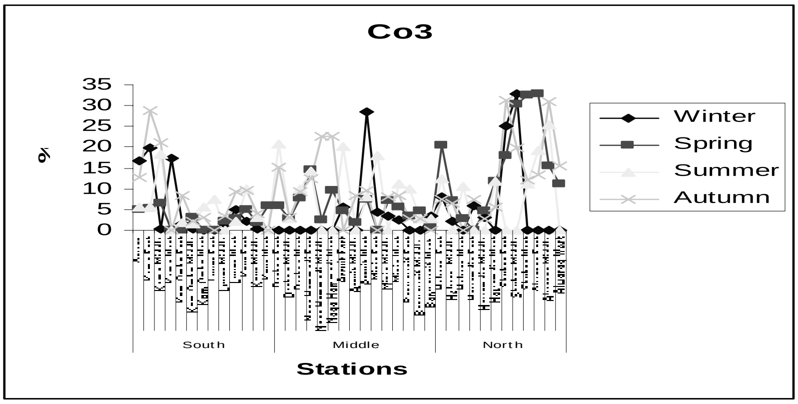

Figure (2): The horizontal distribution of carbonate (%) in winter, spring, summer and autumn in river Nile sediment 2007-2008.

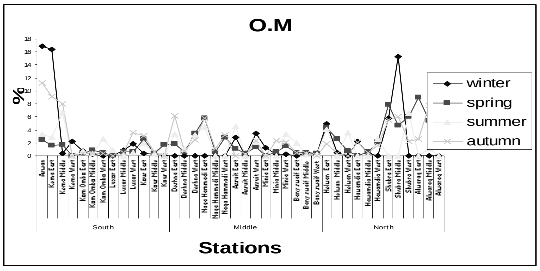

Figure (3): The horizontal distribution of organic matter (%) in winter, spring, summer and autumn in river Nile sediment 2007-2008.

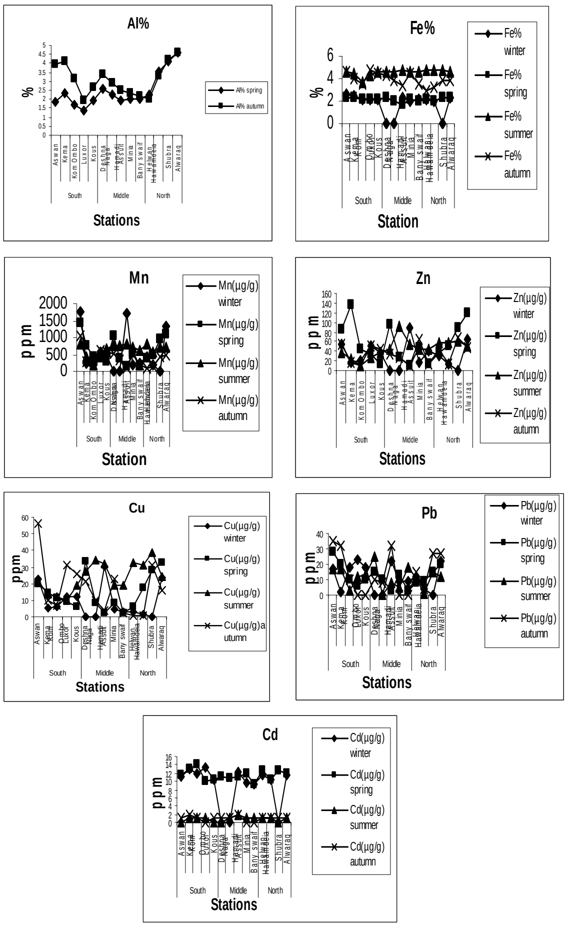

Figure (4): The Zone average variation of (Al %, Fe %, Mn, Cu, Pb, Zn and Cd ppm) in sediment of river Nile.

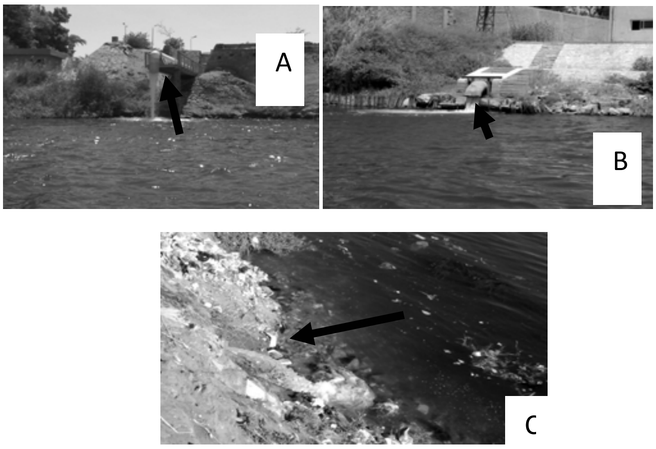

Figure (5): Photographs A, B and C show some industrial sewage on river Nile.

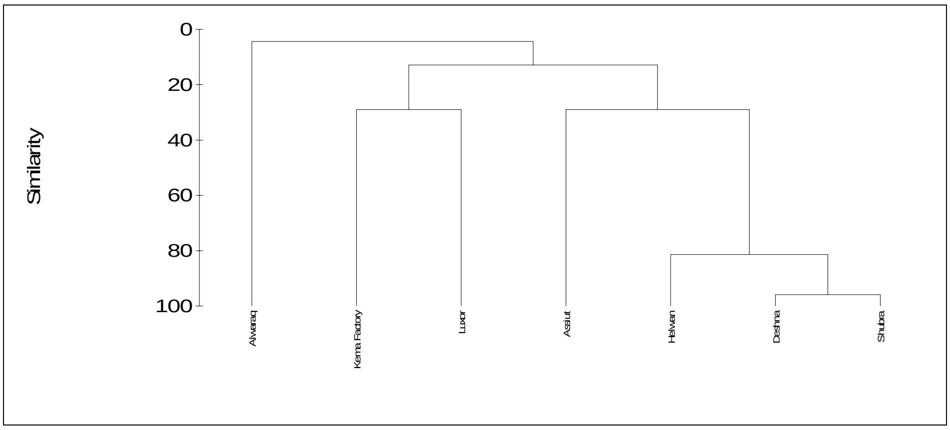

Figure (6): Dendrogram showing the similarty in heavy metal of sediment in studied area.

SUMMARY AND CONCLUSION

The river Nile is the main source of life to many African countries in general and Egypt in particular. It is a classical proverb that says that "Egypt is the gift of the Nile". Egypt has always been an agricultural country depending almost entirely on the Nile water as the main source for irrigation. Even when Egypt started is program for industrialization, the river Nile was the main source of its energy.

The distribution of carbonates is mostly controlled by the facies of sediment i.e. (the carbonate increased with the high accumulation of mud). The high accumulation of carbonate contents is occurred in the depth between 2 and 5 m. This accumulation increases towards the beach. The relative order of abundance of carbonates can be summarized as follows: autumn> summer> spring> winter and in south> middle> north zone. The highest value of organic matter is occurred in winter northwards. There is tendency to increasing eastwards and westwards, i.e. near the mouth of drainage water and high accumulation of mud. The relative order of seasonal distribution according to abundance of organic matter is; in winter > autumn > summer > spring.The highest values of aluminum are observed at Kema factory southern and northern zones and decreasing at middle. It increased at autumn than spring season. The increased of aluminum occurred near the factory on river Nile.In case of Fe, the river is nearly divided into north rich zone and middle and south poor basins. With respect to stations, the high value of Fe takes place at Shubra and Alwaraq station (Greater Cairo) i.e near the factory in the area and at Aswan (south zone) during autumn at Kema factory station and decreased in the middle zone. Seasonally, the accumulation of iron increased during summer and autumn and decreased during winter and spring. According to the distribution of manganese, the southern zone proved to have a maximum value in spring and decreased at the north, on the other hand the manganese content become high concentration in the autumn and the low value recorded at the middle and north at Helwan after that increased at Alwaraq and Shubra stations. The relative order at abundance of Mn: winter > summer > spring > autumn. The southern zone proved to have a maximum value in all season and decreased at the middle and northwards. The highest values of Zn are observed at Kema factory south zone and decreasing at middle and also increased northwards. Zinc contents in bottom sediments of river Nile increased during spring > autumn > winter > summer seasons. The value increased in front of the factories on river Nile. The copper content increased northward and decreased at middle and southwards and summer and autumn and decreased during winter and spring. In case of lead at the south zone, it is proved to have the highest value and decreasing northwards. The concentration of lead increased during summer > autumn > spring > winter. The concentration of Cadmium increased during winter > spring > summer > autumn and varied between 0 at most stations and 2 ppm at little stations.

The zonal average of the elements showed changes, the averages of heavy metal elements Fe, Mn, Cd, Zn, Pb and Cu are concentrated near the factories on river and the agriculture drainages the sediments of the north zone are riche in Pb, and the bottom sediments of the west zone in Cu.the chemical analysis of the recent river Nile sediments proved that the upper river Nile is nearly divided into southern zone; rich in Mn, Pb and Cd at the same time poor in Zn, Cu, Co, Bo, Cr, Ni, mud and carbonates and those of the middle area, rich in Fe and poor in Al, Mn, Pb, Cd, Bo, Cu and organic matter, whereas those of the northern zone are rich in Al, Zn, Cu, Co, Bo, Cr, Ni, V, Sr, mud, organic matter and carbonates and poor in Fe. Large volume of organic matter and mud imputes may be an important factor in this enrichment of trace metals.The source of trace metals in the river Nile sediments is mostly allocthonous from agricultural drainage waters and Industrial). The remobilization of metals from water depending on some physio-chemicals changes occur in water and sediments; elevated of salt content, changes in the redox condition, lowering of pH, presence of natural competing agents, sediment facies change, organic matter and mud content and biochemical processes (i.e. high accumulation of biogenic origin of carbonates).The concentration of elements in river Nile sediment are Fe> Al> Mn> Sr> V> Cr> Zn> Ni> Bo> Cu> Co> Pb> Cd.

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دراسات جيوكيميائية علي رسوبيات القاع الحديثة لنهر النيل من أسوان إلي القاهرة. مصر

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****: كلية العلوم جامعة بنها**

.أوضحت الدراسة أن المتوسط للعناصر الثقيلة حديد ومنجنيز وكادميوم وزنك ورصاص ونحاس تتركز قرب المصانع والمصارف الزراعية وأن الرواسب في المنطقة الشمالية غنية بالرصاص ومصدر هذه الرواسب غالبا ما يكون من المصارف الصناعية والزراعية. يزداد محتوي الكربونات في إتجاه الشمال ومعظم الكربونات يتحكم في توزيعها السحنة الرسوبية فنجد أن الكربونات يزداد تجمعها مع تزايد الطمي بينما تقل في المناطق الرملية وأعلي تجمع لمحتوي الكربونات يوجد عند عمق بين ٢ و ٥ متر وهذا التجمع يزداد إتجاه الشاطئ وتقل تدريجيا في إتجاه العمق ويكون محتوي للكربونات في الخريف > الصيف > الربيع > الشتاء وفي الجنوب > الوسط > الشمال. أعلي قيم للمحتوي العضوي توجد في الشتاء عند المنطقة الشمالية ويزداد تركيز المحتوي العضوي في إتجاه الشاطئ الشرقي والغربي بالقرب من مصبات المصارف والعمق القليل وتجمع الطمي ومن التوزيع الموسمي للمحتوي العضوي نجد أن المحتوي العضوي في الشتاء > الخريف > الصيف > الربيع.

التحليل الكيميائي لرواسب نهر النيل الحديثة أوضح أن نهر النيل ينقسم إلي منطقة الجنوب الغنية بالمنجنيز والرصاص والكادميوم وفي نفس الوقت فقيرة ب الزنك والنحاس أما منطقة الوسط فهي غنية بالألومنيوم و المنجنيز والرصاص والكادميوم والنحاس بينما المنطقة الشمالية غنية بالألومنيوم والزنك والنحاس وفقيرة بالحديد. ربما يرجع فقر هذه المناطق بالعناصر النادرة إلي عاملين مهمين هما الطمي والمحتوي العضوي.أوضحت الدراسة أن توزيع العناصر الثقيلة في رسوبيات نهر النيل يكون معظمه محكوم بواسطة السحنات الرسوبية لرسوبيات القاع بالإضافة إلي الملوثات الناتجة عن الصرف الزراعي والمنزلي ومخلفات الصرف الصناعية وأن مصدر العناصر الثقيلة في رسوبيات النهر يكون معظمه منقول عن طريق مصارف المياه الزراعية. وقد وجد أن عملية الامتصاص هي المتحكم الرئيسي في إعادة تجمع العناصر من الماء بواسطة الاعتماد علي الصفات الفيزيوكيميائية التي تحدث تغير في الماء والرسوبيات.ارتفاع المحتوي الملحي و التغير في ظروف الأكسدة و الاختزال و نقص قيمة التركيز الأيوني لأيون الهيدروجين و وجود عوامل طبيعية متزاحمة (كثيرة) و تغير سحنة الرسوبيات و المواد العضوية ومحتوي الطمي و العمليات الكيميائية الحيوية.وقد وجد أن تركيز العناصر في رسوبيات نهر النيل يكون كالتالي الحديد > الألومنيوم > المنجنيز > الزنك >

النحاس > الرصاص > الكادميوم. ومعظم ترسيب هذه المواد هو هوائي والعلاقة بين الحديد والعناصر المتنوعة الأخري.