Factors Affecting Chemical DTPA-Extractabilily of Some Heavy Metals From Different Soil Types in Egypt

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ABSTRACT

The objectives of this study were to determine the amounts of total and available heavy metals in some Egyptian soils and their relation with some soil properties. Five soil profiles; two from Kafr El-Sheikh Governorate located at south Kafr El-Sheikh city and south Baltim city to represent Delta soils and three profiles from El-Beheira Governorate located at Housh-Eisa, Abo El-Matameir and Mariut to represent Delta fringes soils. These profiles were chosen to cover as far as possible the Delta soils (Fluvial and Lacustrine soils) and Delta fringes soils (Sandy calcareous and Alluvial calcareous soils and Calcareous soils) at the northern part of Egypt.

Data showed that, the surface layers of Delta soil contained higher amounts of total and available Cu, Ni, Cd and Pb than the subsurface soil layers and decreased with depth. The contents of total Cu, Ni, Cd and Pb in Delta soils varied from 246.3 to 102.5, 186.3 to 100.0, 9.85 to 1.85 and 175.0 to 60.0 mg/kg soil, respectively in the surface layers. The corresponding values of the DTPA-extractable metals were 11.8 to 11.4, 0.78 to 0.8, 0.21 to 0.023 and 0.37 to 0.22 ppm, respectively.

The average content of total Cu, Ni, Cd and Pb for Delta fringes soils varied from one metal to another and also from one soil to another. Therefore, these metals can be arranged according to their contents in the order: Cu > Pb > Ni >Cd. The contents of total Cu, Ni, Cd and Pb in Delta fringes soils varied from 57.5 to 120.0, 62.5 to 95.0, 2.3 to 4.65 and 39.5 to 69.5 mg/kg, respectively for the surface layers. The alluvial calcareous soils recorded the lowest amounts of heavy metals; whereas sandy calcareous soils recorded the highest ones. The available amounts of these metals varied relatively in narrow range and the averages were 2.11, 0.16, 0.035 and 0.20 mg/kg soil for Cu, Ni, Cd and Pb, respectively.

The values reveal that metal content is mainly dependent on soil parent material, organic matter content and cation exchange capacity. Highly positive significant correlations were found between clay and silt % with total and available heavy metals, and also between organic matter content and total and available metals except available Cu. Cation exchange capacity showed highly significant correlations with either total or available metals. On the other hand, negative correlations were found between calcium carbonate and total and available metals. It can be concluded that, the heavy metal contents in the studied soils are affected mainly by the geochemical sources or soil parent material.

Keywords. Heavy metals, Delta soils and Delta fringes soils, Total metal, DTPA-metal.

INTRODUCTION

Heavy metals are the most widely recognized and used term for metals having atomic density greater than 6 gm/cm^3 (Alloway, 1995). Also, heavy metals are those elements having densities greater than 5 gm/cm^3 (Sparks, 1995). Heavy metals are also classed as "trace elements" because they occur in concentration of less than 1% in the rock of the earth's crust, Alloway (1995). During the last decade, they have been paid increasing attention owing to their frequent occurrence as soil pollutants. In addition, some of these metals are essential for plant growth, the adequate supply of which is of a great importance in agriculture. The evaluation of potential hazards, when pollution occurs, requires knowledge's of the normal contents of these metals in soils (Rashad, et al. 1995).

The sources of heavy metals are parent material, commercial fertilizers, liming materials, sewage sludge, irrigation with contaminated water, capillary rise of contaminated groundwaters, coal combustion, metal-smelting industries, auto emissions, and others (Sparks, 1995). There are different sources of heavy metals that adversely affect soil properties, especially microbiological activities, plant growth, animal and human health. Hence, they present risk of toxicity depending on their rate of transfer from soil compartments to the soil solution, plants, groundwaters and more generally to the food chain. In Egypt, emission from automobile exhaust, high use of fertilizers and pesticides as well as the industrial activity are the main sources of pollution by heavy metals such as, Zn, Pb, Cd, Ni, Mn and Cu (Shahin and Abdel-Tawab, 1988, Morsy, 1990 and Omran, et al.,1996). Rabie et al. (1989 and 1996) reported that heavy texture, non calcareous and Nile alluvial deposits have the highest micronutrients content, Aeolian sandy soils attain lowest, while calcareous soils display an intermediate case. Highly significant correlation was observed between both total and available micronutrient and clay, clay+ silt, and organic matter content rather than those with mineralogical composition, Rabie et al. (1989), Abou El-Khir (2003) and Dai et al. (2004). Soil pH, Eh,

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Received November 5, 2007, Accepted December25, 2007

exchange capacity, organic matter content, soil texture, oxides content, exchangeable bases and clay mineralogy had great effects on the distribution and uptake of Mn, Cu, and Zn and sorption of Cd in soil (McBride et al., 1981 and McLaren et al. 1983). Heavy metal adsorption varies among soil types and may depend on one or a combination of soil properties (Alloway, 1990). Soil proprieties, often correlated with metal adsorption, include soil pH (Christensen, 1984), soil CEC (Harter, 1979), soil organic matter (Gerriste and Van Driel, 1984) and clay content (Korte et al., 1976.) However, direct cause-and-effect relationships between soil properties and metal adsorption are difficult to determine because soil properties are often intercorrelated. Correlation analysis may inadequately describe these relationships because correlation does not ensure that a direct cause-and-effect relationship exists (Wright, 1921). The current study aimed to determine the total and available heavy metals in some Egyptian soils and their relation to some soil parameters.

MATERIALS AND METHODS

Five soil profiles, two from Kafr El-Sheikh Governorate located south Kafr El-Sheikh city and south Baltim city to represent Delta soils and three profiles from El-Beheira Governorate located at Housh-Eisa, Abo El-Matameir and Mariut to represent Delta fringes soils. Samples from the different soil layers were collected to represent some soil types in Egypt Fig.1. These locations were chosen to cover as far as possible the following soils types:

1- Delta soils:

A- Fluvial deposits.

B- Lacustrine deposits.

2- Delta fringes soils:

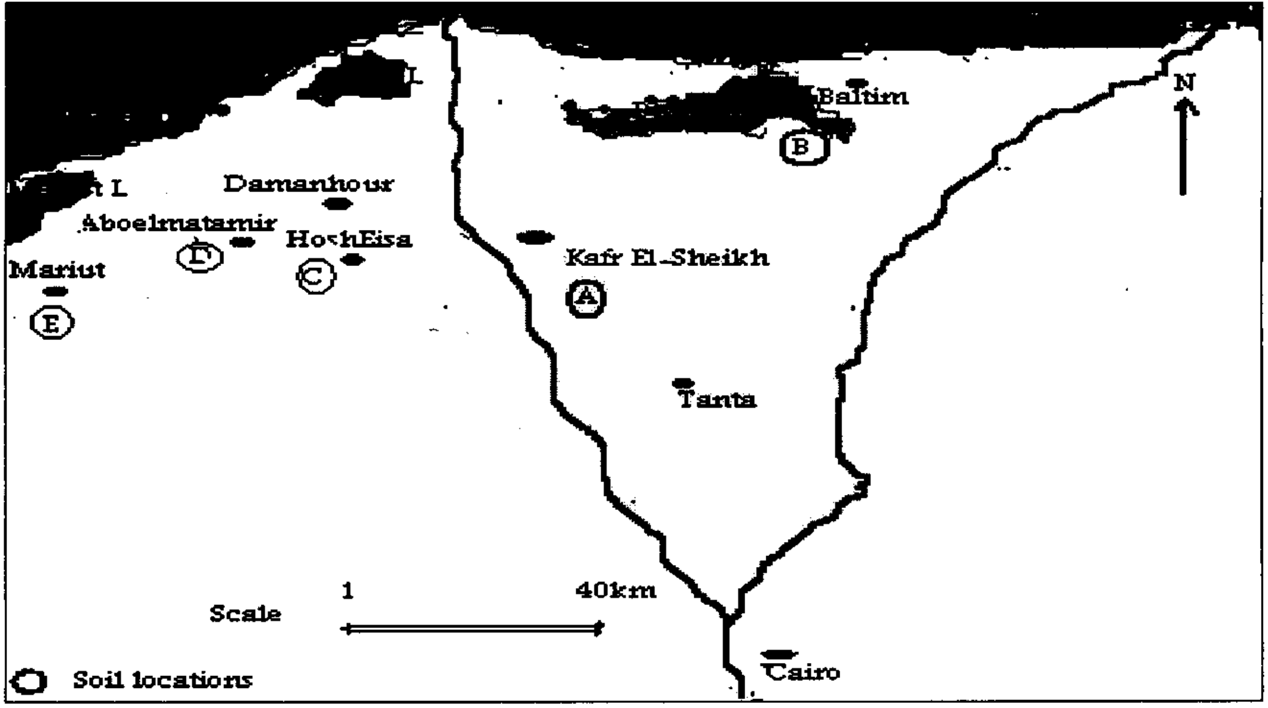
C- Sandy calcareous.

D- Alluvial calcareous.

E- Calcareous.

The soil samples were air-dried, gently crushed, passed through a 2-mm sieve. Some chemical and physical properties of the soil samples were determined according to Page (1994). The EC of soil was measured in the soil paste extract by electrical conductivity meter (Model 4320 JENWAY), the pH was measured in 1: 2.5 soil-water suspension by pH-meter (Model 420 A), total $CaCO_3$ by Collins calcimeter and O.M. by Walkly and Black method. The particle size distribution (Sand, Silt and clay) was determined by hydrometer method.

Fig 1. **locations of soil samples collected from the Nile Delta and Delta fringes**



Total content of heavy metals (Cu, Ni, Cd and Pb) in soils were determined using hot extraction with aqua regia (Cottenie et al., 1982).

The available amounts of heavy metals in soil samples were extracted by 0.005 M DTPA solution buffered at pH 7.3 (Lindsay and Norvell, 1978). Both total and available heavy metals were measured by Atomic Absorption Spectrophotometer (Perken Elmer 380).

Statistical analyses were carried out by using computer programs according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Soil properties:

Some soil physical and chemical properties of the studied soils profiles are presented in Table1. Data showed that fluvial soils have relatively heavy texture in all layers, where the clay content was found to be around 40% and the texture class is silty clay.Lacustrine soil is characterized by their heavy texture in the surface (0-30 cm) and subsurface layers (30-70 cm)where the texture is clay loam and changes with depth (>70 cm) to light where the texture was found to be sandy clay loam and silty clay loam. Sandy and alluvial calcareous soils are nearly similar particularly with respect to the dominancy of sandy clay loam texture except for top soil layer (0-28 cm) in sandy calcareous soils which was loamy

Table1. Chemical and physical properties of the investigated soil profiles

Soil type	Soil depth (cm)	Particle-size distribution			Texture class	$CaCO_3$ %	OM %	EC dS/m	pH	C.E.C. meq/100 gm soil
		Clay %	Silt %	Sand %						
Fluvial soils										
A-Fluvial	0--30	45.69	45.39	8.92	Silt clay	4.10	1.78	2.32	8.39	40.60
	30--60	48.04	44.93	7.03	Silt clay	2.98	1.68	3.58	8.50	48.00
	60--90	47.99	44.31	7.70	Silt clay	3.16	0.55	7.06	8.33	42.78
	90--120	45.25	47.72	7.03	Silt clay	1.22	0.63	8.47	8.14	45.67
	120-150	43.62	50.24	6.14	Silt clay	1.18	0.66	10.42	8.09	43.65
Lacustrine soils										
B-Lacustrine	0--30	36.30	40.20	23.50	Clay loam	14.40	2.02	84.80	7.95	33.66
	30--70	36.30	24.88	38.82	Clay loam	15.20	2.14	64.20	7.95	26.73
	70--80	21.06	13.40	65.54	Sandy clay loam	0.48	0.50	53.40	8.23	13.86
Sandy calcareous soils										
C-Sand calcareous	0--28	7.70	11.64	80.66	Loamy sand	7.40	0.40	1.74	8.60	8.34
	28--40	25.32	14.57	60.11	Sandy clay loam	14.88	0.15	1.88	8.32	17.21
	40--80	23.21	14.56	62.23	Sandy clay loam	11.28	0.15	2.63	8.28	15.28
	80--100	16.74	16.13	67.13	Sandy loam	10.08	0.10	2.06	8.37	21.30
	100-125	22.40	9.65	67.95	Sandy clay loam	9.44	0.10	2.15	8.36	15.25
Alluvial calcareous soils										
D-alluvial calcareous	0--20	33.04	20.90	46.06	Sandy clay loam	22.24	1.30	10.10	8.25	21.14
	20--40	35.30	19.80	45.90	Sandy clay loam	20.00	1.38	13.35	8.15	17.28
	40--70	32.29	13.32	54.39	Sandy clay loam	31.80	0.19	5.06	8.49	7.21
Calcareous soils										
E-calcareous	0--20	28.11	28.17	43.72	Sandy clay loam	30.10	0.21	2.46	8.21	13.00
	20--50	37.73	32.49	29.78	Clay loam	38.22	0.68	2.48	8.42	14.08
	50--80	33.46	21.89	44.65	Clay loam	44.13	0.29	2.08	8.50	12.32
	80--110	35.68	23.24	41.08	Clay loam	48.15	0.29	2.36	8.56	8.80

sand and the intermediate layer (80-100 cm) were sandy loam.The texture of the calcareous soils varied from sandy clay loam in the upper (0-20 cm) to clay loam in the subsurface layers up to 110 cm depth.This could be due to the physical characteristics of parent material developed under marine and lagoonal conditions and to the increasing in carbonate content.

Regarding the distribution and content of $CaCO_3$, the fluvial soils recorded the lowest value of total carbonate content (an average of 4.1%) whereas the calcareous soils recorded the highest value (an average of 30.1%). The amounts of total carbonate content tend to decrease or increase with depth according to soil formation circumstances and land use.

Values of Electrical conductivity (EC) had wide range in Delta soils which varied from 2.32 to 84.8 dS/m in surface layer for fluvial and uncultivated lacustrine soils. In fluvial soil, EC values tend to increase with depth, whereas in uncultivated lacustrine soils took another direction which decreased with soil depth. This may be due to the effect of sea water intrusion and upward movement of water table (El-Shahawy, 1994). On the other hand, EC values of Delta fringes soils ranged between 1.74 and 10.1 dS/m (in the upper soil layer) and tend to slightly increase with depth in sandy calcareous soils. In alluvial calcareous soils, EC values increased in subsurface layer and decreased in the deepest layer. This may be due to increase of total carbonate content which led to form confined water table and encourage upward water movement and in the same time decrease water deep percolation.

Organic matter content ranged between 1.78 and 2.02 % in Delta soils and from 0.21 to 1.3 % in Delta fringes soils. The lowest values of O.M. in delta fringes soils may be related to the low rate of organic matter addition and high rate of decompsion as compared to Delta soils. The values of pH, generally ranged between 7.95 and 8.6 for all soils under study.

Concerning, the cation exchange capacity (CEC), their values ranged from 40.6 to 33.66 (meq/100g soil) in Delta soils and from 8.34 to 21.14 (meq/100g soil) in Delta fringes soils. It seems that CEC values correlated mainly with clay content of soils.

Total and available heavy metals in soils:

1- Delta soils:

Table2 showed that the surface layers of Delta soil contained higher amounts of total and available heavy metals (Cu, Ni, Cd and Pb) than the subsurface soil layers which decreased with depth. This may be due to the cycling through vegetation, atmospheric deposition and adsorption by the colloidal materials. The results were similar to those obtained by El-Sikhry (1985), Elsokkary (1994) and Abou El-khir (2003).

The contents of total Cu, Ni, Cd and Pb in Delta soils varied from 246.3 to 102.5, 186.3 to 100.0, 9.85 to 1.85 and 175.0 to 60.0 mg/kg, respectively. Whereas, the DTPA extractable values of these metals were 11.8, 0.78, 0.21 and 0.37 ppm, respectively for the above mentioned metals, for fluvial soils and 11.4, 0.80, 0.023 and 0.22 ppm, respectively, for lacustrine soils. Generally, total values of these metals were higher than in the natural concentrations in soil which were 100 ppm for Cu, Pb or Ni and 5 ppm for Cd (Tietjen, 1975). Data showed that, the average contents of metals varied from one metal to another and from one soil to another. Therefore, these metals can be arranged, according to their contents, in the order: Cu > Pb > Ni >Cd. With regard to soil types, lacustrine soils recorded the lowest amounts of heavy metals as compared with fluvial soils. These results agree with those of Elsokkary and Lăg, (1980), Rashad et al., (1995), Aboulroos et al., (1996), Meshref et al., (1998) and Abou El-Khir, (2003).

Regarding the relative percentage of available to their total metals content; data showed that, this is increased in lacustrine soil compared to fluvial soil for all studied metals. The mean values of this ratio were 6.13, 0.47, 0.63 and 0.34 % for Cu, Ni, Cd and Pb respectively, in the fluvial soil and were 11.73, 1.78, 1.09 and 0.57 %, respectively in the lacustrine soils. This my be due to the high clay content in fluvial than lacustrine soils.

2- Delta fringes soils:

Table 3 showed that the average content of total Cu, Ni, Cd and Pb in soils varied from one metal to another and also from one soil to another. Therefore, these metals can be arranged according to their total contents in the order: Cu > Pb > Ni >Cd. With regard to soil types, the contents of total Cu, Ni, Cd and Pb in soils varied from 57.5 to 120.0, 62.5 to 95.0, 2.3 to 4.65 and 39.5 to 69.5 mg/kg, respectively for the surface soil layers. This indicates that alluvial calcareous soils recorded the lowest amounts of heavy metals, whereas sandy calcareous soils recorded the highest ones. The amounts of available metals varied in a relatively narrow range and the average were 2.11, 0.16, 0.035 and 0.20 mg/kg for Cu, Ni, Cd and Pb, respectively. The values tend to increase with depth among soil profile except for total Cu in sandy calcareous soil which decreased in subsurface layer and increased markedly in the other layers.The mean values of total metals in Delta fringes soils were generally higher than in normal soils, while, the available contents were lower than in the normal soils (Tietjen, 1975). These results were similar to those obtained by Elsokkary and Lăg (1980) and Aboulroos et al. (1996). The percentage of available metal relative to the total were nearly similar, and varied, generally in a narrow range, from 1.1 to 8.93 %, 0.05 to 0.66 %, 0.48 to 2.84 % and 0.26 to 1.38 % for Cu, Ni, Cd and Pb, respectively.

Table2. Average values of the amounts of total and available Cu, Ni, Cd and Pb (mg/kg) in Delta soils

Soil depth (cm)	Cu (ppm)			Ni (ppm)			Cd(ppm)			Pb(ppm)		
	T.	A.	A/T (%)	T.	A.	A/T (%)	T.	A.	A/T (%)	T.	A.	A/T (%)
						Fluvial soil						
0--30	246.3	11.8	4.78	186.3	0.78	0.42	9.85	0.21	2.10	175.0	0.37	0.21
30--60	186.3	9.38	5.04	112.5	0.70	0.63	7.13	0.044	0.62	145.0	0.34	0.23
60--90	125.0	8.84	7.07	100.0	0.58	0.58	6.5	0.022	0.34	117.5	0.35	0.30
90-120	118.8	8.77	7.38	93.8	0.39	0.41	5.0	0.004	0.08	56.3	0.32	0.57
120-150	115.0	7.32	6.36	107.5	0.32	0.29	2.88	0.001	0.03	73.8	0.28	0.38
						Lacustrine soil						
0--30	102.5	11.4	11.08	100.0	0.80	0.8	1.85	0.023	1.24	60.0	0.22	0.37
30--70	88.5	10.8	12.19	19.0	0.62	3.28	1.70	0.012	0.71	49.0	0.54	1.10
70--80	62.5	7.5	11.92	12.5	0.15	1.22	0.60	0.008	1.33	27.5	0.07	0.25

T. = Total A. = Available

Table3. Average values of the amounts of total and available Cu, Ni, Cd and Pb (mg/kg) in Delta fringes soils

Soil depth (cm)	Cu (ppm)			Ni (ppm)			Cd(ppm)			Pb(ppm)		
	T.	A.	A/T (%)	T.	A.	A/T (%)	T.	A.	A/T (%)	T.	A.	A/T (%)
						Sandy calcareous soil						
0--28	120.0	1.71	1.42	95.0	0.22	0.23	4.65	0.03	0.65	69.5	0.20	0.29
28--40	73.0	1.38	1.88	81.5	0.26	0.32	2.90	0.02	0.79	57.0	0.15	0.26
40--80	91.5	1.76	1.92	70.5	0.12	0.17	3.65	0.00	0.00	20.0	0.28	1.38
80--100	118.5	1.47	1.24	59.0	0.00	0.00	4.25	0.05	1.15	45.0	0.17	0.38
100-125	131.0	1.44	1.10	31.0	0.11	0.35	3.90	0.05	1.28	41.5	0.00	0.00
						Alluvial calcareous soil						
0--20	57.5	3.80	6.62	62.5	0.41	0.66	2.30	0.02	0.74	39.5	0.37	0.93
20--40	36.5	3.16	8.66	58.5	0.10	0.17	1.65	0.01	0.48	39.5	0.18	0.46
40--70	30.0	4.68	8.93	63.5	0.19	0.30	1.80	0.03	1.56	34.0	0.10	0.31
						Calcareous soils						
0--20	92.0	2.17	2.36	73.5	0.20	0.28	3.90	0.10	2.62	69.0	0.47	0.68
20--50	82.5	1.00	1.21	70.5	0.19	0.27	2.50	0.07	2.84	54.5	0.28	0.51
50--80	64.5	1.72	2.67	71.5	0.09	0.12	2.00	0.03	1.30	47.0	0.20	0.43
80--110	55.5	1.05	1.90	58.5	0.03	0.05	1.60	0.01	0.81	12.5	0.03	0.26

T. = Total A=Available

Heavy metals relation with soil properties:

Table (4) showed the correlations between total and available heavy metals and some soil properties. The values revealed that the metal content is mainly dependent on soil parent material, organic matter content and cation exchange capacity of soils.

Highly significant positive correlations were found between clay and silt % and total and available heavy metals. Fine-textured soils retain more Cu than coarse-textured soils. Apart from the clay content, the nature of clay mineral in soil also governs the retention and desorption of Cu (Srivastava and Gupta, 1996). Heavy-textured soils are richer in Cd than light-textured soils. The retention of Cd by montmorillonite clay is at least five times greater than in the case of kaolinite (Khadr, 1961and Zachara et al., 1992). High charge density sites are supposed to hold metals more strongly than low charge density sites (Ziper et al., 1988).

Organic matter revealed positive correlation with total metals and available metals except available Cu. Srivastava and Gupta, (1996) found that Cu strongly binds with both soluble and insoluble organic matter in soil and peat soils retain a substantially high amount of Cu (130-190 meq/100g).

There were highly significant correlations between CEC and either total or available metals.

On the other hand, negative correlations were found between calcium carbonate and total and available metals. Calcareous soils retain higher amounts of Cu than other soils because of their greater adsorption of Cu on $CaCO_3$ particles. The adsorption of Cu by clays and organic matter also increases with the increase in soil pH (Srivastava and Gupta, 1996).

Generally, soils having high clay content, $CaCO_3$ and cation exchange capacity (CEC) retained more Ni (Estan et al., 1987). Soil organic matter metal-complexes and soluble organic compounds can increase the solubility of Ni and consequently its availability in soils. Low pH increases the solubility of Ni (Uren 1992).

It has also been reported that retention of Cd increases with increasing soil pH and consequently, Cd availability in the soil decreases with pH. High pH favours precipitation of added Cd as $CdCO_3$ (Eriksson, 1990). Humic substances form strong complexes with Cd (Petruzzelli et al., 1977) and reduce its mobility to lower horizons. The solubilization of Cd by organic matter occurs in the pH range of 7-8.

The content and solubility of Pb in soils decreases with pH, CEC and available phosphorous. Lead forms relatively insoluble and stable chelates with organic matter (Srivastava and Gupta, 1996).

Table 4. Correlations between total and available heavy metals and soil properties

		Cu		Ni		Cd		Pb	
		Total	Available	Total	Available	Total	Available	Total	Available
Cu	Total	1.00							
	Available	+0.50	1.00						
Ni	Total	+0.72	+0.40	1.00					
	Available	+0.56	+0.88	0.53	1.00				
Cd	Total	+0.91	+0.36	0.78	+0.46	1.00			
	Available	+0.66	+0.17	0.59	+0.31	+0.66	1.00		
Pb	Total	+0.86	+0.58	0.81	+0.69	+0.87	+0.66	1.00	
	Available	+0.32	+0.46	0.31	+0.58	+0.35	+0.26	+0.46	1.00
Clay (%)		+0.35	+0.29	0.65	+0.38	+0.52	+0.21	+0.63	+0.25
Silt (%)		+0.52	+0.40	+0.70	+0.41	+0.63	+0.16	+0.65	+0.32
Sand (%)		-0.46	-0.37	-0.71	-0.41	-0.60	-0.19	-0.66	-0.30
$CaCO_3$ (%)		-0.69	-0.45	-0.33	-0.38	-0.53	-0.12	-0.44	-0.29
O M (%)		+0.36	-0.16	+0.54	+0.04	+0.46	+0.50	+0.44	+0.21
EC (ds/m)		-0.01	-0.38	+0.12	-0.30	+0.07	-0.13	-0.07	-0.07
pH		-0.03	+0.17	-0.16	+0.11	+0.01	+0.12	+0.06	+0.01
CEC (meq/100g soil)		+0.69	+0.55	+0.64	+0.54	+0.71	+0.19	+0.75	+0.41

Conclusion

Heavy metal contents in the studied soils are affected mainly by the geochemical source or soil parent material. The effects of extensive use of agrochemicals, practices of mechanization and atmospheric deposition are generally of secondary importance. Many authors suggested that soils should be protected from excessive inputs of heavy metals by fixing maximum acceptable levels of these metals in soils, corresponding to the amounts which will not cause any risk for crop failure or water pollution and human health. Cautions should be alarmed to prevent the continuous accumulation of these metals, which may finally lead to the soil pollution at a toxic level. To reduce dependence on agricultural agrochemicals, to promote cultural practices and to introduce and implement proven biological and alternative control technologies by integrated pest management.

REFERENCES

Abou El-Khir, A.M. (2003). Trace elements and their relations to some soil properties in Kafr El-Sheikh soils. J.Agric. Res. Tanta Univ., 29(2):354-370.

Aboulroos, S.A., Holah, Sh. Sh., and Badawy, S.H. (1996). Background levels of some heavy metals in soils and corn in Egypt. Egypt. J. Soil Sic. 36: 83-97.

Alloway, B.J. (1995). Heavy Metals In Soils. Blackie Academic Professional, an Imprint of Chapman and Hall, Estern Cleddens Road, UK.

Alloway, B.J. (1990). Heavy metals in soils. John Wiley & Sons, New York.

Christensen, T. H. (1984). Cadmium soil sorption at low concentrations: I. Effect of time, cadmium load, pH and calcium. Water Air Soil Pollut. 21:105-114.

Cottenie, A.; P.M, Verloo; L. Kiekens; G Velghe and R. Camerlynck (1982). Chemical Analysis of Plants and Soils. Lab. Anal. and Agrochem. State Univ., Gent. Belgium, 63.

Dai, J.; T. Becquer; J. H. Rouiller; G. Reversat; F. B. Reversat; P. Lavelle (2004). Influence of heavy metals on C and N mineralization and microbial biomass in Zn-, Pb-, Cu-, and Cd-contaminated soils. Applied Soil Ecology 25: 99-109.

El-Shahawy, M. I. (1194). Pedochemical studies on some Egyptian soils. Ph.D.Thesis. Fac. Of Agric. Tanta University, Egypt.

El-Sikhry, E.M. (1985). Chemical status and behavior of certain heavy metals in some Egyptian soils and their relation to plants. Ph.D. Thesis, Fac. Agric. Ain Shams Univ.., Egypt.

Elsokkary, I. H. (1994). Contamination of the western area of Nile Delta by Cd, Pb and Hg. In: Global prospective of Pb, Hg, and Cd Cycling in the Environment. I.C. Hutchinsen, G. Gordan and K. Meama. Eds. Wiley Eastern Ltd. Pub., pp.217-234.

Elsokkary, I. H. and Låg, J. (1980). Status of some trace elements in Egyptian soils and wheat grains. Beiträge trop. Landwirtsch. Veterinärned. 18: 35-47.

Estan , M. T., Bolarin, M.C., Guillen, M.G., and Caro, M. (1987). Adsorption of nickel in calcareous soils. Application of the angmuir isotherm and its modifications. Agrochimica 31: 344-354.

Eriksson, J. E. (1990). Effect of nitrogen-containing fertilizers on solubility and plant uptake of cadmium. Water Air Soil Pollut. 49: 355-368.

Gerriste, R. G. and W. Van Driel (1984). The relationship between adsorption of trace metals, organic matter, and pH in temperate soils. J. Environ. Qual. 13: 197-204.

Harter, R. D. (1979). Adsorption of copper and lead by Ap and B2 horizons of several northeastern United States soils. Soil Sci. Soc. Am. J. 43: 679-683.

Khadr, M. (1961). Heavy residues of some Egyptian soils. Geol. en. Mijnb., 40: 11-25.

Korte, N. E., J. Skopp,W. H. Fuller, E. E. Niebla, and B. A. Alesii (1976). Trace element movement in soils: Influence of soil physical and chemical properties. Soil Sci. 122: 350-359.

Lindsay, W.L. and Norvell (1978). Development of DTPA soil test for zinc, iron, manganese and copper. Soil Sci. Soc. Am. J. 42:421-428.

McBride, M.B.; Tyler, L.D. and Hord, D.A. (1981). Cadmium adsorption by soils and uptake by plants as affected by soil chemical properties. Soil Sci. Soc. Amer. J.45, 739-744.

McLaren, R.G.; Williams, J.G. and Swift, R.S.(1983). Some observations of the description and distribution behavior of copper with soil components. J. Soil. Sci. 34,325-331.

Meshref, H.A.; Kh.H. El-Hamdi; A.A. Hagag and M.Y. El-Arquan (1998). Evaluation of micronutrients status in some soils of the northern coast of Nile Delta. J. Agric. Mansoura Univ., 23: 2815-2825.

Morsy, M. (1990). "Studies on pollution of some Egyptian soil by heavy metals". Ph.D.Thesis Fac. Of Agric. El-Minia Univ.

Omran, M.S.; M.H. Shalaby and M.I. Raslan (1996). Effect of soil pollution on the growth and active ingredient of some medicinal plants. Egypt J. Soil Sci. 36: 59-67.

Page, A.L. (1994). Methods of Soil Analysis. 2nd Edition, ASA,Madison, Wisconsin, USA.

Petruzzelli ,G., Guidi, G,. and Lubrano, L. (1977). Cadmium occurrence in soil organic matter and its availability to wheat seedlings. Water Air Soil Pollut. 8: 393-399.

Rabie, F.; A. Fawzy,; A. Khader and W. Hussein (1996). Content of biogenic and nonbiogenic heavy metals in El-Saff soils as related to different polluted sources. Egypt J. Soil Sci. 36: 165-177.

Rabie, F.; A. El-Araby and M. El-Shazly (1989). Micronutrients status as related to soil constituents in some soil of eastern desert of Egypt. J. Soil Sci., 29 (3):331-343.

Rashad, I.F.; A.O. Abd El-Nabi, M.E. El-Hemely and M.A. Khalaf (1995). Background levels of heavy metals in the Nile Delta soils. Egypt. J. Soil Sci. 35, No.2. pp. 239-252.

Sparks, D.L. (1995). Environmental Soil Chemistry. Academic Press, Inc., USA.

Shahin, R.R; and S.H.I. Abd El-Tawab (1988). Soil contamination with heavy metals and salts product by activities at Helwan Egypt. Egypt. J. Soil Sci., 23 (4):407-419.

Snedecor, G.W. and Cochran, D.W. (1967). Statistical methods. 6th ed. Oxford and IBH Pub. Co., Calcutta, India.

Srivastava P. C. and U. C. Gupta, (1996). Trace elements in crop production. Copyright Reserved, Science Publishers, Inc. USA Chapters, 8 and 9.

Tietjen, C. (1975). Principal problems of the use of city wastes for crop production and soil conservation. F.A.O. Soil Bulletin 27.

Uren, N.C. (1992). Forms, reactions and availability of nickel in soils. Adv. Agron. 48:141-203.

Wright, S. (1921). Correlation and causation. J. Agric. Res. 20: 557-585.

Zachara, J. M., Smith, S.C., Resch, C.T., and Cowan , C.E. (1992). Cadmium sorption to soil separates containing layer silicates and iron and aluminum oxides. Soil Sci. Soc. Amer. J. 56:1074-1084.

Ziper, C., Komarneni, S., and Baker, D. E. (1988). Specific cadmium sorption in relation to the crystal chemistry of clay minerals. Soil Sci. Soc. Amer. J. 56:1074-1084.

الملخص العربي

العوامل المؤثرة على الإستخلاص الكميائى لبعض العناصر الثقيلة من أنواع مختلفة من الأراضى فى مصر

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أجريت هذه الدراسة بهدف تقدير محتوى بعض الأراضى المصرية من العناصر الثقيلة الكلية والمستخلصة وعلاقاتها ببعض خواص الأرض. لذلك أخذت خمس قطاعات من الأراضى المصرية إثنان منها فى محافظة كفر الشيخ (جنوب مدينة كفر الشيخ وجنوب مدينة بلطيم) لكى تمثل أراضى الدلتا وثلاث منها فى محافظة البحيرة واقعة فى مناطق حوش عيسى وأبو المطامير ومريوط لتمثل الأراضى خارج الدلتا. هذة المواقع اختيرت لكى تمثل الأراضى الرسوبية والبحورية فى الدلتا والأراضى الرملية الجيرية والرسوبية الجيرية والأراضى الجيرية خارج الدلتا.

النتائج توضح أن الطبقات السطحية فى أراضى الدلتا تحتوى على تركيزات كبيرة من العناصر الثقيلة الكلية والمستخلصة مقارنة بالطبقات التحت سطحية وقلت تلك التركيزات مع العمق. تراوح المحتوى الكلى من النحاس والنيكل والكادميوم والرصاص فى أراضى الدلتا من ٢٤٦,٣ الى ١٠٢,٥ ومن١٨٦,٣الى ١٠٠,٠ ومن ٩,٨٥ الى ١,٨٥ ومن ١٧٥,٠ الى ٦٠,٠ مليجرام/كيلوجرام أرض على التوالى. وأيضا كانت القيم المستخلصة المماثلة لهذه العناصر هى ١١,٨ الى١١,٤ ، ٠,٧٨ الى ٠,٨، ٠,٢١ الى ٠,٠٢٣ ، ٠,٣٧ الى ٠,٢٢ مليجرام/كيلوجرام أرض على التوالى.

وتشير النتائج ان متوسط المحتوى الكلى من النحاس والنيكل والكادميوم والرصاص فى الأراضى خارج الدلتا يختلف من عنصر لأخر وأيضا يختلف من أرض لأخرى وكان ترتيب محتوى العناصر كالاتى: النحاس> الرصاص> النيكل> الكادميوم وان المحتوى الكلى من النحاس والنيكل والكادميوم والرصاص فى الأراضى خارج الدلتا تراوح على التوالى من ٥٧,٥ الى١٢٠,٠ ومن ٦٢,٥ ومن٢,٣ الى الى ٤,٦٥ ومن ٣٩,٥ الى٦٩,٥ مليجرام/كيلوجرام أرض. وتبين أيضا ان اقل المحتويات من العناصر المدروسة وجد فى الأرض الجيرية الرسوبية بينما أعلى المحتويات كانت فى الأرض الرملية الجيرية. ووجد أيضا أن المحتويات المستخلصة من هذة العناصر تختلف فى مدى صغير حيث كان متوسطها ٢,١١ ، ٠,١٦، ٠,٠٣٥، ٠,٢٠ مليجرام/كيلوجرام أرض من عناصر النحاس والنيكل والكادميوم والرصاص على التوالى.

النتائج تبين أن محتوى الأراضى من العناصر يعتمد أساسا على مادة الأصل والمادة العضوية والسعه التبادلية الكاتيونية. وتشير النتائج إلى وجود إرتباط معنوى عالى موجب بين النسبة المئوية للطين أوالسلت مع العناصر المدروسة الكلية والذائبة. ووجود إرتباط موجب بين محتوى الأراضى من المادة العضويه والمحتوى الكلى من العناصر المدروسة وأيضا مع المحتويات المستخلصة من تلك العناصر عدا عنصر النحاس. وأيضا إرتبطت العناصر المدروسة الكلية و المستخلصة مع السعة التبادلية الكاتيونية إرتباط معنوى عالى موجب. وعلى الجانب الأخر وجد إرتباط سالب بين محتويات الأراضى من كربونات الكالسيوم الكلية والمحتويات الكلية و المستخلصة من العناصر المدروسة. وعموما يمكن القول أن تركيزات العناصر الثقيلة فى الأراضى المدروسة يعتمد فى الأساس على المصدر الجيوكيميائى أو مادة الأصل.