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Status of Cadmium and Lead in Soils of Kaluobia Governorate

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THIS WORK aims at evaluating the relations between total as well as DTPA extractable Cd and Pb and each of soil texture, $CaCO_3$, organic matter (OM) and CEC of soils of Kaluobia Governorate.

Seventeen soil profiles representing the main soil types of El-Kaluobia Governorate were examined. The obtained results could be summarized as follows:

1. Total Cd ranged from 0.35 to 4.99 mg kg^{-1}; DTPA extractable Cd varied from 0.01 to 0.09 mg kg^{-1} both forms decreased with depth.
2. Total Pb ranged from 10.0 to 38.0 mg kg^{-1}, and DTPA - extractable Pb ranged from 0.20 to 3.04 mg kg^{-1} with no pattern of distribution.
3. Significant negative correlations occurred between both total Cd, and DTPA - extractable Cd and each of pH, sand and clay ; and highly significant positive correlation occurred with OM.
4. No significant correlations occurred between total Pb and soil parameters but a significant positive correlation occurred between DTPA- extractable Pb and $CaCO_3$.
5. The trend T indicates that some of the soil profiles are highly symmetric with respect to Cd, whereas nearly all soil profiles showed symmetrical distribution with respect to Pb.
6. The relatively high values of trend (T) and specific range (R), showed no evidence of heterogenity of some soil profiles with respect to Cd and heterogenity with respect to others.

Environmental pollution is the most urgent problem associated with industrial progress and civilization development of societies since, the numerous industrial wastes and refuse cause pollution of air, soils, water and plants. The wastes of the industrial factories are mainly loaded with heavy metals such as Cd and Pb which are pumped into the river Nile, irrigation canals or directly to the surrounding soils. Most of the industrial factories in Egypt lies within and around the agricultural land, thus the occurrence of soil pollution with these metals would be expected.

In addition, toxic hazard of heavy metals in soil are mainly due to the use of sewage sludge in agriculture and intensive fertilization, where, commercial to plants in soils treated with large amounts of domestic sludge for a number of years. Also, increasing dependence on pesticides application is one of the major sources of pollution of our community. It is a very serious problem as most of these chemicals might contain toxic heavy metals that are hazard to the metabolism of living organisms and leading to very seriuos diseases to mankind such as kidney failure and cancer disease.

In areas polluted with Cd and Pb, plant growth and consequently food chain may be affected and toxicity has been observed in some agricultural crops.

Cadmium in magnetic and sedimentry rocks does not exceed 0.3 mg Cd kg^{-1}, and this metal is likely to be concentrated in argillaceous and shale deposits (Kabata-Pendias and Pendias, 1984). They added that the main factor determining Cd content in soil is the chemical composition of the parent rock. The average content of Cd in soils lies between 0.07 and 7.10 mg Cd kg^{-1}. However, the background levels of Cd in soils apparently do not exceed 0.50 mg Cd kg^{-1}, and all higher values reflect the anthropogenic impact on the Cd status in top soils. Adriano (1986) reported that Cd is normally found in earth materials only in trace amounts, and the average concentration of the metal in uncontaminated soils is less than 10 mg kg^{-1} Alloway (1995) mentioned that the maximum recorded concentration of Cd in top soils (0 – 15 cm) was 41 mg Cd kg^{-1} soil.

El-Sokkary and Lag (1980) reported that the unpolluted soils of Egypt contained about 0.20 mg kg^{-1} as total Cd, whereas, the polluted soils contained 2.0 mg kg^{-1}. Abd El-Shakour (1982) mentioned that the average of total Cd content in Shobra El-Kheima region does not exceed 0.50 mg Cd kg^{-1} . Also, El-Leithi (1986) reported that the Cd content in Egyptian Nile alluvial soils ranged between 3.10 – 6.10 mg Cd kg^{-1}. Abd El-Aziz (1992) reported that the average content of total Cd in the surface layers of El-Saff virgin soils was 0.60 mg Cd kg^{-1}.

Badawy (1992) showed that DTPA-extractable Cd content in El-Sharkia soils ranged from 0.024 to 0.075 mg Cd kg^{-1} with a mean value of 0.036 mg Cd kg^{-1}, while in Kafer El-Sheikh soils it ranged from 0.015 to 0.037 mg Cd kg^{-1} with a mean value of 0.027 mg Cd kg^{-1} and in El-Menofia soils it ranged from 0.024 to 0.04 mg Cd kg^{-1} with a mean value of 0.03 mg Cd kg^{-1}. El-Sayad and Hegazy (1993) found that in Nile alluvial, calcareous and sandy soils of El-Fayoum Governorate, the available Cd content ranged from 0.011 to 0.095 mg Cd kg^{-1} soil with an average value of 0.027 mg Cd kg^{-1}. The highest value of available Cd was found in the Nile alluvial soils followed by the calcareous soils and the lowest one was found in the sandy soils. Aboulroos *et al.* (1996) stated that DTPA extractable Cd content ranged from non detected to 0.06 mg Cd kg^{-1} with an average of 0.018 mg Cd kg^{-1} in the surface of cultivated soils of Egypt.

The terrestial abundance of Pb indicated a tendency of Pb to concentrate in the acid series of magnetic rocks and argillaceous sediments in which the common Pb concentrations ranged from 10.0 to 40.0 mg Pb kg^{-1} (Micheal and Lionel, 1984). Also, Adriano (1986) reported that Pb is normally found in earth minerals only in trace amount, the average concentration of the metal in uncontaminated soils is less than 50 mg Pb kg^{-1}.

El-Rashidi *et al.* (1979) found that the total Pb content in 71 soil samples collected from 14 saline sodic soils in the Nile Delta region ranged from 25.0 to 100.00 mg Pb kg^{-1}. Abd El-Shakour (1982) obtained a lower range of Pb from 9.00 to 21.00 mg Pb kg^{-1} in the cultivated Nile alluvial soils. Alloway (1995) reprted that the maximum recoreded concentration of Pb in top soils (0 - 15) was 16.38 mg Pb kg^{-1} soil.

As regarding the DTPA extractable-Pb, El-Sokkary and Lag (1980) showed that it ranged from 0.11 to 0.34 mg Pb kg^{-1} soil. El-Leithi (1986) found that the concentrations of Pb extracted by DTPA were in the range of 0.3 - 8.5 and 0.2 - 1.9 mg Pb kg^{-1} near and far from Alex-Cairo sides road, respectively. El Tabey (1993) reported that the the average concentration of DTPA extractable-Pb was 5.42 mg Pb kg^{-1}soil, in the soil surface at a distance of 100 m from the super-phosphate factory (Abou Zaabel region). Rashad *et al.* (1995) recorded that the available content of Pb extracted by DTPA ranged between 1.4 and 2.5 mg Pb kg^{-1} with an average of 1.9 mg Pb kg^{-1} in recent Nile alluvial soils and between 0.6 and 1.2 mg Pb kg^{-1} with an average of 0.8 in coastal barrier plain soils. Aboulroos *et al.* (1996) showed that the available Pb content extracted by DTPA ranged from 0.51 to 2.88 mg Pb kg^{-1} with an average of 1.19 mg Pb kg^{-1} in 82 soil samples collected from different locations in Egypt. Hassan (1997) mentioned that the available contents of Pb extracted by DTPA were 10.80 and 9.59 mg Pb kg^{-1} in cultivated surface soil samples irrigated with waste water of Shebin El-Kanater collector and Mostorod collector, respectively .

The aim of the present work is to describe the status of Cd and Pb in different soil types of El-Kaluobia Governorate. Moreover, some factors controlling their status, *i.e.*, soil texture, $CaCO_3$ and organic matter contents, salinity, soil reaction and exchange characteristics are also considered.

Material and Methods

The current agricultural study was carried out to study the status of some Cd and Pb in soils of El - Kaluobia Governorate. To fulfill this purpose, seventeen soil profiles were dug at different locations of El - Kaluobia Governorate to represent most soils in the area (map 1). Table 1 shows some physical and chemical properties, of the studied soils, determined according to the methods outlined by Jackson (1973).

Total Cd and Pb in the soils were extracted by digestion in HF- $HClO_4$ acids mixture in platinum crucibles, (Jackson 1973) whereas available Cd and Pb were

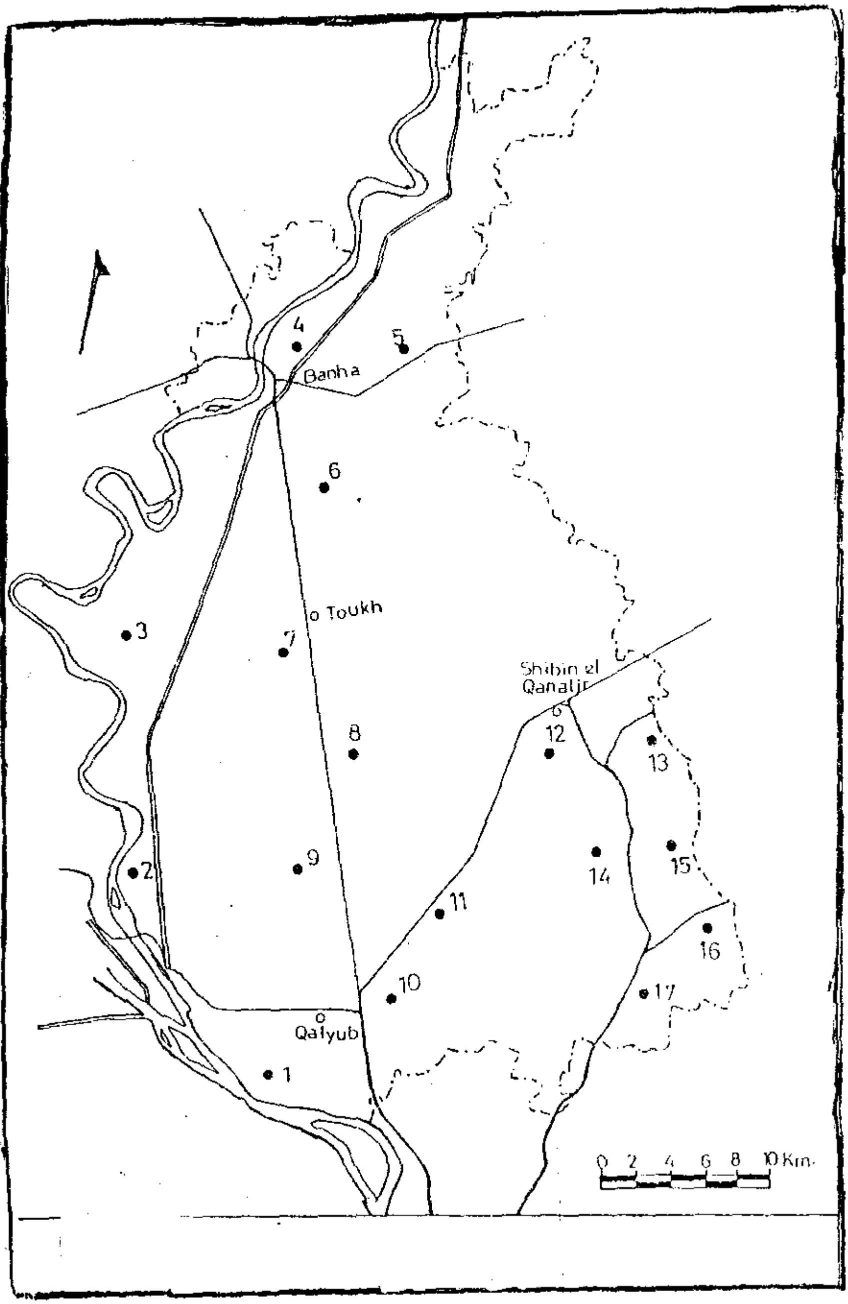
TABLE 1. Some physical and chemical properties of the studied soils.

Prof. No.	Location	Depth (cm)	Particle size distribution: C Sand %	F Sand %	Silt %	Clay %	Textural class	O.M %	$CaCO_3$ %	pH	EC dSm^{-1}	Soluble cations (me/L): Ca^{2+}	Mg^{2+}	Na^+	K^+	Soluble cations (me/L): Cl^-	HCO_3^-	$CO_3^=$	$SO_4^=$	CEC (me /100 g soil)
1	Abu El Ghait	0 - 25	2.3	42.4	36.5	18.8	C.L.	1.7	2.1	7.3	0.97	3.5	3.7	4.7	0.7	4.0	4	-	4.6	32
		25-75	0.7	35.7	38.3	25.3	L.C.	0.9	2.8	7.1	0.94	3.5	1.6	3.4	0.2	3.1	5	-	0.6	38.4
		75-125	1.6	23.9	41.6	32.9	L.C.	0.9	3.6	7.3	0.98	3.5	2.7	4.8	0.2	4.0	3.6	-	3.6	40
2	El Munira	0-20	1.1	35.5	34.5	28.9	C.L.	1.7	1.2	7.5	0.65	4.6	0.5	2.9	0.2	3.2	4.6	-	0.4	39.2
		20-50	0.5	47.4	32.2	19.9	C.L	0.9	2.6	7.2	0.84	3.5	2.7	4.5	0.2	4.0	4	-	2.9	35.2
		50-100	0.3	39.8	40.3	19.6	C.L.	1.4	2.3	7.5	0.64	4.6	0.5	3.4	0.1	3.2	3.2	-	2.2	33.6
		100-150	0.4	40.9	37.9	20.8	C.L	1.2	2.9	7.5	0.70	3.5	1.6	3.9	0.2	3.2	3.8	-	2.2	39.2
3	Kafr El-Ragalat	0-30	38.5	30.5	15.5	15.5	S.C.L.	1.7	0.95	7.4	0.76	3.5	2.7	3.0	1.0	3.1	5.8	-	1.3	23.2
		30-70	79.1	9.7	3.2	8.0	L.S.	0.9	0.21	7.4	0.61	1.2	2.9	2.4	0.6	2.3	3.2	-	1.6	13
		70-120	86.6	6.3	2.3	4.8	S.	0.3	0.32	7.5	0.34	1.2	1.9	2.9	0.4	2.3	3.0	-	1.1	8.4
4	Kafr Saad	0-20	2.6	62.6	18.9	15.9	S.C.L.	2.3	2.6	7.4	1.6	4.6	5.6	7.6	0.5	6.0	5.6	-	6.7	32.8
		20-50	32.3	37.5	14.9	15.3	S.C.L.	0.6	2.1	7.6	0.98	1.2	2.9	5.6	0.2	6.0	3.4	-	0.5	24.8
		50-90	8.4	67.6	12.5	11.5	S.L.	1.2	0.43	7.6	0.67	2.3	2.8	4.8	0.2	5.0	2.8	-	2.3	18.4
		90-120	1.1	89.3	4.7	4.9	S.	0.6	2.3	7.6	0.65	1.2	3.0	3.9	0.2	4.0	3.0	-	1.3	27.2
5	Shiblanga	0-20	4.1	55	24.1	16.8	C.L.	1.8	3.3	7.9	1.3	3.5	2.6	10	0.2	9.0	5.2	-	2.1	47
		20-60	4.2	54.5	20.5	20.8	C.L.	1.7	2.9	7.8	1.8	2.3	3.8	12.3	0.1	10.0	3.8	-	4.7	47
		60-110	5.2	43.5	19.6	31.7	C.L.	1.7	1.2	7.8	2.2	2.3	3.3	19.5	0.1	18.0	5.0	-	2.2	49
6	Sandanhor	0-20	4.6	59.8	17	18.6	S.C.L.	1.9	3.2	7.6	0.73	2.3	4..3	3.9	0.4	3.3	5.0	-	2.6	36
		20-50	3.5	61.7	16.4	18.4	S.C.L.	1.7	3.3	7.6	0.91	4.6	2.5	5.0	0.2	4.1	7.0	-	1.2	39.2
		50-100	4.3	59.9	16	19.8	S.C.L.	1.7	3.1	7.5	1.1	4.6	2.5	7.2	0.2	8.0	3.8	-	2.7	36.2
		100-150	2.6	61.1	17.2	19.1	S.C.L.	1.4	3.1	7.5	1.4	2.3	3.3	9.4	0.2	8.0	3.8	-	3.4	52.1
7	Kafr El Gemal	0-20	1.9	69.7	3.7	24.7	S.C.L.	1.9	2.2	7.5	0.66	2.3	4.3	2.0	0.6	2.1	5.0	-	2.1	46.3
		20-60	0.9	73.8	17.9	7.4	S.L.	1.9	2.5	7.5	0.66	2.3	2.2	2.7	0.3	2.3	4.0	-	1.2	28.0
		60-90	0.5	85.2	9.6	4.7	L.S.	1.7	0.5	7.5	0.62	2.3	2.3	2.8	0.1	2.3	3.2	-	2	35.2
		90-120	0.9	64.9	16.4	17.8	S.C.L.	1.7	1.6	7.5	1.5	4.6	3.5	10	0.4	8.0	4.2	-	6.3	38.4
8	Qaha	0-25	6.4	62.4	15.4	15.5	S.C.L.	2.2	6.1	7.6	0.69	2.3	2.8	3.9	0.1	3.3	3.3	-	2.6	38.4
		25-60	3.1	29.5	15.1	52.3	C.	1.2	2.5	7.5	2.1	5.7	5.4	13.8	0.3	11.0	4.0	-	10.2	50.2
		60-90	3.7	33.7	16.8	45.8	C.	1.2	4.5	8.0	1.2	1.2	1.9	12.0	0.1	11.0	3.0	-	1.2	50.2
		90-120	1.8	36.2	19.3	42.7	C.	1.2	2.3	8.3	1.2	1.2	1.9	11.3	0.1	10.0	4.3	-	0.5	40.0

TABLE 1. Contd.

Prof. No.	Location	Depth (cm)	Particle size distribution C Sand %	F Sand %	Silt %	Clay %	Textural class	O.M %	$CaCO_3$ %	pH	EC dSm^{-1}	Soluble cations (me/L) Ca^{2+}	Mg^{2+}	Na^+	K^+	Soluble cations (me/L) Cl^-	HCO_3^-	$CO_3^{=}$	$SO_4^{=}$	CEC (me /100 g soil)
9	Sindiyun	0-25	2.1	28.6	24.7	44.6	C.	1.4	2.4	7.5	0.59	2.9	2.2	2.8	0.2	3.0	3.0	-	2.1	50.9
		25-75	1.4	29.4	21.8	47.4	C.	0.9	2.9	7.6	0.69	2.9	2.7	3.5	0.1	3.0	2.6	-	3.6	38.4
		75-110	1.9	30.6	22.9	44.6	C.	1.2	2.8	7.4	0.96	2.3	3.8	6.8	0.1	6.0	2.2	-	4.8	36
10	Qalyub	0-25	2.9	42.9	29.0	25.2	L.C.	2.2	3.1	7.4	1.1	5.2	4.5	4.7	0.5	4.0	4.8	-	6.1	37.6
		25-50	3.5	36.5	21.3	38.7	C.	1.2	3.3	7.5	0.65	3.5	1.6	2.9	0.3	3.0	2.4	-	1.9	45.0
		50-90	4.3	39.3	20.4	36	C.	1.2	2.3	7.4	0.84	4.0	2.1	3.8	0.3	3.0	2.8	-	4.4	36.0
		90-120	2.9	35.5	17.2	44.4	L.C.	0.9	2.2	7.4	0.70	3.5	2.7	3.6	0.2	3.0	2.9	-	4.2	37.6
11	Nawa	0-30	5.3	29.6	21.5	43.6	C.	1.9	3.7	7.6	1.2	2.3	2.8	9.2	0.3	8.0	4.4	-	2.2	39.2
		30-60	5.8	24.5	19.9	51.8	C.	1.7	3.5	7.9	1.5	1.7	1.8	14.0	0.2	12.0	5.0	-	0.7	35.2
		60-90	5.2	31.1	16.7	47	C.	1.4	3.2	8.1	1.6	1.2	0.9	17.3	0.2	16.0	3.0	-	0.6	37.6
		90-120	5.7	29.6	24.7	40	C.	1.4	3.3	7.8	1.9	1.2	1.9	19.0	0.2	18.0	3.4	-	0.9	27.2
12	Kafr Sheben	0-20	4.5	34.7	32.7	28.1	C.	2.3	4.3	7.7	1.4	3.5	3.7	9.4	0.6	8.0	5.0	-	4.2	24
		20-60	2.5	38.9	28.7	29.9	L.C.	0.9	2.9	7.8	1.1	2.3	1.8	7.4	0.3	7.0	4.0	-	0.8	24.4
		60-90	1.9	44.1	26.4	27.6	L.C.	0.9	2.8	7.7	1.1	2.3	1.8	8.8	0.2	8.0	2.8	-	2.3	24.8
		90-120	1.8	41.7	25.2	31.6	L.C.	1.1	2.3	7.7	1.3	2.9	2.7	9.0	0.2	9.0	3.8	-	2.0	32.4
13	Abu Zaabal I	0-25	68	18.3	4.7	9.0	L.S.	0.9	1.1	7.2	1.2	3.5	5.7	4.8	0.4	4.0	3.0	-	7.4	17.2
		25-50	76.3	11.4	6.2	6.1	L.S.	0.6	2.2	7.3	0.9	3.5	4.7	2.8	0.3	3.0	3.0	-	5.3	9.2
		50-75	88.4	5.1	2.4	4.1	S.	0.6	1.1	7.4	0.7	2.3	2.8	2.5	0.3	2.0	2.2	-	3.7	4.8
14	Abu Zaabal II	0-25	21.2	26.5	23.3	29	L.C.	1.7	2.6	7.4	1.1	3.5	3.7	6.0	0.3	6.0	4.4	-	3.1	25.6
		25-60	21.5	20.2	23.4	34.9	L.C.	1.4	3.6	7.4	1.9	3.5	8.8	11.3	0.2	10.4	3.2	-	0.2	34.0
		60-90	8.9	22.9	26.6	41.6	C.	1.2	3.4	7.5	1.8	2.3	3.8	15.6	0.1	14.0	3.0	-	4.8	23.4
		90-120	4.7	30.6	25.8	38.9	C.	1.4	3.7	7.5	1.8	1.2	3.9	16.4	0.1	16.0	3.6	-	2.0	16.8
15	El-Khanka	0-20	62.5	27.8	4.3	5.4	L.S.	1.7	4.3	7.4	5.8	6.9	16.5	43.5	1.1	43.0	6.4	-	18.6	37.0
		20-75	74.4	10.2	6.8	8.6	S.L	0.9	1.4	7.6	3.4	6.9	4.3	27.5	1.0	25.0	3.4	-	11.3	15.6
		75-120	96.3	0.5	1.3	1.9	S.	0.9	0.3	7.8	2.0	2.9	3.3	12.3	0.5	12.0	2.0	-	5.0	1.2
16	El-Gabal El–Asfar	0-20	45.5	41.7	8.6	4.2	L.S.	1.9	0.40	7.1	0.93	3.5	2.2	4.8	0.75	4.0	4.0	-	3.3	23.4
		20-60	78.4	14.2	2.4	5	L.S.	1.2	0.30	7.3	0.71	2.3	2.3	3.9	0.5	3.0	2.2	-	3.8	8.6
		60-100	91.2	4.3	0.2	4.3	S.	0.9	0.2	7.3	0.75	2.3	2.8	3.9	0.5	3.0	2.4	-	4.1	3.2
17	El – Qalag	0-25	67.1	11.9	5.7	15.3	S.C.L	1.7	1.6	7.1	0.96	3.5	3.7	3.7	0.73	3.0	6.0		2.63	20.0
		25-60	84.6	5.9	0.3	9.2	L.S.	1.2	0.30	7.1	0.51	2.3	1.8	2.6	0.22	3.0	2.0	-	0.92	12.8
		60-90	81.6	11.7	1.4	5.3	L.S.	0.6	0.10	7.3	0.96	4.6	2	4.6	0.22	3.0	2.8	-	5.62	8.4

L.S. = Loamy sand S. = Sand S.L. = Sandy Loam C. = Clay S.C.L. = Sandy Clay Loam



Map 1. Locations of the studied soil profiles.

extracted by DTPA, according to Lindsay and Norvell (1978). Both total and extractable Cd and Pb were determined by Atomic - Absorptions - Spectrophotometer, Perkin Elmer, model 3110.

Results and Discussion

Status of cadmium and lead in soils

Data in Table 2 show the total and available contents of both Cd and Pb in the studied soil profiles.

Total cadmium

Table 2 sets out the values of total Cd content in the investigated soils expressed as mg kg^{-1} though the total content of Cd is not a good measure for the amounts of Cd available to plants, yet it gives an idea concerning the potential supply.

The presented data reveal that total Cd content ranges between 0.35 and 4.99 mg kg^{-1} in the studied soils. The highest value is recorded in the surface layer of profile 16 representing the soils of El-Gabal El-Asfar, while the lowest value is detected in the deepest layer of profile 3 representing Kafr El-Ragalat soil.

From the above mentioned data, it is evident that total Cd displays a relative increase in the uppermost surface layers compared with the other below layers. Also, total Cd content distribution does not follow any specific pattern particularlly in the soils of profiles 2, 4, 5, 6, 7 and 9, while in the soils represented by the rest profiles, total Cd content seemed to decrease with depth.

This indicates that the chance of variation in parent material as well as the depositional regime of soil sediments play the major role in the depthwise distribution of total Cd.

Computed correlation coefficients between total Cd content and soil variables indicate that total Cd is negatively and significantly correlated with soil pH ($r = -0.338^*$), sand % ($r = - 0.267^*$) and clay % ($r = 0.284^*$) and highly positively and significantly correlated with OM % ($r = 0.563^{**}$). The multiple regression equation reads:

Total Cd = 8.436 – 1.1318 (pH) + 1.199 (OM) + 0.011 (EC) + 0.276 (Sand %) + 0.265 (clay %).

The direct and joint effects of OM, pH and sand % on total Cd are 54.37 % 26.59 % and 12.49 %, respectively .

TABLE 2. Total and DTPA-extractable Cd and Pb (mg kg^{-1}) of the studied soil horizons.

Prof. No.	Location	Soil depth (cm)	Cd		Pb	
			Total	Available	Total	Available
		0 - 25	2.01	0.05	31.30	2.55
1	Abu El	25-75	1.72	0.08	24.90	1.56
	Ghait	75-125	1.61	0.06	16.80	1.21
		0-20	1.92	0.09	19.70	2.30
2	El Munira	20-50	2.41	0.06	16.50	1.45
		50-100	1.35	0.04	12.80	1.32
		100-150	0.75	0.01	23.20	1.34
		0-30	1.55	0.03	17.70	2.38
3	Kafr El-	30-70	1.50	0.02	18.30	2.72
	Ragalat	70-120	0.35	0.01	14.20	1.30
		0-20	3.65	0.05	30.00	2.24
4	Kafr Saad	20-50	1.05	0.01	29.00	1.26
		50-90	1.85	0.05	17.20	1.32
		90-120	1.10	0.01	29.70	1.68
		0-20	2.85	0.02	17.70	1.36
5	Shiblanga	20-60	1.42	0.01	17.20	1.76
		60-110	1.91	0.01	27.70	2.35
		0-20	3.52	0.04	24.70	1.42
6	Sandanhor	20-50	1.39	0.02	12.30	0.30
		50-100	1.77	0.01	11.50	0.42
		100-150	1.23	0.02	18.10	0.58
		0-20	3.84	0.04	29.00	0.56
7	Kafr	20-60	1.84	0.01	23.50	0.22
	El Gemal	60-90	2.51	0.02	22.00	0.60
		90-120	1.56	0.02	21.50	0.26
		0 - 25	2.79	0.03	24.50	1.38
8	Qaha	25-60	2.71	0.01	22.30	1.62
		60-90	1.28	0.01	20.00	0.36
		90-120	0.85	0.01	18.30	1.32
		0-25	1.22	0.03	25.10	0.26
9	Sindiyun	25-75	0.79	0.02	10.10	0.96
		75-110	0.91	0.01	24.70	1.16
		0-25	2.38	0.05	16.30	1.18
10	Qalyub	25-50	1.92	0.03	17.20	1.40
		50-90	1.85	0.01	22.70	0.28
		90-120	1.12	0.02	35.10	0.32
		0-30	2.45	0.05	18.00	1.34
11	Nawa	30-60	1.24	0.05	29.00	0.70
		60-90	1.16	0.05	24.70	1.20
		90-120	0.68	0.01	17.00	0.42
		0-20	3.81	0.09	23.70	1.66
12	Kafr	20-60	1.15	0.08	19.80	1.68
	Sheben	60-90	0.98	0.07	15.50	0.80
		90-120	0.82	0.05	30.00	0.36

TABLE 2. contd.

Prof. No.	Location	Soil depth (cm)	Cd Total	Cd Available	Pb Total	Pb Available
13	Abu Zaabal I	0 –25	3.43	0.05	21.50	1.22
		25 – 50	1.94	0.02	18.90	0.52
		50 – 75	0.76	0.02	18.00	0.72
14	Abu Zaabal II	0 – 25	1.55	0.06	34.70	1.38
		25-60	1.19	0.05	34.00	0.70
		60-90	1.12	0.05	22.00	1.34
		90-120	0.87	0.06	38.00	0.02
15	El-Khanka	0-20	2.91	0.09	25.10	1.44
		20-75	1.48	0.01	23.50	1.74
		75-150	1.15	0.05	19.00	0.82
16	El-Gabal El -Asfar	0-20	4.99	0.09	32.90	3.04
		20-60	2.81	0.07	25.00	1.30
		60-100	2.36	0.03	35.00	1.30
17	El - Qalag	0-25	2.82	0.07	28.50	2.58
		25-60	1.67	0.03	19.80	1.28
		60-90	1.42	0.04	17.40	1.62

Depthwise distriution of total Pb indicates a tendency of decrease downwards in profiles 1,7,8, 13, 15 and 17, while in the rest profiles total Pb distriution pattern does not portray any specific pattern with depth.

DTPA - extractable cadmium

The distribution and levels of chemically extractable Cd content in the studied soils are represented clearly by the data presented in Table 2 . These data reveal that the extractable Cd varies within a narrow limit from 0.01 to 0.09 mg kg^{-1} and is slightly higher in the top layers relative to the deeper ones.

Depthwise distribution of extractable Cd indicates a relative increase of Cd in the uppermost surface layer in most of the studied soils and slightly decrease with depth regardless of soil type.

The statistical evaluation of DTPA- extractable Cd content in relation to soil variables indicates that DTPA-extractable Cd is positively, significantly correlated with pH ($r = -0.274^*$). The multiple regression equation between DTPA-extractable Cd and these soil constituents is:

Available Cd = 0.237 + 0.008 (ECe) – 0.029 (pH) + 0.018 (OM) – 0.001 (CEC) + 0.001 (silt %) + 0.002 (clay %).

The direct and joint effects of OM, pH, CEC, EC, silt % and clay % on DTBA-extractable Cd are 21.88 %, 19.36 21.16 %, 16.92 18.67 % and 2.01 %, respectively .

Depthwise distribution of total cadmium

Data of weighted mean (W), trend (T) and specific range (R) in the soils under consideration are given in Table 3. From this Table, the computed weighted mean of the studied soils ranges between 0.93 to 3.0 mg kg^{-1}. The lowest value is recorded for the soils of profile (9) representing Sindiyun soils, while the highest value is found in the soils of profile 16, representing the soils of El-Gabal El-Asfar.

Regarding the other statistical measures of Qertel and Giles (1963), *i.e.*, trend (T) and specific range (R), Table 3 reveals that the soils of Abu El-Ghait, Sindiyun and Abu Zabal II (profile '14') attain the highest symmetry for total Cd distriution as indicated by their small (T) and (R) values. On the other hand, the high symmetry for Cd distribution is distorted in profiles 2, 3, 4, 6, 7, 8, 11, 13 and 15. The relatively high values of (T) and (R) in some soil profiles give no evidence of heterogenity of soil parent materials exerted by multiorigin rather than soil formation and development processes or local prevailing conditions in such soils.

Total lead

Data presented in Table 2 show the reginal distribution of total Pb. From the data, it is quite clear that total Pb content ranges from 10.0 to 38.0 mg kg^{-1} in the studied soil profiles. The highest value of total Pb is recorded in the deepest layer of profile 14 representing the soils of Abu Zabal, while the lowest content is found in the subsurface layer of prfile (9) representing Sindiyun soils.

TABLE 3. Weighted maen, (W) trend (T) and specific range (R) of total Cd and Pb in the studied soil profiles.

Prof. No.	Location	Cd			Pb		
		W	T	R	W	T	R
1	Abu El - Ghait	1.75	- 0.13	0.22	13.90	- 0.56	1.04
2	El Munira	1.44	- 0.25	1.15	17.90	- 0.09	0.58
3	Kafr El -Ragalat	1.03	- 0. 51	1.16	15.30	- 0.13	0.26
4	Kafr Saad	0.76	- 0.51	1.47	25.40	- 0.15	0.50
5	Shiblanga	1.89	- 0.33	0.75	22.06	0.19	0.47
6	Sandanhor	1.75	-0.50	1.31	15.62	- 0.36	0.84
7	Kafr El -Gemal	1.63	-0.57	1.39	23.50	- 0.18	0.31
8	Qaha	1.90	-0.31	1.02	21.10	- 0.13	0.29
9	Sindiyun	0.93	-0.24	0.46	18.10	- 0.27	0.83
10	Qalyub	1.79	-0.25	0.70	23.30	- 0.30	0.81
11	Nawa	1.38	-0.44	1.28	22.20	0.19	0.49
12	Kafr Sheben	1.47	-0.61	2.30	21.90	- 0.07	0.66
13	Abu Zaabal I	2.04	-0.41	1.31	19.50	- 0.09	0.18
14	Abu Zaabal II	1.15	-0.25	0.59	17.50	- 0.49	0.91
15	El - Khanka	1.51	-0.48	1.16	12.80	- 0.49	0.47
16	El Gabal El-Asfar	3.10	0.37	0.84	20.58	- 0.37	0.48
17	El - Qalag	1.91	-0.32	0.73	13.70	- 0.52	0.81

Statistical analysis was carried out to clarify the relationship between total Pb content and some soil variables in the studied soils. The obtained results indicate that total Pb is insignificantly correlated with soil variables. The multiple regression equation of these soils is :

Total Pb = - 597.097 + 1.131 (Ece) - 77.441 (pH) + 2.966 (OM %) - 0.091 (CEC) + 10.204 (clay %).

The direct and joint effects of CEC, pH, OM % EC and clay % on total Pb are 14.86 %, 11.45 %, 11.20 %, 8.23 % and 6.95 %, respectively.

DTPA - extractable lead

Data presented in Table 2 show that the values of DTPA-extractable Pb ranges from 1.1 to 9.9 mg kg^{-1}. The lowest value is detected in the deepest layer of profile (14) representing Abu Zabal soils, while the highest value is recorded for the surface layer of profile (16) representing El-Gabal El Asfar soils. Generally, the highest Pb content is associated with the uppermost surface layer.

Depthwise distribution of DTPA-extractable Pb does not show any specific pattern, except for profile 1 and 17 in which Pb content tends to decrease with depth. In profile 5 and 9 Pb tends to increase downwards.

Further information about the relationship between chemically extractable Pb content and soil variables in the studied soils could be elucidated from the correlation coefficients. These coeffiicients reveal that there is a positively significant correlation between DTPA-extractable Pb and $CaCO_3$ content. The multiple regression equation has taken the form.

DTPAextr.Pb = 4.978 – 0.245 ($CaCO_3$ %) + 0.365 (OM %).

The direct and joint effect of $CaCO_3$ % and OM % on DTPA-extractable Pb are 33.76 % and 31.7 % , respectively.

Depthwise distribution of total lead

Table shows that the weighted mean of total Pb ranges from 12.8 to 25.4 mg kg^{-1}. The lowest value is recorded for El-Khanka soils (profile 15), while the highest one is found in Kafr Saad, Shiblanga, Kafer El-Gemal, Quha, Qalyub, Nawa, Kafr Shebeen and El Gabal El-Asfar may be rendered to the intermixing of parent material with the Nile sediments. Moreover, the variable soil environments prevailing in each locality also contributed to these variations.

Concerning Values of the trend (T) and specific range (R), the data presented in Table 3 indicate that, except for profiles 5, 10 and 11 all the soil profiles have symmetrical distribution as indicated by the negative **T** values which range from – 0.9 to - 0.55. The highest T value is detected in Abu El-Ghaite and El-Qalag profiles, whereas the lowest is that of El-Munira and Abu Zabal profiles.

With regard to the specific range, Table 3 shows that the highest specific range is recorded in Abu El-Ghaite and also in Abu Zabal soils (profile "13"). Shiblanga, Nawa, El-Khanka, El-Gabal El-Asfar, Sandanhor and El-Qalag display nearly a unique value for the specific range.

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حالة الكادميوم والرصاص فى أراضى محافظة القليوبية

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يهدف هذا البحث إلى دراسة حالة الكادميوم والرصاص فى أنواع الأراضى المختلفة فى محافظة القليوبية وكذلك إيجاد العلاقة بين الكميات الكلية والميسرة (المستخلصة كميائيا بواسطة الـ (DTPA) وبين بعض المتغيرات (كربونات الكالسيوم، المادة العضوية، قوام التربة، السعة التبادلية الكاتيونية) فى أراضى المحافظة .ولتحقيق الهدف من البحث أختير سبعة عشرة قطاعا أرضيا لتمثل أنواع الأراضى المختلفة بالمحافظة وقدر بها بعض الخواص الطبيعية والكيميائية وكذلك تركيز العناصر السابقة ويمكن تلخيص النتائج المتحصل عليها فيما يلى:

١. تراوحت كمية كل من الكادميوم الكلية فى الأراضى المدروسة ما بين ٠,٣٥ إلى ٤,٩٩ ملليجرام/كجم ، والمستخلصة بالـ DTPA بين ٠,٠١ إلى ٠,٠٩ ملليجرام/كجم وقد تناقصت كل من الصورتين بالعمق.
٢. تراوح المتوسط الوزنى(Weighted mean (W للكادميوم بالقطاع مابين ٠,٩٣ إلى ٣,١ ملليجرام/كجم كما أن نتائج الإتجاه Tend (T) تشير إلى أن القطاعات ١، ٥، ١٤ تكون أكثر تناسق بالنسبة إلى الكادميوم عن باقى القطاعات. أما نتائج النطاق النوعى (Specific range (R تشير إلى أن القطاعات ٢، ٣، ٤، ٦، ٧، ٨، ١١، ١٢، ١٥ غير متجانسة
٣. أظهرت نتائج التحليل الاحصائى وجود إرتباط معنوى سالب بين الكمية الكلية من الكادميوم وكل من الـ pH ، نسبة الرمل ، نسبة الطين ، بينما وجد إرتباط موجب وعالى المعنوية مع نسبة المادة العضوية. أيضاً وجد إرتباط معنوى سالب بين الكمية الميسرة من الكادميوم والـpH
٤. تراوحت كمية الرصاص الكلية فى الأراضى المدروسة ما بين ١٠,٠ إلى ٣٨,٠ ملليجرام/كجم بينما تراوح المتوسط الوزنى (W) ما بين ١٢,٨ إلى ٢٥,٤ ملليجرام/كجم أما نتائج الإتجاه (T) فقد تراوحت ما بين -٠,٠٩ إلى ٠,٥٥ . وتشير قيم النطاق النوعى (R) إلى أن القطاعات ٥ ، ١١ ، ١٥ ، ١٦ ، ١٧ غير متجانسة فى مواد التربة.
٥. أظهرت نتائج التحليل الإحصائى عدم وجود إرتباط معنوى بين الكمية الكلية من الرصاص ومتغيرات التربة المدروسة.تراوحت كمية الرصاص المستخلصة بالـ DEPA بين ٠,٢٠ و ٣,٠٤ ملليجرام/كجم . وقد أظهرت نتائج التحليل الإحصائى وجود إرتباط معنوى موجب بين كمية الرصاص المستخلصة بواسطة الـ DTPA ونسبة كربونات الكالسيوم بالتربة .