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SAND AND CLAY MINERALOGY OF SOME ALLUVIAL SOILS WITH RELATION TO SOIL ORIGIN, UNIFORMITY AND HEAVY METALS CONTENT, ASSIUT, EGYPT.

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ABSTRACT

Four soil profiles were selected to represent the Nile alluvial soils; that lies between the Nile River and El-Ibrahimya Canal, northwest of Assiut city. Representative soil samples were collected from various layers of each profile to examine the mineralogy of the fine sand and clay fractionS and also to evaluate the supplying power of these soils for some heavy metals. This study reveals that the mean-size values (Mz) of the sand fraction of the studied soil samples vary between fine and very fine sand-sized fraction. These fractions are characterized by being very well to poorly sorted and are very coarse skewed. This suggests that the deposition mode was by one source, namely, Nile river water.

The amounts and distributions of the heavy minerals in the fine sand fraction range between 0.73 and 12.01%. Generally, the heavy mineral fraction increases with depth. The mineralogical examination shows that the non-opaque minerals are the most abundant with a range between 71.3 and 84.71%, including amphiboles, epidotes, biotite, pyroxenes, zircon, sphene, garnet, rutile, tourmaline, lemonite and apatite in a decreasing order of abundance. Opaque minerals are less abundant in the studied samples. The light minerals constitute the main part ranging between 87.99 and 99.27% in the fine sand fraction. They are represented mainly by quartz with small amounts of feldspars (plagioclase, microcline and orthoclase). Assemblages of the constituent minerals, resistant minerals and weathering ratios reflect that these soils are derived from different provenances and are recently deposited with a weak weathering changes. Ratios between zircon, rutile and tourmaline were evaluated. The data indicated some clear variations between various layers of each soil profile; indicating variable origin and heterogeneous nature.

Generally, low positive correlations are found between extractable Mn, Zn, Cu, Ni and Pb and their bearing-minerals, while low negative correlation with Fe and B is shown. This reflects the young nature of these soils.

Smectites are the most dominant clay minerals in the studied clay fraction (<2μ) of the soil samples followed by interstratified minerals namely mica-vermiculite and mica-smectite. Also, sepiolite, palygorskite, vermiculite, kaolinite, mica, chlorite, pyrophyllite, feldspars and quartz are present in a decreasing order of abundance. This assemblage of clay minerals emphasizes the concept that these studied soils are young, less weathered and are derived as detritals from the older Nile sediments and the calcareous deposits of the western plateau.

Keywords: Grain size, heavy and light minerals, deposition mode, origin, uniformity and weathering ratios, heavy metals.

INTRODUCTION

The present work deals with the Neonile deposits. These deposits are made up of silts and clays indistinguishable in aspect and composition from those which were deposited over the land of Egypt by the modern Nile up to the very recent past. These deposits form the top layer of the flood plain of the modern Nile and are also found outside this plain in the form of benches that fringe the valley at elevations ranging from 1 to 12m above the modern flood plain. These sediments seem to have been deposited by a river, which could not have been very much different in regimen and sources from the modern river. The younger Neonile sediments of the valley and delta of the Nile have been accumulated since the Holocene forming continuous column of sediments (Said, 1981).

Fine sand fraction in soils is likely to have been derived from the more easily weathered minerals, which are also the main source of trace elements (Sillanpaa, 1972). Therefore, many authors reported that the highest content of trace elements in soils is related to fine-textured soils than coarse ones (Eden and Parfitt, 1992; Awadallah, 1993; Amer *et al.* 1991; Farragallah, 1995). Trace elements are constituents of many minerals, therefore; it is difficult to relate the content of specific nutrient to the mineralogical composition of the soil since there is no specific mineral for every specific nutrient (Mitchell, 1964).

Studies of origin and uniformity of sediments and parent materials are generally more reliable when based on size fractions greater than 2μm, especially on the heavy minerals fractions, because they contain the greatest number of mineral species in sediments and are most likely to be diagnostic for particular igneous rocks and sedimentary beds (Milner, 1962).

Clay fraction is important in determining most soil physical and chemical properties, evaluating status soil fertility, in giving a clear indication about weathering processes, and sometimes in controlling soil and water pollution (McBride, 1989; Miller and Donahue, 1992).

The aims of the present study are (a) to identify soil minerals of the fine sand as well as clay fractions in soil layers and to study their relation to levels of heavy metals and (b) to search for more evidence about origin, uniformity and weathering ratio of the soil.

MATERIALS AND METHODS

The area under investigations is located between the Nile River and El-Ibrahimya canal at northwest of Assiut city. It situated between longitudes 31° 11` and 31° 13` E and latitudes 27° 11` and 27° 13` N. Four soil profiles were selected representing the studied area (Fig. 1). These profiles were dug to 150cm and morphologically described (Table 1) according to Soil Survey Staff (1999). Soil samples were collected according to the vertical morphological variations. The physical and chemical analyses (Table 2) were performed according to Page (1982) and Black *et al.* (1982) and heavy metals according to Lindsay and Norvell (1978).

Grain-size analyses of sand fraction were carried out by sieves to obtain different sand size fractions. These fractions were used for plotting cumulative curves in semi-logarithmic form. The phi (Φ) values at 5, 16, 25, 50, 75, 84 and 95 % were obtained from the cumulative curves. The statistical size parameters, namely, mean size (Mz), the sorting coefficient (So) and skewness (Sk) were obtained according to Folk and Ward (1957).

Fine and very fine sand fractions (0.25 to 0.063mm) were subjected to heavy and light mineral separations by using the procedure of Brewer (1964). These minerals were identified according to Milner (1962).

The ratios between some of the identified heavy minerals were used to evaluate the uniformity and weathering degrees of the soil according to Haseman and Marshall (1945), Barshad (1964), Brewer (1964) and Chapman and Horn (1968).

The clay-size fractions (<2μ) were separated from the studied soil samples after different treatments to remove the total soluble salts (since the studied samples were disaggregated using ultrasonic equipment and washed in distilled water until all soluble salts were removed). Thereafter, each sample was dispersed with calgon. The clay fraction samples were prepared as untreated and glycolated oriented samples. Then the samples were investigated using PHILLIPS X-ray diffractometer with CuKα radiation, 45 KV and 35 mA and scanning between 2 and 40 2θ at rate 1.2 2θ/minute. In order to distinguish between the 7A° chlorite and kaolinite minerals, oriented samples were heated to 550 C. Thereafter the samples were scanned between 2 and 40 2θ. The clay minerals were identified using the standard tables for X-ray mineral identifications and their relative proportions were determined using semi-quantitative peak area technique proposed by Schultz (1964).

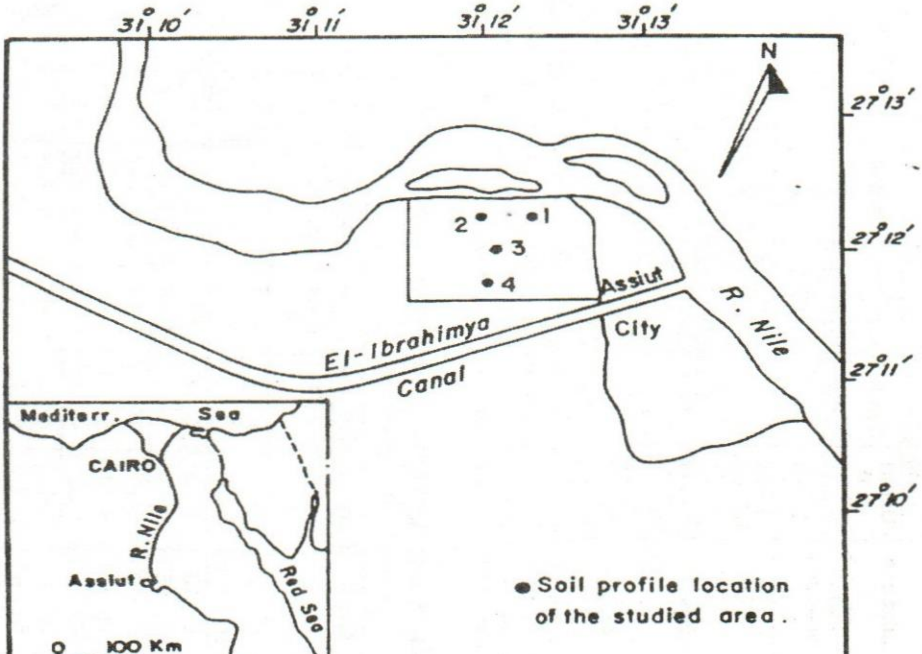

Fig.(1) Location of the studied area and soil profiles.

Table (1). Morphological description of the studied soil profiles.

Profile No.	Land use	Horizon Depth (cm)	Horizon Symbol	Color Hue	Color Dry	Color Moist	Soil texture class	Soil structure	Consistency Dry	Consistency Moist	Consistency Wet	Boundary	Notes
1	Grapes, Citrus and Figs	0 - 10	Ap	10YR	3/3	2/2	sic	mo m sbk	ha	fir	sstpl	cs	few f to m r
		10 - 150	C	10YR	3/2	2/2	c	mo m bk	vha	vfir	stpl	-----	few f to m r
2	Wheat	0 - 10	Ap	10YR	3/3	3/2	c	mo m bk	ha	vfir	vstpl	ds	co f to m r
		10 - 150	C	10YR	3/2	2/2	c	s m bk	xha	xfir	vstpl	-----	few f to m r
3	Wheat	0 - 10	Ap	10YR	3/3	3/2	sic	s m bk	vha	vfir	stpl	cs	co f to m r
		10 - 50	C1	10YR	4/4	3/3	c	mo m sbk	ha	vfir	vstpl	cs	few f to m r
		50 - 150	C2	10YR	4/2	3/2	sic	mo m sbk	vha	vfir	vstpl	-----	-----
4	Clover	0 - 10	Ap	10YR	4/2	3/2	sic	s m bk	vha	vfir	stpl	cs	co f to m r
		10 - 90	C1	10YR	3/3	2/2	c	mo m bk	xha	vfir	vstpl	cs	co f to m r
		90 - 150	C2	10YR	4/2	2/2	sic	mo m sbk	vha	vfir	vstpl	-----	-----

structure : grade (mo= moderatly, s= strong), size (m= medium) and type (sbk= subangular blocky, bk= angular blocky)
consistancy : ha= hard, v= very, x= extremly, fir = firm, sst = slightly sticky, st sticky and pl= plastic
texture: sic= silty clay c= clay boundary : cs= clear smooth ds= diffuse smooth
notes : f= fine m= medium co= common r = root

Table (2): Some physical and chemical properties as well as contents of the extractable heavy metals of the studied soil profiles

Profile No.	Depth	Sand %	Silt %	Clay %	Texture grade	O.M. %	CaCO3 %	PH* 01:01	ECe ds/m	Fe ppm	Mn ppm	Zn ppm	Cu ppm	B ppm	Pb ppm	Ni ppm
1	0 - 10	17.24	40.36	42.4	Silty clay	1.45	1.97	8.03	1.20	11.89	25.61	1.02	3.01	1.47	0.72	0.64
	10 - 150	11.8	35.4	52.8	Clay	1.24	1.46	8.00	1.37	12.92		1.1	3.03	1.34	0.62	0.94
2	0 - 10	10.76	37.24	52	Clay	1.65	1.67	8.01	1.18	10.65	11.04	1.66	2.45	1.03	0.7	0.65
	10 - 150	9.98	31.62	58.4	Clay	1.34	1.71	8.05	1.10	12.83	16.19	2.84	2.78	1.06	0.59	0.51
3	0 - 10	12.88	43.92	43.2	Silty clay	1.83	2.34	8.03	1.25	18	30.32	0.81	3.25	1.22	0.68	0.72
	1o -50	8.22	39.78	52	Clay	1.58	2.51	8.01	1.08	13.38	11.64	0.92	2.65	1.25	0.12	0.73
	50 - 150	5.52	40.08	54.4	Silty clay	1.26	2.55	8.02	0.96	13.73	13.15	1.05	2.69	1.33	0.58	0.89
4	0 - 10	19	41	40	Silty clay	1.95	1.88	7.99	1.18	14.03	33.73	0.69	3.72	0.96	0.47	1.14
	1o - 90	12.54	27.46	60	Clay	1.28	1.59	8.14	1.10	16.57	29.9	1.49	3.94	1.01	0.71	1.32
	90 - 150	13	39.9	39.1	clay loam	1.24	0.33	8.11	1.43	14.76	23.39	1.19	3.04	0.87	0.65	0.86

RESULTS AND DISCUSSION

1- Grain size analysis:

Grain size distributions of the sand fraction are listed in Table (3) and are illustrated as cumulative curves on semi-logarithmic papers (Fig. 2). From these data, certain parameters, median (Mz), sorting (So) and skewness (Skl) were calculated in Table (4). Mean size values of the sand fraction in the studied soil samples range between Φ 2.57 and Φ 3.78 indicating fine sand to very fine sand-sized fraction. The almost nearly sized fractions reflect that the soil materials were formed originally under nearly water current conditions.

Table (3): Grain-size distribution of sand fractions of the studied soil samples.

Profile No.	Depth	V.C	C	M	F	V.F	Total %
1	0-10	0.4	1.36	1.9	3.2	10.38	17.24
	10-150	0.08	0.74	1.09	0.88	9.01	11.8
2	0-10	0.04	0.77	0.94	0.04	8.97	10.76
	10-150	0	0.39	0.71	0.6	8.28	9.98
3	0-10	0.1	2.22	1.5	0.06	9	12.88
	10-50	0	0.22	0.42	0.2	7.38	8.22
	50-150	0	0.04	0.01	0.1	5.37	5.52
4	0-10	0.6	2.58	3.13	1.8	10.89	19
	10_90	0	0.32	0.96	0.78	10.48	12.54
	90-150	0	0.05	0.48	0.68	11.79	13

Sorting coefficient values of the studied sand fraction particles vary from Φ 0.16 to 1.25 (Table 4) indicating very well sorted to poorly sorted. Skewness values range from Φ 0.37 to 0.83 very coarse skewed for all studied soil samples.

The above-mentioned data suggest that the mode of deposition was by one source; namely, Nile river water.

Table (4): Grain-size parameters and indices of the studied soil samples.

Profile No.	Depth	Mz	Mean size	So	Sorting index	Sk	Skewness index
1	0-10	2.77	fine sand	0.96	moderately sorted	-0.69	very coarse-skewed
	10-150	3.13	very fine sand	0.92	moderately sorted	-0.79	very coarse-skewed
2	0-10	3.00	fine sand	0.85	moderately sorted	-0.78	very coarse-skewed
	10-150	3.08	very fine sand	0.58	moderately well sorted	-0.54	very coarse-skewed
3	0-10	2.57	fine sand	1.13	poorly sorted	-0.83	very coarse-skewed
	10-50	3.62	very fine sand	0.44	well sorted	-0.54	very coarse-skewed
	50-150	3.78	very fine sand	0.16	very well sorted	-0.37	very coarse-skewed
4	0-10	2.67	fine sand	1.25	poorly sorted	-0.70	very coarse-skewed
	10_90	3.43	very fine sand	0.58	well sorted	-0.80	very coarse-skewed
	90-150	3.60	very fine sand	0.30	very well sorted	-0.63	very coarse-skewed

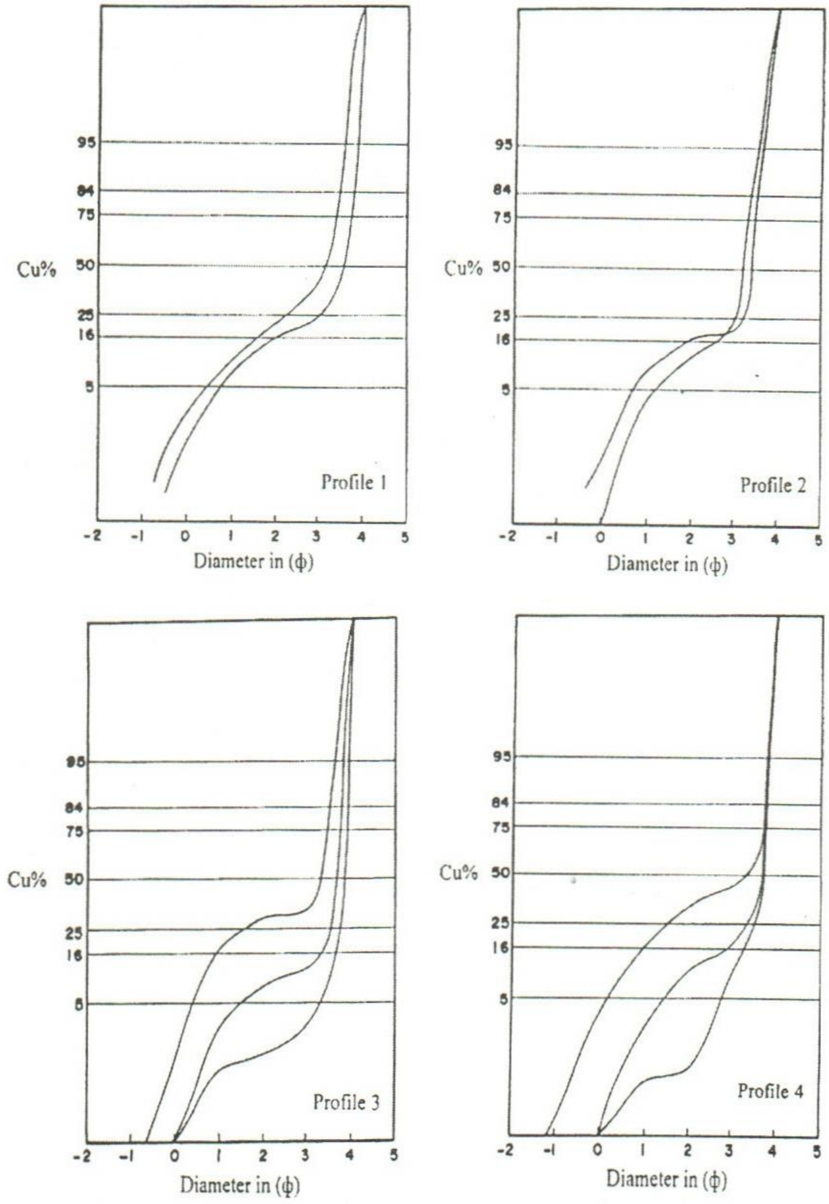

Fig. : Cumulative frequency curves of sand fractions of studied soil profiles.

Cu% Cumulative weight %

2-Mineralogical composition of the fine sand fractions:

Heavy and light mineral suits and their distributions in the fine sand fraction of the studied soil samples are given in Tables (5, 6 & 7).

a. Heavy minerals:

Data in Table (5) reveal that the content and distribution of the heavy minerals in the fine sand fractions are relatively low and range from 0.73% to 12.01%. Generally the heavy mineral fraction increases with depth in profiles 1 and 2. This distribution trend is similar to those reported by Kishk (1972) and Farragallah (1995). The heavy minerals are represented by opaques and non-opaques. Opaque minerals are less abundant with ranges that vary between 14.29% and 28.66%. The non-opaque minerals are the most abundant and are represented by amphiboles, epidotes, biotite, pyroxenes, zircon, sphene, garnet, rutile, tourmaline, lemonite and apatite; arranged in a decreasing order of abundance (Table 6). Amphiboles include hornblende and tremolite that range from 18.45% to 31.12%, epidotes are represented mainly by pistacite with range between 15.06% and 38.69%, biotite (5.94% - 27.33%) is mainly present as flakes and pyroxenes in the range of 0.66% to 15.34% and are dominated by augite, diopside and hypersthene. These minerals are easily decay, so their highest contents in the non-opaques can be taken as an indication of the existence of immature conditions and/or recent deposition (Kassem *et al.*, 1979; Gewaifel *et al.*, 1981; Amira *et al.*, 2000 and Faragallah, 2001).

On the other hand, the more stable minerals are in low amount and are represented by sphene (up to 10.71%), zircon (up to 7.95%), garnet (up to 1.32%) and tourmaline (up to 1.21%).

Table (5): Percentages of heavy and light minerals in the fine sand fraction < 0.25 mm of the studied soil samples

Profile No.	Depth	Total weight of fine sand (gm)	Heavy Fraction		Light Fraction	
			Weight (gm)	%	Weight (gm)	%
1	0 - 10	6.79	0.4834	7.12	6.3066	92.88
	10 - 150	4.9452	0.455	9.20	4.4902	90.80
2	0 - 10	4.5051	0.41	9.10	4.0951	90.90
	10 - 150	4.4405	0.4445	10.01	3.996	89.99
3	0 - 10	4.53	0.1821	4.02	4.3932	95.98
	1o -50	3.7903	0.1899	5.01	3.6004	94.99
	50 - 150	2.735	0.02	0.73	2.715	99.27
4	0 - 10	5.9801	0.7182	12.01	5.2619	87.99
	1o - 90	5.6304	0.4133	7.34	5.2171	92.66
	90 - 150	10.2351	0.6469	6.32	9.5882	93.68

Table (6): Percentages of minerals and their distribution in the heavy fraction of the fine sand of Studied soil samples

Profile No.	Depth	Opa-ques	Epi-dotes	Amphiboles			Pyroxenes				Bio-tite	Sph-ene	Zir-con	Gar-net	Ru-tile	Tourm-aline	Lemo-nite	Apa-tite
				Horn.	Trem.	Total	Aug.	Diop.	Hyper.	Total								
1	0- 10	14.29	38.69	18.45	0	18.45	7.74	0	1.19	8.93	6.55	10.7	0	1.19	0	0	1.19	0
	10 - 150	28.66	27.08	29.69	0	29.69	1.56	0	0	1.56	8.85	2.08	0.52	0.52	0.52	0.52	0	0
2	0 - 10	25.75	27.23	21.78	0	21.78	12.4	1.48	1.48	15.3	5.94	1.98	1.48	0	0	0.5	0	0
	10 - 150	23.81	24.4	22.62	2.38	25	7.74	4.76	0	12.5	9.52	1.19	1.78	0.6	0.6	0	0	0.6
3	0 - 10	22.89	15.06	21.09	3.61	24.7	6.02	6.02	1.81	13.9	15.1	1.81	4.82	0.6	0	1.21	0	0
	10 -50	23.18	20.53	23.18	1.32	24.5	0	0.66	0	0.66	21.2	0	7.95	1.32	0.67	0	0	0
	50 - 150	20	18.67	26.66	2	28.66	2	0.67	0	2.67	27.3	0	0.67	0	1.33	0.67	0	0
4	0 - 10	26.32	24.81	22.56	1.5	24.06	7.52	1.5	0	9.02	9.77	0	6.02	0	0	0	0	0
	10 - 90	25.61	24.39	30.49	0	30.49	1.22	0.61	0	1.83	12.8	0.61	1.83	1.22	1.22	0	0	0
	90 - 150	14.82	31.85	27.41	3.71	31.12	3.7	0.74	0	4.44	12.6	0	2.97	0	1.47	0.74	0	0

b. Light minerals:

The light minerals are the main constituent (87.99% - 99.27%) of the fine sand fractions of the studied soils (Table 5). These light minerals are mainly composed of quartz with a range between 87.72% and 94.89% as well as small amount of feldspars (5.11% to 12.28%). Feldspars include plagioclase, microcline and orthoclase with amounts up to 8.08%, 7.63% and 2.34% respectively (Table 7). The dominancy of quartz is mostly related to its resistance to weathering and disintegration during the multicyclic processes of sedimentation. Also, the presence of feldspars could indicate that the weathering prevailing during soil formation was not enough to cause a complete decay of these minerals (Hassona *et al.*, 1995).

Table (7): Percentages of minerals and their distribution in the light fraction of the fine sand of the studied soil samples

Profile No.	Depth	Quartz	Feldspars			
			Microcline	Orthoclase	Plagioclase	Total
1	0 - 10	94.89	1.46	1.46	2.19	5.11
	10 - 150	91.76	4.71	1.18	2.35	8.24
2	0 - 10	87.79	7.63	0.76	3.82	12.21
	10 - 150	88.89	3.7	1.48	5.93	11.11
3	0 - 10	91.84	1.02	1.02	6.12	8.16
	1o -50	90.4	3.39	1.69	4.52	9.6
	50 - 150	87.72	4.09	2.34	5.85	12.28
4	0 - 10	89.17	2.55	1.91	6.37	10.83
	10 - 90	88.82	1.97	1.32	7.89	11.18
	90 - 150	88.38	2.02	1.52	8.08	11.62

3-Soil origin, uniformity and weathering ratios:

Data in Tables (6 and 8) represent the assemblages and frequencies of heavy minerals in the studied soil samples. These data suggests that the soils are derived from different provenances. The presence of opaques, pyroxenes and rutile reflect basic igneous rocks; the sphene, zircon, apatite represent the acidic igneous rocks; the epidotes represent the metamorphic rocks and the amphiboes, biotite, tourmaline as well as garnet represent igneous and/or metamorphic rocks (Pettijhon, 1975; Friedmen and Sanders, 1978 and Nechaev and Isphording, 1993).

Concerning the evaluation of soil profile uniformity, the ratios between resistance minerals (zircon, rutile and tourmaline) were used (Haseman and Marshall, 1945; Barshad, 1964; Brewer, 1964 and Chapman and Horn, 1968). Data in Table (6 and 8) show some variations between the layers of profiles. This indicates that the soil materials forming the different layers are of different origins or of heterogeneous nature.

Table (8): Percentages of minerals and their distributions in the studied soil (bulk samples).

Profile No.	Depth	Fine sand	Heavy frac.	Opa-ques	Epi-dotes	Amphiboles			Pyroxenes				Bio-tite	Sph-ene	Zir-con	Gar-net	Ru-tile	Tourm-aline	Lemo-nite	Apa-tite	Light Frac.	Qua-rtz	Feld-spars
						Horn.	Trem.	Total	Aug.	Diop.	Hyper.	Total											
1	0 – 10	13.58	0.97	0.14	0.37	0.18	0.00	0.18	0.07	0.00	0.01	0.09	0.06	0.10	0.00	0.01	0.00	0.00	0.01	0.00	12.61	11.97	0.64
	10 - 150	9.89	0.91	0.26	0.25	0.27	0.00	0.27	0.01	0.00	0.00	0.01	0.08	0.02	0.00	0.00	0.00	0.00	0.00	0.00	8.98	8.24	0.74
2	0 - 10	9.01	0.82	0.21	0.22	0.18	0.00	0.18	0.10	0.01	0.01	0.13	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	8.19	7.19	1.00
	10 - 150	8.88	0.89	0.21	0.22	0.20	0.02	0.22	0.07	0.04	0.00	0.11	0.08	0.01	0.02	0.01	0.01	0.00	0.00	0.01	7.99	7.10	0.89
3	0 - 10	9.06	0.36	0.08	0.05	0.08	0.01	0.09	0.02	0.02	0.01	0.05	0.05	0.01	0.02	0.00	0.00	0.00	0.00	0.00	8.79	8.07	0.72
	10 -50	7.58	0.38	0.09	0.08	0.09	0.01	0.09	0.00	0.00	0.00	0.00	0.08	0.00	0.03	0.01	0.00	0.00	0.00	0.00	7.20	6.51	0.69
	50 - 150	5.47	0.04	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.43	4.76	0.67
4	0 - 10	11.96	1.44	0.38	0.36	0.32	0.02	0.35	0.11	0.02	0.00	0.13	0.14	0.00	0.09	0.00	0.00	0.00	0.00	0.00	10.52	9.38	1.14
	10 - 90	11.26	0.83	0.21	0.20	0.25	0.00	0.25	0.01	0.01	0.00	0.02	0.11	0.01	0.02	0.01	0.01	0.00	0.00	0.00	10.43	9.27	1.17
	90 - 150	20.47	1.29	0.19	0.41	0.35	0.05	0.40	0.05	0.01	0.00	0.06	0.16	0.00	0.04	0.00	0.02	0.01	0.00	0.00	19.18	16.95	2.23

Based on the ratios between the most susceptible weathered minerals (amphiboles, pyroxenes and biotite) and the ultrastable ones (zircon, tourmaline) that used by Hammad (1968); weathering values are listed in Table (9). These values increase markedly with depth in the majority of profiles that reflect a slight effect of weathering in most surface layer.

From the above- mentioned discussion, it could be concluded that the studied soils are weakly weathered and precipitated from Nile sediments, which are derived from the igneous & metamorphic rocks of Ethiopian Plateau (Said, 1981).

Table (9): Uniformity and weathering ratios of the studied soil samples.

Profile No.	Depth	Uniformity ratios			Weathering values		
		Zr/R	Zr/T	Zr/R+T	A+P/Zr+T	H/Zr+T	B/Zr+T
1	0-10	0	0	0	0	0	0
	10-150	1	1	0.5	30.05	28.55	1.5
2	0-10	0	2.96	2.96	18.75	11	7.75
	10-150	2.97	0	2.97	21.07	12.71	7.02
3	0-10	0	3.98	3.98	6.39	3.5	2.3
	10-50	11.87	0	11.87	3.16	2.92	0.08
	50-150	0.5	1	0.34	23.38	19.9	1.99
4	0-10	0	0	0	5.5	3.75	1.5
	10_90	1.5	0	1.5	17.66	16.66	1
	90-150	2.02	4.01	1.34	9.58	7.39	1.2

4-Relation between constituent minerals and extractable elements

Elements such as Fe, Mn, Zn, Cu, B, Pb and Ni are constituents of many minerals.

Iron

Iron occurs in opaques, epidotes, amphiboles, pyroxenes, biotite and feldspars (Wedepohl, 1974 and Dress & Wilding, 1978). The correlation coefficients between detected iron-bearing minerals in sand fraction and DTPA extractable Fe from the whole soil samples are very low and almost negative (Table 10). In all cases the relation is not significant. These data indicate that the role of these minerals as a source for iron is ineffective and unreliable in the studied soil. This may be related to the relatively very low percentages of these minerals and the prevailing dry climatic conditions in the studied soils.

Manganese

Manganese is present in magnetite (opaques), hornblende, epidote, garnet, rutile and sphene (Gladilovich & Sergeeva, 1971). Data in Table (10) show that the correlation coefficients between these minerals and DTPA manganese are low and insignificantly positive.

Zinc

Zinc is found mainly in pyroxenes, biotite, magnetite (opaques) and hornblende (White, 1957; Wiklander, 1958). Data in Table (10) reveal that there are a very low and insignificant positive correlation between these minerals and extractable Zn. The only exception appears with biotite, which shows very low negative correlation.

Copper

Copper occurs in hornblende, augite, biotite, feldspars, opaques (ilmenite & magnetite), epidotes, garnet, rutile and sphene (Gladilovich & Sergeeva, 1971). In most cases, the correlation values between these minerals and DTPA extractable Cu are positive and insignificant. Whereas, a negative correlation is found with augite and sphene (Table 10).

Boron

Boron is present as an essential constituent in tourmaline (Wedepohl, 1974). The correlation coefficient of the DTPA extractable B and tourmaline content is low and negative (Table 10).

Lead

Lead occurs in feldspars, biotite, amphiboles, quartz and magnetite (Wedepohl, 1974). Very low and insignificant negative correlation is observed with biotite, while there are positive correlations with the rest of bearing minerals (Table 10).

Nickel

Nickel is found mainly in pyroxenes, hornblende, garnet and biotite. Similar, the most extractable elements in these soils, insignificant positive correlation coefficient is found between Ni and the above-mentioned bearing minerals except pyroxenes, which show low negative correlation (Table 10).

Table (10): Correlation coefficient between the heavy metals and their bearing-minerals.

Element	mineral	r	Element	mineral	r
Fe	opaques	-0.163	Cu	opaques	0.481
	epidotes	-0.289		epidotes	0.281
	amphiboles	-0.004		hornblende	0.485
	pyroxenes	-0.3933		augite	-0.003
	biotite	0.217		biotite	0.531
	feldspars	-0.48246		garnet	0.288
Mn	opaques	0.41		rutile	0.223
	hornblende	0.441		sphene	-0.091
	epidotes	0.392		feldspars	0.23
	garnet	0.203	B	tourmaline	-0.35
	rutile	0.12	Pb	opaques	0.103
	sphene	0.112		amphiboles	0.208
Zn	opaques	0.11		biotite	-0.089
	hornblende	0.084		quartz	0.318
	pyroxenes	0.331		feldspars	0.188
	biotite	-0.042	Ni	hornblende	0.398
				pyroxenes	-0.313
				biotite	0.401
				garnet	0.048

Table (11): Relative abundance of the identified minerals in the clay fractiopns (calculations based on the method of scultz,1964).

Minerals	1	2	3	4	5	6	7	10	11	12	Min	Max
Smectite	49.4	39.7	43.5	35.6	48.1	35.7	52.8	42.9	43.0	32.6	6.2	14.3
Mica-Vermiculite	9.6	15.7	17.1	16.9	10.3	19.6	12.3	15.2	12.8	18.0	3.3	5.6
Mixed layer Mica-Smectite	7.7	13.6	14.2	13.7	11.4	14.3	7.7	13.4	6.2	2.7	32.6	52.8
Palygorskite	9.2	5.2	3.7	5.9	2.9	5.3	3.3	3.3	1.9	4.6	4.0	12.1
Sepiolite	4.4	4.3	4.0	4.7	8.6	5.0	5.1	4.2	10.6	12.1	9.6	19.6
Vermiculite	4.1	3.5	3.3	3.6	3.9	3.7	3.7	3.5	4.7	5.6	1.9	9.2
Kaolinite	4.7	4.0	3.9	4.0	5.0	4.6	3.3	2.5	5.5	6.7	1.9	5.6
Mica	3.8	5.6	1.9	3.6	2.7	3.6	2.4	4.3	4.4	3.2	0.4	2.2
Chlorite	1.0	1.9	1.7	3.8	1.4	2.5	2.8	2.8	2.3	3.0	1.0	3.8
Pyrophyllite	2.0	0.9	1.0	1.7	0.4	1.8	1.1	1.3	1.2	2.2	2.5	6.7
Feldspars	2.4	4.0	3.6	3.8	4.2	2.1	3.1	3.9	4.0	6.0	1.0	3.5
Quartz	1.7	1.6	1.9	2.7	1.0	1.9	2.5	2.5	3.5	3.2	2.1	6.0

Table (12): Percentages of the identified minerals of the clay fractions in the Bulk soil samples

	1	2	3	4	5	6	7	10	11	12	Min	Max
Mixed layer Mica-Smectite	3.3	7.2	7.4	8.0	4.9	7.4	4.2	5.4	3.7	1.1	**1.1**	**8.0**
Vermiculite	1.7	1.9	1.7	2.1	1.7	1.9	2.0	1.4	2.8	2.2	**1.4**	**2.8**
Smectite	20.9	20.9	22.6	20.8	20.8	18.6	28.7	17.2	25.8	12.8	**12.8**	**28.7**
Sepiolite	1.9	2.3	2.1	2.7	3.7	2.6	2.8	1.7	6.3	4.7	**1.7**	**6.3**
Mica-Vermiculite	4.1	8.3	8.9	9.9	4.5	10.2	6.7	6.1	7.7	7.0	**4.1**	**10.2**
Palygorskite	3.9	2.7	1.9	3.4	1.2	2.8	1.8	1.3	1.1	1.8	**1.1**	**3.9**
Mica	1.6	3.0	1.0	2.1	1.2	1.9	1.3	1.7	2.6	1.3	**1.0**	**3.0**
Pyrophyllite	0.9	0.4	0.5	1.0	0.2	0.9	0.6	0.5	0.7	0.9	**0.2**	**1.0**
Chlorite	0.4	1.0	0.9	2.2	0.6	1.3	1.5	1.1	1.4	1.2	**0.4**	**2.2**
Kaolinite	2.0	2.1	2.0	2.3	2.2	2.4	1.8	1.0	3.3	2.6	**1.0**	**3.3**
Quartz	0.7	0.8	1.0	1.6	0.4	1.0	1.4	1.0	2.1	1.3	**0.4**	**2.1**
Feldspars	1.0	2.1	1.9	2.2	1.8	1.1	1.7	1.6	2.4	2.3	**1.0**	**2.4**

The insignificant correlations that occur between less to moderately stable minerals of epidotes, amphiboles, pyroxenes, biotite as well as feldspars and the extractable heavy metals may be attributed to the narrow range of these metals content in the studied soils, and reflect the young nature of this soil. These obtained results are agreement with the opinions of Sillanpaa (1962) and Mitchel (1964) who stated that, it is possible or not to relate the trace elements contents of a soil to their mineralogical composition depends actually on the intensity of weathering processes prevailing in the course of the soil formation..

5-Mineralogical composition of the clay fraction:

Figure 3 shows X-ray diffractograms of the clay fraction of the studied soil samples. Semi-quantitative measurements of the identified clay minerals in the clay fraction and bulk samples are given in tables (11 & 12), respectively. Smectite was found to be the most abundant clay mineral in the studied soil samples (32.65 to 52.80%), followed by interstratified minerals; namely mica-vermiculite (9.64-19.60%) and mica-smectite (6.17-14.29%). Also, sepiolite (4.01-12.06%), palygorskite (1.87-9.23%), vermiculite (3.32-5.64%), kaolinite (2.50-6.67%), mica (1.94-5.625%), chlorite (1.03-3.77%) and pyrophyllite (0.37-2.25%) are present. Feldspars (2.09-5.97%) and quartz (1.00-3.52%) are present in all clay samples. The presence of smectites as the abundant clay minerals in the studied clay fraction of the soil samples, followed by interstratified minerals; namely mica-vermiculite and mica-smectite, as well as sepiolite, palygorskite, vermiculite, kaolinite, mica, chlorite and pyrophyllite emphasize that these soils were derived from the older Nile sediments as well as the calcareous deposits of the western plateau (Elwan *et al.*, 1980). Occurrence of micas in all studied soil samples indicate that the soils are young and less weathered (Fanning *et al.*, 1989). Low and insignificant correlations are found between the extractable heavy metals and clay minerals present (Table 13). These data suggest that the heavy metals are not mainly in the exchangeable form on clay minerals and/or no clearly difference in the clay minerals contents within these soils.

Table (13): Matrices for the correlation coefficients of the investigated clay fractions and heavy metals.

Minerals	Fe	Mn	Zn	Cu	B	Pb	Ni
Mixed layer Mica-Smectite	-0.41	-0.51	0.39	-0.40	0.15	-0.40	-0.36
Vermiculite	0.34	-0.02	0.38	0.27	-0.25	0.21	0.38
Smectite	-0.01	-0.24	0.14	-0.05	0.43	0.25	0.15
Sepiolite	0.69	0.33	0.11	0.51	-0.43	0.28	0.50
Mica-Vermiculite	-0.37	-0.69	0.56	-0.40	-0.28	-0.49	-0.13
Palygorskite	-0.64	-0.41	0.36	-0.51	0.54	-0.12	-0.66
Mica	0.06	0.09	0.18	0.40	0.13	-0.08	0.43
Pyrophyllite	-0.38	-0.29	0.49	-0.19	-0.14	-0.30	-0.21
Chlorite	-0.04	-0.33	0.70	-0.09	-0.36	-0.26	0.01
Kaolinite	0.34	-0.06	0.36	0.13	-0.17	0.18	0.12
Quartz	0.11	-0.04	0.53	0.30	-0.46	0.07	0.45
Feldspars	0.33	0.12	0.48	0.29	-0.63	0.49	0.32

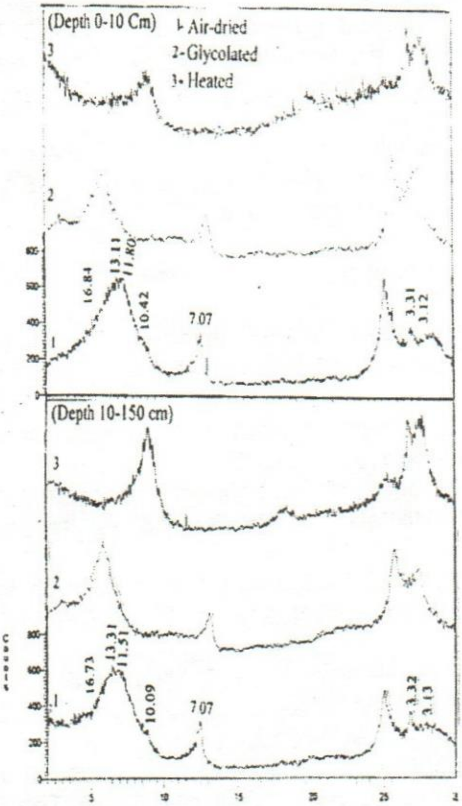

Fig. (3): Diffractograms representing the clay fraction in the studied soil profile (No.2).

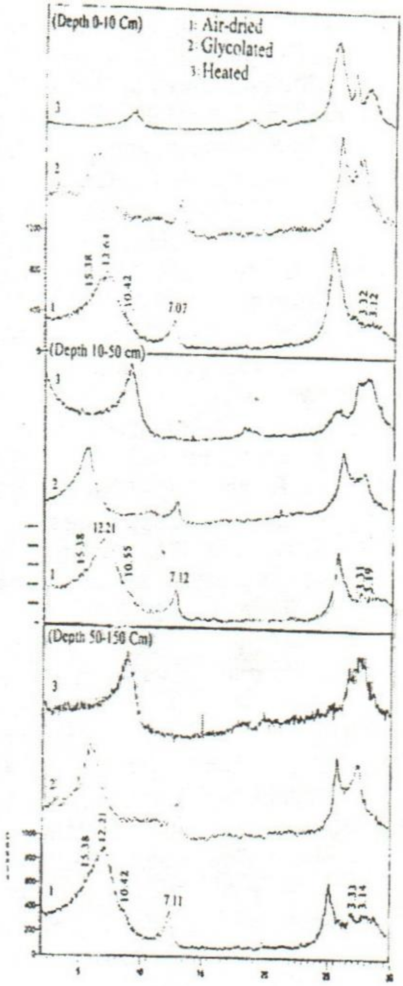

Fig. (4): Diffractograms representing the clay fraction in the studied soil profile (No.3).

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التركيب المعدنى الرملى والطينى لبعض الأراضى النهرية وعلاقتها بأصل وتماثل التربة ومحتوى العناصر الثقيلة– أسيوط – مصر.

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أجرى هذا البحث بدراسة أربعة قطاعات تمثل الأراضى الرسوبية النهرية فى المنطقة الواقعة مابين نهر النيل والترعة الإبراهيمية شمال غرب مدينة أسيوط بهدف التعرف على التركيب المعدنى للرمال الناعمة والطين فى هذه التربة وعلاقتها بالعناصر الثقيلة الموجودة فى التربة ووضع تصور لطريقة الترسيب ونشأة تجانس هذه الأرض.

وقد أوضحت نتائج التحليل الحجمى للحبيبات الخشنة (الرملية) أن الحجم المتوسط لها يتراوح مابين رمال ناعمة إلى رمال ناعمة جدا ودرجة الفرز لها تتراوح مابين رديئة الفرز إلى جيدة جدا وانحراف هذه الرواسب ينحرف عن الحجم الخشن. ويمكن أن يرجع ذلك إلى ترسب هذه التربة تحت تأثير عامل واحد فقط وهو ماء النيل.

كما أوضحت التحليلات المعدنية للرمل الناعم أن المعادن الخفيفة تمثل النسبة الأعلى لهذه الرواسب ويسود فيها معدن الكوارتز بالإضافة إلى كمية قليلة من معادن الفلسبارات.

وبفحص المعادن الثقيلة وجد أنها تميل إلى الزيادة مع العمق ويسود فيها المعادن الغير معتمة متمثلة بالأمفيبولات والأبيدوت والبيوتيت والبيروكسينات والزيركون والأسفين والجارنت والروتيل والتورمالين والأباتيت مرتبة ترتيبا تنازليا. وقد أتضح عدم وجود ارتباطات معنوية بين المعادن سهلة التجوية وهى الأمفيبولات والأبيدوت والبيوتيت والبيروكسينات والفلسبارات والتى توجد بكميات صغيرة نسبيا فى هذه الأراضى مع كميات العناصر الثقيلة المستخلصة. ويمكن إرجاع ذلك إلى أن هذه الأراضى حديثة النشأة وضعيفة التطور.

ويدل وجود مجموعات المعادن المختلفة فى حجم الرمل الناعم على تعدد مواد الأصل التى تكونت منها هذه الأراضى. كما تدل علاقة المعادن المقاومة ومعدلات التجوية أن هذه الأراضى ضعيفة التطور وتكونت من مواد غير متجانسة.

وقد أوضحت نتائج فحص الأحجام الطينية لعينات التربة تحت الدراسة باستخدام جهاز حيود الأشعة السينية أن معادن الأسمكتيت هى أكثرالمعادن الطينية شيوعا تليها معادن الطين المتداخلة ممثلة بالميكا–فيرموكيولايت والميكا–إسمكتيت ثم معادن السبيولايت والباليجروسكيت والفيرموكيولايت والكاولينيت والميكا والكلورايت والبيروفلليت. كما أظهرت النتائج أن معادن الفلسبارات والكوارتز تتواجد بكميات صغيرة جدا فى الجزء الطينى. وتؤكد هذه النتائج صغر عمر هذه الأرض من الناحية البيدولوجية وضعف تأثير التجوية وأنها تكونت من رواسب نيلية قديمة بالأضافة إلى رواسب جيرية من الهضبة العربية.