J. Agric. Sci. Mansoura Univ., 30 (4): 2293 - 2313, 2005

CHEMICAL AND MINERALOGICAL PROPERTIES OF SOME TOSHKA SOILS.

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ABSTRACT

Nowadays, Egypt is starting some gigantic programs and projects which can be called national projects for long-term strategies and apply scientific planning to lay out the foundations of a modern society. Toshka project is the most important national project in Egypt now to go out from the narrow Nile Valley, and to set up new agro-industrial centers in the Western Desert. This project needs more detailed scientific research and studies. Therefore, the aim of this investigation is to study the chemical and mineralogical characteristics of some Toshka soils. Seventeen soil profiles were taken to represent the study area.

These profiles were morphologically described and their chemical and mineralogical properties were evaluated. Total $CaCO_3$ % is mainly low and ranges between 2.49% to 25.1%. Soil salinity is also low, Meanwhile, soluble cations are dominated by Sodium followed by Calcium. Meanwhile, soluble anions generally follow the order of SO_4^{-2} > Cl^{-1} > HCO_3^{-1} . Gypsum content is checked out in soil samples, to verify the reason of sulfate occurrence, but there is no significant amount of it (Gypsum % is less than 3% in all samples).

Cation exchange capacity ranges from 1.72 to 10.5 meq/100 g of dry soil. The dominant exchangeable cation is Ca^{++}, followed by Mg^{++} ,Na^{+} and finally, K^{+} which is the least abundant. Exchangeable sodium percentage of soil samples ranges between 0.23 and 37.5 %.

Mineralogical studies of clay fraction by X-ray diffraction, differential thermal analysis and infrared spectroscopy indicate that the clay fraction of the studied samples are generally dominated by kaolinite with less pronounced occurrence of Smectite. The identified accessory minerals are mainly dominate by quartz, followed by calcite and goethite.

Meanwhile, Mineralogical studies of fine sand fraction showed that, quartz is the dominant light mineral. Few feldspar grains have been also recorded. Other minerals are very rare. Opaque minerals constitute about 77% of the heavy minerals. Pyroxenes and amphiboles are the dominant non-opaque heavy mineral followed by zircon, epidote and biotite.

INTRODUCTION

Toshka Project was officially inaugurated at a ceremony on Jan. 9, 1997 by President Mubarak. The official name of Toshka Project is the National Project for Developing Upper Egypt (NPDUE). Toshka depression is near the beginning of the new canal (Sheikh Zayed Canal). Altorkomani (1999) reported that Toshka project is confined to the eastern part of Toshka depression where pedo-geological studies have indicated its suitability for agricultural development. The total arable area which could be put under cultivation is estimated as 870000 feddans. Priority is given to some 540000 feddans which may lead to the emergence of 27 new agricultural agglomerations. This entails digging some 67 kilometers of new irrigation canal (El-sheikh Zayed canal) which takes its water from Lake Naser by a huge pumping station on the western bank of Lake Naser.

Shaltout (1997) mentioned that only three permanent meteorological stations are present in South-western Egypt (Aswan, Kharga and Dakhla). The monthly ranges of variation in the maximum air temperature are 23.8 - 42.0 °C in Aswan, 23.2 - 41.6 °C in Kharga and 23.4 - 41.2 °C in Dakhla, and those of the minimum temperature are: 10.1 - 27.5 °C at Aswan, 7.0- 24.9 °C at Kharga and 6.1 – 23.8 °C at Dakhla. The annual mean of relative humidity in Kharga (40.1 %) is higher than that of Dakhla (39.1%) and Aswan (26.8%). Evaporation has the lowest value during January and the highest during June. The monthly ranges of variation are 8.6 - 21.8 mm day at Aswan, 7.5 - 21.5 mm/day at Kharga and 7.9 -24.3 mm/day at Dakhla . This region is practically rainless. The mean annual rainfall at Aswan is 0.1 mm/year.

Geological and geomorphological studies show that, most of southwestern Egypt is a cuesta type landscape of late Jurassic to Cretaceous Clastic, of small to moderately escarpments with extensive sand and gravel sheets situated between them. Towards Lake Naser, the morphology keeps the same cuesta type character, which dominates the area between the oasis of the New Valley and Gilf Kebir. In some places a relatively minor extension of Pre-Cambrian basement is exposed. The areas around the New Valley, along Darb El - Arba'in and Lake Naser belong to Nubian sandstone.

The geological units of the study area are: *Sabaya formation* (Medium-to coarse-grained floodplain sandstone with interbeded channel deposits and soil horizons), *Kiseiba formation* (Mainly clayey siltstone and fine grained sandstone with shale intercalations), *Sand Sheet*, *Campanian to Oligocene basalt* and *Gneiss and migmatic gneiss* (Corral, 1987).

On the other hand, Abu Al Izz (1971) divided the Western desert into six morphological regions (*limestone hills along Mediterranean coast, sand and gravel hills including the areas to the west and southwest of the delta, the Marmarica Miocene plateau, the limestone plateau, the sandstone plateau* and *The southwestern Eocene limestone plateau*). The studied area is located in the region of the sandstone plateau; it may be affected by the characteristics of the southern Eocene limestone plateau.

MATERIALS AND METHODS

The study area is a part of Toshka project. It lies 75 km to the east of El-sheikh Zayed canal. This canal starts 8 km to the North of Khor Toshka at Lake Naser. Soil profiles are located along Aswan- Abo Simbel road (between km 130 to 200) at the western fringe of Lake Naser. It lies between latitudes 22° 49' and 23° 30' N and longitudes 31° 30' and 32° 00' E in the northern-east of Khor Toshka (Figure 1). Fifty-five soil samples were collected from seventeen profiles. These profiles were dug deep down to 150 cm, unless hindered by bedrock, and morphologically described as outlined by USDA-NRCS (1998) and the Guidelines for soil description of F.A.O. (1990).

Physical, chemical and mineralogical analyses were carried out as follows:

Particle size distribution (USDA-NSSC, 1996), grain size parameter (Folk and ward, 1957 & Sahu, 1964), soil pH, soil salinity and $CaCO_3$ % (Richards, 1954), soluble cations and anions (Rowell, 1994), exchangeable cations, C.E.C and O.M% (USDA-NSSC, 1996). Soil morphology and classification were carried out according to USDA- Soil survey staff (1999).

For clay mineral identification, a number of techniques were applied, namely: X- ray diffraction analysis, differential thermal analysis (DTA) and Infrared (IR) analysis. These techniques characterize the crystalline, non crystalline and their accessory minerals.

X-ray diffraction analysis of the separated clay fraction was carried out for seven clay samples using Phillips PW 1140 90X-ray apparatus, with Nickel filter and Cu- radiation. Crystalline clay minerals peaks were identified according to Carroll (1970) and Wilson (1987). Meanwhile, semi- quantitative analysis of the clay minerals was conducted by measuring the peak area as outlined by Gjems (1967).

The differential thermal analysis was carried out on ten soil samples using means of Shimadzu DTA-50H, and TGA-50H. Each powdered sample was heated by 10 °C/min. up to 1000 °C with α- Al_2 O_3 as a reference material. Crystalline clay minerals peaks were identified according to Paterson and Swaffield (1987).

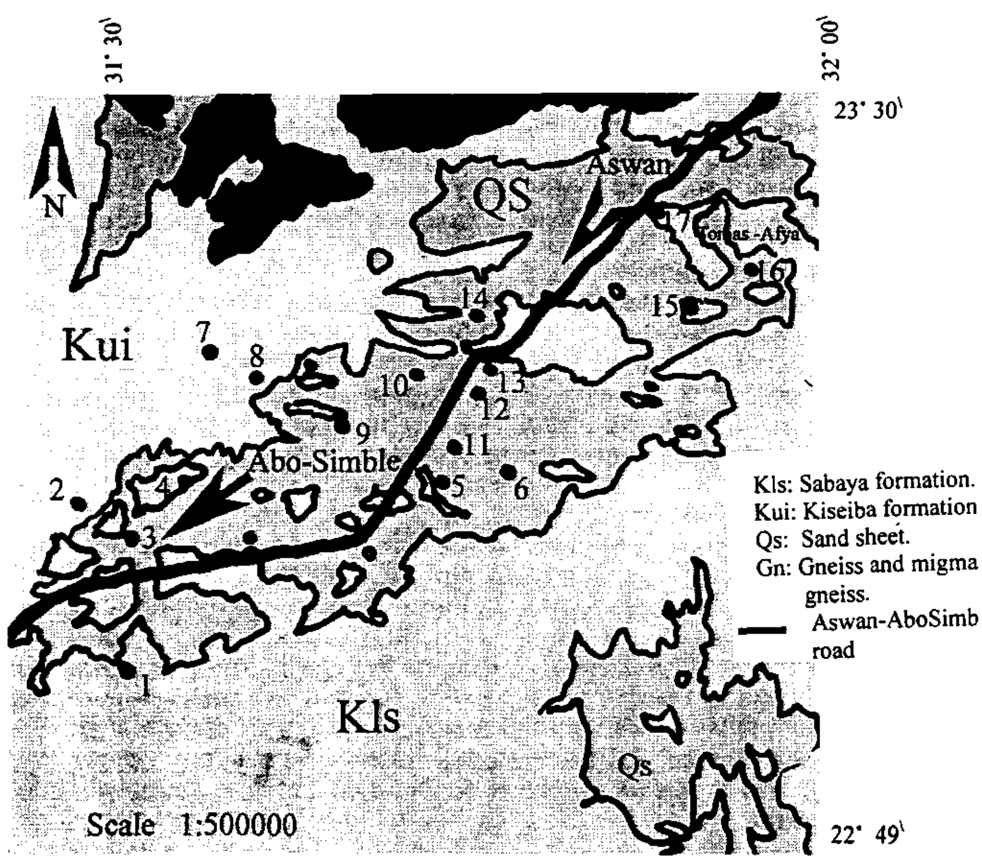


Figure (1): Map of the studied soil profiles.

For the infrared analysis, silt and clay fractions were separated from the soil samples by sieving with mechanical shaker. The samples were left without pretreatments to avoid changes in the properties of minerals so that IR spectra are representative of the mineral components in their original condition, (El-Hassanin, 1988). Soil- K Br discs were prepared in a ratio of 2:300 mg by using a mini die device for 5 minutes to form the soil- k Br disc as well as the reference disc, (El- Hassanin, 1993). The discs were examined using FTIR Matson instrument. IR assignments were made following Farmer (1974); Russell (1987) and El- Hassanin, (1993).

For the mineralogy of sand fraction, Fine sand fraction (125-250 µ) was separated by dry sieving. Bromoform (Sp. Gr. 2.84 ± 0.02) was used to separate heavy and light minerals as described by Brewer (1964). About 500 grains were examined by the polarizing microscope according to Milner (1962) and El- Hinnawi (1966).

RESULTS AND DISCUSSION

Soil morphology and classification:

The morphological characteristic of the representative soil profiles are presented in Table (1). The texture classes of most of the studied soil profile layers are sandy loam (table 1). The coarseness of all layers in most soil profiles refers to the high percentage of sand fraction (mostly exceeds 70%), which is inherited from the dominant parent material, (Nubian sandstone).
Soil classification was carried out following the American system, USDA- Soil Survey Staff (1999). Toshka soils may be placed under the order Aridsol and classified as: *Typic haplocambids, Coarse, Kaolinite ,Hyperthermic.*

Grain size parameters:

Folk and Ward statistical grain size parameters of the studied soil profiles are given in Table (2). Sahu's functions are calculated from the grain size parameters of Folk and Ward. The values of Mean size (M_z) range between 0.533 to 2.367 mm. All layers have poorly sorted sediments (σ ranged between 1.538 and 0.939) except the deepest layer in profile No. 1 and 6, which have moderately sorted sediments. These poorly sorted values indicate that the role of water environment is evident in the deposition and formation of soil material.

Sahu's functions confirmed that the studied soil profiles had deposited under water environment of turbidity current deposition except the deepest layer of profile No.1 and 6, which were deposited under shallow agitated marine conditions.

Values of Skewness varied among the soil layers. They range between 0.278 to - 0.506. Most layers have a negative or nearly symmetrical Skewness. This trend indicates that these soils have a tail of coarseness due to the nature of soil parent material. Kurtosis values are usually very Platykurtic. Platykurtic and Mesokurtic indicate that the sediments have coarse mode.

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

Profile No.	Surface cover	Horizon Depth (cm)	Color		Texture	structure	Consistency			Lower boundaries
			Dry	Wet			Dry	Stickiness	Plasticity	
1	Many fine to medium gravels	0-20	5 YR 6/8	5 YR 5/6	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Diffuse smooth
		20-50	5 YR 6/6	5 YR 5/6	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Diffuse smooth
		50-70	5 YR 6/6	5 YR 5/6	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Diffuse smooth
		70-1 00	5 YR 7/6	5 YR 5/8	Sandy Loam	Massive	Soft	Slightly sticky	Slightly plastic	
2	Many fine to coarse gravels	0-30	7.5 YR 8/4	7.5 YR 6/6	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Diffuse smooth
		30-60	7.5 YR 5/8	7.5 YR 4/6	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Clear smooth
		60-1 00	5 YR 5/6	5 YR 4/6	Sandy Loam	Massive	Soft	Slightly sticky	Slightly plastic	
3	Many fine to coarse gravels	0-10	7.5 YR 7/6	7.5 YR 6/6	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Clear smooth
		10-25	2.5 YR 5/8	2.5 YR 4/6	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Diffuse smooth
		25-60	2.5 YR 4/8	2.5 YR 3/6	Loamy sand	Single grains	Loose	Non sticky	Non plastic	Diffuse smooth
		60-110	2.5 YR 5/8	2.5 YR 4/6	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	
4	Many fine to medium gravels	0-7	7.5 YR 7/6	7.5 YR 5/8	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Clear smooth
		7-17	5 YR 6/6	5 YR 5/6	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Diffuse smooth
		17-27	5 YR 6/6	5 YR 5/8	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Diffuse smooth
		27-50	2.5 YR 7/4	2.5 YR 6/6	Sandy Loam	Massive	Soft	Slightly sticky	Slightly plastic	
5	Many fine to coarse gravels	0-10	10 YR 7/6	10 YR 5/8	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Clear smooth
		10-30	5 YR 6/6	5 YR 5/6	Loamy sand	Single grains	Loose	Non sticky	Non plastic	Diffuse smooth
		30-90	5 YR 6/6	5 YR 5/6	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	
6	Many fine to medium gravels	0-7	5 YR 6/6	5 YR 6/8	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Clear smooth
		7-25	2.5 YR 5/6	2.5 YR 4/8	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Diffuse smooth
		25-50	2.5 YR 5/6	2.5 YR 4/8	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Diffuse smooth
		50-110	2.5 YR 5/6	2.5 YR 4/8	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	
7	Many fine to medium gravels	0-15	1OYR6/8	1OYRS/8	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Clear smooth
		15-35	7.5 YR 7/4	7.5 YR 5/8	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Diffuse smooth
		35-60	10 YR 8/5	10 YR 8/6	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	
8	Many fine to medium gravels	0-15	7.5 YR6/8	7.5 YRS/8	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Clear smooth
		15-45	2.5 YR 5/8	2.5 YR 4/8	Sandy Loam	Single grains	Loose	Slightly sticky	Slightly plastic	Diffuse smooth
		45-80	2.5 YR 5/6	2.5 YR 4/8	Sandy Loam	Massive	Soft	Slightly sticky	Slightly plastic	

Cont. Table (1).

Profile No.	Surface cover	Horizon Depth (cm)	Color		Texture	structure	Consistency			Lower boundaries
			Dry	Wet			Dry	Stickiness	Plasticity	
9	Many fine to medium gravels	0-10 10-40 40-80	7.5 YR 7/6 2.5 YR 5/8 10 YR 4/8	7.5 YR 6/8 2.5 YR 4/8 10 YR 4/6	Loamy sand Sandy Loam Sandy Loam	Single grains Single grains Single grains	Loose Loose Loose	Non sticky Slightly sticky Slightly sticky	Non plastic Slightly plastic Slightly plastic	Clear smooth Diffuse smooth
10	Many fine to medium gravels	0-10 10-50 50-100	7.5 YR 7/8 5 YR 6/6 2.5 YR 6/6	7.5 YR 6/6 5 YR 5/6 2.5 YR 4/8	Sandy Loam Sandy Loam Sandy Loam	Single grains Single grains Massive	Loose Loose Soft	Moder. sticky Slightly sticky Slightly sticky	Modem. plastic Slightly plastic Slightly plastic	Clear smooth Diffuse smooth
11	Many fine to medium gravels	0-25 25-75 75-1 25	10 YR 7/6 7.5 YR 6/6 7.5 YR 6/6	10 YR 6/8 7.5 YR 5/8 7.5 YR 5/8	Sandy Loam Sandy Loam Sandy Loam	Single grains Single grains Single grains	Loose Loose Loose	Slightly sticky Slightly sticky Slightly sticky	Slightly plastic Slightly plastic Slightly plastic	Clear smooth Diffuse smooth
12	Many fine to medium gravels & sand sheet	0-15 15-60 60-100	7.5 YR 6/6 5 YR 5/6 2.5 YR 5/6	7.5 YR 5/8 5 YR 4/8 2.5 YR 4/8	Sandy Loam Sandy Loam Sandy Loam	Single grains Single grains Single grains	Loose Loose Loose	Slightly sticky Slightly sticky Slightly sticky	Slightly plastic Slightly plastic Slightly plastic	Clear smooth Diffuse smooth
13	Many fine to medium gravels & sand sheet	0-15 15-70 70-110	7.5 YR 7/8 7.5 YR7/6 10 YR 7/6	7.5 YR 6/8 7.5 YR 6/6 10 YR 6/8	Sandy Loam Sandy Loam Sandy Loam	Single grains Single grains Massive	Loose Loose soft	Slightly sticky Slightly sticky Slightly sticky	Slightly plastic Slightly plastic Slightly plastic	Clear smooth Clear smooth
14	Many fine to medium gravels & sand sheet	0-15 15-30 30-60 60-1 00	10 YR 7/6 7.5 YR 6/6 10 YR 7/6 10 YR 6/6	10 YR 6/6 7.5 YR 5/8 10 YR 6/8 10 YR 5/6	Sandy Loam Sandy Loam Sandy Loam Sandy Loam	Single grains Single grains Massive Massive	Loose Loose soft sl. hard	Slightly sticky Slightly sticky Slightly sticky Slightly sticky	Slightly plastic Slightly plastic Slightly plastic Slightly plastic	Clear smooth Clear smooth Diffuse smooth
15	Many fine to medium gravels & sand sheet	0-20 20-45 45-80	7.5 YR 7/4 7.5 YR 6/6 10 YR 7/6	7.5 YR 6/6 7.5 YR 5/8 10 YR 6/8	Sandy Loam Sandy Loam Sandy Loam	Single grains Single grains Massive	Loose Loose Loose	Slightly sticky Slightly sticky Slightly sticky	Slightly plastic Slightly plastic Slightly plastic	Clear smooth Clear smooth
16	Many fine to medium gravels & sand sheet	0-20 20-50	7.5 YR 7/6 5 YR 5/6	7.5 YR 6/6 5 YR 3/6	Sandy Loam Loam	Single grains Single grains	Loose Loose	Slightly sticky Slightly sticky	Slightly plastic Slightly plastic	Clear smooth
17	Many fine to medium gravels & sand sheet	0-15 15-50 - 50-100	10 YR 7/6 7.5 YR 7/4 10 YR 7/6	10 YR 6/8 7.5 YR 6/8 10 YR 6/8	Sandy Loam Sandy Loam Sandy Loam	Single grains Massive Massive	Loose Soft Sl. hard	Slightly sticky Slightly sticky Slightly sticky	Slightly plastic Slightly plastic Slightly plastic	Clear smooth Clear smooth

Table (2): Statistical grain size parameters of the studied soil profiles according Folk and Ward (1957)

P. No.	Layer	Mz	σ	Sk	KG
1	0-20	1.917	1.045	0.043	0.82
	20-50	1.65	1.158	-0.09	1.018
	50-70	1.45	1.035	-0.19	1.178
	70-100	1.267	0.988	-0.22	1.127
2	0-30	1.423	1.454	0.117	0.611
	30-60	1.2	1.389	0.019	0.677
	60-100	1.383	1.331	-0.05	0.82
3	0-10	2.183	1.331	-0.5	0.911
	10-25	1.707	1.271	-0.24	0.82
	25-60	1.583	1.231	-0.17	0.844
	60-110	1.553	1.222	-0.17	0.861
4	0-7	2.367	1.183	-0.36	1.018
	7-17	1.775	1.224	-0.13	0.863
	17-27	1.867	1.155	-0.18	0.856
	27-50	1.35	1.158	0.031	0.843
5	0-10	2.1	1.254	-0.21	0.932
	10-30	1.45	1.236	-0.07	0.925
	30-90	1.35	1.162	-0.04	0.803
6	0-7	1.983	1.138	-0.24	0.939
	7-25	1.717	1.145	-0.18	0.952
	25-50	1.55	1.123	-0.25	0.82
	50-110	1.657	0.939	0.035	1.099
7	0-15	1.967	1.358	-0.41	0.76
	15-35	1.45	1.256	-0.06	0.809
	35-60	0.95	1.213	0.279	0.944
8	0-15	1.85	1.298	-0.32	0.887
	15-45	1.35	1.162	-0.06	1.025
	45-80	1.45	1.228	-0.07	0.999
9	0-10	2.333	1.151	-0.41	0.973
	10-40	1.425	1.452	-0.11	0.634
	40-80	1.693	1.336	-0.13	0.841
10	0-10	1.908	1.31	-0.38	0.789
	10-50	1.183	1.328	-0.08	0.68
	50-100	1.092	1.322	-0.03	0.68
11	0-25	2.023	1.336	-0.42	0.735
	25-75	1.325	1.187	-0.27	0.71
	75-125	1	1.227	-0.12	0.738
12	0-15	1.667	1.153	-0.1	0.935
	15-60	1.6	1.189	-0.14	0.83
	60-100	1.325	1.143	-0.14	0.748
13	0-15	1.992	1.197	-0.27	0.809
	15-70	1.517	1.216	-0.1	0.809
	70-110	0.533	1.538	0.246	0.658
14	0-15	2.142	1.095	-0.3	1.133
	15-30	1.8	1.163	-0.34	0.808
	30-60	1.267	1.308	-0.02	0.717
	60-100	1.367	1.308	-0.04	0.725
15	0-20	1.8	1.292	-0.17	0.738
	20-45	1.367	1.348	-0.12	0.744
	45-80	1.383	1.067	0.192	0.609
16	0-20	2	1.155	-0.23	0.736
	20-50	1.033	1.263	0.205	0.799
17	0-15	2.167	1.241	-0.51	0.969
	15-50	1.567	1.362	-0.2	0.762
	50-100	1.725	1.272	-0.11	0.82

** σ_I < 0.35, Very well sorted. 0.35 - 0.50, Well sorted. 0.50 - 0.70, Moderately well sorted. 0.70 - 1.00, Moderately sorted. 1.00 - 2.00, Poorly sorted. 2.00 - 4.00, very poorly sorted. > 4.00, Extremely poorly sorted.

** Sk_I -1.00 to - 0.3, very negative skewed. - 0.30 to - 0.1, negative skewed. - 0.1 to + 0.1, nearly symmetrical. +0.1 to +0.3, positive skewed. +0.3 to +1.00 very positive skewed.

** K_G <0.67, very platykurtic. 0.67 - 0.90, platykurtic. 0.90 - 1.11, mesokurtic. 1.11 - 1.50, leptokurtic. 1.50 - 3.00, very leptokurtic. > 3.00, extremely leptokurtic.

Chemical properties of the studied soil profiles:

Total Calcium Carbonate %: Values of total calcium carbonate are shown in Table (3). They range from 2.01% to 25.1% with an average of 8.84%. Soil profiles No. 2, 5, 8, 9 and 17 are the most calcareous profiles, where the average $CaCO_3$ % in these profiles are 13.16, 16.2, 18.71, 12.25, 13.53%, respectively. The presence of $CaCO_3$ in soil samples may refer to the mineralogical composition of Nubian sandstone, which contains 11.1 % of secondary carbonates. The aridic condition in the study area encourages the formation and accumulation of $CaCO_3$ in soils. On the other hand, the study area may also be affected by the neighboring Eocene limestone plateau.

Table (3): Chemical composition of soil – water 1:5.

Profile No.	Layer	$CaCO_3$ %	O.M %	pH	EC (dS/m)	SAR	Soluble cations (meq/L)				Soluble anions (meq/L)		
							Ca^{++}	Na^{+}	Mg^{++}	K^{+}	Cl^{-}	HCO_3^{-}	SO_4^{--}
1	0-20	2.01	0.03	7.40	0.35	3.14	0.67	2.19	0.30	0.36	0.72	2.78	0.02
	20-50	4.82	0.02	8.00	0.53	7.19	0.66	4.40	0.08	0.18	2.53	2.78	0.02
	50-70	4.02	0.02	8.00	0.70	3.47	2.06	4.06	0.67	0.17	1.70	2.00	3.26
	70-100	6.01	0.02	8.03	0.54	2.53	2.06	2.82	0.43	0.12	1.10	2.40	1.92
2	0-30	10.45	0.02	8.02	0.52	4.01	0.84	3.29	0.51	0.52	1.30	2.20	1.67
	30-60	13.01	0.02	8.10	0.67	9.18	0.48	5.59	0.26	0.39	1.50	2.80	2.42
	60-100	16.02	0.02	8.05	0.72	7.32	0.81	5.66	0.39	0.38	2.20	2.40	2.64
3	0-10	7.45	0.02	7.20	2.15	4.84	0.42	4.41	1.24	15.43	1.10	3.40	17.00
	10-25	6.03	0.02	7.60	0.92	4.88	2.27	5.81	0.56	0.51	2.80	2.40	3.96
	25-60	5.23	0.03	7.85	1.17	9.99	1.43	9.04	0.59	0.67	4.60	2.00	5.13
	60-110	4.82	0.03	7.90	1.16	6.45	2.43	8.04	0.69	0.48	4.90	2.20	4.54
4	0-7	10.15	0.02	7.96	0.66	310	1.77	3.33	0.54	0.92	0.90	1.60	4.07
	7-17	3.89	0.03	7.80	3.26	6.12	12.2	16.12	1.66	2.62	2.70	1.20	28.7
	17-27	3.62	0.04	8.00	1.17	8.29	1.87	8.71	0.34	0.79	6.60	2.20	2.91
	27-50	23.10	0.04	8.07	0.79	11.08	0.53	6.72	0.20	0.41	4.70	2.20	0.97
5	0-10	21.31	0.02	8.10	0.25	1.90	0.58	1.28	0.33	0.30	0.10	1.80	0.60
	10-30	20.87	0.01	7.97	0.52	3.27	1.10	2.94	0.52	0.63	0.50	1.60	3.09
	30-90	6.43	0.03	7.90	0.49	4.41	0.77	3.30	0.34	0.47	1.50	1.80	1.58
6	0-7	5.63	0.03	7.95	0.30	2.19	0.67	1.59	0.39	0.31	0.80	2.00	0.16
	7-25	2.41	0.02	7.93	0.30	3.24	0.50	1.95	0.23	0.28	0.70	1.80	0.46
	25-50	2.01	0.01	8.00	0.30	4.04	0.39	2.21	0.21	0.19	0.60	2.20	0.20
	50-110	11.20	0.02	7.90	0.30	2.42	0.86	1.77	0.21	0.15	1.60	1.30	0.10
7	0-15	4.90	0.05	8.05	0.41	5.04	0.45	2.95	0.24	0.43	0.90	2.20	0.97
	15-35	2.81	0.02	7.70	2.19	6.69	6.40	12.87	1.01	1.63	14.5	1.20	6.20
	35-60	3.62	0.02	7.76	1.95	3.31	9.84	7.74	1.06	0.86	5.20	1.80	12.5
8	0-15	3.42	0.02	7.86	0.49	1.68	1.95	1.87	0.53	0.57	1.50	1.40	2.02
	15-45	22.6	0.01	7.90	0.51	5.63	0.62	3.83	0.30	0.32	1.10	1.40	2.57
	45-80	25.1	0.02	7.82	0.73	3.15	2.56	3.89	0.49	0.32	3.90	1.40	1.97
9	0-10	11.0	0.03	7.90	0.31	3.11	0.50	1.94	0.28	0.39	0.60	2.40	0.10
	10-40	12.0	0.03	8.00	0.43	7.65	0.32	3.65	0.14	0.20	1.40	2.60	0.31
	40-80	13.8	0.04	7.80	0.94	4.69	3.01	5.97	0.23	0.22	5.50	1.40	2.53

Cont. table (3): Chemical composition of soil – water 1:5

Profile No.	Layer	$CaCO_3$ %	O.M%	pH	EC (dS/m)	SAR	Soluble cations (meq/L)				Soluble anions (meq/L)		
							Ca^{++}	Na^{+}	Mg^{++}	K^{+}	Cl^{-}	HCO_3^{-}	SO_4^{--}
10	0-10	7.24	0.01	7.85	0.51	3.92	0.85	3.25	0.52	0.46	0.50	2.40	2.18
	10-50	5.70	0.01	7.83	1.07	15.30	0.38	9.57	0.40	0.32	8.10	2.47	0.10
	50-100	13.8	0.07	7.65	2.18	10.28	2.29	15.97	2.53	1.01	20.5	1.20	0.10
11	0-25	6.03	0.02	7.98	0.23	2.19	0.45	1.35	0.31	0.18	0.80	1.45	0.05
	25-75	5.91	0.07	7.95	0.27	5.09	0.24	2.23	0.15	0.12	0.50	2.20	0.03
	75-125	2.01	0.02	7.96	0.34	5.73	0.31	2.82	0.18	0.08	0.77	2.60	0.01
12	0-15	3.85	0.01	7.80	1.07	8.38	1.48	8.11	0.40	0.68	6.70	1.60	2.36
	15-60	2.41	0.03	7.85	0.69	5.83	1.09	5.07	0.42	0.31	3.30	1.40	2.19
	60-100	2.01	0.02	7.80	0.90	4.31	1.94	5.49	1.30	0.30	6.40	1.40	1.22
13	0-15	4.02	0.01	7.90	0.25	2.65	0.52	1.62	0.23	0.17	0.68	1.83	0.03
	15-70	9.25	0.02	7.94	0.45	5.93	0.50	3.62	0.25	0.09	1.00	2.40	1.06
	70-110	13.4	0.07	7.95	0.45	4.14	0.91	3.18	0.27	0.11	2.00	2.00	0.47
14	0-15	4.85	0.02	7.95	0.27	2.23	0.65	1.59	0.35	0.11	0.75	1.95	0.01
	15-30	4.02	0.01	7.95	0.32	4.19	0.48	2.38	0.17	0.12	0.95	2.15	0.05
	30-60	6.83	0.03	8.01	0.28	3.73	0.37	1.98	0.20	0.29	0.80	1.80	0.24
	60-100	6.43	0.02	8.01	0.22	3.17	0.40	1.63	0.13	0.07	0.50	1.70	0.02
15	0-20	8.84	0.02	7.90	0.64	6.07	0.70	4.59	0.45	0.66	1.60	2.80	2.00
	20-45	11.4	0.03	7.75	0.49	7.20	0.48	4.14	0.18	0.14	1.80	2.60	0.54
	45-80	14.5	0.07	7.80	0.93	2.57	4.44	4.03	0.49	0.28	3.40	1.40	4.45
16	0-20	10.1	0.01	7.88	0.30	2.92	0.70	2.00	0.24	0.04	0.80	1.60	0.58
	20-50	8.44	0.02	7.55	2.69	6.29	10.74	15.01	0.64	0.51	7.90	0.80	18.2
17	0-15	8.44	0.03	7.80	0.34	3.97	0.52	2.52	0.28	0.03	2.10	1.20	0.05
	15-50	16.9	0.07	8.09	0.51	10.18	0.28	4.60	0.13	0.12	1.20	3.20	0.73
	50-100	15.3	0.04	8.06	0.41	8.76	0.22	3.65	0.12	0.07	2.00	2.05	0.02

Table (4): The cation exchange capacity, exchangeable cations and exchangeable sodium percentage.

Profile No.	Layer	C.E.C meq/100g	ESP %	Exchangeable cations (meq/100 g)			
				Ca^{++}	Na^{+}	Mg^{++}	K^{+}
1	0-20	6.0	0.38	3.76	0.02	2.13	0.06
	20-50	6.5	9.66	4.75	0.63	1.02	0.08
	50-70	6.3	12.14	3.60	0.76	1.72	0.10
	70-100	4.0	5.00	3.35	0.20	0.40	0.03
2	0-30	4.2	8.76	1.12	0.37	2.54	0.17
	30-60	4.4	8.98	1.95	0.39	1.80	0.20
	60-100	5.3	9.02	3.46	0.48	1.20	0.17
3	0-10	3.4	4.60	1.32	0.16	1.12	0.80
	10-25	3.3	22.29	0.40	0.74	1.95	0.20
	25-60	3.0	27.10	0.25	0.81	1.75	0.18
	60-110	3.2	25.63	0.45	0.82	1.75	0.15
4	0-7	8.4	8.89	5.66	0.75	1.72	0.31
	7-17	6.9	9.02	4.35	0.62	1.70	0.19
	17-27	8.5	7.65	6.05	0.65	1.61	0.18
	27-50	4.5	14.56	2.98	0.66	0.75	0.13
5	0-10	3.2	0.95	1.00	0.03	2.02	0.08
	10-30	3.0	9.55	0.95	0.29	1.55	0.18
	30-90	3.1	8.02	1.15	0.25	1.53	0.15
6	0-7	4.2	0.24	0.20	0.01	3.88	0.12
	7-25	3.1	1.47	1.86	0.05	1.11	0.11
	25-50	2.5	8.89	0.50	0.22	1.58	0.18
	50-110	3.4	4.73	2.36	0.16	0.80	0.12
7	0-15	3.4	8.52	1.53	0.29	1.15	0.42
	15-35	3.6	37.50	0.30	1.35	1.55	0.40
	35-60	3.8	11.40	2.15	0.43	1.05	0.10
8	0-15	5.5	8.18	1.82	0.45	3.14	0.08
	15-45	5.0	10.70	3.05	0.54	1.21	0.19
	45-80	4.3	11.16	2.85	0.47	0.79	0.14
9	0-10	3.3	10.08	0.75	0.33	2.06	0.15
	10-40	3.0	12.91	1.57	0.39	0.83	0.19
	40-80	3.3	18.62	1.60	0.61	0.9	0.12
10	0-10	7.0	1.99	4.45	0.14	2.28	0.11
	10-50	4.5	22.94	2.05	1.03	1.20	0.19
	50-100	4.1	26.70	1.20	1.10	1.63	0.19

Cont. Table (4).

Profile No.	Layer	C.E.C meq/100g	ESP%	Exchangeable cations (meq/100 g)			
				Ca^{++}	Na^{+}	Mg^{++}	K^{+}
11	0-25	6.5	2.23	2.42	0.14	3.80	0.10
	25-75	7.5	1.50	6.70	0.11	0.60	0.09
	75-125	8.0	4.92	6.87	0.39	0.63	0.08
12	0-15	7.0	9.99	5.45	0.70	0.70	0.13
	15-60	4.3	15.48	2.4	0.66	1.02	0.15
	60-100	5.0	13.00	2.75	0.65	1.50	0.14
13	0-15	3.8	2.62	1.55	0.10	2.00	0.10
	15-70	4.8	16.51	1.20	0.78	2.50	0.24
	70-110	3.8	15.00	1.55	0.57	1.53	0.16
14	0-15	6.3	0.23	3.35	0.01	2.80	0.08
	15-30	4.3	2.46	2.22	0.10	1.74	0.18
	30-60	4.5	3.59	2.85	0.16	1.32	0.13
	60-100	6.5	0.90	5.35	0.06	0.96	0.07
15	0-20	6.3	1.60	5.10	0.10	0.96	0.09
	20-45	4.8	2.00	2.85	0.10	1.02	0.75
	45-80	6.3	1.52	5.11	0.10	0.96	0.08
16	0-20	5.0	1.50	3.85	0.08	1.00	0.07
	20-50	10.5	12.39	6.70	1.30	2.33	0.07
17	0-15	4.0	2.64	0.61	0.11	3.09	0.19
	15-50	3.5	22.07	0.85	0.77	1.79	0.07
	50-100	3.3	8.87	1.72	0.29	1.79	0.03

Soil salinity: The values of (EC) are shown in Table (3). EC values range from 0.22 to 3.26 dS/m in 1:5 soil: water extract. Most soil profiles didn't suffer from salinity problems except soil profiles No. 3, 4, 7 and 12 and the sub-surface layers of profiles No. 10, 15 and 16 which possess some salinity problems. The relatively high salinity of these profiles and layers is due to the effect of aridic conditions. Furthermore, those profiles are located on Kiseiba and Sabaya formations, which are deposited under lacustrine to coastal floodplain and shallow marine low energy environment.

Soil reaction (soil pH) and organic matter %: Soil pH values are mainly neutral or slightly to moderately alkaline. They range from 7.20 to 8.10. Meanwhile, these soils exhibit very low content of organic matter. It ranges between 0.01 % to 0.07%. The absence or poverty of organic matter is due to the aridity conditions in the study area (Table 3).

Soluble cations and anions: Sodium is the dominant cation in soil solution, followed by calcium. Sulfate and/or chlorine anions are the dominant anions (Table 3).The high amount of SO_4^{2-} and Cl^{1-} ions in the studied soil profile seems to be due to the mode of formation, which may reflect that deposits were formed under water environment of marine turbidity current deposition. Gypsum content are checked out in soil samples, to verify the reason of Sulfate presence, but there is no significant amount of gypsum where its percentage is less than 3% in all samples. Soil profile No. 3 show higher concentration of K^{1+} and SO_4^{2-} in the surface layer which may reflect the occurrence of potassium sulfate as a highly fertile layer.

Cation exchange capacity and exchangeable cations: The values of cation exchange capacity ranged from 2.5 to 10.5 meq/100 g of dry soil

(Table 4), with a standard deviation of 1.41 meq/100 g. The variation in cation exchange capacity is due to the differences in clay % and amount of the dominant clay mineral. The amounts of exchangeable cations indicate that Ca^{2+} is the dominant exchangeable cation (ranging from 0.2 to 6.87 meq/100 g of soil, average = 2.66, standard deviation = 1.84). Exchangeable Ca^{2+} is followed by Mg^{2+} which ranges between 0.4 to 3.88 meq/ 100 g of soil (average = 1.58, standard deviation = 0.76). Exchangeable Na ranged between 0.01 and 1.35 meq/ 100 g (average = 0.43 and standard deviation = 0.33). Exchangeable K is the lowest and ranged between 0.03 and 0.8 meq/ 100 g with an average of 0.17 and standard deviation of 0.14 .

Base saturation % and Exchangeable sodium percent: The base saturation percentage and the exchangeable sodium percentage of the studied soil samples are shown in Table (4). Base saturation of soil samples ranged between 99.6 % to 100 %. That is mainly ascribed to the arid conditions prevailing in the study area, where there is no leaching for basic cations. Exchangeable sodium percentage (ESP) of soil samples ranges between 0.23 and 37.5 % with an average of 9.62 %, and a standard deviation of 8.15 .

The origin of kaolinite in the studied soils is controversial. However, Inheritance is explanation for the genesis of kaolinite in these soils which are formed originally from igneous and metamorphic rocks. In the study area the chemical weathering is limited due to the prevailing aridity, therefore, it is expected that most of the minerals are rather inherited from the parent material. Furthermore, X - ray diffraction patterns depicted few very - week peaks characteristic for quartz (3.35 - 4.26 A^0), Calcite (3.03 A^0) and Fe Oxides (Goethite) (4.18 A^0). This exhibits the very poor crystallization of these accessory minerals in the clay fraction. However, they may be in better crystallization in the silt and sand fractions.

Table (5): Semi-quantitative mineralogical composition of the clay fraction (< 0.002 mm) separated from the studied soil profiles.

Profile No.	Depth	Clay mineral		Accessory minerals			
		Kaolinite	Mont.	Quartz	Calcite	Iron oxides	Others
1	20-50	Dominant	Common	Few	Few	Trace	Trace
4	17-27	Dominant	Moderate	Few	Few	Trace	Trace
9	10-40	Dominant	Trace	Trace	Trace	Trace	Trace
10	10-50	Dominant	Trace	Trace	Trace	Trace	Trace
11	25-75	Dominant	Dominant	Few	Trace	Trace	Trace
11	75-125	Dominant	Dominant	Few	Trace	Trace	Trace
14	60-100	Dominant	Trace	Few	Trace	Trace	Trace

Dominant > 40%, Common = 25-40%, Moderate = 15-25 %, Few = 5-15%, Trace<5%

Differential thermal analysis was carried out on some selected clay and silt fractions. DTA- patterns confirm the occurrence of the following minerals:

Kaolinite: endothermic peak at temperature ranging between (510- 530^{0}C) related to loss of structural water and the second peak is an exothermic reaction at temperature ranging between (910-962^{0}C) due to structural change.

Smectite: It exhibits three peaks, The first peak is an endothermic peak at low temperature ranging between (70 – 80 ^{0}C) due to the loss of adsorbed moisture. The second is a main endothermic peak at temperature ranging between (510 -530 ^{0}C) related to loss of structural water. The third peak is an exothermic reaction at temperature ranging between (840-860^{0}C) due to structural change.

Calcite: It gives an endothermic peak on DTA curves in all the studied samples at temperature ranging between (700-800 ^{0}C) due to the decomposition of the carbonate ions associated with calcium.

Goethite: It shows a small endothermic peak on DTA curves in all studied samples at temperature ranging between (275-325 ^{0}C) related to loss of hydroxyl water.

Gupsum: It exhibits a double endothermic peak on DTA curves in three samples (the second layer of profile 9, the second layer of profile No. 10, and the third layer of profile 11 at temperatures ranging between (100-105 ^{0}C) and at (135-160 ^{0}C) corresponding to loss of hydroxyl water in two stages.

Quartz: It yields a very small endothermic peak on DTA curves in the first layer in profile No. 16 at temperature 575 ^{0}C due to structural change of, α - quartz.

The IR technique verified the presence of kaolinite, Smectite, iron oxide, calcite and quartz (Figure 4).

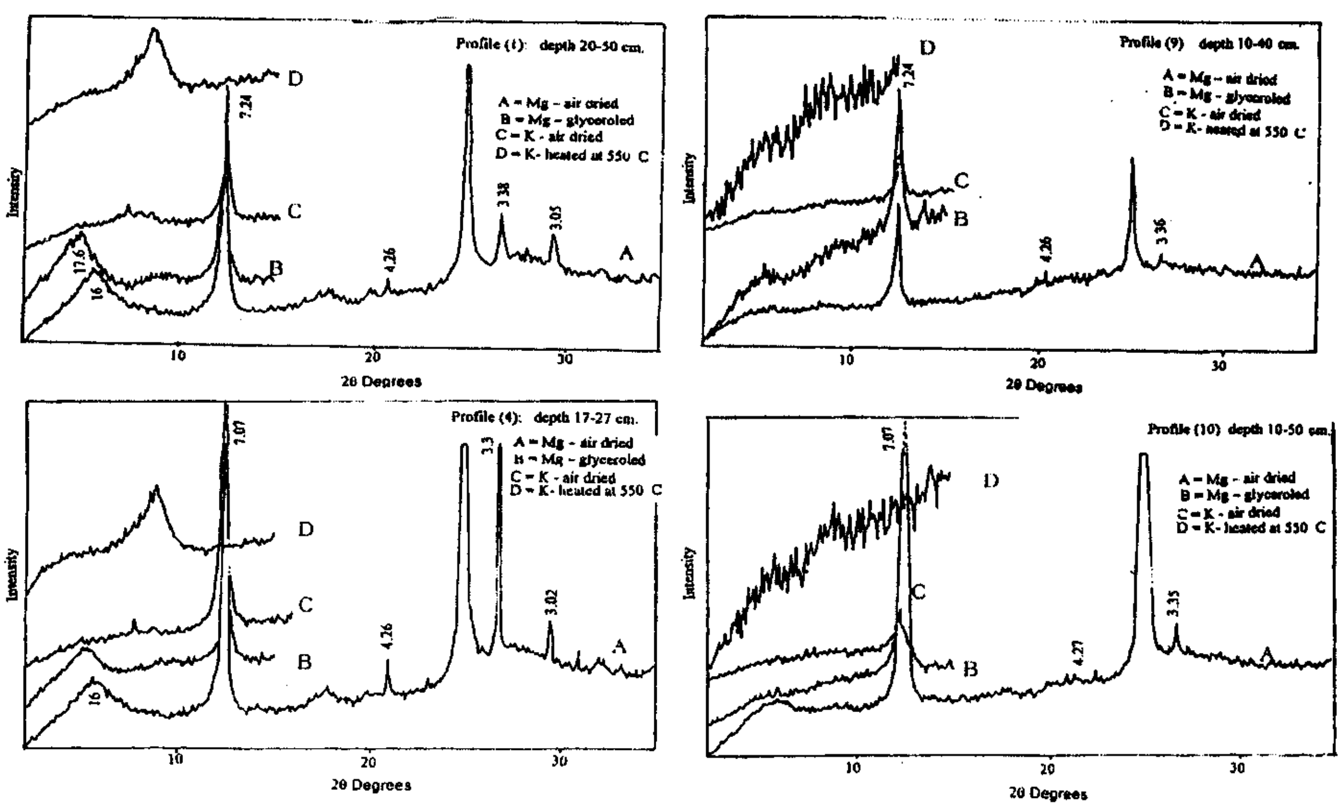
Kaolinite depicted significant broadening absorption bands at the 3620 cm^{-1}, 916 cm^{-1} and a very weak band at 795 cm^{-1} in all soil samples. Meanwhile, Smectite exhibited two main bands at 3622 and 915 cm^{-1}, IR patterns confirm the presence of kaolinite and Smectite in all examined samples. IR spectra detected absorption bands at 532, 450 cm^{-1} confirming the presence of iron oxides (hematite and goethite). Sharp IR absorption bands were detected for calcite at 1428 cm^{-1}. Few absorption bands were detected for quartz at 800 and 781 cm^{-1} in some soil samples.

- ***Mineralogical composition of fine sand fraction:***

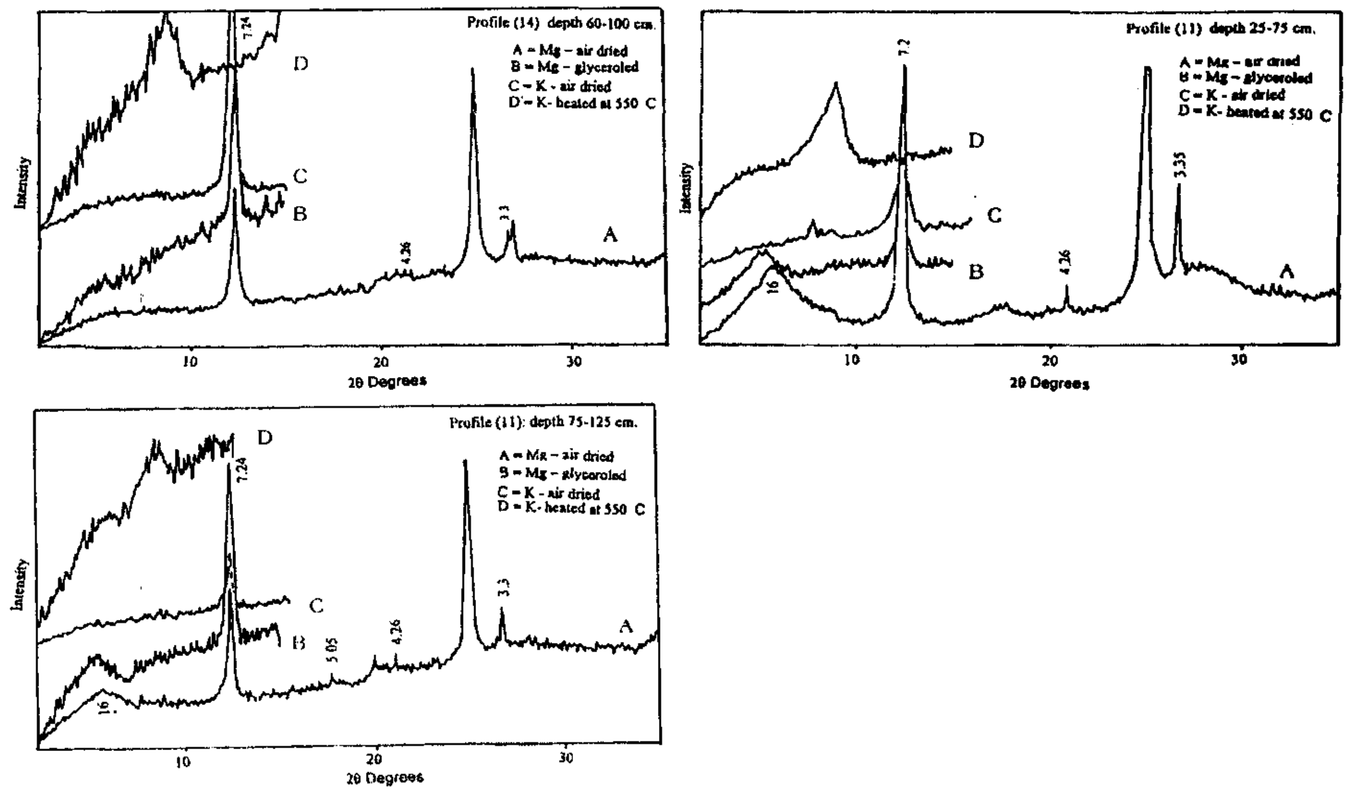
In order to study the mineralogy of the sand fractions (250-125 μ) of soil samples, light and heavy fractions were separated and examined. The percentages of heavy minerals were nearly the same for the studied soil samples (about 4%).

Light minerals data (Table 6) revealed that quartz is the dominant mineral (91-97 %). Few feldspar grains (mainly orthoclase) are also recorded (1 .8 – 3 %). Other minerals such as mica and glauconite in the fine sand grains are very rare (0.8 - 5.9%). Heavy minerals analysis is presented in Table (7). Opaque minerals constitute about 77% of the heavy fraction. The frequency distribution of non-opaque minerals showed that Pyroxenes and amphiboles are dominated (42-52 %) and (14-19 %), respectively. They were followed by zircon (5-12 %), epidote (3-12%) and biotite (6-10%). The frequency distribution pattern of the resistant minerals and their weathering ratios throughout the successive soil layers are presented in Table 8. Zircon/Rutile and Zircon/Tourmaline ratios ranged from (2.4 to 6.4) to (1.6 to 2.8), respectively. Higher pyroxene/zircon ratios were obtained (3.7 to 10). These results indicate that these soils are heterogeneous.

Fig. (3): X-ray diffraction patterns of clay fraction in the studied soil samples.



Cont. Fig. (3): X-ray diffraction patterns of clay fraction in the studied soil samples.



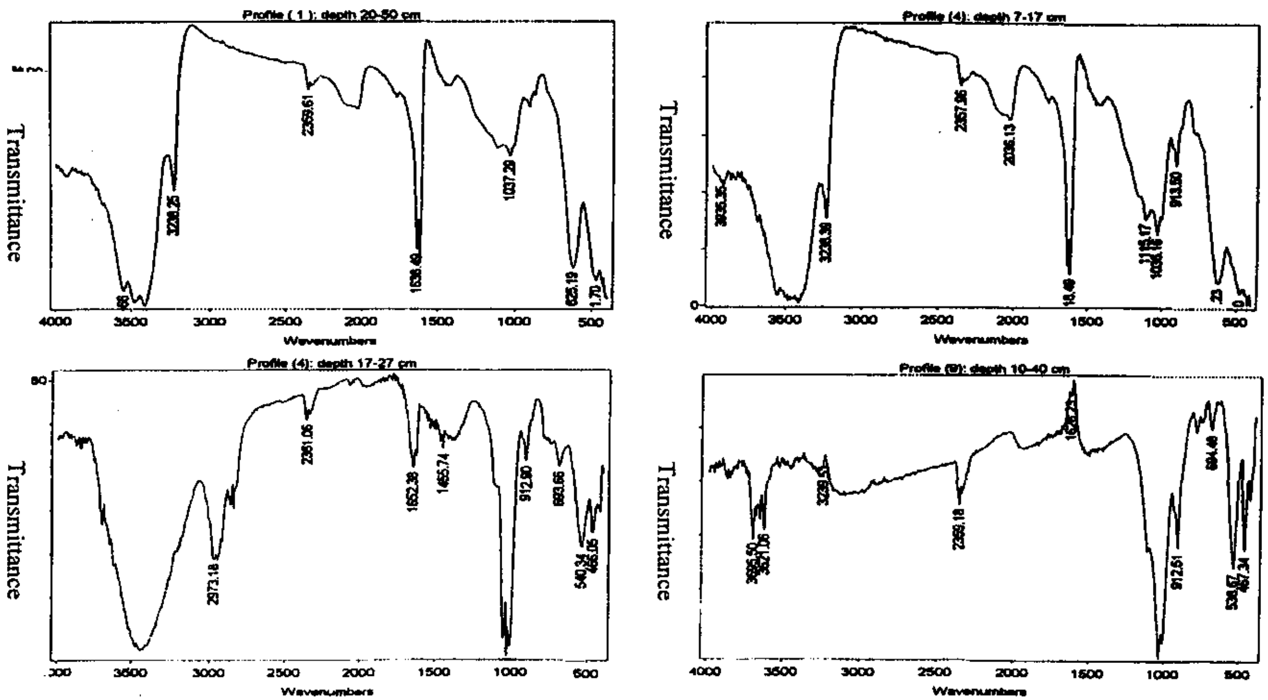
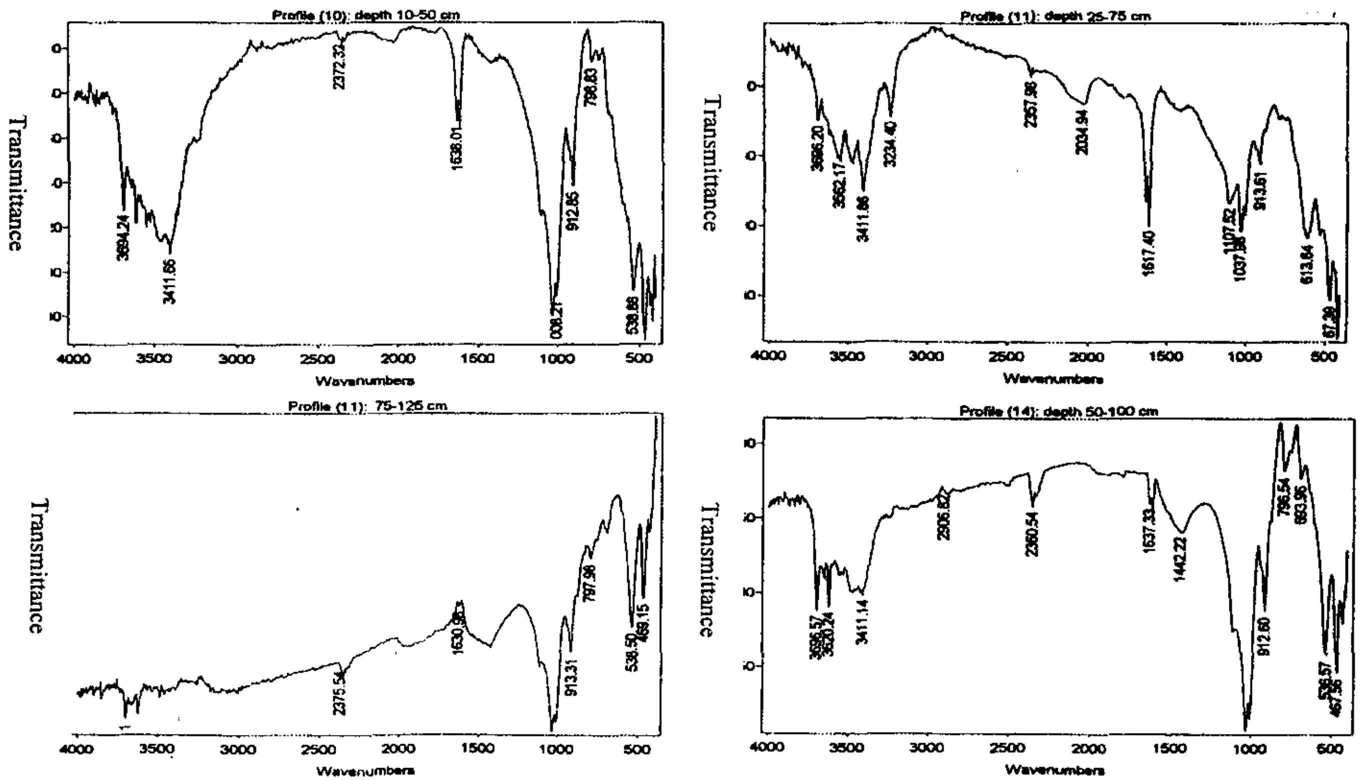
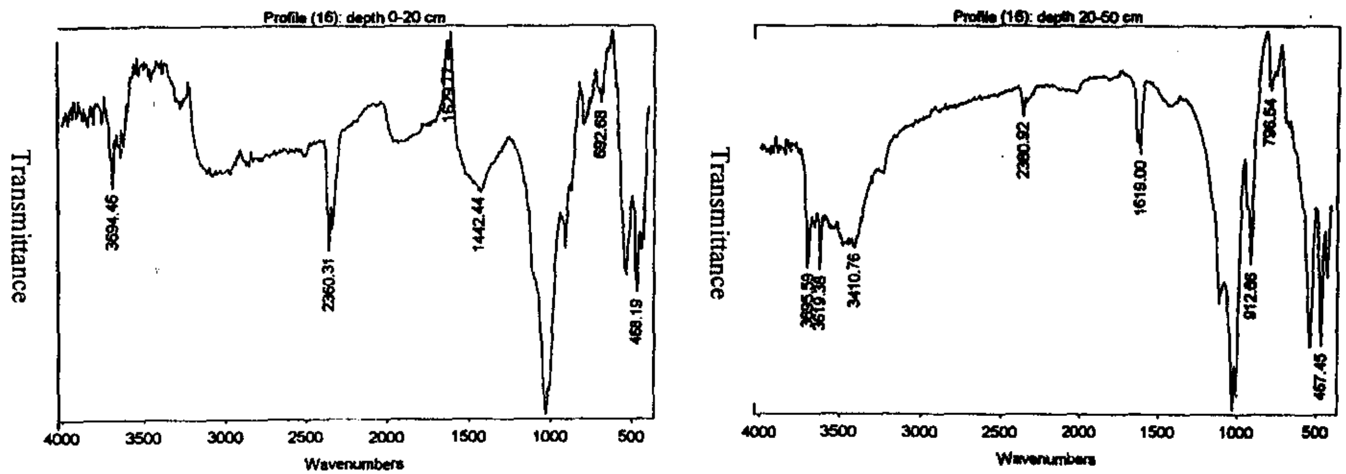


Fig (4): *Infrared analysis patterns of clay and silt fractions.*


Profile (10): depth 10-50 cm
Transmittance
Wavenumbers
Profile (11): depth 25-75 cm
Transmittance
Wavenumbers
Profile (11): 75-125 cm
Transmittance
Wavenumbers
Profile (14): depth 50-100 cm
Transmittance
Wavenumbers

Cont. Fig. (4).


Profile (16): depth 0-20 cm
Transmittance
Wavenumbers
3694.46
2360.31
1442.44
692.68
468.19
Profile (16): depth 20-50 cm
Transmittance
Wavenumbers
3695.59
3619.38
3410.76
2360.92
1619.00
912.86
796.64
467.45

Cont. Fig. (4).

Table (6): Percentage of light minerals.

Profile No.	Depth (cm)	Quartz	Feldspar	Other minerals
1	0-20	95.2	2.1	2.7
	20-50	95.3	1.9	2.8
	50-70	94.8	2.4	2.8
	70-100	94.7	2.4	2.9
4	0-7	93.3	2.5	4.2
	7-17	93.6	2.7	3.7
	17-27	93.5	2.6	3.9
	27-50	91.1	3.0	5.9
11	0-25	97.3	1.8	0.9
	25-75	97.4	1.8	0.8
	75-125	96.7	1.9	1.4

Table (7): Frequency distribution of non opaque heavy minerals in some studied soil profiles.

Profile No.	Depth (cm)	Pyroxene	Amphiboles	Zircon	Rutile	Tourmaline	Garnet	Staurolite	Kyanite	Sillimanite	Biotite	Epidote	Others
1	0-20	44.7	14.2	12.0	5.1	5.0	2.0	1.7	1.7	2.0	7.3	3.0	1.3
	20-50	44.2	14.6	11.1	4.3	4.0	2.2	1.6	1.5	1.5	7.0	5.4	2.6
	50-70	46.4	15.2	11.2	4.0	4.0	2.1	1.7	1.4	1.2	7.4	5.3	0.1
	70-100	43.5	17.0	9.2	3.5	3.8	2.1	1.5	1.6	1.0	10.0	6.2	0.6
4	0-7	42.5	17.0	6.5	1.2	3.5	1.9	1.5	2.0	1.7	7.9	12.0	2.3
	7-17	44.1	19.0	5.6	1.2	3.6	2.5	1.8	2.1	1.8	8.0	9.8	0.5
	17-27	43.2	18.2	6.4	1.0	3.4	2.0	1.9	1.9	1.6	8.2	10.2	2.0
	27-50	42.8	18.0	6.3	1.3	3.3	2.4	1.8	2.0	1.8	8.5	10.6	1.2
11	0-25	52.2	15.0	5.2	1.9	2.0	1.2	1.2	3.0	1.2	6.1	9.2	1.8
	25-75	50.0	14.5	7.5	2.2	3.2	1.2	1.3	3.1	0.8	6.0	8.5	1.7
	75-125	45.0	16.2	6.5	2.5	3.5	1.6	1.3	2.0	0.9	7.8	12.0	0.7

Table (8): Uniformity and weathering ratios.

Profile No.	Depth (cm)	Zr/R	Zr/T	Zr/R+T	A/Zr	P/Zr	E/Zr	G/Zr
1	0-20	2.4	2.4	1.2	1.2	3.7	0.3	0.2
	20-50	2.6	2.8	1.3	1.3	4.0	0.5	0.2
	50-70	2.8	2.8	1.4	1.4	4.1	0.5	0.2
	70-100	2.6	2.4	1.3	1.8	4.7	0.7	0.2
4	0-7	5.4	1.9	1.4	2.6	6.5	1.8	0.3
	7-17	4.7	1.6	1.2	3.4	7.9	1.8	0.4
	17-27	6.4	1.9	1.5	2.8	6.8	1.6	0.3
	27-50	4.8	1.9	1.4	2.9	6.8	1.7	0.4
11	0-25	2.7	2.6	1.3	2.9	10.0	1.8	0.2
	25-75	3.4	2.3	1.4	1.9	6.7	1.1	0.2
	75-125	2.6	1.9	1.1	2.5	6.9	1.8	0.2

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الخصائص الكيميائية و المعدنية لتربة توشكا

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دخلت منطقة توشكى (جنوب الصحراء الغربية) حيز الاهتمام باعتبارها مشروع مصر القومي الأول في مجال التوسع الزراعي الأفقي خارج وادي النيل والدلتا. و يعتبر التوسع الأفقي هو الحل الأول في مواجهة مشكلة الفجوة الزراعية التي تعاني منها دول القارة الأفريقية ومصر، و لذا فقد كان الهدف من هذه الدراسة هو:

دراسة الخصائص الكيميائية والمعدنية لبعض أراضي توشكى و قد أظهرت النتائج سيادة المكون الخشن (الرملي) بنسب تتجاوز ٧٠%. و وجد أن رتبة القوام السائدة هي الطميي الرملي sandy loam and Loamy sand مع وجود قوام طميي بصورة نادرة . كما ثبتت من دراسة المعادلات الإحصائية لمعاملات التوزيع الحجمي للحبيبات سيادة الترسيب بفعل المياه على قطاعات التربة المختلفة. و قد لوحظ بصفة عامة أن ملوحة التربة قليلة في معظم القطاعات، فيما عدا قطاعات قليلة مع الوضع في الاعتبار أن هذا الوضع قابل للتدهور بعد دخول نظم الري مما يستلزم وضع معدلات إضافية من المياه لغسيل التربة. و بالنسبة للكاتيونات و الأنيونات الذائبة والمتبادلة، فقد كانت السيادة في الحالة الذائبة للصوديوم يليه الكالسيوم بينما ساد أنيون الكبريتات و الكلوريد، أما في الحالة المتبادلة للكاتيونات فقد ساد كاتيون الكالسيوم. كما وجد أن السعة التبادلية الكاتيونية منخفضة بوجه عام و متناسبة مع التركيب المعدني للتربة ومحتواها من معادن الطين، و هي تتراوح بين ١,٧٢ إلى ١٠,٥ مللي مكافئ /١٠٠ جرام من التربة. هذا و تراوحت نسبة كربونات الكالسيوم بين ٢,٥ – ٢٥,١ % .

أما الدراسة المعدنية لقطاعات التربة المختارة فقد أظهرت سيادة معدن طين الكاؤلينيت مع تواجد أقل لمعدن طين المونتموريللونيت، بينما وجد الكوارتز ثم الكالسيت فالجيوسيت كمعادن مصاحبة. كما أظهرت الدراسة المعدنية للمكون الرملي سيادة الكوارتز على تركيبة المعادن الخفيفة Light minerals و تواجدت حبات من الفلسبار بدرجة أقل وضوحا، ينما كانت بقية المعادن الخفيفة نادرة الوجود للغاية . في حين شكلت المعادن المعتمة ٧٧ % من تركيب المعادن الثقيلة و ظهرت سيادة البيروكسين و الأمفيبولات على تركيب المعادن غير المعتمة، تلاهما الأبيدوت و البيوتيت. و هذا يوضح عدم تجانس الأرض من الناحية التركيبية.