Zagazig J.Agric. Res., Vol. 32 No. (1) 2005 183 - 203

PEDOLOGICAL STUDIES ON WADI ABAD SOIL EASTERN DESERT, EGYPT

Behiry, E.M.K.

Soil, Water and Environment Research Institute, Agric. Res. Center, Giza, Egypt.

Accepted 16 / 12 / 2004

ABSTRACT: The investigation was done on the soils of wadi Abad in order to give an account on their physical, chemical and mineralogical properties to evaluate their soil genesis and the degree of homogenity. Eight soil profiles were selected to represent the main geomorphic units of wadi Abad (wadi bottom, terraces, plain, river terraces and fan).

The data show that, the soil texture classes ranged from sand to clay loam, $CaCO_3$ content varied from 5.1 to 20%, while organic matter contents are extremely low. The soils are non saline to extremely saline and have neutral to moderately alkaline. Soluble cations are generally in order $Na^+ > Ca^{++} > Mg^{++} > K^+$, while the soluble anions Cl^- and $SO_4^=$ are alternatively dominated and exceeds HCO_3^- .Also, the data obtained reveal that moisture characteristies coincide very well with textural variations among soil profiles and layers.

The mineralogy of the sand fraction indicate that the light fraction is dominated by quartz which constitutes more than 91.33%, while orthoclase, plagioclase and microcline are found in minute amounts. Heavy minerals, on the other hand, are detected as opaques, amphiboles, pyroxenes, epidote and zircon in high amounts. Kyanite, rutile garnet and staurolite are also present but in relatively moderate amounts, while the remining minerals are found in less pronounced amounts.

Using the petrographic analysis of the studied samples and the ratios of Zr/T, Zr/R and Zr/T+R, data indicate that the soils have various members of heavy minerals in different levels. Results of the mineral assemblage and the resistant mineral ratios also confirm that the soils have a state of stratification due to the contamination of more than one parent material or to multi-depositional regimes.

The identification of the clay fraction using x-ray analysis, data reveal that smectite (montmorillonite) domintes the mineralogical composition of all the investigated geomorphic units followed by kaolinite illite, chlorite, vermiculite and palygroskite were also detected in small amounts. The identified accessory minerals, dominantly quartz and feldspars. Calcite and dolomite are detected in traceable amounts.

INTRODUCTION

The Eastern Desert occupies an area of 223,00sq.km. or about 21% of the total area of Egypt. It overlooks the Nile valley with high scarps cut by wadis flowing toward the River Nile from the Red Sea Mountains. Wadi Abad is located along the Eastern side of the Nile valley. Specifically, the investigated wadi is bounded by latitudes 24°, 50′ to 25°, 20′ North and longitudes 32°, 50′ to 33°, 20′ East. Fig. (1).

Topographically, wadi Abad could be differentiated from east to west a mountains landscape (Gabal Atod) followed by steep stoops ending with a bouldary landscope.The mountaine is dissected by a number of dry streams that had been found during more wet climatic periods that prevailed during geologic evolution of Egypt's land. Wadi Abad carried out the weathering products of Gabal Atod and deposited them eastwards. Wadi Abad extends from Idfu in the west to about of 20 km. in the east. This wadi area occupies about 30.000 feddans and is considered the most promising area for agricultural expansion.

Geology and geomorphology:

According to the geological map of Egypt, published by the Egyptian geological survey in (1981), wadi Abad is occupied by the sedimentary rocks belonging to the quaternary and Mesozoic formations, Said, (1962), and Abu Al-Izz, (1971). Wadi Abad is occupied by :

a) Quaternary deposits, composed of, older Nile deposits adjacent to the Nile valley, gravel-file and mud-fill playas.

b) Cretaceous formations, divided between; the undifeerentiated upper cretaceous and the Dakhala formation composed of shale, marl and limestone forward the Nile valley.

c) Nubia group, consisting of; Taref sand stone, and Quseir variegated shale.

According to the High dam Soil Survey project (HDSS), (1969), the

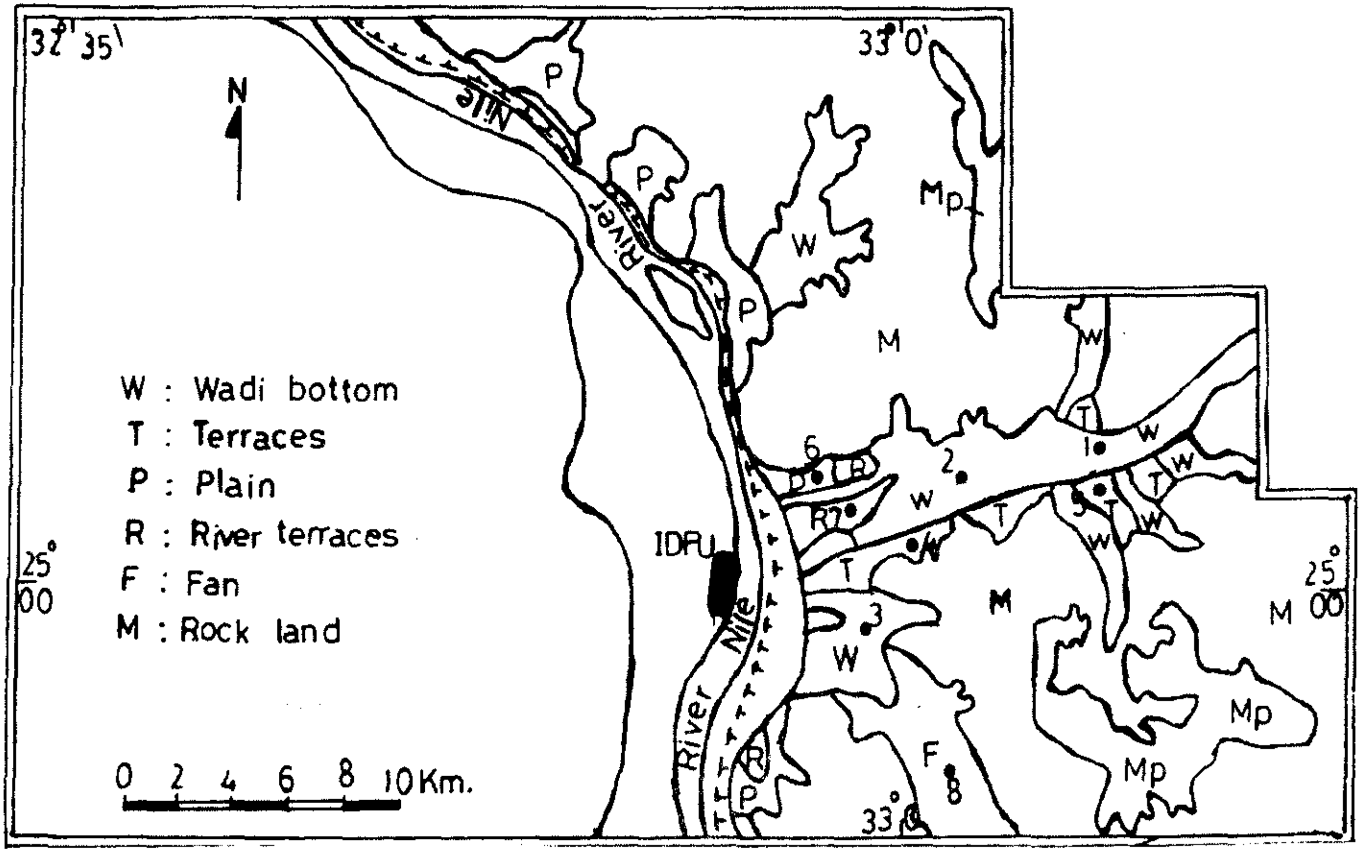

Fig. (1): Geomorphic units and profiles location of Wadi Abad area.

soils of wadi Abad could be assigned to five main geomorphic units. The soils of wadi Abad were classified into wadi bottom; fan, rubble terraces, plain and river terraces. Land Master plant (LMP) (1986) studied the soils of several transects across the HDSS mapping units. The survey was based on aerial photo and landsat images, and the soils are classified according to USDA (1975).

Therefore, the objective of the current work is to evaluate the physical, chemical and mineralogical characteristics of the soils of wadi Abad in order to increase the arable area to overcome the crucial sitution of the increasing population.

MATERIALS AND METHODS

Wadi Abad lies east of Idfu city in the eastern side of the River Nile (Fig. 1).

Eight soil profiles were chosen to represent the main geomorphic units. The morphological variations throughout the soil studied, were described following the Guidlines FAO (1990), Table (1). Soil samples were air dried, crushed sieved through 2mm sieve and subjected to the following analyses.

Mechanical analysis was carried out by the pipette method after Kilmer and Alexander (1949). EC and soluble ions of the soil saturation extract, according to the method described by Jackson, (1967). Soil pH was measured in the soil paste (Jackson, 1967). Organic matter content was determined using the Walkley and Black method Page, (1982). Moisture retention values were determined using the pressure cooker at 0.1 and 0.33 atm, and using the pressure membrane apparatus at 15 atm. (Richards, 1954).

Separation of the sand fraction:

After the ordinary treatment (Jackson, 1965), the sand fraction, (63-125 um) was separated from each sample by dry sieving method. Separation of light and heavy minerals was carried out following the procedure described by Brewer, (1964), where separatory fennel containing Bromoform (Sp. Gr. 2.85 ± 0.02)as a heavy liquid was adopted. Mounting of the mineral was under taken according to the method outlined by Brewer, (1964). Systematic identification of the light and heavy minerals was done using the optical properties as given by Milner, (1962).

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

Geomorphic unit	Profile No.	Depth (cm)	Colour		Texture	Structure	Consistency		Lower boundary
			Dry	Moist			Dry	Moist	
Wadi bottom	(1)	0-35	10 YR 7/4	10 YR 6/4	LS	s.g	Lo	n.s , n.p	cs
		35-80	10 YR 6/4	10 YR 6/4	SL	ma	So	s.s , s.p	cs
		80-150	10 YR 6/4	10 YR 6/4	SL	ma	So	s.s , s.p	-
	(2)	0-20	10 YR 7/4	10 YR 5/6	SL	s.g	Lo	s.s , s.p	cs
		20-70	10 YR 7/6	7.5 YR 5/6	SCL	w.c.sub	Fr	m.s , m.p	ds
		70-150	10 YR 5/6	7.5 YR 5/6	SCL	w.f.sub	Fr	m.s , m.p	-
	(3)	0-25	7.5 YR 7/6	7.5 YR 5/6	SL	s.g	Lo	s.s , s.p	ds
		25-55	7.5 YR 7/6	7.5 YR 5/6	SL	ma	So	s.s , s.p	ds
		55-100	7.5 YR 7/4	7.5 YR 5/6	SL	ma	So	s.s , s.p	cs
		100-150	7.5 YR 7/6	7.5 YR 5/6	LS	ma	So	n.s , n.p	-
Terraces	(4)	0-40	10 YR 7/4	10 YR 7/6	LS	s.g	Lo	n.s , n.p	cs
		40-90	7.5 YR 7/6	7.5 YR 5/6	SL	ma	So	s.s , s.p	ds
		90-150	7.5 YR 6/6	7.5 YR 5/6	SL	ma	So	s.s , s.p	-
	(5)	0-20	10 YR 7/4	10 YR 6/4	LS	s.g	Lo	n.s , n.p	ds
		20-80	5 YR 5/7	5 YR 4/8	LS	ma	So	n.s , n.p	ds
		80-150	5 YR 5/8	5 YR 4/8	LS	ma	So	n.s , n.p	-
Plain	(6)	0-20	10 YR 5/4	10 YR 4/4	SL	s.g	Lo	s.s , n.p	cs
		20-85	10 YR 5/4	10 YR 4/4	SCL	w.c.sub	Fr	m.s , m.p	ds
		85-150	7.5 YR 8/6	7.5 YR 6/8	SCL	w.f.sub	Fr	m.s , m.p	-
River terraces	(7)	0-35	10 YR 7/3	10 YR 6/3	CL	w.c.sub.bl	Fr	v.s , v.p	ds
		35-70	10 YR 6/6	10 YR 5/4	CL	m.f.sub.bl	Fr	v.s , v.p	cs
		70-150	10 YR 6/4	10 YR 5/4	SICL	m.f.an.bl	Fr	v.s , v.p	-
Fan	(8)	0-30	10 YR 7/4	10 YR 6/4	LS	s.g	Lo	n.s , n.p	cs
		30-60	10 YR 7/6	10 YR 6/4	S	ma	So	n.s , n.p	ds
		60-100	10 YR 8/3	10 YR 6/3	S	ma	So	n.s , n.p	ds
		100-150	10 YR 7/3	10 YR 6/3	S	ma	So	n.s , n.p	-

Texture		Structure		Consistency		Lower Boundary
S : Sand	LS : Loamy sand	s.g : single grain	sub : subangular	Lo : Loose	s.s : slightly sticky	c : clear
C : Clay	Si : Silt	ma : massive	bl : blocky	So : Soft	m.s : moderately sticky	s : smooth
SCL: Sandy clay loam	L : Loam	w : weak	f : fine	Fr : Friable	v.s : very sticky	d : diffuse
SL : Sandy loam		c : coarse		n.s : non sticky	p : plastic	

Separation of the clay fraction:

The soil samples were treated with, 1N Na OAc (pH 5) and H_2O_2 to remove carbonates and organic matter respectively. But removal of free iron oxides by sodium citrate, bicarbonate, dithionite mixture, (Jackson, 1965). After complete dispersion of the samples in distilled water, the soils were separated by sedimentation.

X-ray diffraction analysis was carried out on the clay fraction less than 2u in diameter using Philips PW 1140/90v-ray apparatus, with Ni filter and K_{α} Cu radiation. Oriented clay samples were prepared on glass slides and examined as:

1) Mg-saturated, air dried,
2) Mg-saturated, glycerol solvated and
3) K-saturated, heated to 550°C for 4 hrs.

The obtained X-ray diffraction analysis were interpreted in light of the tables presented by Brown, (1961). Semi-quantitative estimation of the clay minerals proportions was then conducted by measuring the peak areas outlined by Gjems, (1967).

RESULTS AND DISCUSSION

1- Physical and chemical properties:

Due to the geomorphic unit basis, the soils of wadi Abad could be classified into the following:

1- Soils of wadi bottom (represented by profiles 1,2 and 3).
2- Soils of terraces (profiles 4 and 5).
3- Soils of plain(profile 6).
4- Soils of river terraces (profile 7).
5- Soils of fan (profile 8).

1- Soils of wadi bottom:

Wadi bottom represent the lower parts of the natural drainage pathways showing one or more stream beds. Topography of this geomorphic unit is almost flat gently sloping towards the River Nile. The surface is barren from natural vegetation and covered with desert pavment. The analytical data given in Tables (2 and 3) show that texture class of these soils ranges from loamy sand to sandy clay loam. $CaCO_3$ content varied between 5.1 and 19.9% which is regularly distributed with depth. Organic matter content is very low not exceed 0.08% reflecting the hyper arid climatic conditions of the area and the absence of vegetation cover. The chemical composition of the soil saturation extract, (Table 3) shows

Table (2): Particle size distribution, $CaCO_3$, OM contents and texture class of the studied soil profiles

Geom. unit	Profile No.	Depth, (cm)	$CaCO_3$ (%)	OM (%)	Particle size distribution (%)				Texture class
					C. sand	F. sand	Silt	Clay	
Wadi bottom	(1)	0-35	10.5	0.05	35.5	54.5	4.5	5.5	L.S
		35-80	19.9	0.03	68.3	11.7	10.1	9.9	S.L
		80-150	17.8	0.03	75.2	9.5	10.8	4.5	SL.
	(2)	0-20	10.9	0.08	55.2	13.8	17.7	13.3	S.L
		20-70	5.5	0.05	48.1	23.3	7.5	21.1	S.C.L
		70-150	5.1	0.05	45.8	28.6	4.5	23.2	S.C.L
	(3)	0-25	15.1	0.06	69.4	13.7	11.1	5.8	S.L
		25-55	13.6	0.05	75.5	4.6	9.9	10.0	S.L
		55-100	19.1	0.02	75.0	10.1	10.0	4.9	S.L
		100-150	7.2	0.02	72.4	12.3	7.7	7.6	L.S
Terraces	(4)	0-40	12.2	0.05	43.2	43.5	2.5	10.8	L.S
		40-90	16.8	0.04	42.3	40.6	5.6	11.5	S.L.
		90-150	20.0	0.02	65.4	20.8	3.5	13.3	S.L
	(5)	0-20	13.0	0.05	65.3	24.0	4.0	6.7	L.S
		20-80	10.2	0.03	56.5	29.6	6.3	7.6	L.S
		80-150	13.6	0.03	60.4	31.7	2.6	5.3	L.S
Plain	(6)	0-20	6.3	0.10	52.6	18.3	14.4	14.7	S.L
		20-85	4.5	0.02	36.3	33.4	8.8	21.5	S.C.L
		85-150	4.3	0.02	35.1	35.8	8.8	20.3	S.C.L
River terraces	(7)	0-35	15.5	0.30	21.3	25.4	30.8	22.5	C.L
		35-70	18.4	0.10	12.5	40.9	22.5	24.1	C.L
		70-150	12.9	0.10	14.1	14.8	51.3	20.2	Silt clay loam
Fan	(8)	0-30	15.2	0.06	75.7	9.6	11.8	2.9	L.S
		30-60	17.6	0.02	80.2	8.1	9.7	2.0	S
		60-100	10.4	0.02	80.2	12.4	4.6	2.8	S
		100-150	12.5	0.01	81.5	8.3	8.8	1.4	S

Table (3): Chemical composition of the soil saturation extract of the studied soil profiles.

Geom. unit	Profile No.	Depth, (cm)	pH	EC (dS/m)	Soluble ions (me/L)							
					Cations				Anions			
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
Wadi bottom	(1)	0-35	7.6	1.6	3.4	3.0	9.1	0.5	-	2.0	11.0	3.0
		35-80	7.6	4.5	3.2	5.0	36.1	0.7	-	2.8	38.2	4.0
		80-150	7.4	3.4	3.1	3.0	27.1	0.8	-	2.0	29.8	2.2
	(2)	0-20	7.5	9.0	27.5	11.2	50.7	0.6	-	2.3	77.5	10.3
		20-70	7.5	8.5	24.3	10.1	55.0	0.7	-	2.4	78.4	9.3
		70-150	7.6	8.4	25.4	11.4	49.0	0.8	-	2.5	72.3	12.0
	(3)	0-25	8.2	21.3	55.0	28.2	153.6	0.8	-	12.0	174.6	51.0
		25-55	7.5	116.0	55.0	30.3	1188.0	2.8	-	20.0	1195.0	61.0
		55-100	7.9	62.7	40.0	18.5	629.0	1.8	-	14.0	629.0	46.0
		100-150	7.9	52.5	40.0	19.5	484.0	1.6	-	12.0	484.0	44.0
Terraces	(4)	0-40	7.9	1.3	2.7	2.5	7.1	0.7	-	1.8	8.0	3.2
		40-90	7.7	1.4	3.5	2.5	7.5	0.5	-	2.4	8.1	3.5
		90-150	7.6	2.4	4.0	3.0	16.1	0.9	-	2.0	18.0	4.0
	(5)	0-20	7.2	36.9	120.1	80.2	223.3	0.8	-	13.1	310.9	100.4
		20-80	8.1	2.1	4.1	4.0	12.1	0. 9	-	3.2	14.2	3.6
		80-150	8.0	1.8	3.7	3.5	10.1	0.7	-	3.1	11.2	3.7
Plain	(6)	0-20	8.2	4.3	17.0	4.4	24.2	1.0	-	7.4	28.4	11.0
		20-85	8.2	6.7	15.6	8.4	45.2	1.1	-	10.0	48.0	12.4
		85-150	7.9	8.8	23.6	17.5	53.4	1.1	-	10.5	71.8	13.3
River terraces	(7)	0-35	8.2	1.9	6.9	2.7	8.8	0.7	-	2.4	15.9	0.7
		35-70	8.1	4.0	11.7	7.3	20.0	1.0	-	4.1	30.2	5.7
		70-150	8.1	3.5	11.2	7.1	16.2	0.5	-	5.6	24.4	7.0
Fan	(8)	0-30	7.5	12.1	44.0	20.6	70.4	1.0	-	8.5	91.1	38.4
		30-60	7.8	6.9	21.8	9.4	40.2	1.4	-	4.5	52.3	16.2
		60-100	7.8	7.5	23.0	7.6	46.2	1.5	-	5.5	54.3	18.2
		100-150	7.9	6.5	22.0	12.8	31.6	1.6		8.5	40.5	20.0

that soil reaction is slightly alkaline to moderately alkaline as revealed by pH values which ranged between 7.4 to 8.2. the soils are non saline to strongly saline as shown by EC values which ranged from 1.6 to 166 dSm^{-1}. The cationic composition are dominated by Na^+ followed by Ca^{++}, Mg^{++} and K^+. The anionic composition is dominated by Cl^- followed by $SO_4^=$ and HCO_3^-.

2- Soils of terraces:

Soils of terraces are generally high elevation, almost flat to undulating surface covered with some scattered natural vegetation and composed of coarse texture in all subsequent layers and are mainly affected by both past and current erosional processes with different degrees. These soils are represented by profiles 4 and 5. Table (2) reveals that soil texture of terraces are variable from loamy sand to sandy loam. $CaCO_3$ content ranges from 10.2 to 20.0%. Organic matter content is extremely low and not exceed 0.05% owing to the prevailing aridity of the region. Table (3) shows that the soils of terraces are neutral to moderately alkaline (pH values ranged from 7.2 to 8.1). Soils are non saline as indicated by ECe values which ranged from 1.3 to 2.4 dSm^{-1}, except for the surface layer of profile 5 which is strongly saline. The cationic composition could be arranged in the descending order; $Na^+ > Ca^{++} > Mg^{++} > K^+$, while the anionic composition is dominated by Cl^- followed by $SO_4^=$ and HCO_3^-.

3- Soils of plain:

These soils occupy a narrow strip covered with desert pavment and sand hummock, extended from Nile alluvial soils and river terraces. Topography of this unit is almost flat to gently undulating. Table (2) reveals that soil texture class is sandy loam in the surface layer changed into sandy clay loam in the deepest layers. $CaCO_3$ content is very low and ranges from 4.3. to 6.3% which is irregular distribution pattern with depth. Organic matter is extremely low not exceed 0.1%. Data in Table (3) show that soil reaction of the respentive layers of soil profile are moderately alkaline as pH values of soil paste fluctuate from 7.9 to 8.2. Values of EC ranged from 4.3 to 8.8 dSm^{-1} indicating that the soils are slightly saline to moderately saline. The cationic composition could be arranged in the descending order $Na^+ > Ca^{++} > Mg^{++} > K^+$, while the anionic composition is dominated by Cl^- followed by $SO_4^=$ then HCO_3^-.

4- Soils of river terraces:

This geomorphic unit is extending in the eastern part of the cultivated area and represented by profile 7. Topography is almost flat to gently undulating and remnants of old Nile deposits (fluvial soils) deposited by the Nile in Sabilian Period. Table (2) shows that texture class vary from clay loam in the upper most surface layers and silty clay loam in the deepest layers. $CaCO_3$ content ranges from 12.9 to 18.4% with an irregular distribution pattern with depth. Organic matter content is very low not exceed 0.3%. Data in Table (3) indicate that soil reaction of the representive profile is moderately alkaline as pH values of soil paste fluctuate from 8.1 to 8.2. Values of ECe ranged from 1.9 to 4.0 dSm^{-1} indicating that the soils are non saline. The cationic composition could be arranged in the descending order $Na^+ > Ca^{++} > Mg^{++} > K^+$, while the anionic composition is dominated by Cl^- followed by $SO_4^=$ and HCO_3^-.

5- Soils of fan:

This geomorphic unit located in the south studied area and extend about 10 km. in length with a width ranging between 2 and 3 km. The surface is mainly almost flat and covered with desert pavment, aeolian and alluvial deposits.

Table (2) reveals that the fan soils are mainly composed of coarse texture class (loamy sand in the surface layer and sand in the deepest layers). $CaCO_3$ content ranges between 10.4 to 17.6% without significant variations between the successive horizons depth. Organic matter content is about 0.06% or less. The analytical data in Table (3) shows that the soils of fan are slightly to moderately alkaline (pH value ranges from 7.5 to 7.9). Soils are slightly to moderately saline as indicated by EC values which ranged from 6.5 to 12.1 dSm^{-1}. The dominant cations of soil extract are Na^+ followed by Ca^{++}, Mg^{++} and K^+, while anions can be arranged in descending order of abundance as $Cl > SO_4^= > HCO_3$.

2- Moisture characteristics:

Undisturbed soil samples were collected from the soils of wadi Abad to determine their soil moisture characteristics. The saturated soil samples were subjected to different suction levels ranged from 0.1 to 15 atm.

The data in Table (4) represent the percentages of retained moisture on volume basses at any particular suction. From the data presented in Table (4), it can be noticed that soil moisture content decreases by

Table (4): Percentage of soil moisture contents on volume at different tension values of the studied soil profiles.

Geomorphic unit	Profile No.	Depth, No.	Moisture (%)			Available moisture (%)
			0.10 atm.	0.33 atm.	15 atm.	
Wadi bottom	(1)	0-35	9.17	6.51	5.21	3.96
		35-80	14.1	10.22	8.12	5.98
		80-150	12.9	9.60	7.62	5.28
	(2)	0-20	10.32	8.3	4.36	5.96
		20-70	22.54	14.8	10.50	12.04
		70-150	25.6	15.1	10.80	14.8
	(3)	0-25	12.90	9.41	7.30	5.60
		25-55	18.20	10.32	9.50	8.70
		55-100	10.61	8.51	5.41	5.20
		100-150	9.50	6.40	4.72	4.78
Terraces	(4)	0-40	9.35	7.25	5.91	3.44
		40-90	11.48	9.10	6.94	4.54
		90-150	10.23	7.10	5.81	4.42
	(5)	0-20	8.81	6.26	5.00	3.81
		20-80	9.45	7.16	5.64	3.81
		80-150	8.27	6.13	4.65	3.62
Plain	(6)	0-20	28.35	19.26	12.41	15.94
		20-85	40.61	36.52	15.85	24.76
		85-150	43.22	37.12	18.21	25.01
River terraces	(7)	0-35	45.78	36.81	25.13	20.65
		35-70	48.23	35.41	24.16	24.07
		70-150	43.26	29.92	20.12	23.14
Fan	(8)	0-30	14.6	12.4	7.51	7.09
		30-60	9.55	6.61	5.12	4.43
		60-100	8.13	5.41	4.17	3.96
		100-150	7.16	4.84	3.25	3.91

increasing the applied suction. The soils of plain and river terraces exhibit the highest soil moisture contents at any particular suction and the decreases in their moisture contents by increasing suction levels are gradual. Also, the data in Table (4) indicate that the soils of plain and river terraces contain the highest values of available soil water which are ranged from 15.94 to 25.01%. This is due to the presence of certain clay minerals. The clay minerals are known to have a quite high specific surface area to retain moisture.

Regarding to the coarse textured soils of wadi bottom, terraces and fan, data in Table (4) reveal that these soils are characterized by low moisture content at any of the applied suction. It can be noticed that the soil moisture contents decrease by increasing sand content at any particular suction. This behaviour is due to the absence of finer fractions and OM which if present they are mostly of invective finely distigrated coarse texture class. The data also showed that the soils of wadi bottom, terraces and fan contain the lowest values of available soil water which are ranged from 3.44 to 14.8%. These due to rendered to the low energy of water retention on these soils and low specific surface of the coarse textured sediments as well as absence of O.M. Moreover, the slight variations in retained moisture are ascribed to the narrow change in the fine fractions content of these soils.

Mineralogy of the sand fraction:

Tables (5 and 6) present the distribution of light and heavy minerals respectively in the sand fraction of the investigated profiles as well as their distribution throughout the entire depth of each profile. Included also the ratios between the highly resistant minerals and those susceptible to weathering.

To discuss the obtained results, it is found convenient to present them as follows:

Light minerals:

Examination of the light minerals (Sp.Gr.<2.85) revealed that this fraction is composed almost entirely of quartz which constitutes more than 91.33%, (Table, 5). Other associated light minerals are mainly orthoclase and plagioclase, while microcline is detected yet percent. Quartz minerals ranged between 91.33% in the soils of fan and 98.82% in the soils of terraces. Considering the vertical distribution of such mineral, quartz show minute variations with depth. Total feldspars percent varies from

1.08 to 8.67%. The highest percent is noticed in the subsurface layer of profile 8 (fan), while the lowest is in the subsurface layer of profile 4 (terraces). Also, the dominance of quartz over than other members of the light fractions mostly related to its resistance to weathering and the disintegration during the multi-cyclic processes of sedimentation.

Heavy minerals:

The detected minerals in the heavy fraction are dominated by opaques which form the main constituent of such fraction. These minerals were counted and reported as opaques because it was not possible to identify their individuals, i.e., magnetite, ilmenit ete. (Table, 6).

Other identified minerals are amphiboles, pyroxenes, epidote, zircon, rutile, garnet, staurolite, kyanite, tourmaline and biotite in different frequency percentages depending on the profile location and its depth. When the non-opaques are considered as 100%, an account on their relative distribution could be interpreted in the following.

Amphiboles: Amphiboles are the dominant non-opaque minerals in most cases. Their frequency ranges between 10.78% (terraces, profile 4) and 51.77% (river terraces, profile 7). The vertical distribution of amphiboles does not portray any specific pattern with depth, except for the soils of wadi bottom (profile 2) which amphiboles tend to increase with depth, while in profile 4, amphibole decreases with depth.

Pyroxenes: pyroxenes content ranged widely from 10.85% (terraces, profile 4) to 29.73% (fan, profile 8). Its vertical distribution does not shown any particular tend with depth.

Garnet: Garnet is presented in all the studied samples and its frequency varies between 1.42% (fan, profile 8) and 8.10% (river terraces, profile 7). Its vertical distribution does not shown any specific pattern with depth, except for profile 4 and 8 which garnet tends to decrease with depth.

Staurolite: It is recorded in all the studied samples and varies widely from 1.31 to 6.74 with an irregular distribution pattern with depth, except for profile 2, which staurolite tends to decrease with depth.

Kyanite: Its percentage ranges between 1.27 and 8.42% of the non opaques being characterically high for the surface layer of profile 6 (plain), while its lowest value is found in the deepest layer of profile 7 (river terraces).

Table (5): Frequency distribution of light minerals in the sand fraction (0.125-0.063 mm) of the studied soil profiles.

Geomorphic unit	Profile No.	Depth (cm)	Quartz	Feldspars			Total
				Orthoclase	Plagioclase	Microcline	
Wadi bottom	(2)	0-20	97.10	2.04	0.87	-	2.91
		20-70	93.75	2.36	1.72	0.17	4.25
		70-150	96.14	2.10	1.40	0.36	3.86
Terraces	(4)	0-40	96.67	1.61	0.95	0.78	3.34
		40-90	98.92	0.75	0.33	-	1.08
		90-150	98.38	0.88	0.74	-	1.62
Plain	(6)	0-20	97.28	1.20	1.01	0.51	2.72
		20-85	97.20	1.57	0.90	0.33	2.80
		85-150	97.38	1.21	1.10	0.31	2.62
River terraces	(7)	0-35	92.58	3.85	2.19	1.38	7.42
		35-70	93.10	2.59	2.59	1.72	6.90
		70-150	95.77	2.38	1.46	0.39	4.23
Fan	(8)	0-30	93.23	2.93	2.27	1.57	6.77
		30-60	91.33	4.35	2.77	1.55	8.67
		60-100	97.29	1.53	1.00	0.18	2.71
		100-150	93.48	2.59	2.21	1.72	6.52

Zircon: It is recorded in all the studied samples and its amounts ranged from 2.15% (river terraces, profile 7) to 18.66% (fan, profile 8). The vertical distribution of zircon shows decrease with depth in profiles 2,6 and 7 whereas, an irregular distribution is observed in the rest of the studied profiles.

Rutile: It is detected in all the examined soil samples and vary from 0.47 to 8.27% with an irregular distribution pattern with depth. The lowest amounts are recorded in the subsurface layer of profile 7 (river terraces), while the highest amounts are found in the 60-100 cm depth of profile 8 (fan).

Table (6): Frequency distribution of heavy minerals in the sand fraction (0.125 – 0.063 mm) and uniformity ratios of the studied soil profiles.

Geomorphic unit	Profile No.	Depth (cm)	Non – Opaques (%)													Uniformity ratios		
			Opaques	Pyroxenes	Amphiboles	Garnet	Saturolite	Kyanite	Sillimanite	Zircon	Rutile	Tourmaline	Biotite	Epidote	Monazite	Zr/R	Zr/T	Zr/T+R
Wadi bottom	(2)	0-20	43.17	26.00	15.55	5.92	6.68	4.03	-	15.13	7.10	4.77	0.92	12.42	0.60	2.13	3.17	1.27
		20-70	48.75	27.79	17.24	2.64	5.82	7.44	-	11.32	3.72	2.81	2.34	16.13	-	3.04	4.03	1.73
		70-150	41.26	20.30	24.36	7.35	4.35	5.71	0.34	9.50	6.35	5.31	1.31	10.62	-	1.50	1.79	0.81
Terraces	(4)	0-40	48.20	10.85	27.22	7.10	6.74	5.26	-	6.97	2.22	1.03	0.17	30.23	-	3.14	6.77	2.14
		40-90	56.91	15.00	18.21	5.01	2.32	4.71	0.02	10.37	5.80	5.05	0.82	32.10	-	1.79	2.05	0.96
		90-150	49.60	14.65	10.78	4.93	5.21	6.37	-	5.76	1.69	2.85	1.23	43.80	0.42	3.41	2.02	1.27
Plain	(6)	0-20	44.21	22.01	30.09	3.50	4.88	8.42	-	9.17	2.31	1.70	1.30	12.51	0.13	3.97	5.39	2.29
		20-85	40.00	23.64	17.72	4.77	3.44	2.14	-	4.92	2.57	0.72	1.40	38.20	-	1.91	6.83	1.50
		85-150	35.10	15.86	48.16	4.49	6.52	1.82	-	3.06	1.71	1.36	0.84	13.64	-	1.79	2.25	0.99
River terraces	(7)	0-35	45.61	13.23	51.77	2.17	1.31	3.09	-	5.10	2.39	1.91	0.79	13.22	0.10	2.13	2.67	1.19
		35-70	31.20	28.68	30.10	2.95	3.03	1.27	-	3.08	0.47	0.32	0.10	28.71	-	6.55	9.63	3.90
		70-150	37.20	20.77	39.53	8.10	2.74	1.02	-	2.15	1.88	0.51	0.37	20.93	-	1.14	4.22	0.90
Fan	(8)	0-30	60.30	18.27	21.11	5.45	1.40	6.33	-	18.66	6.07	4.42	0.13	14.54	-	3.07	4.22	1.78
		30-60	51.72	14.13	30.70	3.42	2.93	4.29	-	13.37	5.69	6.57	1.01	17.14	0.20	2.35	2.04	1.09
		60-100	55.17	26.28	16.89	3.29	6.31	8.06	0.66	13.64	8.27	5.63	1.10	8.71	-	1.65	2.42	0.98
		100-150	49.60	29.73	22.02	1.42	4.04	5.68	0.41	11.22	6.19	4.81	0.37	12.11	-	0.20	2.33	1.02

Zr = Zircon , R = Rutile , T = Tourmaline

Tourmaline: It is presented in a variable amounts, ranges between 0.32 to 6.57% of the non-opaque minerals. The highest percent characterizes the subsurface layer of profile 8 (fan), whereas the lowest one in exhibite in the subsurface layer of profile 7 (river terraces).

Biotite: It is presented in most of the examined soil samples and its content ranges from 0.10 to 2.34% of the non opaque mineral. Depth wise distribution of biotite mineral does not portray any specific pattern with depth.

Epidote: They are detected in all the studied samples and vary from 8.71 (fan, profile 8) to 43.8% (terraces, profile 4) with an irregular distribution with depth, except for profile 4 which epidote tends to increase with depth.

From the former discussion it can be concluded that opaque, pyroboles, epidote and zircon are the most abundant minerals. Kyanite, rutile, garnet and staurolite are presented in relatively moderate amounts, while the remaining minerals are found in less pronounced amounts.

Uniformity of soil materials:

The heavy mineralogical analysis data can be used for evaluation of homogenity or heterogeneity of soil material. This is based on the assumption that certain minerals are most resistant to weathering during course of soil sediments development (Brewer, 1964).

Such minerals are termed as the index minerals. Generally, there is an agreement to consider zircon, tourmaline and rutile as index minerals because of their stability under any weathering processes (Mitchell, 1975). In this respect, and/or the ratio between any two of them are constant throughout the entire soil profile, the might suggest one parent material. On the other hand, a difference in such trend in the profile marks the location of another parent material.

Based on the data in Table (6) representing the ratios between the resistant minerals (uniformity index) i.e., Zr/T, Zr/R and Zr/T+R which are taken as criteria for uniformity of soil material, El-Demerdashe *et al.* (1979) and Hassona, (1999). As a result of the differences between the values of uniformity index, it can be concluded that soils of wadi Abad are either of multi-origin or multi-depositional regime. The hetero-geneity of the parent materials prior to inception to geogenetic weathering or resulted from the geo-chemical weathering prevailed in the source sediments.

In conclusion, it is quite clear that the studied soil profiles have quite different feature due to lithologic discontinuity. The latter is indicated by the distribution of minerals within successive layers of profiles. This difference in distribution is attributed to either heterogeneity of parent material prior to inception to weathering.

X-Ray diffraction analysis:

Data illustrated in Table (7) and depicted in Fig. (2) showed that the assemblages of clay minerals that occurred in the clay fractions of the soils of wadi Abad were smectite (montmorillonite), kaolinite, illite, chlorite, vermiculite, palygroskite and interstratified minerals in different amounts. Moreover, quartz, feldspars, calcite and dolomite were recorded as non-clay admixture.

Based on the x-ray diffractions of the clay fractions belonging to the different soils of the studied geomorphic units, the following discussion about the mineralogical nature of clay could be summarized into.

Smectite (in forms of montmorillonite) is the predominant clay mineral and present in different percentages ranging between 32 and 63% of the clay mineral assemblages. The lower values are recorded in the soils of wadi bottom, while the highest are found in the river terraces soils. Montmorillonite mineral tends to increase with depth in the soils of profiles 6 and 7, while in profile 2 the mineral decreases with depth. In the soils of terraces (profile, 4) montmorillonite is uniformily distribution throughout the entire depth of the considered soils.

Kaolinite mineral is detected in the second predominant clay mineral and ranges from 16-17% throughout the soils of river terraces, while those of plain soils have higher content (about 23-24%). The hydrous mica is present in few amounts (8-14%). Chlorite and palygroskite minerals are found in trace amounts (2-4%) exception being the deepest layer of profile 4 (terraces) which has relatively higher amounts of palygroskite, about 10%.

Vermiculite mineral ranges from 2 to 10% of the clay minerals and disappear in the soils of terraces and the deepest layer of profile 6 (plain).

Interstratified clay minerals are found only in the subsurface layer of profile 4 (4%) and the deepest layer of profile 7 (2%), while are absent in other layers.

The identified accessory minerals are dominated by quartz which ranges from 2 to 14% followed by feldspars (2-4%), while calcite and dolomite minerals are detected in traceable amounts (>5%) in some layers of the studied soils.

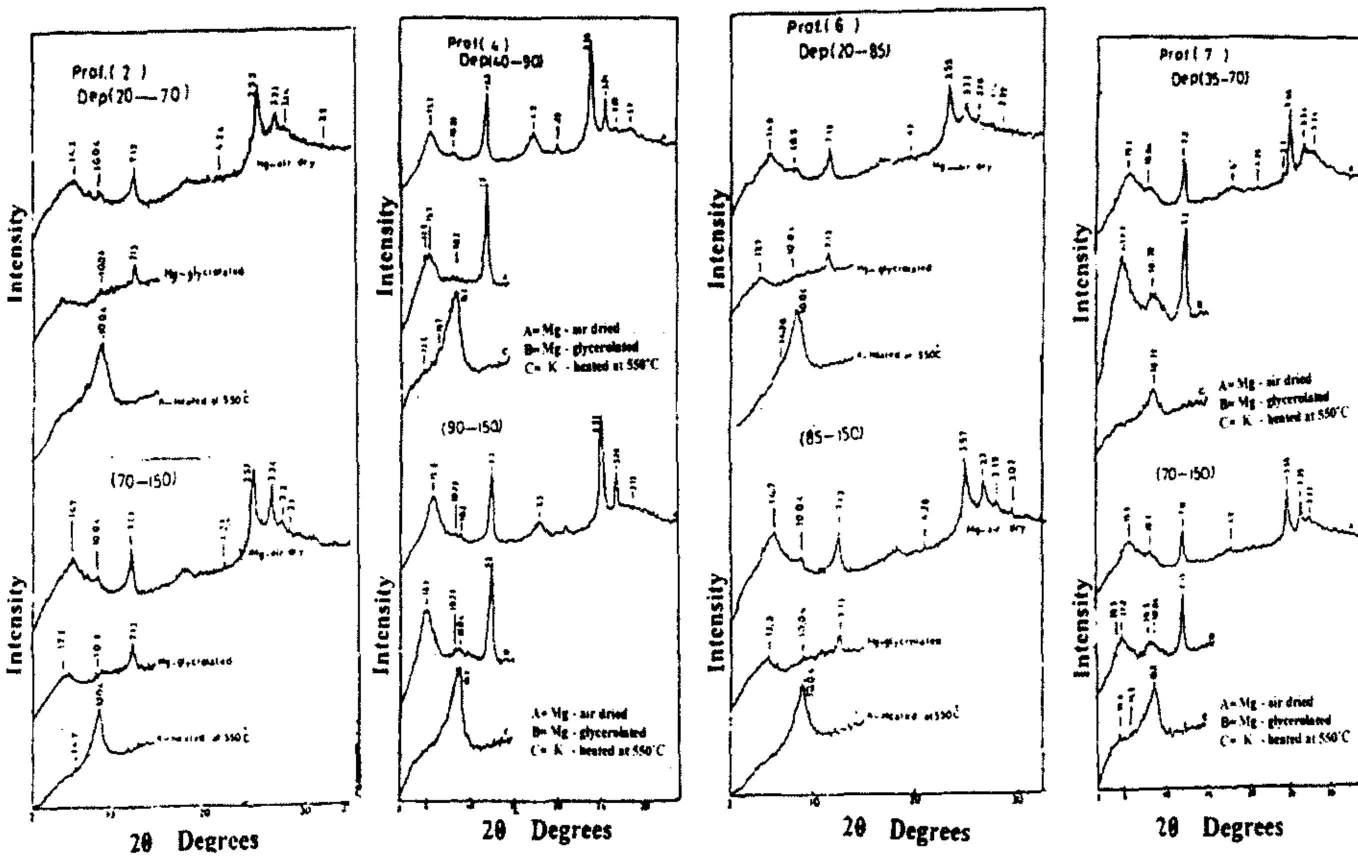

Fig. (2): X-ray diffraction pattern of the clay fraction separated from the studies soils.

Table (7): Semi-quantitative mineralogical composition of the clay fraction (<0.002 mm) separated from the studied soil profiles.

Geomorphic unit	Profile (No)	Depth (cm)	Clay minerals (%)							Accessory minerals (%)			
			Interstratified	Montmorillonite	Kaolineite	Illite	Chlorite	Vermiculite	Palygorskite	Quartz	Feldspar	Calcite	Dolomite
Wadi bottom	(2)	20-70	-	38	20	12	-	10	-	12	4	-	4
		70-150	-	32	23	14	4	8	3	13	3	-	-
Terraces	(4)	40-90	4	44	22	10	3	-	-	11	4	-	2
		90-150	-	44	16	12	-	-	10	14	4	-	-
Plain	(6)	20-85	-	38	24	12	4	4	-	12	4	-	2
		85-150	-	45	23	12	-	-	-	14	3	3	-
River terraces	(7)	35-70	-	60	16	10	-	3	-	8	3	-	-
		70-150	2	63	17	8	2	2	2	2	2	-	-

Finally it is clear that montmorillonite dominates the mineralogical composition of all the investigated clay fractions followed by Kaolinite and illite. Traceable amounts of chlorite, vermiculate, palygroskite and interstratified minerals were also detected.

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دراسات بيدولوجية على أراضى وادى عباد - والصحراء الشرقية – مصر

السيد محمد قطب بحيري

معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

أجريت هذه الدراسة على أراضى وادى عباد بالصحراء الشرقية وذلك بدراسة الخواص الطبيعية والكيمائية والمنرالوجية بغرض التعرف على طبيعة وأصل وتكوين أراضى تلك الوادى ولتحقيق ذلك تم اختيار ثمانية قطاعات أرضية ممثلة للوحدات الجيومورفولوجية السائدة فى هذا الوادى وتشمل قاع الوادى والمصاطب والسهل والمصاطب النهرية والمروحيات.

وقد أوضحت نتائج التحاليل إلى أن قوام هذه الأراضى يختلف من رملى إلى طمى طيني وقد تراوحت نسبة كربونات الكالسيوم ما بين ٥,١ إلى ٢٠٪ مع وجود نسبة قليلة جداً من المادة العضوية وملوحة التربة من عديمة الملوحة إلى عالية الملوحة وتفاعل التربة من متعادل إلى متوسطة القلوية وقد تميزت الكاتيونات الذائبة بالترتيب التالى ص$^{+}$ > كا$^{++}$> مـع$^{++}$> بـو$^{+}$ بينما الأنيونات الذائبة فقد تميزت بسيادة أنيون الكلوريد ثم الكبريتات والبيكربونات. وقد أوضحت الدراسة توافق واضح بين صفات الرطوبة الأرضية وقوام التربة فى جميع القطاعات المدروسة.

تبين من الدراسة المنرالوجية للرمل أن المعادن الخفيفة تتكون أساساً من الكوارتز والذى تزيد نسبته عن ٩١,٣٣٪ مع وجود نسبة من الفلسبارات والتى يسود بها معادن الأورثوكليز والبلاجيوكليز والميكروكلين بينما المعادن الثقيلة يسودها المعادن المعتمة والأمفيبول والبيروكسين والأبيدوت والزركون بينما معادن الكيانيت والروتيل والجارنت والأشترواليت وجدت بكميات متوسطة وباقى المعادن وجدت بكميات قليلة نسبياً.

وقد أوضحت الدراسة باستخدام توزيع المعادن المقاومة للتجوية وعلاقتها ببعضها أن جميع القطاعات المدروسة غير متجانسة ويرجع ذلك إلى تعدد مواد الأصل المكونة لها أو لاختلاف ظروف الترسيب.

ومن نتائج دراسة معادن الطين وذلك باستخدام الأشعة السينية أظهرت سيادة معادن السمكتيت (المونتمور يللونيت) فى جميع الوحدات تحت الدراسة يليه الكاؤولنيت. كذلك وجدت معادن الأليت والكلوريت والفيرميكوليت والباليجورسكيت والمعادن المستطبقة بكميات قليلة أما المعادن الغير طينية فقد تميزت بسيادة الكوارتز والفلسبارات مع وجود كميات قليلة جداً من الكالسيت والدولوميت.