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ORIGIN, MODE OF FORMATION OF UNIFORMITY STUDIES ON SOILS OF SOME PHYSIOGRAPHIC UNITS OF HALAIB AND SHALATEEN AREA, EGYPT

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ABSTRACT: This investigation was performed using the soils of Halaib and Shalateen area in order to evaluate their genesis and degree of homogeneity. Accordingly, eight soil profiles were selected to represent the main physiographic units of this area.

The grain size distribution indicates that these soils are mainly coarse texture (sand to sand clay loam). Moreover, the statistical size parameters indicate that these soils are formed by water sediments which mainly transported by rivers and tractive, and turbidity currents, strongly coarse to coarse skewed, very platy to platy and mesokurtic.

Mineralogical composition of the sand fraction reveal that the light fraction is generally dominated by quartz with less pronounced amounts of feldspars. The heavy minerals are composed essentially of opaques followed by pyreboles, (pyroxene + amphipoles). Epidote, zircon, tourmaline and rutile are detected in moderate amounts, while staurolite, garnite, kyanite, silimanite, biotite, monazite and andolusite occur in variable little amounts.

Uniformity and weathering rations indicate that these soils are heterogenous either due to their multiorigin or due to subsequent variations along the course of sedimentation, thus the soils are considered young from the pedological point of view.

INTRODUCTION

Halaib, Abu Ramad and Shalateen region triangle is considered as one of the new promising lands for agriculture reclamation and expansion. These investigated area constitutes a strip of the Eastern

Desert of southern Egypt. It is bounded by longitudes 35° 21' to 36° 40' East and latitudes 22° 15' to 23° 15' North.

Geological information given by Said (1990), Abu-El-Izz (1971), Kheder (1989), and the Egyptian geological survey (1992) indicated that the surface of Halaib, Abu Ramad and Shalateen triangle region is essentially occupied by different types of rocks belonging to the Cenozoic, Mesozoic, Paleozoic and Pre-Cambrian eras.

The aridic climate, is prevailing in this area, the mean annual temperature is 24.17C°. The average annual rainfall are 186 mm/year while the relative humidity is fluctuating between 28% and 52%. The water resources in the studied area depend mainly on the ground water and rainfall.

Several trials were under taken to evaluate profile uniformity and development of some soils of Egypt (Hammad 1968,El-Demerdashe *et al.* (1972) and Hassona (1999). These authors studied soils of different origin and tried to evaluate their mode of formation and factors affecting their depositional regime based on different parameters.

Therefore, the objective of the present study is to search for more evidence indicating the origin and uniformity of soils using morphological and mineral composition of the sand subfraction and their relation to soil development as a degree of uniformity of parent material in Halaib, Abu Ramad and Shalateen triangle region.

MATERIALS AND METHODS

The study was carried out on Halaib and Shalateen area taking into consideration the physiographic units in choosing the locations of soil profiles (Grais, 2002). Accordingly, eight soil profiles were selected to represent the main physiographic units, which are alluvial fans (profiles 1,2 and 3), alluvial plains (profiles 4 and 5), alluvial terraces (profile, 6), Colluvial alluvial (profile, 7) and marine sediments (profile, 8), Fig. (1).

These soil profiles were morphologically described following the FAO System, (1998), (Table, 1). Twenty eight soil samples were collected, air-dried, crushed and sieved through a 2 mm sieve and subjected to the following analyses.

Particle size distribution was mechanically conducted by dry sieving (Piper, 1950). Then the data were statistically evaluated according to Folk and Ward (1957).

The mineralogical studies of the sand fraction were carried out as follow; after the ordinary

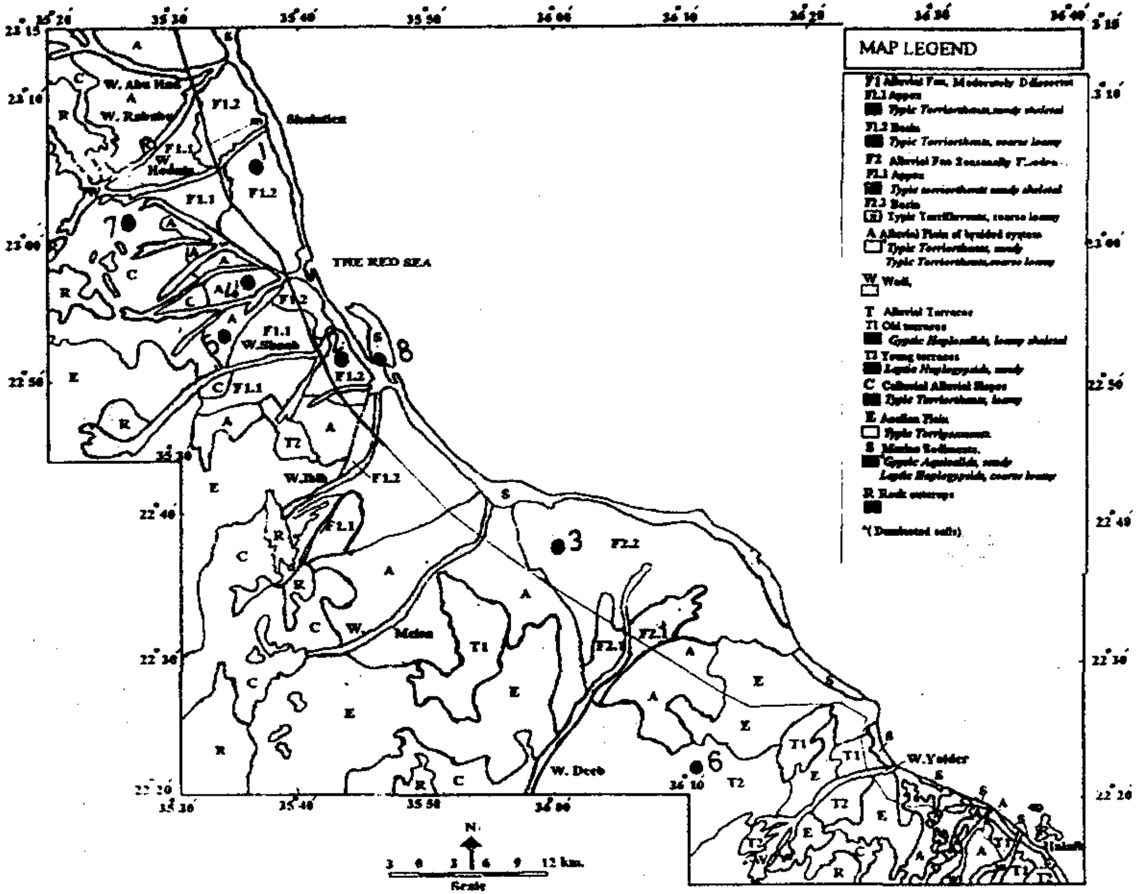

Fig. (1): Physiographic soil map and profiles location of the studied soils.

Table (1): Main field morphological features of the studied soil profiles .

Physiographic units	Prof. No.	Depth (cm)	Colour		Texture class	Structure	Consistency			Lower boundary
			Dry	Moist			Dry	Moist	Plasticity	
Alluvial fans	1	0-15	10 YR 7/4	10 YR 6/4	L.S	ma.	So.	n.st	n.pla	c.s
		15-40	10 YR 6/6	10 YR 5/8	S.L	ma.	s.h	s.st	s.pla	c.s
		40-100	10 YR 6/6	10 YR 5/6	S.C.L	ma.	s.h	m.st	m.pla	d.s
		100-150	10 YR 6/6	10 YR 5/6	S.C.L	ma.	h.	m.st	m.pla	-
	2	0-10	10 YR 6/4	10 YR 5/4	S.	s.g	l.	n.st	n.pla	c.s
		10-35	10 YR 5/4	10 YR 6/4	S.L	ma.	So.	s.st	s.pla	d.
		35-75	10 YR 6/6	10 YR 5/6	S.L	ma.	s.h	s.st	s.pla	c.s
		75-150	10 YR 6/4	10 YR 5/6	L.S	ma.	h.	n.st	n.pla	-
	3	0-35	10 YR 6/4	10 YR 5/6	S.L	ma.	So.	s.st	s.pla	c.s
		35-90	10 YR 5/6	10 YR 6/4	S.	ma	So.	n.st	n.pla	c.s
		90-150	10 YR 5/6	10 YR 4/6	S.	ma	So.	n.st	n.pla	-
Alluvial plains	4	0-25	10 YR 7/4	10 YR 6/4	S.C.L	ma.	So.	m.st	m.pla	c.s
		25-62	10 YR 6/4	10 YR 5/4	S.C.L	ma.	s.h	m.st	m.pla	c.s
		62-100	10 YR 6/4	10 YR 5/8	S.L	ma.	s.h	s.st	s.pla	c.s
		100-150	10 YR 7/4	10 YR 6/4	L.S	ma.	s.h	n.st	n.pla	-
	5	0-10	10 YR 7/4	10 YR 6/4	S.	s.g	l.	n.st	n.pla	c.s
		10-30	10 YR 6/4	10 YR 5/6	S.L	ma.	So.	s.st	s.pla	d.s
		30-70	10 YR 6/4	10 YR 5/6	S.L	ma.	So.	s.st	s.pla	d.s
		70-150	10 YR 6/4	10 YR 5/6	S.L	ma.	s.h	s.st	s.pla	-
Alluvial terraces	6	0-30	10 YR 7/4	10 YR 6/8	S.	s.g	l.	n.st	n.pla	c.s
		30-70	10 YR 7/4	10 YR 6/8	S.	ma.	So.	n.st	n.pla	c.s
		70-150	10 YR 6/6	10 YR 5/6	S.	ma.	So.	n.st	n.pla	-
Colluvial alluvial	7	0-30	10 YR 6/4	10 YR 5/4	S.L	ma.	So.	s.st	s.pla	c.s
		30-85	10 YR 6/6	10 YR 5/6	S.L	ma.	So.	s.st	s.pla	d.s
		85-150	10 YR 6/4	10 YR 5/6	L.S	ma.	So.	s.st	s.pla	-
Marine sediments	8	0-25	10 YR 6/4	10 YR 5/6	S.	ma.	So.	n.st	n.pla	c.s
		25-75	10 YR 6/4	10 YR 5/6	L.S	ma.	s.h	n.st	n.pla	c.s
		75-90	10 YR 7/1	10 YR 7/2	C.L	ma.	h.	m.st	m.pla	-

Structure	***Consistence***		***Lower boundary***
ma =massive	So =soft	pla=plastic	c.s =clear smooth
s.g =single grain	s.h =slightly hard	n =non	d.s =diffuse smooth
Texture	l. =loose	s =slightly	
S. = sand	st =sticky	m =moderately	
S.L = sand loam			
S.C.L= sandy clay loam			
L.S = loamy sand			

pretreatments (Jackson, 1973) the sand subfraction 0.125-0.063 mm, was separated from each sample by dry sieving, cleaned up and further differentiated into heavy and light minerals using bromoform (sp. Gr. 2.85 ± 0.02). The heavy and light residues were mounted on slide in Canada balsam for identification (Brewer, 1964). About 500 grains were identified by the polarizing microscope, using a gradual mechanical stage for counting. Identification of minerals was undertaken according to the procedure of Milner (1962).

RESULTS AND DISCUSSION

1- Morphological features of the studied soils:

Morphological features of the representative soil profiles are shown in Table (1). From the table, landscape of these soils is almost flat, and undulating to gently undulating with deep soil profiles. Soil dry colour varies between yellowish brown (10 YR 5/4) to pale brown (10 YR 7/4), while the moist colour varies from dark yellowish brown (10 YR 4/6) to light gray (10 YR 7/2). The studied soils have different textural grades, in general the majority of soils are relatively coarse texture class. Soil structure is structureless (massive or single grain), while soil consistence is coincide well with soil texture being non sticky, and non plastic to moderately sticky and moderately plastic. It could be concluded that the variations of morphological features which observed along the studied area mostly reflect a combination of both physiographic position and sediments nature.

2- Grain size analysis:

In the present work, graphic presentation of mechanical analysis data of the skeletal grains was done according to Folk and Ward (1957) and Passega (1957 and 1964). Cumulative percentage were plotted against phi-diameter on an arithmetic probability paper and eight percentiles; φ_1, φ_5, φ_{16}, φ_{25}, φ_{50}, φ_{75}, φ_{84} and φ_{95} in Table (2) are recorded graphically for each sample statistical size parameters (M_z, Q_I, SK_I and KG) are calculated using the formula of Folk and Ward (1957), Table (3) and Fig. (2) These values indicate that, as to the graphic mean M_z, most of the studied soil profiles fall within medium to fine sand (1.27φ to 3φ), with exception case of the deepest layer of profile (7) which represented Colluvial alluvial soils, all soil samples are poorly sorted (1.03 φ to 1.72 φ). The poorly sorted nature of the sediments suggests that the soils are mainly deposited by water action, while

Table (2): φ values read from the cumulative frequency curves of the studied soils profiles .

Physiographic units	Prof. No.	Depth (cm)	φ_1	φ_5	φ_{16}	φ_{25}	φ_{50}	φ_{75}	φ_{84}	φ_{95}
Alluvial fans	1	0-15	-0.5	-0.2	0.2	1.0	2.8	3.2	3.4	4.0
		15-40	-0.5	-0.2	0.4	1.2	2.5	3.0	3.4	4.0
		40-100	-0.4	-0.3	0.2	1.1	3.0	3.2	3.4	4.0
		100-150	-0.5	-0.1	0.1	1.4	1.9	3.1	3.2	3.9
	2	0-10	-0.5	-0.2	0.4	1.2	3.1	3.6	3.7	4.2
		10-35	-0.3	-0.0	0.9	1.4	2.4	3.2	3.7	4.1
		35-75	-0.2	0.4	1.9	2.4	3.2	3.9	4.0	4.4
		75-150	-0.4	-0.2	0.1	0.5	2.0	3.1	3.5	4.0
	3	0-35	-0.5	-0.1	0.3	0.9	2.0	3.2	3.4	4.1
		35-90	-0.6	-0.2	0.0	0.2	1.4	2.9	3.1	3.9
		90-150	-0.6	-0.2	0.0	0.5	1.6	2.6	3.2	4.0
Alluvial plains	4	0-25	-0.5	-0.1	0.5	1.1	2.3	3.2	3.4	4.0
		25-62	-0.3	-0.1	0.4	0.9	1.6	3.1	3.4	4.3
		62-100	-0.5	-0.1	0.4	0.8	1.7	2.9	3.1	3.8
		100-150	-0.5	-0.1	0.3	0.7	1.4	2.4	2.8	3.5
	5	0-10	-0.3	-0.1	0.4	1.0	2.4	3.4	3.6	4.0
		10-30	-0.2	-0.1	0.9	1.4	2.3	3.3	3.5	4.2
		30-70	-0.2	0.2	1.4	2.0	3.2	3.6	3.7	4.2
		70-150	-0.6	-0.2	0.4	1.2	2.4	3.2	3.4	4.0
Alluvial terraces	6	0-30	-0.4	-0.2	0.2	0.7	1.5	2.2	2.8	3.4
		30-70	-0.3	-0.1	0.3	0.8	1.4	2.1	2.4	3.4
		70-150	-0.2	0.1	0.9	1.0	1.9	2.6	2.9	3.6
Colluvial alluvial	7	0-30	-0.3	-0.1	0.9	1.3	2.9	3.3	3.5	4.2
		30-85	-0.5	-0.2	-0.1	0.5	1.4	2.4	3.2	3.9
		85-150	-0.5	-0.1	0.4	1.0	1.4	2.0	2.2	2.8
Marine sediments	8	0-25	-0.3	-0.1	0.4	0.8	2.0	3.2	3.4	4.1
		25-75	-0.5	-0.2	0.0	0.4	3.2	3.8	4.1	4.4
		75-90	-0.6	-0.3	-0.1	-0.1	0.5	3.0	3.5	4.3

Table (3): The statistical size parameters of the studied soil profiles according to Falk and Ward (1957).

Physiographic units	Prof. No.	Depth (cm)	Mean size (MZ)	σ_1	Indication	SK_1	Indication	KĞ	Indication	KG
Alluvial fans	1	0-15	2.13	1.44	P.S	-0.53	S.C. sK	0.44	P.K	0.78
		15-40	2.10	1.39	P.S	-0.34	S.C. sK	0.49	M.K	0.96
		40-100	2.20	1.45	P.S	-0.64	S.C. sK	0.46	P.K	0.84
		100-150	1.73	1.38	P.S	-0.08	n.sym	0.49	M.K	0.96
	2	0-10	2.40	1.49	P.S	-0.60	S.C.sK	0.43	P.K	0.75
		10-35	2.33	1.32	P.S	-0.12	C.sK	0.48	M.K	0.93
		35-75	3.00	1.13	P.S	-0.32	S.C.sK	0.52	M.K	1.09
		75-150	1.87	1.43	P.S	-0.08	n.sym	0.40	P.K	0.66
	3	0-35	1.90	1.41	P.S	-0.05	n.sym	0.43	P.K	0.75
		35-90	1.50	1.40	P.S	0.16	f.sK	0.38	V.P.K	0.62
		90-150	1.60	1.44	P.S	0.07	n.sym	0.45	P.K	0.82
Alluvial plains	4	0-25	2.07	1.35	P.S	-0.24	C.sK	0.44	P.K	0.80
		25-62	1.80	1.42	P.S	0.21	f.sK	0.45	P.K	0.82
		62-100	1.73	1.27	P.S	0.06	n.sym	0.43	P.K	0.76
		100-150	1.50	1.17	P.S	0.14	f.sK	0.47	P.K	0.87
	5	0-10	2.13	1.42	P.S	-0.23	C.sK	0.41	P.K	0.70
		10-30	2.23	1.30	P.S	-0.10	C.sK	0.48	M.K	0.93
		30-70	2.77	1.18	P.S	-0.53	S.C.sK	0.50	M.K	1.02
		70-150	2.07	1.39	P.S	-0.30	S.C.sK	0.46	P.K	0.86
Alluvial terraces	6	0-30	1.50	1.20	P.S	0.03	n.sym	0.49	M.K	0.98
		30-70	1.37	1.06	P.S	0.05	n.sym	0.52	M.K	1.10
		70-150	1.90	1.03	P.S	-0.01	n.sym	0.47	P.K	0.90
Colluvial alluvial	7	0-30	2.43	1.30	P.S	-0.47	S.C.sK	0.47	P.K	0.88
		30-85	1.50	1.45	P.S	0.15	f.sK	0.47	P.K	0.88
		85-150	1.33	0.89	M.S	-0.07	n.sym	0.54	L.K	1.19
Marine sediments	8	0-25	1.93	1.39	P.S	-0.03	n.sym	0.42	P.K	0.72
		25-75	2.43	1.72	P.S	-0.52	S.C.sK	0.35	V.P.K	0.55
		75-90	1.27	1.60	P.S	0.64	S.f.sK	0.38	V.P.K	0.61

P.S = Poorly sorted (by water)
W.S = Well sorted (by wind)
M.S = Moderately sorted (by wind)
S.C.sK = Strongly coarse skewed
C.sK = Coarse skewed
n.sym = Near symmetrical
S.f.sK = Strongly fine skewed

f.sK = Fine skewed
P.K = Platy kurtic
V.P.K = Very ptaly kurtic
M.K = Mesokurtic
V.L.K = Very leptokurtic
L.K = Lepta kurtic

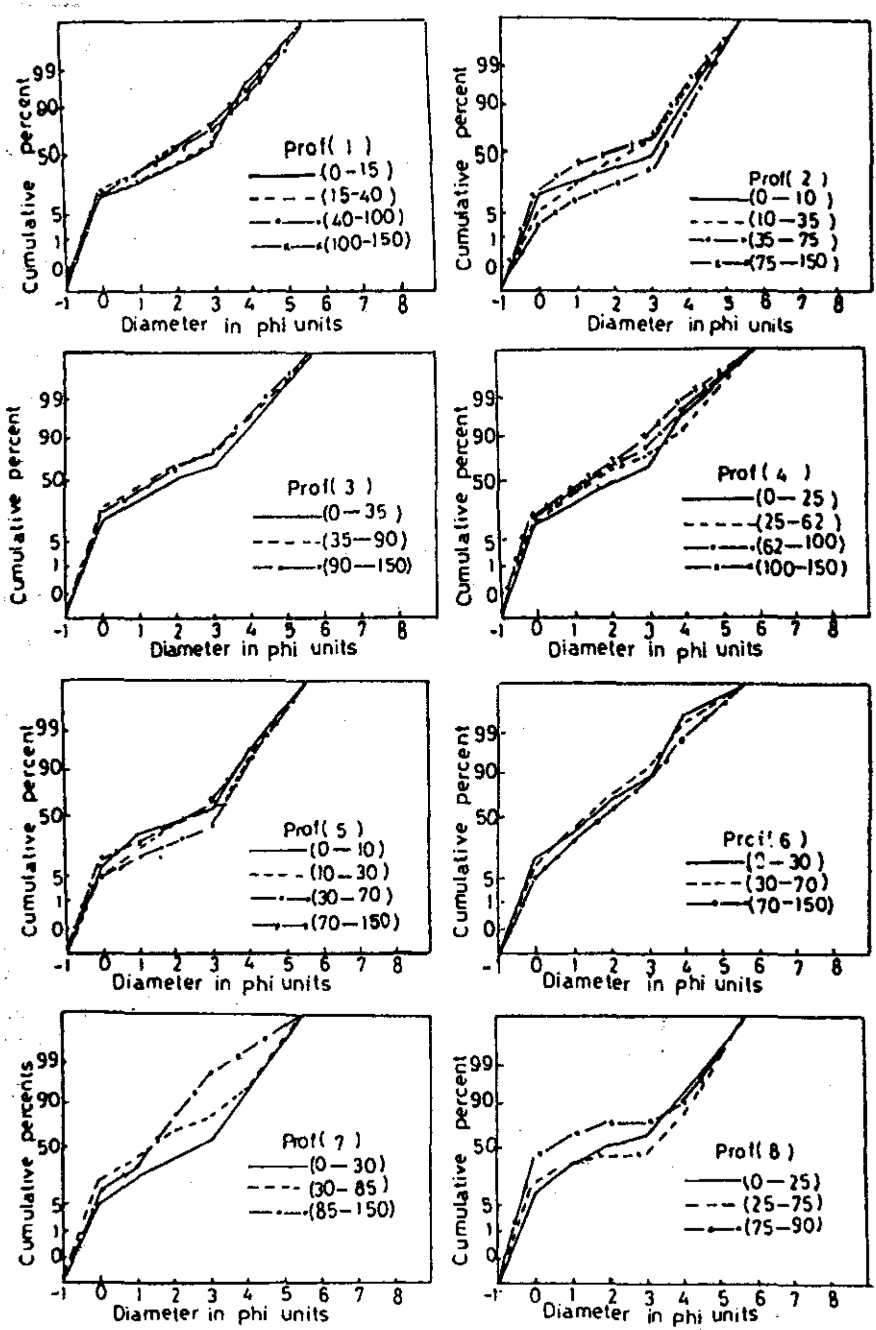

Fig. (2): Particle size distribution of the studied physiographic units. (Prof. 1,2,3,4,5,6,7 and 8).

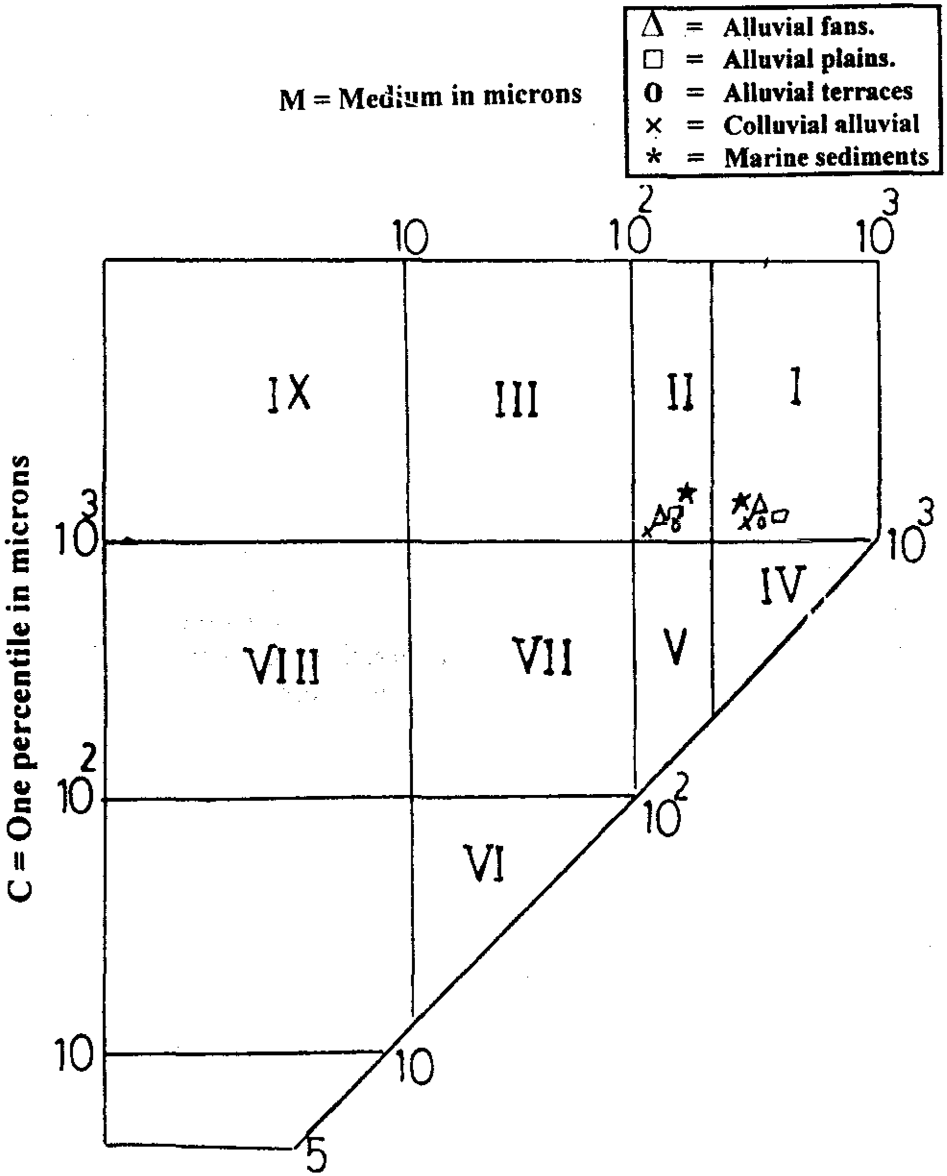

Fig. (3): Plots of the Eocene clastic sediments on the C-M diagram of Passega (1964).

moderately sorted sediments suggest two means of transportation and deposition, i.e. water and wind. As to inclusive graphic skewness (SK_I) or symmetry, most of the studied samples fall within the range of strongly coarse skewed -0.32 φ to -0.64 φ to coarse skewed (-0.10 φ to -0.24 φ) and near symmetrical (-0.01 φ to 0.07 φ), except for the middle layers of profiles 3,4,7 and the deepest layers of profile 8 which fall within fine skewed and strongly fine skewed, respectively.

With regard to the values of the graphic kurtosis (KG) parameters the soils range between very platy kurtic to platy kurtic (0.35 φ to 0.47 φ) and mesokurtic (0.48 φ to 0.52 φ). Exception one case in the deepest layer of profile 7 which fall in leptakurtic (0.54 φ).

Taking into consideration that platy kurtic and very platy kurtic values indicate that water is the main factor responsible for soil formation, while mesokurtic and leptokurtic values indicate the involvement of wind and water actions in the formation of soils.

In view of the former findings, one can conclude that the studied soils occur in medium to fine sand grade. These samples are mainly poorly sorted, strongly coarse skewed, coarse skewed to near symmetry and very platy kurtic, platy kurtic to mesokurtic.

The C-M pattern of the examined sediments is also used as a tool for indicating the hydrodynamic conditions of sedimentation as suggested by Passega (1957 and 1964). The C-M diagram of the studied area is constructed in Fig. (3) by plotting C, which is grain size associated with one percent value of cumulative curve (in micron) against M, which is the mediam diameter (in micron) Table (4). Data of C-M diagram pattern (Table, 4) show that the sediments of studied soil profiles are represents in two classes, I signifies transportation by rivers and tractive currents, and II represents turbidity currents, the latter mechanism of transportation are the dominant one in the studied soil profiles.

3- Mineralogy of the sand fraction:

- Light minerals:

Data of the light minerals of the sand subfraction are tabulated in Table (5) and reveal that values of quartz content range from 91.6% to 97.2% in the alluvial fan soils. The low value is recorded in the surface layer of profile 2, while the highest one is found in the subsurface layer of profile 1. Depthwise distribution of quartz does not portray any specific pattern with depth, except for profiles 3 and 7

Table (4): Mechanism of transportation (C-M pattern diagram) according to Passega and Byramjee (1969).

Physiographic units	Prof. No.	Depth (cm)	(C) One percentile			(M) Mediam percentile			Segments
			φ	mm	Micron	φ	mm	Micron	
Alluvial fans	1	0-15	-0.5	1.414	1414	2.8	0.144	144	II
		15-40	-0.5	1.414	1414	2.5	0.177	177	II
		40-100	-0.4	1.320	1320	3.0	0.125	125	II
		100-150	-0.5	1.414	1414	1.9	0.268	268	II
	2	0-10	-0.5	1.414	1414	3.1	0.117	117	II
		10-35	-0.3	1.231	1231	2.4	0.189	189	II
		35-75	-0.2	1.149	1149	3.2	0.110	110	II
		75-150	-0.4	1.320	1320	2.0	0.250	250	II
	3	0-35	-0.5	1.414	1414	2.0	0.250	250	II
		35-90	-0.6	1.516	1516	1.4	0.379	379	I
		90-150	-0.6	1.516	1516	1.6	0.330	330	I
Alluvial plains	4	0-25	-0.5	1.414	1414	2.3	0.203	203	II
		25-62	-0.3	1.231	1231	1.6	0.330	330	I
		62-100	-0.5	1.414	1414	1.7	0.308	308	I
		100-150	-0.5	1.414	1414	1.4	0.379	379	I
	5	0-10	-0.3	1.231	1231	2.4	0.189	189	II
		10-30	-0.2	1.149	1149	2.3	0.203	203	II
		30-70	-0.2	1.149	1149	3.2	0.110	110	II
		70-150	-0.6	1.516	1516	2.4	0.189	189	II
Alluvial terraces	6	0-30	-0.4	1.320	1320	1.5	0.354	354	I
		30-70	-0.3	1.231	1231	1.4	0.379	379	I
		70-150	-0.2	1.149	1149	1.9	0.268	268	II
Colluvial alluvial	7	0-30	-0.3	1.231	1231	2.9	0.134	134	II
		30-85	-0.5	1.414	1414	1.4	0.379	379	I
		85-150	-0.5	1.414	1414	1.4	0.379	379	I
Marine sediments	8	0-25	-0.3	1.231	1231	2.0	0.250	250	II
		25-75	-0.5	1.414	1414	3.2	0.110	110	II
		75-90	-0.6	1.516	1516	0.5	0.707	707	I

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

Physiographic units	Prof. No.	Depth (cm)	Quartz	Feldspars (%)			
				Orthoclase	Plagioclase	Microcline	Total
Alluvial fans	1	0-15	96.30	2.70	1.7	0.6	5.0
		15-40	97.20	2.80	1.6	0.7	5.1
		40-100	96.30	2.70	1.7	0.6	5.0
		100-150	96.60	2.40	1.7	0.8	4.9
	2	0-10	91.60	4.00	2.6	1.4	8.0
		10-35	94.50	3.50	1.5	0.5	5.5
		35-75	95.30	2.70	1.3	0.7	4.7
		75-150	94.60	3.40	1.4	0.6	5.4
	3	0-35	93.90	3.10	2.1	0.9	6.1
		35-90	94.60	3.40	1.4	0.6	5.4
		90-150	95.30	2.70	1.1	0.9	4.7
Alluvial plains	4	0-25	95.80	2.30	1.2	0.8	4.3
		25-62	94.90	2.10	2.3	0.7	5.1
		62-100	96.30	1.70	1.3	0.7	3.7
		100-150	95.40	2.60	1.4	0.6	4.6
	5	0-10	95.60	2.20	1.8	0.7	4.7
		10-30	94.90	3.10	1.4	0.6	5.1
		30-70	94.70	3.10	1.5	0.8	5.4
		70-150	95.10	2.90	1.3	0.7	4.9
Alluvial terraces	6	0-30	96.50	1.50	1.3	0.7	3.5
		30-70	92.80	3.20	2.5	1.5	7.2
		70-150	94.30	2.70	2.6	0.4	5.7
Colluvial alluvial	7	0-30	90.20	4.50	3.3	2.1	9.9
		30-85	92.30	4.50	2.5	0.7	7.7
		85-150	94.50	2.50	2.1	1.0	5.6
Marine sediments	8	0-25	94.20	2.30	1.7	1.8	5.8
		25-75	95.60	2.40	1.6	0.4	4.4
		75-90	93.80	3.20	1.9	1.1	6.2

which quartz tends to increase with depth. Feldspars are distinguished as orthoclase, plagioclase and microcline, it ranges from 1.5 to 4.5%, 1.1 to 3.3% and 0.4 to 2.1%, respectively.

Moreover, the presence of feldspars could be taken as an indication that weathering prevailed during soil formation was not so drastic to cause a complete decay of these minerals susceptible to weathering.

- Heavy minerals:

In the following a concise description of the heavy minerals recorded and their distribution is given in the same order of abundance as shown in Table (6).

Opaque minerals are mostly composed of iron ores such as hematite, ilmenite and pyrite. These minerals are characterized as being isotropic between crossed nicoles, black coloured in plain light, non peleochroic and generally subrounded to rounded in shape. The opaque minerals constitute the greater part of the heavy minerals in all samples (ranges from 40.6% to 49.2% of the total heavy minerals) with an irregular distribution pattern with depth.

Non opaque minerals: data in Table (7) show that pyroxenes and amphiboles (pyroboles) are the most abundant non-opaque minerals in the studied samples. Soil profiles of the marine sediments, alluvial plains and Colluvial alluvial comprise the higher content of pyroboles among the different physiographic units. These minerals display an irregular distribution with depth in the studied soils.

Garnet constitutes 1.1 to 2.1% (as a weight mean) in the soil of alluvial fans, while being from 1.4 to 1.6% in the rest of the studied soils.

Staurolite constitutes 0.9 to 2.1%, the lowest value recorded in the soil of profile 4 (alluvial plain), while the highest content is in profile 6 (alluvial terraces).

Kyanite constitutes 0.9 to 2.6% and lowest value is recorded in profile 5 (alluvial plain), while the highest value characterize profile 6 (alluvia terraces).

Silimanite constitutes 0.5 to 2.0% (as a weight mean) of the non-opaques.

Zircon, rutile and tourmaline have frequency ranging between 5.1-12.1%, 1.0-5.4% and 2.1-5.4%. respectively The higher contents of these minerals are recorded in the soils of alluvial fans, while the lowest values are detected in the soils of Colluvial alluvial, and soils of marine sediments. On the other

Table (6): Frequency distribution of heavy minerals in the sand fraction (0.125-0.063 mm) of the studied soils.

Physiographic units	Prof. No.	Depth (cm)	Opaque (%)	Non-opaque minerals: Pyroboles % P.	Pyroboles % A.	Parametamorphic % G.	Parametamorphic % St.	Parametamorphic % K.	Parametamorphic % Si.	Ubibuitous % Zr	Ubibuitous % R.	Ubibuitous % To	B.	E.	An.	M.	Apa
Alluvial fans	1	0-15	46.7	38.4	12.6	1.3	1.5	1.4	2.0	14.5	4.8	4.9	5.2	11.5	0.8	0.9	0.4
		15-40	44.3	42.8	14.1	2.5	1.3	1.2	1.1	10.4	4.2	4.3	6.1	9.8	1.4	0.8	0.3
		40-100	45.6	41.6	15.5	2.3	1.4	0.9	1.3	12.2	3.3	3.4	11.4	4.9	1.2	0.6	-
		100-150	46.9	38.0	17.1	1.8	1.2	1.3	0.8	8.1	7.3	7.4	6.0	8.9	1.2	0.6	0.3
	2	0-10	46.2	41.9	16.3	1.4	1.3	1.5	1.1	9.7	3.9	3.7	4.5	12.4	0.8	1.1	0.4
		10-35	45.9	39.5	14.8	2.1	1.5	1.3	1.2	11.1	5.1	5.3	7.0	8.6	1.2	0.8	0.5
		35-75	44.1	38.5	13.6	2.0	1.6	0.8	1.7	13.2	4.2	6.5	6.6	9.1	1.1	0.7	0.4
		75-150	45.3	42.0	15.1	1.8	1.0	1.6	0.9	12.1	3.8	5.0	6.8	8.0	0.7	0.7	0.5
	3	0-35	42.6	51.0	16.8	0.8	1.7	2.5	0.8	4.1	1.6	1.7	7.0	8.5	1.6	1.2	0.7
		35-90	41.3	45.7	14.9	1.3	1.6	2.3	0.5	8.0	2.1	3.2	6.5	11.5	1.2	0.7	0.5
		90-150	40.6	43.3	18.1	1.1	1.0	0.5	0.7	7.6	2.5	3.8	6.7	13.1	1.1	0.5	-
Alluvial plains	4	0-25	44.2	40.9	13.1	2.3	2.0	2.7	1.7	7.3	2.8	2.2	9.5	12.4	0.8	2.3	-
		25-62	46.4	47.9	19.4	1.1	0.7	2.6	1.0	5.1	2.6	2.8	6.7	8.3	0.5	1.3	-
		62-100	45.6	48.2	18.9	1.2	0.6	1.3	1.2	4.5	0.8	2.3	10.2	7.3	1.0	1.7	0.8
		100-150	42.3	48.4	17.3	1.3	0.7	2.0	1.2	5.5	0.6	2.5	7.1	9.2	1.3	2.0	0.9
	5	0-10	44.7	49.2	16.9	1.6	1.1	1.9	1.4	5.2	1.9	2.6	7.9	9.3	0.9	1.8	0.8
		10-30	46.1	42.9	18.2	1.4	1.2	1.9	1.5	7.9	1.5	3.7	5.5	10.4	1.2	2.1	0.6
		30-70	46.5	48.8	12.7	1.1	0.9	2.1	1.2	5.4	2.9	3.4	5.9	11.1	2.1	1.5	0.9
		70-150	44.7	49.0	13.7	1.7	1.1	2.5	1.8	6.9	2.1	2.8	5.0	10.3	1.8	0.8	0.5
Alluvial terraces	6	0-30	41.5	45.6	15.8	2.2	0.6	1.5	1.4	4.6	0.8	3.4	9.8	9.6	2.1	2.0	0.6
		30-70	41.2	45.8	14.5	1.7	1.3	2.1	1.8	5.2	1.4	2.5	10.2	10.0	1.6	1.9	-
		70-150	45.4	47.9	10.5	1.3	3.1	3.3	1.4	6.7	2.1	2.4	7.3	10.9	1.8	0.9	0.4
Colluvial alluvial	7	0-30	41.7	47.5	12.8	1.3	2.0	1.9	2.3	5.1	1.9	2.5	9.9	9.0	1.5	1.8	0.5
		30-85	40.6	47.8	13.5	1.5	1.4	2.5	2.0	5.5	1.3	2.1	10.0	8.7	1.3	2.0	0.5
		85-150	41.4	46.2	14.3	1.6	1.5	2.3	1.9	4.8	2.2	2.0	8.8	11.2	1.1	1.7	0.4
Marine sediments	8	0-25	41.3	46.9	16.5	1.4	1.0	1.7	1.5	6.6	1.1	3.3	7.5	10.8	1.2	0.5	-
		25-75	43.4	44.8	19.1	1.0	2.1	1.3	2.3	5.0	0.8	3.4	6.2	12.3	0.8	0.9	-
		75-90	45.6	40.2	16.3	2.1	2.7	1.4	0.9	5.8	1.6	3.2	8.6	14.4	1.5	1.3	-

Si = Sillimanite Zr = Zircon P = Pyroxene A = Amphiboles G = Garnet St = Staurolite K = Kyanite
M = Monazite Ap = Apatite R = Rutile To = Tourmaline B = Biotite E = Epidote An = Andalusite

hand, irregularity and discontinuity distribution of zircon, rutile and tourmaline are obvious in the soil profiles under study. This reflects the multiorigin of parent materials or their multi-depositional course, or both.

Epidote content ranges from 7.7 to 12.2% (as a weight mean) of the non-opaques reaching its maximum in profile 8, while the minimum content in profile 1.

Biotite content ranges from 5.0 to 11.4% of the non-opaques, the highest and lowest values are recorded in the deepest layers of profiles 1 and 5, respectively.

Andalusite, monazite and apatite values are recorded in a manuit amounts with an irregular distribution pattern with depth in the studied soils.

From the heavy minerals characteristics of the different profiles, it is evident that these soils have a very short dated pedological history and exhibit some degrees of related genesis. The effect of parent material overshadows other soil forming factors. i.e. most of the soil properties are inherited from the parent sediments. This is indicated from the abundance of pyroxenes and amphipods which are considered to be less stable minerals.

According to Weyl (1952), the non-opaques could classified, extremely unstable, slightly stable, stable, and very stable minerals.

Data in Table (7) reveal that the weatherable minerals (extremely unstable and slightly stable minerals) constitutes 65.6% to 76% of the non-opaques. The lowest content is found in profile 1 (Alluvial fans), while the highest content exists in profile 8 (Marine sediment).

Additionally, the resistant minerals (stable and very stable minerals) constitutes 15.4% to 26.2% of the non-opaques. The lowest value is detected in profile 4 (Alluvial plain), while the highest content exists in profile 2 (Alluvial fans). Generally it can be observable that these resistant minerals follow the order. Alluvial fans > Alluvial plain > Alluvial terraces > Colluvial alluvial > Marine sediments. It could be detected that the immaturity (recently) of the studied soils is in the opposite of this order.

- Genesis of the studied soils:

The study of heavy minerals can give some useful indications of provenance and events in the source area. Certain heavy minerals, such as garnet, epidote, staurolite are mainly derived from metamorphic terrains whereas the others, i.e., rutile, apatite, and tourmaline for instance, are mainly derived from igneous rocks, Tucker (1981).

Zircon is widely-distributed mineral in granite and other igneous rocks and also occurs certain

Table (7): Means of extremely unstable, slightly stable, stable and very stable minerals in the sand fraction (0.125-0.063 mm) of the studied soils (According to Weyl 1952).

Physiographic units	Prof. No.	Extremely unstable			Slightly stable			Stable					Very stable			
		P.	A.	T.	G.	E.	T.	St.	K.	Si.	An.	T.	To.	Z.	R.	T.
Alluvial fans	1	40.3	15.5	55.8	2.1	7.7	9.8	1.3	1.1	1.2	1.2	4.8	5.0	10.8	5.4	21.2
	2	40.6	14.7	55.3	1.9	8.7	10.6	1.3	1.3	1.2	0.9	4.7	5.4	12.1	4.1	21.6
	3	46.0	16.6	62.6	1.1	11.4	12.5	1.4	1.6	0.5	1.3	4.8	3.1	6.9	2.1	12.1
Alluvial plains	4	47.0	17.5	64.5	1.4	9.0	10.4	0.9	2.2	1.3	1.0	5.4	2.6	5.8	1.6	10.0
	5	48.2	14.2	62.4	1.5	10.5	12.0	1.1	0.9	1.6	1.7	5.3	3.1	6.5	4.0	13.6
Alluvial terraces	6	46.9	12.6	59.5	1.6	10.4	12.0	2.1	2.6	1.5	1.8	8.0	2.6	5.9	1.7	10.2
Colluvial alluvial	7	47.0	13.7	60.7	1.5	9.8	11.3	1.6	2.3	2.0	1.3	7.2	2.1	5.1	1.8	9.0
Marine sediments	8	44.6	17.9	62.5	1.3	12.2	13.5	1.9	1.4	1.8	1.0	6.1	3.3	5.6	1.0	9.9

P = Pyroxene T = Total E = Epidote K = Kyanite An = Andalusite Z = Zircon
A = Amphiboles G = Garnet St = Staurolite Si = Silimanite To = Tourmaline R = Rutile

Table (8): Uniformity and weathering ratios of the studied soil profiles.

Physiographic units	Prof. No.	Depth (cm)	Uniformity ratios			Weathering ratios		
			Zr/R	Zr/T	Zr/T+R	Wr_1	Wr_2	Wr_3
Alluvial fans	1	0-15	3.10	3.0	1.5	2.63	0.43	0.26
		15-40	2.50	2.4	1.2	3.87	0.63	0.41
		40-100	3.70	3.6	1.8	3.66	0.65	0.73
		100-150	1.10	1.1	0.6	3.55	0.73	0.39
	2	0-10	2.50	2.6	1.3	4.34	0.81	0.34
		10-35	2.20	2.1	1.1	3.31	0.60	0.43
		35-75	3.10	2.0	1.2	2.64	0.46	0.34
		75-150	3.20	2.4	1.4	3.34	0.58	0.40
	3	0-35	2.60	2.4	1.2	11.69	1.90	1.21
		35-90	3.80	2.5	1.5	5.41	0.88	0.58
		90-150	3.00	2.0	1.2	5.39	1.00	0.59
Alluvial plains	4	0-25	2.60	3.3	1.5	5.68	0.91	1.10
		25-62	2.00	1.8	0.9	8.52	1.62	0.52
		62-100	5.60	2.0	1.5	9.87	1.84	0.82
		100-150	9.20	2.2	1.8	8.21	1.43	0.62
	5	0-10	2.70	2.0	1.2	8.47	1.44	1.01
		10-30	5.30	2.1	1.5	5.27	1.03	0.47
		30-70	1.90	1.6	0.9	6.99	0.95	0.67
		70-150	3.30	2.5	1.4	6.46	0.93	0.52
Alluvial terraces	6	0-30	5.75	1.4	1.1	7.68	1.30	1.23
		30-70	3.70	2.1	1.3	7.83	1.25	1.32
		70-150	3.20	2.8	1.5	6.42	0.76	0.80
Colluvial alluvial	7	0-30	2.70	2.0	1.2	7.93	1.12	1.30
		30-85	4.20	2.6	1.6	8.07	1.17	1.32
		85-150	2.20	2.4	1.1	8.90	1.38	1.29
Marine sediments	8	0-25	6.00	2.0	1.5	6.40	1.10	0.76
		25-75	6.20	1.5	1.2	7.61	1.50	0.74
		75-90	3.60	1.8	1.2	6.28	1.20	0.96

Zr =Zircon , R = Rutile , T = Tourmaline , P = Pyroxenes , A = Amphiboles
H = Hornblend , B = Biotite , Wr_1 = P+A/Zr+T , Wr_2 = H/Zr+T , Wr_3= B/Zr+T

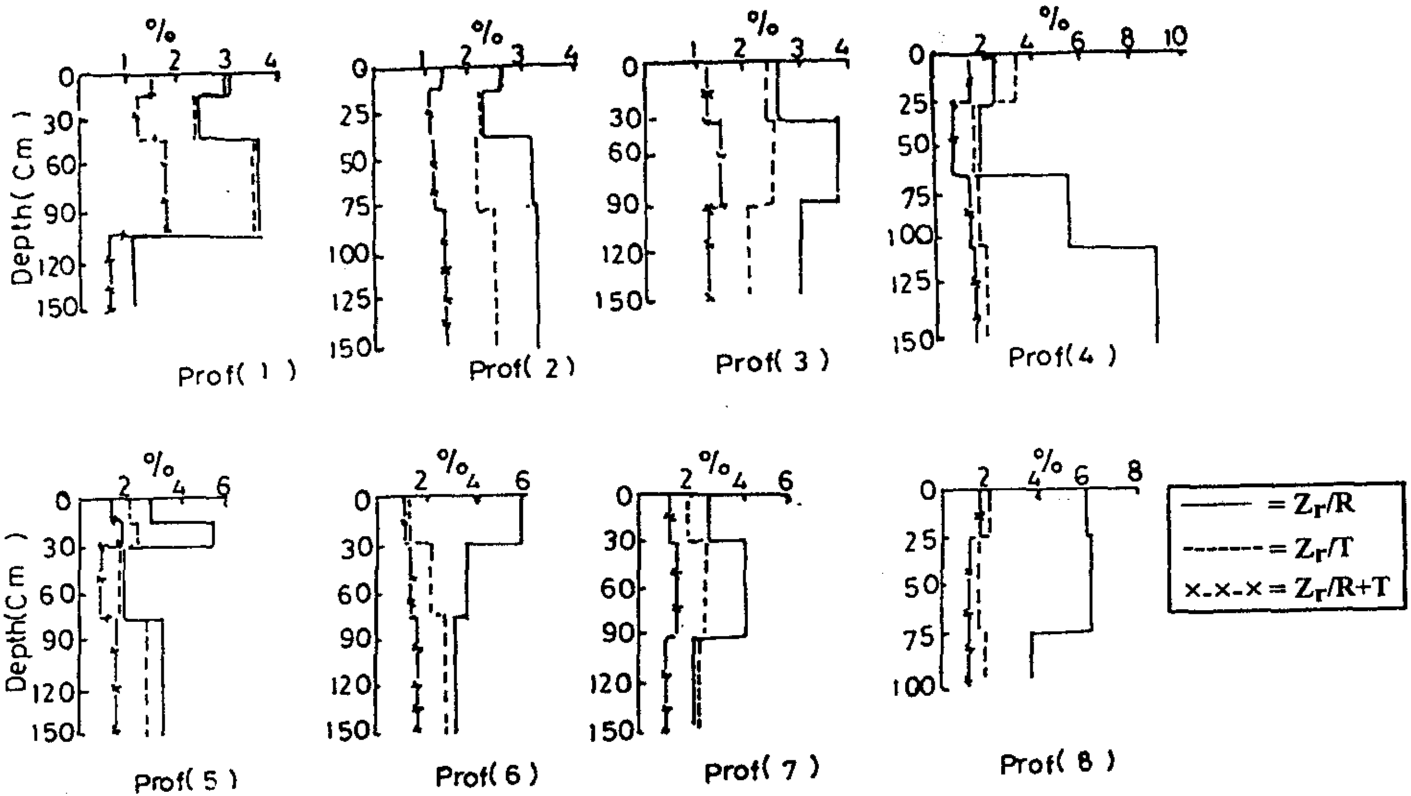

Fig. (4): Depthwise distribution of the most resistant minerals of the sand fraction in the studied soil profiles.

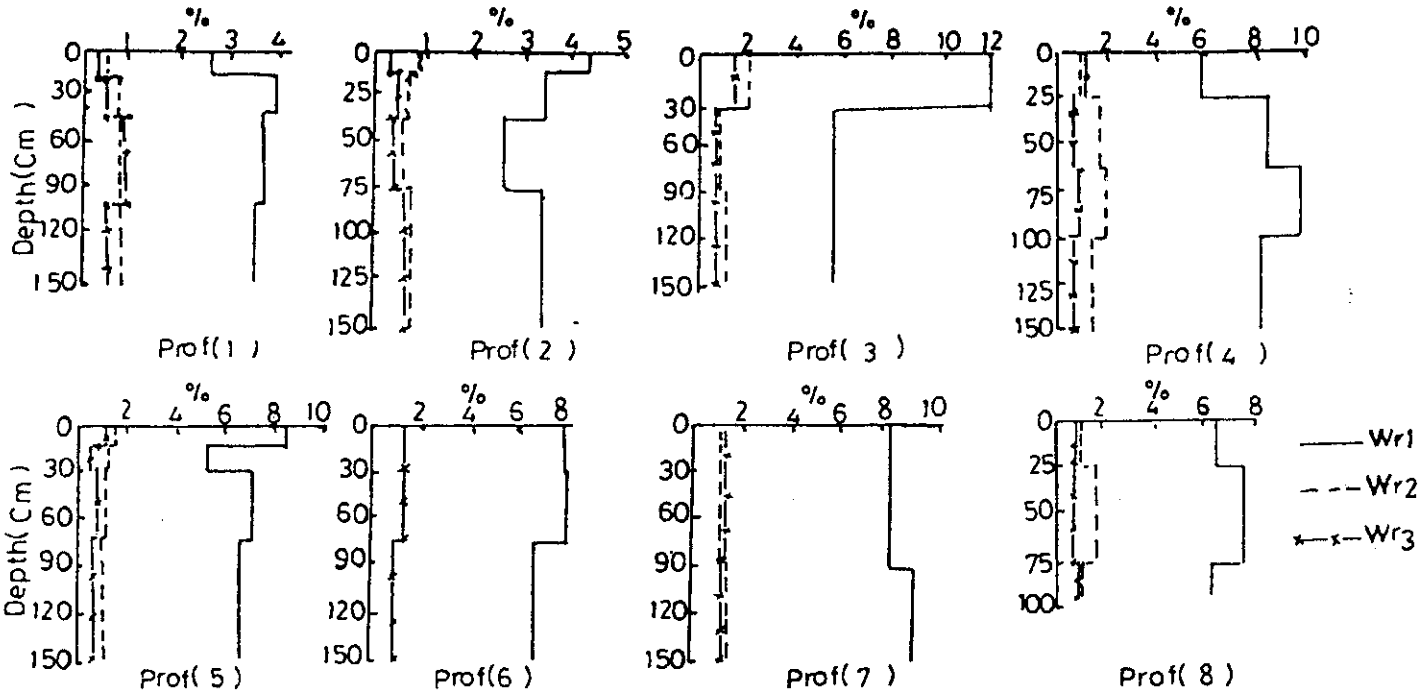

Fig. (5): Depthwise pattern of the weathering ratio in the studied soil profiles.

metamorphic rocks, rutile is widely **distributed** in various metamorphic rocks, while tourmaline is found in tourmalinized granites, other ubibuitous group occur in metamorphic limestones, Kerr (1959).

Table (7), also indicates that weatherable minerals (extremely unstable and slightly stable) were common minerals in the investigated soils. Additionally, the dominance of resistant minerals (stable and very stable minerals) could lead to the conclusion of addition of recent sediments rich in these minerals which are derived mainly from alteration of igneous and metamorphic rocks.

From the previous discussion it is evident that the soil under investigation are mostly derived from granitic and metamorphic rocks.

- Uniformity of soil materials:

The mineral assemblage as well as the ratios of Zr/R, Zr/T, Zr/T+R, Wr_1, Wr_2 and Wr_3 and their distribution pattern are taken as a criterion for profile uniformity as recommended by Marshall (1940) and Brewer (1964).

They were applied to test the uniformity and development of Egyptian soil by Hammad (1968), El-Demerdashe, *et al.* (1972), El-Gundy (1988) and Hassona (1999). The ratios between the total content of pyroxenes and amphi-boles (representing the more susceptible minerals to weathering) and the total content of zircon, tourmaline and rutile (representing the resistant minerals) was calculated for all samples and illustratoted in Table (8) and Fig. (4 and 5).

The results show that the soil constituting each profile is heterogeneous either due to their multi-origin or to the subsequent variations along the course of sedimention and therefore, it is considered young from the pedological point of view.

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دراسة أصل وطبيعة وتكوين ومدى تجانس أراضى بعض الوحدات الفيزيوجرافيه فى منطقة حلايب وشلاتين – مصر

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تهدف هذه الدراسة إلى التعرف على اصل وطبيعة وتكوين ومدى تجانس أراضى منطقة حلايب وشلاتين فى الركن الجنوبى الشرقى لمصر، حيث اختير ثمانية قطاعات أرضيه تمثل الوحدات الفيزوجرافية السائدة فى هذه المنطقة.

وقد أوضحت الدراسة الإحصائية للتوزيع الحجمى للحبيبات إلى أن هذه الأراضى فقيرة التجانس وانها نقلت كمادة معلقة وترسبت فى وسط مائى.

ومن الدراسة المنرالوجية للرمل تميزت المعادن الخفيفة بسيادة معدن الكوارتز مع وجود نسبه قليله جدا من الفلسبارات والتى تتمثل فى الأورثوكليز والبلاجيوكليز والميكروكلين.

وقد تميزت المعادن الثقيله بسيادة المعادن المعتمه أما المعادن الغير معتمه فيسود بها البيروكسينات والامفيبولات مع وجود كميات متوسطة من الابيدوت والزركون والترمالين والروتيل بينما معادن الأشترولیت والجارنت والكيانيت والسلمينيت والبيوتيت والمونازيت والأندالوزيت ، فقد وجدت بكميات قليلة.

وتشير نتائج دراسة توزيع المعادن المقاومة للتجوية ومعدلات التجويه إلى عدم وجود التجانس بين طبقات القطاعات المدروسة وأن هذه الأراضى غير متجانسة كما أنها ذات مواد أصل مركبه أو تعرضت لظروف ترسيب مختلفة كما إنها حديثة من الوجهة البيدولوجية.