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GRANULOMETRICAL AND MINERALOGICAL STUDIES OF THE SOILS IN WADI EL-HAWASHIYA, GULF OF SUEZ REGION

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ABSTRACT: Detailed granulometric and heavy minerals studies of a 36 collected samples representing 8 soil profiles in Wadi El-Hawashiya area have been carried out.

The results obtained reveal that the soils are mainly coarse texture (very coarse sand), poorly sorted, coarse to nearly symmetrical skewed, platy to very leptokurtic and they are formed in aquic environmental conditions that are mainly river and/or turbidity current.

The heavy minerals content show that pyroxenes and amphiboles (Pyroboles) are the predominant in the soils of the study area and then followed by the ubiquitous and epidotes groups. The least dominant is the parametamorphic group. Biotite is common, while monazite and glauconite are found in trace amounts.

Soils are heterogeneous either due to their multi origin or to subsequent variations along the course of deposition; accordingly, these soils are considered young, from the pedological point of view.

Key words: Granulometrical, mineralogical, Wadi, El-Hawashiya, Gulf of Suez.

INTRODUCTION

The study area is located to the east of the Gulf of Suez between longitudes 32° 13' 20" and 32° 57' 00" east. And latitudes 28° 00' 00" and 28° 34' 15" north, Figure 1.

The prevailing climate in this area is arid, whereas the mean annual temperature is 21.9, and the average rainfall is 12 mm/year, while the relative humidity is fluctuating between 19 and 62 %.

The regional geology of this Wadi is a portion of the geology of the Red Sea Region given according to EGPC (1987), Said (1962), and Aggour and Shabana (2003).

The surface of the study area is essentially occupied by different types of rocks belonging to the Cenozoic, Mesozoic, Paleozoic, and Precambrian.

As for the water resources in the study area, it occasionally deals with the heavy and short duration of torrential rainfall in the region and allow for strong to moderate floods. On the other hand, the groundwater hydrology deals with a limited water points in the area located to south of the investigated area. The nature vegetation is rarely found along the study area, MAPGAP (1990).

Eight soil profiles were chosen to represent the main land forms in the study area for the following studies:

Detailed granulometric studies were used for designating the depositional environment of the soils according to Folk and Ward (1957), Friedman (1961), Passega (1964), Sahu (1964), Friedman (1967), Moiola and Wieser (1968), and Visher (1969).

Detailed mineralogical study of sand fraction is used to evaluate the uniformity and development of the soils in the study area. Several trials were taken to evaluate soil profile uniformity as well as the development of some soils in Egypt, such as Hammad (1968), El-Demerdashe *et. al.* (1972), El-Gundy (1988), and Hassona (1999).

MATERIALS AND METHODS

Landforms of the area under consideration are represented by soil profiles, Figure 2, as follows:

1- The present channel is represented by soil profile Nos.1 and 2.

2- The old alluvium terraces are represented by soil profile Nos. 3, 4, 5, and 6.

3- The coastal plain is represented by soil profile Nos. 7 and 8.

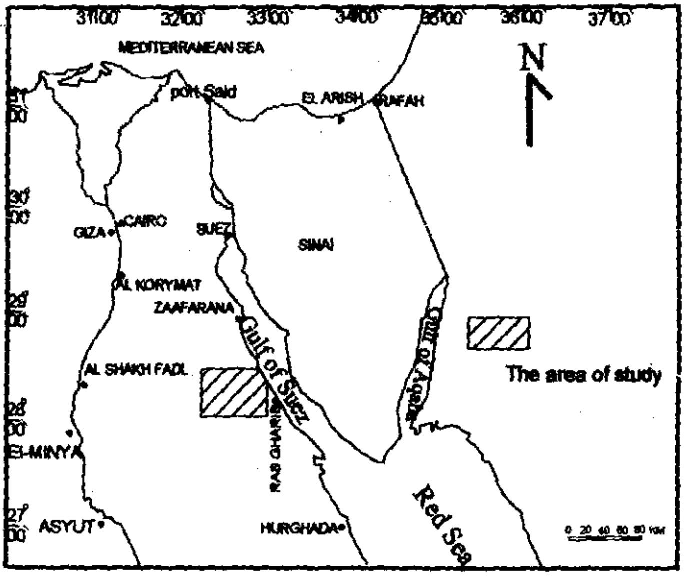

Fig.1: The location of the study area.

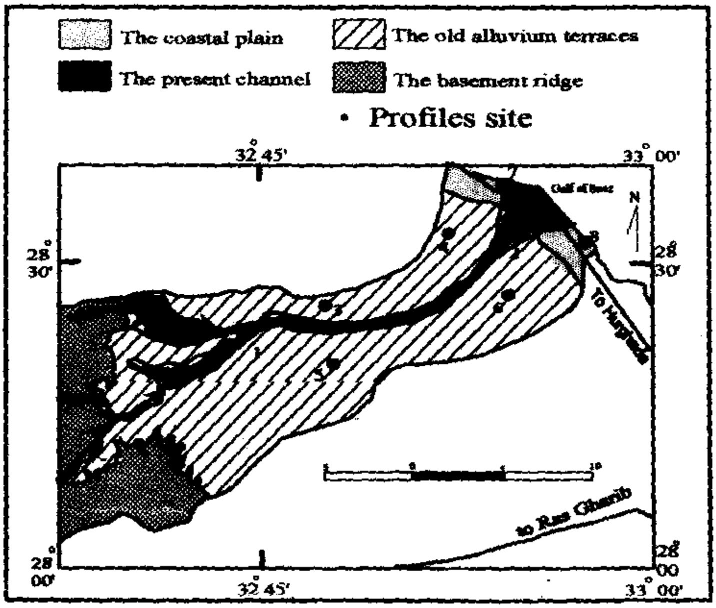

Fig.2: Landform of the lowland area of Wadi El-Hawashiya.

However, thirty six soil samples were collected and subjected to the following analysis:-

Mechanical analysis was carried out for the collected samples using piper techniques (1950).

The cumulative curves were prepared on a series of probability paper, Figure 3. Consequently, the data obtained from these curves were used to calculate the essential statistical parameters according to Folk and Ward (1957).

The discriminant functions of Sahu (1964) were computed.

The statistical size parameters were eventually then plotted on bivariant diagrams according to Passega (1964), Friedman (1961), Friedman (1967), and Moiola and Wieser (1968).

Separation of heavy minerals from the 0.125 to 0.063 mm sand fraction had been followed the technique of Brewer (1964).

Microscopic examination and identification of minerals are carried out according to the principles suggested by Kerr (1959) and the recommendation of Milner (1940 and 1962)

The ratios Zr/R, Zr/T, Zr/R+T, Wrl, Wr3 according to Marshall (1940) and Brewer (1964) were calculated to evaluate the uniformity and development of the soils in the study area.

RESULTS AND DISCUSSION

1. Grain Size Analysis

In the current study, Tables 1 and 2 show that:

The mean size values fluctuate between 0.55 and 1.99 along the study area. This range indicates that the mean grain size of the soils of the study area ranges from medium to coarse sand, according to Wentworth (1922).

With exceptional cases that detected in samples (70 -105 and 140 – 170 cm) of soil profile No. 6 that are defined as fine sand.

Regarding to the mean size, the soils of the lowland of Wadi El-Hawashiya are formed of heterogeneous soil materials.

The inclusive standard deviation indicated that the soils in study area are generally poorly sorted sediments except (70 – 105 cm) and 9130 to 170 cm) layers in the soil profile No. 18 that are moderately sorted.

Moreover, the data of the inclusive standard deviation indicate that the soils are formed from heterogeneous soil parent materials.

The inclusive skewness values range from (-0.291 to 0.066) indicating coarse to nearly symmetrical skewed, except soil sample (30 – 75 and 75 – 105 cm)

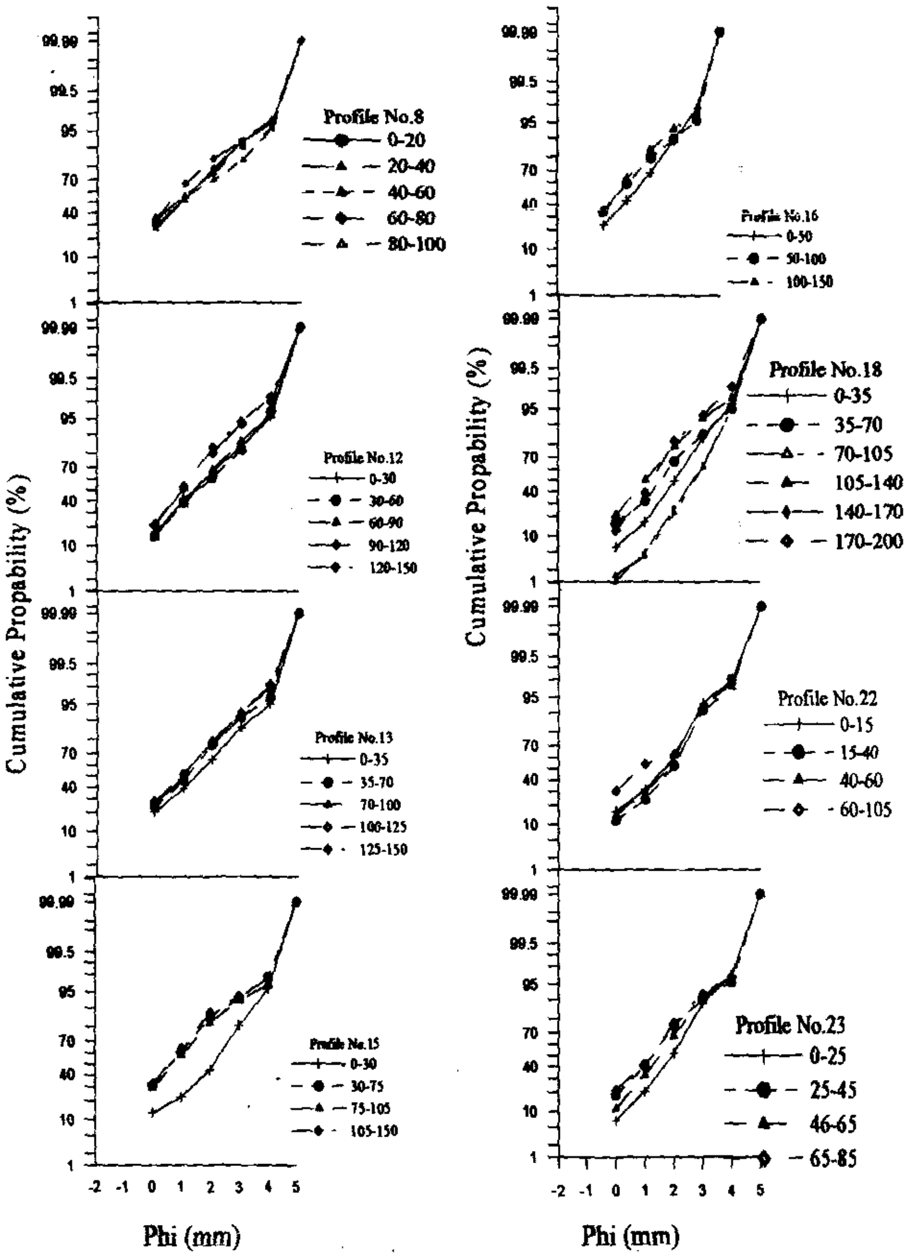

Fig.3: Cumulative curves of particle size distribution of the studied soils.

Table 1: Particle size distribution and Phi values of the studied soils at the lowland in Wadi El-Hawashiya

P. No.	Depth cm	Particle size distribution %							Phi distribution mm						
		2-1 mm	1-0.5 mm	0.5-0.25 mm	0.25-0.125 mm	0.125-0.063 mm	>0.063 mm	total	Ø5	Ø16	Ø25	Ø50	Ø75	Ø84	Ø95
1	0-20	29.48	23.37	25.13	13.91	4.68	3.43	100	-1.91	-0.80	-0.27	0.84	1.84	2.34	3.57
	20-40	26.64	26.17	24.29	14.42	5.33	3.15	100	-1.53	-0.58	-0.13	0.89	1.86	2.41	3.55
	40-60	36.77	18.48	14.08	14.47	11.66	4.54	100	-2.96	-1.51	-0.80	0.66	2.34	3.00	3.93
	60-80	33.55	32.69	18.02	7.92	4.91	2.91	100	-1.60	-0.77	-0.37	0.49	1.41	2.01	3.48
	80-100	33.92	22.09	18.94	14.87	5.55	4.63	100	-2.36	-1.13	-0.51	0.72	2.03	2.53	3.86
2	0-30	15.31	25.51	25.42	17.65	11.57	4.54	100	-0.87	-0.01	0.12	1.36	2.43	3.00	3.93
	30-60	14.19	24.57	23.15	20.06	14.55	3.48	100	-0.80	0.06	0.49	1.48	2.60	3.07	3.79
	60-90	14.54	22.33	30.37	19.54	9.14	4.08	100	-0.82	0.06	0.46	1.41	2.29	2.81	3.81
	90-120	20.51	30.68	28.76	13.60	4.37	2.08	100	-1.01	-0.25	0.15	0.94	1.77	2.19	3.21
	120-150	21.41	31.65	30.43	10.69	4.23	1.59	100	-1.04	-0.27	0.08	0.89	1.65	2.03	3.12
3	0-35	20.07	18.52	26.23	21.74	8.46	4.98	100	-.25	0.94	1.27	2.01	2.67	3.00	3.83
	35-70	23.31	22.64	30.37	14.67	5.33	3.68	100	-1.51	-0.46	0.03	1.10	1.93	2.45	4.40
	70-100	25.36	23.49	27.16	14.87	6.78	2.34	100	-1.65	-0.58	-0.04	1.06	1.93	3.48	3.93
	100-125	27.49	24.17	26.67	14.14	5.77	1.76	100	-1.72	-0.68	-0.16	0.94	1.84	2.34	3.62
	125-150	25.65	25.03	27.77	13.18	6.42	1.90	100	-1.51	-0.53	-0.09	0.96	1.86	2.36	3.79
4	0-30	12.94	9.37	22.02	36.36	15.02	4.29	100	-1.46	0.32	1.13	2.12	2.17	3.29	4.81
	30-75	31.22	29.94	24.74	7.27	4.42	2.41	100	-1.58	0.73	-0.30	0.60	1.50	1.89	3.69
	75-105	28.57	29.10	24.78	9.97	4.10	3.48	100	-1.46	-0.61	-0.20	0.70	1.65	2.15	4.14
	105-150	31.92	31.90	24.01	5.89	3.74	2.54	100	-1.48	0.68	-0.27	0.56	1.39	1.77	3.57
5	0-50	25.23	17.87	24.78	20.98	8.70	2.44	100	-1.72	-0.51	-0.08	1.27	2.27	2.67	3.55
	50-100	34.38	24.62	20.13	10.38	5.95	4.54	100	-2.08	-1.01	-0.49	0.63	1.74	2.41	3.88
	100-150	32.12	30.65	21.31	9.10	3.50	3.32	100	-1.53	-0.70	-0.30	0.56	1.51	2.01	3.41
6	0-35	6.38	10.37	32.83	34.16	12.29	3.97	100	0.58	0.96	1.29	2.00	2.67	3.00	3.86
	35-70	16.55	15.32	34.99	18.77	9.46	4.91	100	-1.48	-0.11	0.58	1.51	2.39	2.88	4.00
	70-105	1.47	2.56	18.64	39.31	32.92	5.10	100	1.09	1.74	2.09	2.69	3.26	3.50	4.01
	105-140	21.43	29.05	27.81	14.07	4.72	2.92	100	-1.10	-0.30	0.11	0.98	1.84	2.34	3.48
	140-170	1.04	3.81	21.28	37.41	31.21	5.25	100	1.09	1.74	2.09	2.69	3.28	3.50	4.05
	170-200	12.67	26.07	43.08	11.60	5.01	1.57	100	-0.56	0.15	0.51	1.22	1.77	2.12	3.19
7	0-15	16.41	15.26	28.65	33.12	4.39	2.17	100	-1.34	-0.03	0.58	1.65	2.32	2.60	3.27
	15-40	11.85	12.07	29.12	38.16	6.77	2.03	100	-1.01	0.39	1.06	1.89	2.46	2.74	3.43
	40-60	14.37	15.63	24.35	36.62	5.99	3.04	100	-1.17	0.09	0.70	1.82	2.46	2.72	3.60
	60-105	30.49	24.36	7.88	29.60	5.14	2.53	100	-1.86	-0.82	-0.30	0.80	2.29	2.58	3.38
8	0-25	9.69	10.74	31.18	34.76	10.32	3.31	100	-0.27	0.73	1.17	1.96	2.53	2.79	3.69
	25-45	18.12	22.42	35.07	14.51	5.21	4.67	100	-1.17	-0.20	0.30	1.25	1.96	2.48	3.93
	45-65	11.13	20.80	35.11	23.96	5.63	3.37	100	-0.63	0.27	0.70	1.51	2.24	2.63	3.60
	65-85	21.43	20.42	35.00	15.09	4.42	3.54	100	-1.53	-0.42	0.16	1.20	1.94	2.36	3.60

Table 2: The statistical parameters of Folk and Ward (1957), Sahu' discriminant functions (1964), and C-M values of Passega (1964)

P. No.	Depth cm	Q_σ	I	Ski	I	Kg	Kg^1	I	Mz	I	YI	YII	YIII	YIV	I	C	M
1	0-20	1.62	P.S	-0.024	N.S	1.06	0.52	M.K	0.79	cS	10.2	203.1	-22.5	4.99	T.C	1906	560
	20-40	1.52	P.S	0.032	N.S	1.05	0.51	M.K	0.91	cS	8.5	185.4	-20.0	5.48	T.C	1906	570
	40-60	2.17	P.S	-0.014	N.S	0.89	0.47	P.K	0.72	cS	17.7	337.5	-41.0	3.29	T.C	1937	607
	60-80	1.47	P.S	0.135	F.S	1.17	0.54	L.K	0.58	cS	9.2	174.1	-19.2	6.65	T.C	1928	722
	80-100	1.86	P.S	0.00	N.S	1.00	0.50	M.K	0.71	cS	13.4	256.3	-30.0	4.43	T.C	1928	603
2	0-30	1.48	P.S	0.08	N.S	0.85	0.46	P.K	1.45	mS	5.4	184.0	-19.1	5.21	T.C	1844	409
	30-60	1.45	P.S	0.032	N.S	0.89	0.47	P.K	1.54	mS	5.0	178.9	-18.0	5.19	T.C	1800	366
	60-90	1.40	P.S	0.027	N.S	1.04	0.51	M.K	1.43	mS	5.2	168.8	-16.6	5.92	T.C	1813	390
	90-120	1.25	P.S	0.05	N.S	1.07	0.52	M.K	0.96	cS	5.6	138.3	-13.6	6.05	T.C	1875	529
	120-150	1.21	P.S	0.032	N.S	1.09	0.52	M.K	0.88	cS	5.5	130.0	-12.6	6.01	T.C	1884	550
3	0-35	1.13	P.S	-0.073	N.S	1.19	0.54	L.K	1.98	mS	1.5	136.2	-10.3	6.74	T.C	1825	380
	35-70	1.62	P.S	0.022	N.S	1.28	0.56	L.K	1.03	mS	10.0	213.2	-22.8	6.58	T.C	1888	479
	70-100	1.60	P.S	-0.022	N.S	1.16	0.54	L.K	0.99	cS	9.7	207.0	-22.3	5.66	T.C	1897	508
	100-125	1.54	P.S	-0.035	N.S	1.09	0.52	M.K	0.87	cS	9.4	194.0	-21.0	5.20	T.C	1905	529
	125-150	1.53	P.S	-0.018	N.S	1.14	0.53	L.K	0.93	cS	8.7	188.4	-20.2	5.75	T.C	1906	541
4	0-30	1.69	P.S	-0.18	C.S	2.47	0.71	V.L.K	1.91	mS	11.8	260.6	-23.6	12.1	D.	1800	235
	30-75	1.09	P.S	0.70	S.F.S	1.20	0.55	L.K	1.07	mS	2.8	129.5	-13.4	11.4	D.	1919	659
	75-105	1.54	P.S	0.14	F.S	1.24	0.55	L.K	0.75	cS	9.7	192.7	-21.2	7.09	T.C	1928	600
	105-150	1.38	P.S	0.09	N.S	1.25	0.56	L.K	0.55	cS	8.8	158.0	-16.8	6.84	T.C	1928	686
5	0-50	1.59	P.S	-0.127	C.S	0.99	0.50	M.K	1.14	mS	8.6	200.7	-21.2	4.17	T.C	1897	461
	50-100	1.76	P.S	0.066	N.S	1.10	0.52	M.K	0.68	cS	12.3	235.1	-27.1	5.48	T.C	1928	651
	100-150	1.43	P.S	0.112	F.S	1.12	0.53	L.K	0.62	cS	8.5	166.1	-18.1	6.30	T.C	1915	678
6	0-35	1.01	P.S	0.057	N.S	0.97	0.49	M.K	1.99	mS	-0.4	116.8	-8.5	5.57	T.C	1624	250
	35-70	1.58	P.S	-0.087	N.S	1.24	0.55	L.K	1.43	mS	8.2	207.3	-20.9	6.00	T.C	1844	332
	70-105	0.88	M.S	-0.088	N.S	1.02	0.51	M.K	2.64	fS	-3.2	109.9	-5.6	6.42	T.C	1800	314
	105-140	1.35	P.S	0.061	N.S	1.09	0.52	M.K	1.01	mS	6.4	157.4	-16.0	6.14	T.C	1884	524
	140-170	0.88	M.S	-0.088	N.S	1.02	0.51	M.K	2.64	fS	-3.2	109.9	-5.6	6.42	T.C	1800	314
	170-200	1.06	P.S	-0.018	N.S	1.22	0.55	L.K	1.16	mS	3.8	114.4	-9.4	6.72	T.C	1785	442
7	0-15	1.36	P.S	-0.287	C.S	1.09	0.52	M.K	1.41	mS	5.8	157.7	-14.2	4.09	T.C	1822	327
	15-40	1.26	P.S	-0.291	C.S	1.30	0.57	L.K	1.67	mS	4.5	149.3	-11.9	5.48	T.C	1783	270
	40-60	1.38	P.S	-0.285	C.S	1.11	0.52	M.K	1.54	mS	5.6	164.7	-14.8	4.31	T.C	1800	285
	60-105	1.64	P.S	0.016	N.S	0.83	0.45	P.K	0.85	cS	9.5	206.6	-23.5	4.02	T.C	1906	581
8	0-25	1.12	P.S	-0.160	C.S	1.19	0.54	L.K	1.83	mS	2.1	129.5	-9.5	6.05	T.C	1643	259
	25-45	1.44	P.S	-0.016	N.S	1.26	0.56	L.K	1.18	mS	7.5	178.2	-17.8	6.57	T.C	1853	440
	45-65	1.23	P.S	-0.031	N.S	1.13	0.53	L.K	1.47	mS	3.9	142.8	-12.6	6.19	T.C	1766	364
	65-85	1.47	P.S	-0.115	C.S	1.18	0.54	L.K	1.05	mS	8.2	178.6	-18.1	5.36	T.C	1888	451

Q_σ: standard deviation Ski: Skewness Kg: Kurtosis Kg^1 : transformation of kurtosis Mz : mean Size mS: medium sand cS: Coarse sand fS: fine sand N.S nearly symmetrical CS: coarse skewed FS: fine Slewed S.F.S: strongly fine Skewed M.K: mesokurtic P.K: platykurtic L.K: leptokurtic V.L.K: L: very leptokurtic T.C: turbidity current C: percentile at 1% M: percentile at 50% I: Interval in soil profile No.4 which are strongly fine skewed. The skewness values indicate that soil profiles are derived from heterogeneous soil parent materials.

Based on the values of kg^1, the kurtosis in the area under study constitutes (0.46 to 0.71) indicating platykurtic to very leptokurtic curves. The studied soils are composed of heterogeneous soil materials as indicated by the kurtosis values.

The prevailing depositional environments

Based on the sorting values, which are mainly poorly sorted, the water is the main factor responsible for soil formation along the area under study.

Referring to the shape of the cumulative curve (Visher, 1969); the soils of the study area are affected by turbidity current.

According to Passega (1964) the examined sediments are grouped in class I signifying transportation by river and tractive current as shown in Figure 4. Applying the boundaries Mz against δi of Friedman (1961), all samples are located in the discriminated area of mixed dune sand and river. So this method reveals that the depositional environment is not clearly indicated, Figure 5.

Appling the boundaries Mz against Ski of Friedman (1961), the sediments of the study area are of beach environmental deposition, Figure 6. Applying the boundaries Mz against δi of Friedman (1967), indicate that river depositional environment is responsible for the deposition of sediments, Figure 7.

Applying the boundaries δi against Ski after Friedman (1967), indicate that the sediments of the studied area are located in river deposits, Figure 8.

Applying the method of Moiola and Weiser (1968), using the relationship between Mz against Ski, the sediments are affected by beach deposits Figure 9. While, using the relationship between Mz and δi, soil samples are affected by river deposits, Figur10.

According to Sahu discriminant function (1964), the turbidity current is the main depositional environment of the sediments in the studied soils, Table 2.

Sahu (1964), Passega (1964) and Friedman (1967), Moiola and Wieser (1969), and Visher (1969) are the best methods to designate the depositional environment of the soils in the study area. Nevertheless, according to Asma (1995), it is recommended to

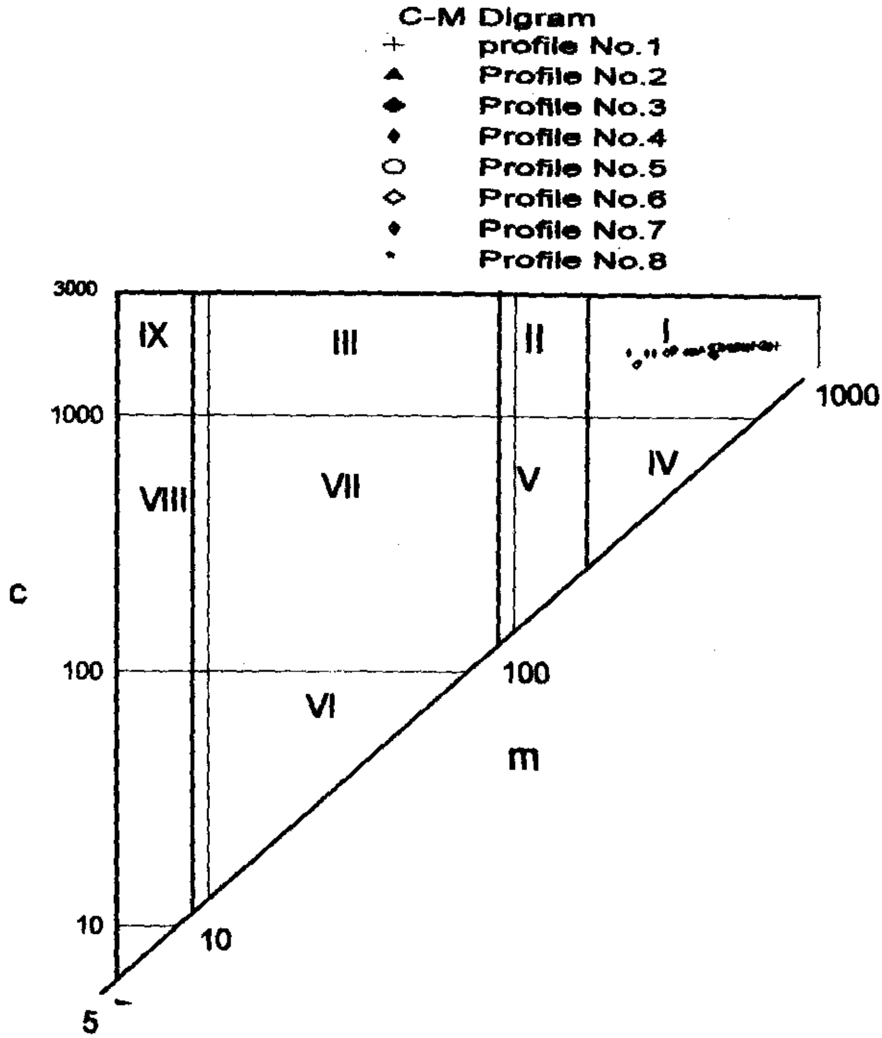

Fig.4: C-M Digram of passega (1964).

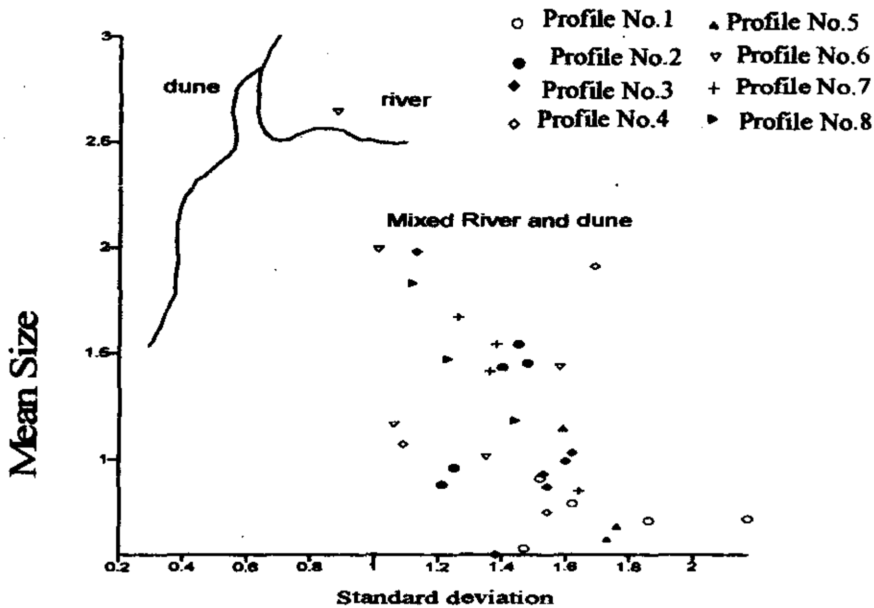

Fig. 5: Bivariant plot on mean size vs. inclusive standard deviation, after friedman (1961).

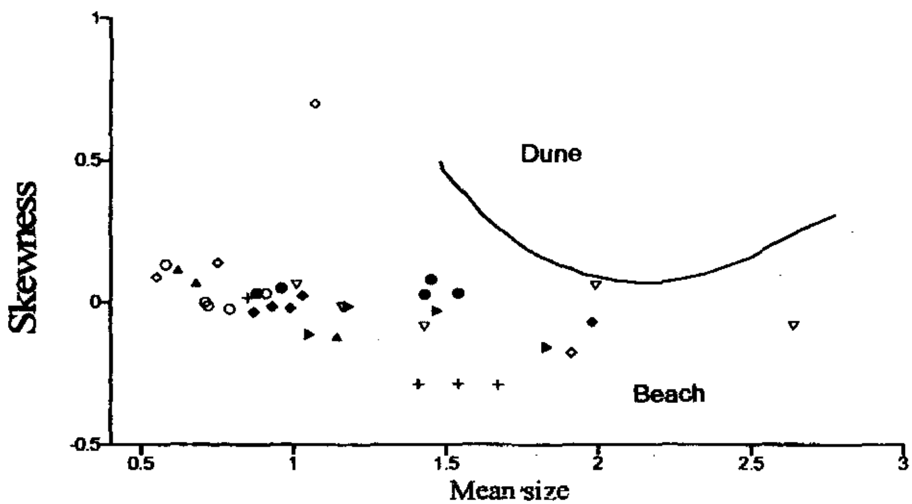

Fig. 6: Bivariant plot of skewness vs. mean size, after Friedman (1961)

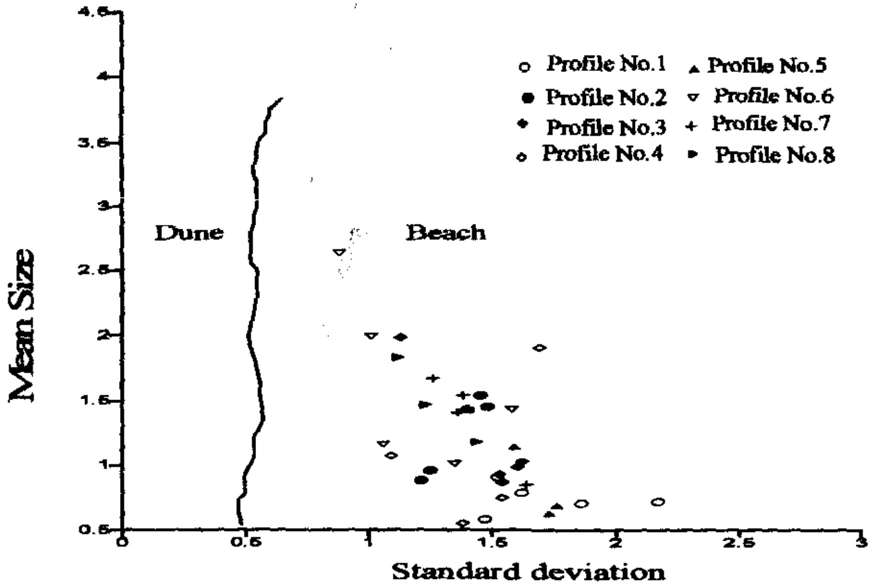

Fig. 7: Bivariant plot of mean size vs, inclusive standard deviation after Friedman (1967).

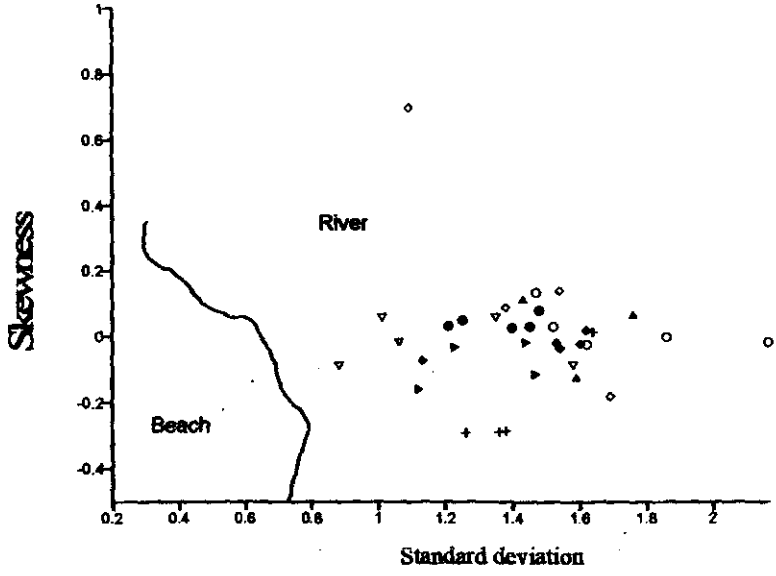

Fig. 8: Bivariant plot of skewness vs. niclusive standard deviation, after friedman (1967).

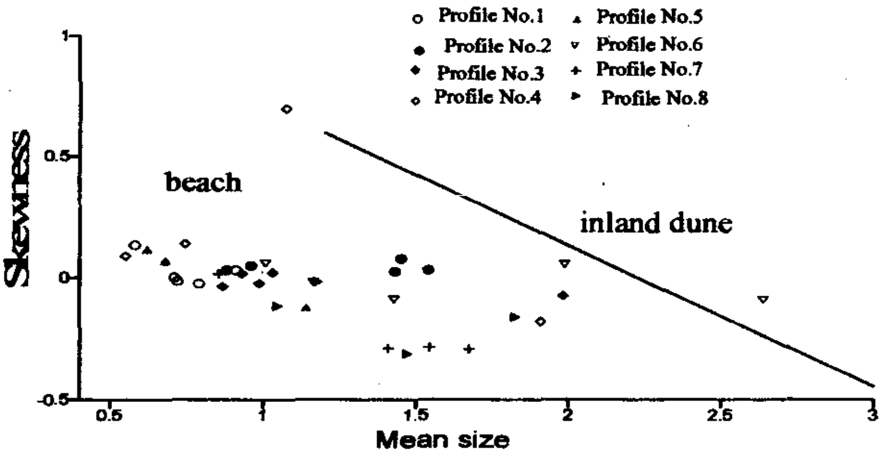

Fig. 9: Bivariant plot of skewness vs. mean size , after Moiola and Weiser (1968).

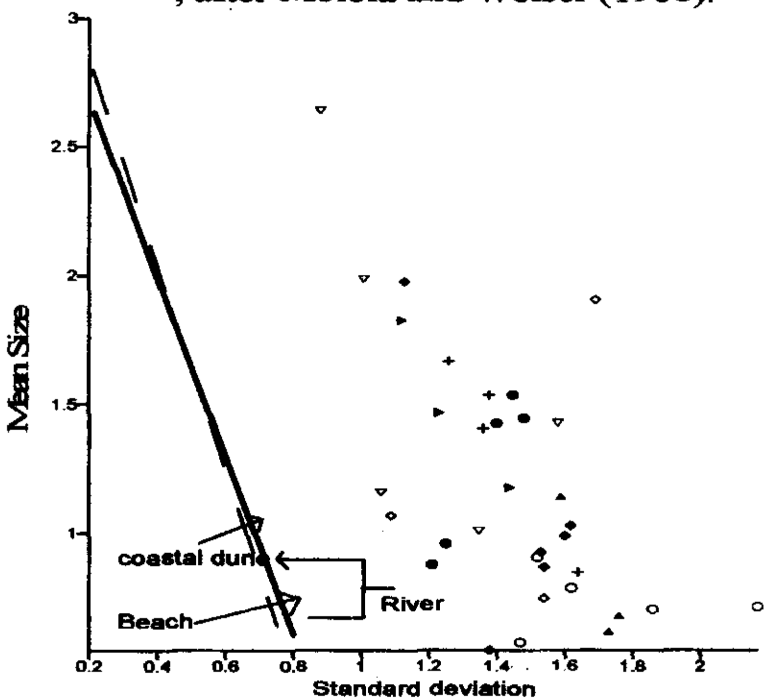

Fig. 10: Bivarinat plot of mean size vs. inclusive standard deviation, after Moiola and Weiser (1968)

conduct further detailed investigations in the vital need to integrated efforts with other geologists and meteorologists.

Therefore, special emphasis should be given to the proposed investigation for different depositional environments (aeolian, alluvial, beach ...etc) under fixed condition (arid, semiarid. etc), under Egyptian condition.

2- Mineralogy of the Sand Fraction.

The data of the heavy minerals contents (weighted mean) which are given in Table 3 show the following:

The opaque minerals vary from 47.82 to 51.04 % in the soils of the present channel, 37.73 to 40.71 % in the soils of the old alluvium terraces, and vary from 35.68 to 38.54 % in the soils of the coastal plain.

The pyroxene and amphiboles (Pyroboles) are the most predominant in the soils of the study area. The pyroxenes range from 11.57 to 24.23 %, 16.69 to 24.12 %, and from 13.37 to 16.37 %, while the amphiboles range from 15.48 to 28.04 %, 17.47 to 22.00 %, and from 14.53 to 14.56 % in the soils of the present channel, the old alluvium terraces, and the coastal plain, respectively.

The parametamorphic group ranges from 3.76 to 12.13 %, 4.60 to 7.16 %, and 8.95 to 9.40 % in the soils of the present channel, the old alluvium terraces, and the coastal plain, respectively.

The epidotes group content ranges from 6.11 to 12.99 % in the soils of the study area.

The ubiquitous group is common in the soils of the study area, where it ranges from 22.18 to 38.03%, 25.00 to 32.54% and from 36.88 to 39.49% in the soils of the present channel, the old alluvium terraces and the coastal plain. Moreover, Zircon is significantly predominating the others members.

Biotite content ranges from 6.48 to 22.2% whereas the lowest value is detected in the coastal plain while the highest one is detected in the present channel.

Monazite and Glauconite are scarcely found in the soils of the study are.

Data in Table 4 and Figures 11 and 12 (the ratios of Zr/R, Zr/T, Zr/R+T, Wr1, Wr2, and Wr3 and their depthwise distribution) show that the soils are heterogeneous either due to their multi origin or to subsequent variations along the course of deposition. They are,

Table 3: Frequency distribution of the heavy minerals in the sand fraction 0.125-0.063 of the studied soils of the study area.

P. No	Depth cm	Opaque	PYROBOLES										Epidote
			Pyroxene					Amphiboles					
			Augite	Hypersth-ene	Diopside	Instatite	Total	Hornblende	Glacoph-ane	Actinolite	Termolite	Total	
1	0-20	60.30	8.84	9.39	6.63	0.00	24.86	23.50	3.31	2.21	0.00	29.02	9.95
	20-40	52.38	4.59	5.18	0.00	7.65	17.42	23.69	0.10	3.57	1.02	28.38	6.36
	40-60	36.31	8.18	14.1	5.58	0.00	28.26	23.90	4.46	2.60	0.00	30.96	8.18
	60-80	48.33	7.08	10.6	0.00	2.75	20.40	18.50	0.77	0.77	0.44	20.48	3.54
	80-100	58.05	9.26	13.6	3.09	0.00	25.93	22.35	3.09	2.47	2.47	30.38	3.70
Weighted mean		51.84	8.06	11.5	3.37	1.32	24.23	22.25	2.65	2.21	0.93	28.04	6.11
2	0-30	41.79	8.00	0.00	0.00	0.00	8.00	12.48	2.86	0.00	1.14	16.29	9.15
	30-60	47.45	9.38	1.73	1.73	0.00	15.15	8.41	2.30	0.00	1.14	11.85	6.59
	60-90	48.98	12.36	1.77	1.77	1.59	18.26	12.06	2.06	0.00	0.59	14.71	7.67
	90-120	53.11	5.77	1.75	1.75	0.00	11.03	10.53	0.00	1.75	0.00	12.28	12.03
	120-150	44.85	1.95	0.00	0.00	2.55	4.05	16.88	0.00	1.98	0.59	19.45	10.12
Weighted mean		47.82	7.23	1.10	1.10	1.29	11.57	12.84	1.11	0.95	0.58	15.48	9.21
3	0-35	35.64	6.11	3.06	3.06	5.34	17.57	15.27	0.00	1.53	0.00	16.80	10.69
	35-70	35.55	7.69	3.85	0.96	0.96	13.46	14.42	2.88	5.77	1.92	24.99	8.56
	70-100	45.23	13.08	5.61	4.67	5.61	28.97	19.63	2.80	1.87	0.00	24.30	1.87
	100-125	34.31	13.95	5.81	4.65	3.49	27.90	15.12	3.49	0.00	0.00	18.61	8.14
	125-150	35.57	12.13	4.10	3.91	4.13	24.27	20.65	1.75	1.19	0.39	23.98	12.40
Weighted mean		37.73	11.70	4.95	3.71	3.76	24.12	16.93	2.72	1.91	0.44	22.00	7.29
4	0-30	58.30	11.69	4.88	3.41	1.74	21.72	14.72	1.45	0.00	0.00	16.17	11.33
	30-75	34.02	10.80	0.00	1.54	3.03	15.34	13.64	0.00	0.00	0.00	13.64	12.54
	75-105	33.87	8.25	0.00	2.41	1.21	11.87	26.50	0.00	0.00	0.00	26.50	10.60
	105-150	32.50	12.13	5.05	4.04	1.01	22.23	15.15	1.01	0.00	0.00	16.16	12.11
Weighted mean		38.39	10.87	2.49	2.83	1.80	17.99	16.88	0.59	0.00	0.00	17.47	11.78
5	0-50	35.04	8.62	6.03	0.86	0.00	15.51	17.24	0.00	0.86	0.00	18.10	12.93
	50-100	48.25	16.05	8.64	0.00	0.00	24.69	18.52	0.00	2.47	0.00	20.99	9.87
	100-150	38.05	12.90	5.53	0.00	4.15	22.58	21.51	0.00	0.00	1.07	22.58	16.18
Weighted mean		40.71	12.52	6.73	0.29	1.38	20.93	19.09	0.00	1.11	0.36	20.56	12.99
6	0-35	34.11	14.25	3.72	2.83	1.89	22.69	14.29	1.89	0.00	0.00	16.18	8.55
	35-70	47.60	12.66	1.53	1.27	0.00	15.46	18.99	0.00	0.00	0.00	18.99	8.60
	70-105	30.98	7.20	0.60	3.20	1.60	12.60	13.60	3.20	0.00	0.00	16.80	11.40
	105-140	37.59	11.11	2.17	0.00	2.47	15.75	16.05	3.70	0.00	0.00	19.75	8.94
	140-170	30.00	10.45	2.97	2.24	0.75	16.41	11.94	0.75	0.75	0.00	13.44	14.19
	170-200	53.63	18.87	2.66	0.00	0.66	22.19	18.87	0.00	0.00	0.00	18.87	19.10
Weighted mean		38.63	11.90	2.10	1.39	1.30	16.69	15.51	1.81	0.15	0.00	17.47	12.20
7	0-15	40.61	8.55	5.13	1.71	0.00	15.39	17.95	0.00	0.86	0.00	18.81	5.98
	15-40	37.58	7.95	0.00	0.00	0.00	7.95	9.93	0.00	0.00	0.00	9.93	5.30
	40-60	32.12	15.04	2.85	0.00	0.00	17.89	12.04	0.00	0.88	0.00	12.92	10.62
	60-105	38.85	12.90	0.00	4.15	0.00	17.05	18.51	0.00	0.00	0.00	18.51	16.18
Weighted mean		35.68	10.89	1.28	1.83	0.00	13.99	14.27	0.00	0.29	0.00	14.56	10.30
8	0-25	34.85	8.93	1.79	0.00	0.00	10.72	13.39	0.89	0.00	0.89	15.17	6.25
	25-45	38.82	12.87	1.98	0.00	0.00	14.85	20.74	0.99	0.00	0.99	22.72	4.95
	45-65	38.85	11.36	13.6	1.14	1.14	29.55	10.04	0.00	0.00	0.00	10.04	6.82
	65-85	46.80	6.99	3.49	0.44	0.44	11.79	8.73	1.31	0.00	0.00	10.04	9.00
Weighted mean		38.54	9.97	5.02	0.37	0.37	16.37	13.23	0.80	0.00	0.00	14.53	6.73

Table 3: Cont.

P. No.	Depth cm	Paramorphic				Ubiquitous				Biotite	Monazite	Glauconite	Others
		Garnet	Staurolite	Kyanite	Total	Zircon	Rutile	Tourmaline	Total				
1	0-20	5.52	4.97	0.55	11.04	9.57	4.42	2.76	16.75	6.63	1.66	0.00	0.00
	20-40	6.63	6.12	1.02	13.77	17.39	5.10	3.06	25.55	6.63	0.51	0.00	1.53
	40-60	8.55	5.20	1.49	15.24	10.16	1.49	0.00	11.65	5.85	0.37	0.00	0.00
	60-80	2.42	2.21	1.77	6.40	31.34	4.50	4.50	40.34	7.52	0.80	0.00	0.80
	80-100	4.94	9.26	0.00	14.20	13.52	2.48	0.62	16.62	7.44	0.62	0.00	0.62
Weighted mean		5.44	5.87	0.86	12.13	16.01	3.34	1.94	22.18	6.84	0.80	0.50	0.50
2	0-30	5.14	1.14	0.57	6.85	34.00	5.14	5.71	44.85	13.4	0.57	0.57	0.00
	30-60	3.01	1.01	0.57	4.59	30.77	4.32	3.36	38.45	22.3	0.57	0.57	0.00
	60-90	1.03	1.03	0.59	2.65	23.84	2.65	4.70	31.19	22.5	1.19	1.79	0.00
	90-120	0.88	0.88	0.00	1.76	26.54	3.51	7.02	37.07	25.4	0.00	0.00	0.00
	120-150	1.19	1.19	0.59	2.97	23.43	5.79	9.38	38.60	21.6	1.19	1.97	0.00
Weighted mean		1.59	1.06	0.48	3.76	25.72	4.16	6.49	38.03	22.26	0.85	0.85	0.06
3	0-35	2.29	0.76	1.53	4.58	15.08	4.76	9.92	28.76	17.6	1.53	0.00	0.00
	35-70	1.72	0.00	1.72	3.44	20.11	3.92	5.77	29.80	20.2	0.00	0.00	0.00
	70-100	1.87	1.87	0.93	4.67	15.89	2.80	11.2	29.89	10.3	0.00	0.00	0.00
	100-125	3.49	2.33	0.00	5.82	11.63	2.33	11.6	25.56	14.0	0.00	0.00	0.00
	125-150	2.54	4.47	0.00	7.01	8.59	3.15	5.81	17.55	13.3	0.79	0.00	0.00
Weighted mean		2.50	1.92	0.69	4.94	14.29	3.04	9.46	27.06	14.38	0.21	0.00	0.00
4	0-30	1.01	4.38	0.95	6.34	21.35	1.95	6.40	29.70	14.6	0.00	0.51	0.00
	30-75	1.51	2.02	1.51	5.04	22.73	4.54	10.6	37.87	16.2	0.00	0.00	0.00
	75-105	0.00	0.00	0.00	0.00	24.53	0.00	4.41	28.94	22.5	0.00	0.00	0.00
	105-150	2.02	4.04	0.00	6.06	18.18	2.02	8.08	28.28	14.1	0.00	1.01	0.00
Weighted mean		1.26	2.70	0.64	4.60	21.45	2.36	7.77	32.54	16.22	0.00	0.41	0.00
5	0-50	3.45	1.75	0.00	5.20	25.00	2.59	4.31	31.90	12.9	2.69	0.86	0.00
	50-100	2.47	0.00	0.00	2.47	7.41	1.23	4.94	13.58	22.2	4.94	1.23	0.00
	100-150	4.38	3.23	1.56	9.17	8.68	0.00	4.30	12.98	12.9	3.23	0.00	0.00
Weighted mean		3.43	1.66	0.52	7.16	13.70	1.27	4.52	26.75	16.02	3.62	0.70	0.00
6	0-35	0.00	4.72	1.89	6.61	24.53	1.89	4.72	31.14	15.1	0.00	0.00	0.00
	35-70	3.80	2.53	0.00	6.33	25.32	2.53	5.06	32.91	13.9	0.00	0.00	3.80
	70-105	0.80	4.00	0.00	4.80	17.60	4.80	8.80	31.20	17.6	0.00	1.60	4.00
	105-140	0.00	2.47	7.41	9.88	19.75	0.00	7.41	27.16	18.5	0.00	0.00	0.00
	140-170	2.24	2.98	3.73	8.95	14.92	2.24	6.72	23.88	18.7	2.24	0.00	2.24
	170-200	1.89	0.00	1.89	3.78	11.32	0.00	6.66	17.98	18.1	0.00	0.00	0.00
Weighted mean		1.41	2.57	3.02	6.74	17.81	1.82	6.99	25.00	17.54	0.45	0.32	0.32
7	0-15	3.42	0.00	2.56	5.98	23.08	6.84	8.55	38.47	9.40	5.98	0.00	0.00
	15-40	8.97	0.66	0.66	10.29	30.17	5.62	13.0	48.79	4.64	13.3	0.00	0.00
	40-60	6.20	3.54	0.00	9.74	28.93	3.31	4.54	36.78	8.00	4.43	0.00	0.00
	60-105	4.30	2.23	1.56	8.09	13.68	6.31	4.38	24.37	12.90	3.00	0.00	0.00
Weighted mean		5.44	1.68	1.12	9.40	21.20	5.35	6.84	36.88	8.89	6.01	0.00	0.00
8	0-25	2.68	3.57	0.89	7.14	30.25	4.46	5.36	40.07	13.39	5.36	0.00	1.79
	25-45	0.99	4.95	0.99	6.93	20.83	1.97	11.9	34.70	12.87	0.99	0.99	0.99
	45-65	4.54	7.95	0.00	12.49	17.36	3.14	3.41	23.91	12.50	3.41	0.00	1.14
	65-85	0.00	7.95	0.00	7.95	38.73	10.3	10.1	59.13	7.24	0.87	0.44	0.44
Weighted mean		2.09	0.67	0.49	8.95	27.00	4.94	7.54	39.49	11.61	2.82	0.34	1.13

Table 4: Uniformity and weathering ratios of the soils of the lowland of Wadi El-Hawashiya

P.No.	Soil depth cm	Some heavy minerals						Uniformity ratio			Weathering ratio		
		P	A	Zr	R	T	B	Zr/R	Zr/T	Zr/T+R	Wr1	Wr2	Wr3
1	0-20	24.86	29.02	9.57	4.42	2.76	6.63	2.17	3.47	1.33	4.37	1.91	0.54
	20-40	17.42	28.38	17.39	5.10	3.06	6.63	3.41	5.88	2.13	2.24	1.16	0.32
	40-60	28.26	30.96	10.16	1.49	0.00	5.58	6.82	N.D	6.82	5.83	2.35	0.55
	60-80	20.40	20.48	31.34	4.50	4.50	7.52	6.96	6.96	3.48	1.14	0.52	0.21
	80-100	25.93	30.38	13.52	2.48	0.62	7.44	5.45	21.81	4.36	3.98	1.58	0.53
2	0-30	8.00	16.29	34.00	5.14	5.71	13.40	6.61	5.95	3.13	0.61	0.31	0.34
	30-60	10.15	11.85	30.77	4.32	3.36	22.26	7.12	9.20	4.01	0.79	0.25	0.65
	60-90	13.26	14.71	23.84	5.65	4.70	22.54	9.00	5.10	3.24	1.16	0.42	0.79
	90-120	9.03	12.28	26.54	3.51	7.02	25.44	7.56	3.78	2.52	0.69	0.31	0.76
	120-160	4.50	19.45	23.43	5.79	9.38	21.64	4.05	2.50	1.54	0.73	0.51	0.66
3	0-35	17.57	16.00	15.08	4.76	9.92	17.56	3.17	1.52	1.03	1.37	0.61	0.70
	35-70	13.46	24.99	20.11	3.92	5.77	20.23	5.13	3.49	2.08	1.49	0.56	0.78
	70-100	28.97	24.30	15.89	2.80	11.51	10.28	5.68	1.42	1.13	1.97	0.72	0.38
	100-125	27.90	18.61	11.36	2.33	11.63	13.95	4.99	1.00	0.83	2.00	0.65	0.60
	125-150	24.27	23.98	8.59	3.15	5.81	13.32	2.73	1.48	0.96	3.35	1.43	0.93
4	0-30	21.72	16.17	21.35	1.95	6.40	14.61	10.95	3.34	2.56	1.37	0.53	0.53
	30-75	15.34	13.64	22.73	4.54	10.61	15.15	5.01	2.14	1.50	0.87	0.41	0.45
	75-105	11.87	26.50	24.53	0.00	4.41	22.53	N.D	5.56	5.56	1.33	0.92	0.78
	105-150	22.23	16.16	18.18	2.02	8.08	14.14	9.00	2.25	1.80	1.46	0.58	0.54
5	0-50	15.51	18.10	25.00	2.59	4.31	12.93	9.65	5.80	3.62	1.15	0.59	0.44
	50-100	24.69	20.99	7.41	1.23	4.94	22.22	6.02	1.50	1.20	3.70	1.50	1.80
	110-150	22.58	22.58	8.68	0.00	4.30	12.90	N.D	2.02	2.02	3.48	1.66	0.99
6	0-35	22.69	16.18	24.53	1.89	4.72	15.09	12.98	5.20	3.71	1.33	0.49	0.52
	35-70	15.46	18.99	25.32	2.53	5.06	13.92	10.01	5.00	3.34	1.13	0.63	0.46
	70-105	12.60	16.80	17.60	4.80	8.80	17.60	3.67	2.00	1.29	1.11	0.52	0.67
	105-140	15.75	19.75	19.75	0.00	7.41	18.52	N.D	2.67	2.67	1.31	0.59	0.68
	140-170	16.41	13.44	14.92	2.24	6.72	18.66	6.66	2.22	1.67	1.38	0.55	0.86
	170-200	22.19	18.87	11.32	0.00	6.66	18.09	N.D	1.70	1.70	2.28	1.05	1.01
7	0-15	15.39	18.81	23.08	6.84	8.55	9.40	3.37	2.70	1.50	1.08	0.57	0.30
	15-40	7.95	9.93	30.17	5.62	12.97	4.64	5.37	2.33	1.62	0.41	0.23	0.11
	40-60	17.89	12.92	28.93	3.31	4.54	8.00	8.74	6.37	3.69	0.92	0.36	0.24
	60-105	17.05	18.51	13.68	6.31	4.38	12.90	2.17	3.12	1.28	1.97	1.02	0.71
8	0-25	10.72	15.17	30.25	4.46	5.36	13.39	6.79	5.64	3.08	0.73	0.38	0.38
	25-45	14.85	22.72	20.83	1.97	11.89	12.87	10.57	1.75	1.50	1.15	0.63	0.39
	45-65	29.55	10.04	17.36	3.14	3.41	12.50	5.53	5.09	2.65	1.91	0.48	0.60
	65-85	11.79	10.04	38.73	10.31	10.06	7.24	3.76	3.85	1.90	0.45	0.18	0.15

P.No. profile number P: Pyroxenes A: amphiboles Zr: Zircon R: Rutile T: Tourmaline Wr1=P+A/ZR+T Wr2=A/Zr+T Wr3= B/Zr+T

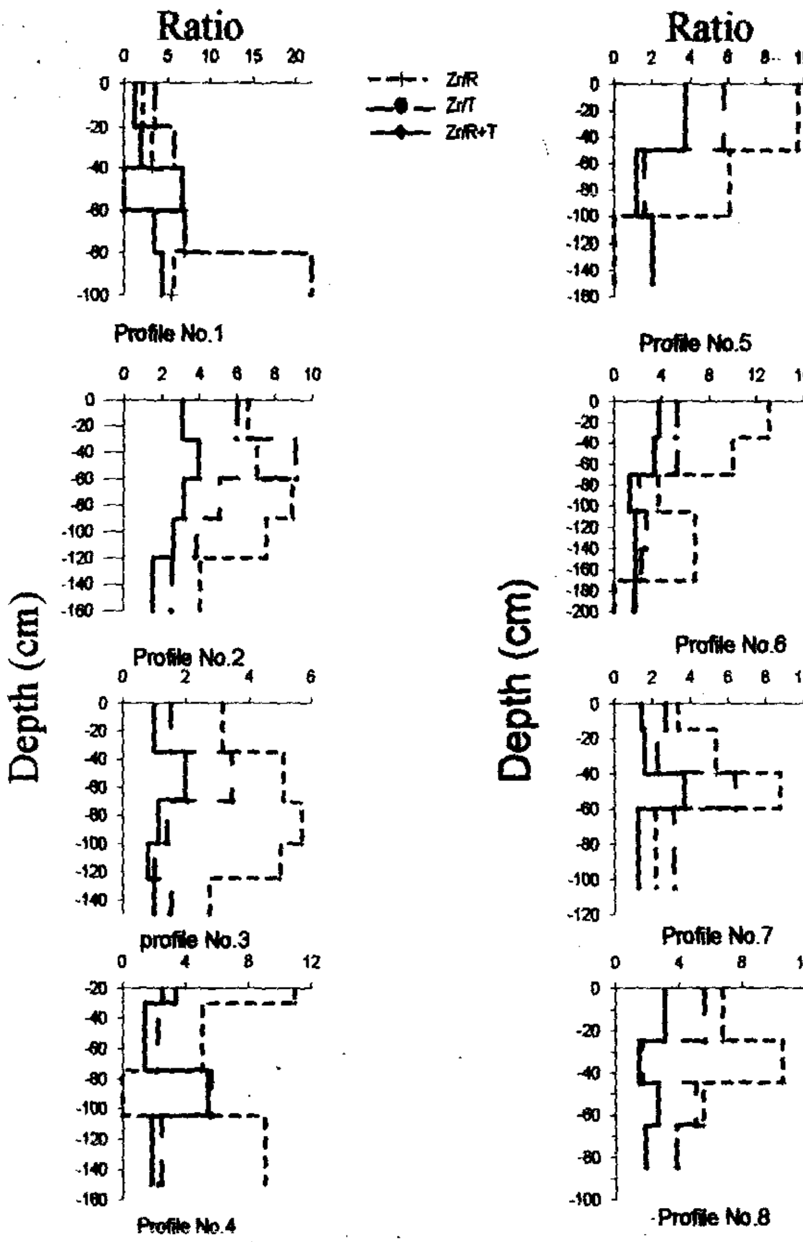

Fig.11: Uniformity indices of the subsequent layers in the soil profiles of the study area.

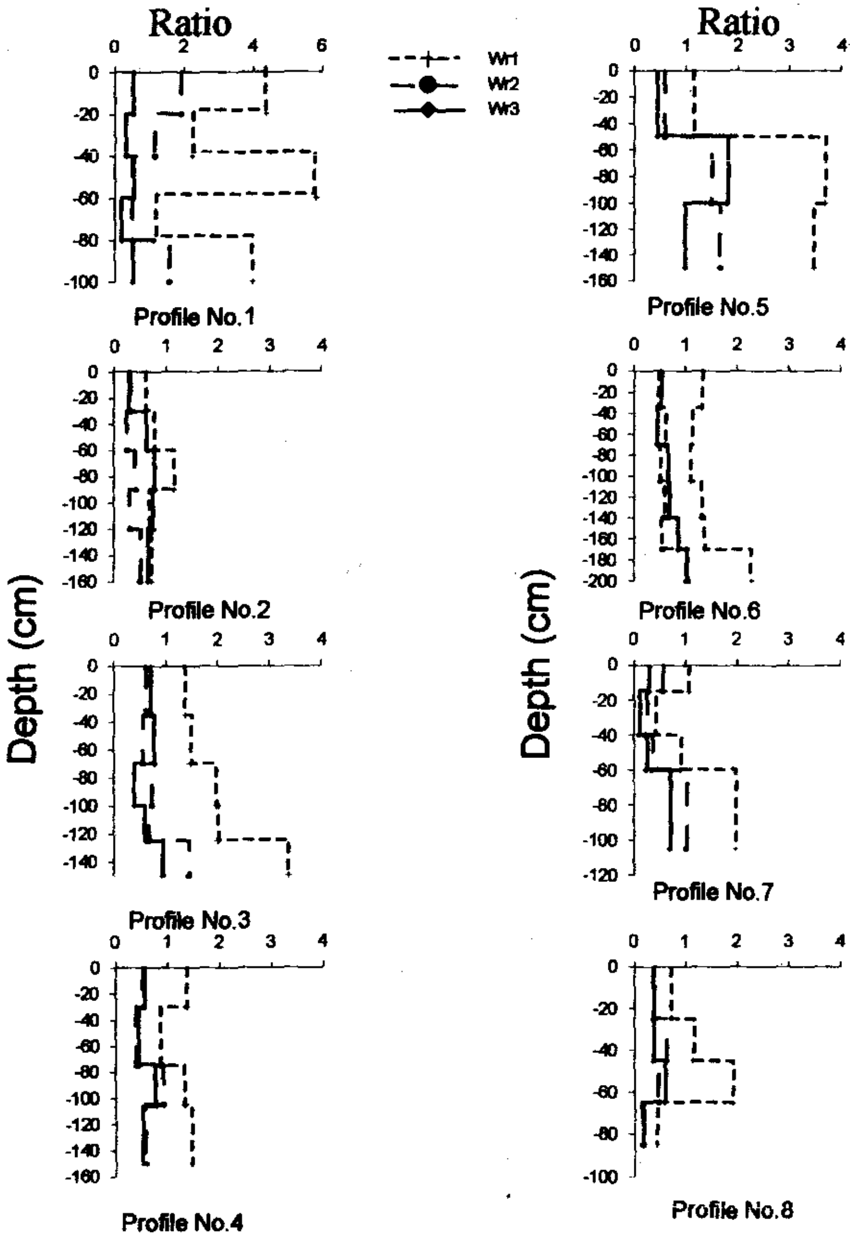

Fig.12: Weathering indices of the subsequent layers in soil profiles of the study area.

therefore, considered young from pedological point of view.

Generally, the irregularity and discontinuity of the depthwise distributions for the opaque and non opaque minerals are obvious in the soil profile and this reflects the multi-origin and/or the multi-depositional courses of the soils in the study area.

Moreover, the abundance of susceptible minerals to weathering; (pyroxenes and amphiboles) as well as biotite indicated that these soils are not well developed.

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دراسات التوزيع الحجمي و المعدني لأراضي وادي الحواشية – منطقة خليج السويس.

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تم جمع عدد ٣٦ عينة تربة من ثماني قطاعات تمثل أراضي وادي الحواشية لدراسة التوزيع الحجمي لحبيبات الرمل و المعادن الثقيلة به دراسة تفصيلية.

و قد أوضحت النتائج أن هذه الأراضي ذات قوام خشن (رملي خشن جدا) و ذات تصنيف ردئ أو فقير و معامل الالتواء (Skewness) يتجه نحو الخشن إلي متماثل تقريبا و معامل التفلطح (Kurtosis) طبقي لمنبعج جدا و ذلك بالإضافة إلي أن التربة تكونت تحت ظروف البيئة المائية والتي إما نهرية أو/و ذات تيارات مائية متغيرة أو الاثنين معا.

أوضحت الدراسة لمحتوي المعادن الثقيلة أن مجموعة المعادن القابلة للتجوية (البيروكسينات Pyroxenes و الأمفيبولات Amphiboles) هي السائدة يليها مجموعة المعادن المقاومة للتجوية (Ubiquitous) بينما معادن البارامیتامورفيك (parametamorphic) هي الأقل انتشارا. البيوتيت من المعادن الشائعة في التربة بينما كل من المونازيت والجلكونيت يتواجدا بكميات نادرة.

تكونت التربة من مادة أصل غير متجانسة وذلك يرجع إلي كونها متعددة المنشئ أو إلي التغيرات المتعاقبة لتيارات الترسيب. وبناءا علي ذلك فإن هذه التربة تعتبر حديثة التكوين من وجهة النظر البيدولوجية.