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HEAVY MINERAL ANALYSIS OF SOME SOILS OF AN OLD DELTAIC PLAIN IN WESTERN DESERT OF EGYPT.

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ABSTRACT

A mineralogical study of the sand fraction was conducted on some soil profiles representing the different physiographic units of the studied area (Samalout to Baharia Oasis) Western Desert of Egypt, to define the nature and origin of these soils.

Data reveal that index figures are fluctuating with depth in most of the studied soil profiles. The relatively high contents of heavy minerals in the deepest layers may be associated with the sedimentation regime rather than the effect of weathering processes. Microscopic inspection of soil samples shows that Opaques are the most abundant minerals. The non-opaque minerals are less abundant and include zircon, epidotes, amphiboles, pyroxenes, tourmaline, rutile, staurolite, garnet, kyanite, boitite and other minerals in trace amounts.

The weathering ratios of soil samples reveal irregular distribution pattern among either layers or sites. This is expected due to the formation of soils from different parent materials of heterogonous nature and/or multi-depositional regimes.

Generally, the soils understudy is pedologically young and are weakly developed. Moreover, processes of soil formation, in such locations, are usually interrupted by alternative water and wind actions. Therefore, good and detailed knowledge of various local conditions, as well as, back history of every site are greatly required

Keywords: Western desert of Egypt, old deltaic plain, sand fraction mineralogy.

INTRODUCTION

The agriculture expansion in the desert area is one of the most objectives of the national plan to meet the food requirements for the tremendous increase in population. Therefore, attention is focused in the present time to the soils occupying the deserts. The amount of nutrients and their supplying power as well as the behavior of fertilizers in soils depend largely on the mineralogical composition of the soils. A full understanding of the geological, geomorphological and pedological as well as chemical and physical properties of these soils is considered as the fundamental base for a successful reclamation plan.

Heavy minerals are important because they consist of a wide variety of minerals that can be used to trace the source of sediments (Hubert, 1971). They may thus be used to differentiate between materials introduced by wind, diffuse surface runoff or stream action, if the source areas for the material transported by these agents were dissimilar. The heavy minerals also differ widely in their mechanical and chemical stability and may therefore be used to infer the magnitude of chemical and mechanical weathering (Milner, 1962). Since both the mode and magnitude of weathering are influenced by climatic conditions, the alteration or destruction of heavy minerals can be used for climatic interpretations. However, changes in the content and preservation of heavy minerals may be a function of micro ecologic conditions at archaeological sites (Farrand, 1973).

Study of the residual minerals, particularly those termed (heavy minerals), which are either derived from parent material or altered during the course of soil formation is considered one of the useful tools in evaluating profile uniformity or discontinuity. Also, they are essential to calculate processes involved in soil formation (Huang, 1977). Minerals percentage to the sand fraction can be taken as criteria to infer the origin of soil parent materials (Abdel-Ghaphour, 1982). These, also, could be used as a tool to evaluate the uniformity and development of the soil profile as well as soil genesis in terms of the degree of weathering (Brewer, 1960 & Bear, 1964). Moreover, mineral content and distribution in soils are good means to estimate the stability of minerals against the weathering processes that occurred under different soil conditions, and to successfully evaluate the soil nutrient supplying power (El-Shanawany, 1992 & Awadalla, 1993).

MATERIALS AND METHODS

The investigated area is situated in the Western Desert of Egypt, its western limit is the Baharia Oasis and its eastern border limit is Samalut city, El-Minia Governorate. It is bounded on the north by Wadi El-Rayan, El-Fayoum and by the Western Desert in the south. The investigated area bounded by longitudes $29^{\circ}\ 00'\ 00''$ west and $30^{\circ}\ 30'\ 00''$ east and latitudes $28^{\circ}\ 00'\ 00''$ south and $29^{\circ}\ 00'\ 00''$ north (Map 1). The area is about 150 km in width and 320 km in length and is oriented roughly in north to east north direction. The area is located to the southwest of Cairo at about 300 km.

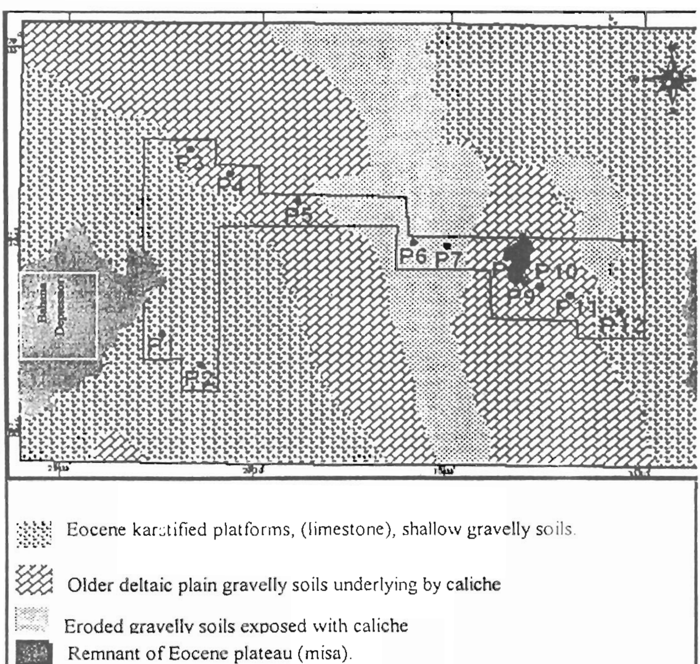
The modified soil texture varied from very gravely loamy sand to gravelly sandy loam. Soil salinity ranged between 3.48 to 156.60 dS/m and soil alkalinity changed from 6.32 to 8.44. The organic matter decreases with soil depth in values up to 0.04%. $CaCO_3$ content ranged between 2.41 and 42.3% with gypsum content up to 16.80%. The physiographic units of these soils (Map 2) are older deltaic plain gravelly soils underlying by caliche represented by profiles 3, 4, 5, 10 & 11; eroded gravelly soils exposed with caliche represented by profiles 6 & 7 and remnant of Eocene plateau (Mesa) represented by profiles 8 & 9 (after El-Desooky, 2009). All these profiles were morphologically described following the FAO system (2006) and set out in Table (1).

The sand fraction (0.125-0.063 mm) was used for microscopic investigation (El Hinnawi, 1966). The fraction was separated into heavy and light minerals using boromoform. The separated heavy minerals were collected and washed with alcohol, dried and mounted by canada balsam according to the method outlined by Brewer (1964). The systematic identification of heavy minerals was carried out using a polarizing microscope according to the principles of identification reported by Kerr (1959) and Milner (1962).

Calculations of heavy minerals percentage were made considering the non-opaque minerals as 100 %, however, the opaque ones were also recorded. The index figure of the sand fraction was calculated as follows:

Index figure = (weight of heavy minerals/weight of light minerals) x 100

Map (1). Location map of the study area in Western Desert of Egypt.



Map (2). Physiographic units of the studied area.

Table (1). Morphological description of the studied area.

Physiographic unit	Profile No.	Slope	Depth (cm)	Color		Modified texture class	Structure	Consistence			Lower boundaries
				Dry	Moist			Dry	Stickiness	Plasticity	
older deltaic plain gravelly soils underlying by caliche	3	level	0- 8	10YR 7/6	10YR 5/6	SIGSL	WP	SIH	SISt	SIP	CS
			8- 20	10YR 7/6	10YR 5/6	SIGSL	WM	So-SIH	SISt	SIP	CS
			20- 35	10YR 7/6	10YR 5/6	SIGSL	WM	SIH	SISt	SIP	GS
			35- 48	10YR 6/6	10YR 5/6	SIGSL	M	C	SISt	SIP	GW
			48- 90	10YR 6/6	10YR 5/6	GSL	M	H	SISt	SIP	CS
	4	Nearly level	0- 20	10YR 7/6	10YR 6/6	GSL	M	So	SISt	SIP	FS
			20- 75	10YR 8/3	10YR 7/3	SIGLS	M	SIH	NS	NP	OS
			75- 95	10YR 7/6	10YR 6/3	SIGLS	M	So	NS	NP	CS
			95- +	10YR 7/3	10YR 6/4	LS	M	So	NS	NP	CS
	5	Level to very gently sloping	0- 8	10YR 6/4	10YR 5/6	SIGLS	WM	So	SISt	SLP	AS
			8- 20	10YR 7/6	10YR 6/6	SIGSL	M	So	SISt	SIP	G
			29- 40	10YR 8/3	10YR 8/6	SIGSL	M	SIH	SISt	SIP	GW
			40- 80	7.5YR 7/8	10YR 6/8	GLS	M	So	NS	NP	GS
			80- 100	10YR 6/6	10YR 5/6	GSL	M	SIH	SISt	SIP	CS
			100- +	10YR 7/4	10YR 6/6	VGLS	M	H	SISt	SIP	S
	10	Nearly level	0- 15	7.5YR 8/5	10YR 5/6	GSL	M	So	SISt	SIP	CS
			15- +	7.5YR 5/8	5YR 5/8	GSL	M	H	SISt	SIP	CS
	11	Nearly level to very gently sloping	0- 3	7.5YR 7/2	10YR 6/4	GSL	M	H	SISt	SIP	DS
			3- 35	10YR 7/6	10YR 6/6	GSL	M	SIH	SISt	SIP	CS
			35- +	7.5YR 5/8	10YR 5/8	GSL	M	So	NS	NP	CS
eroded gravelly soils exposed with caliche	6	Nearly level	0- 10	10YR 8/4	10YR 5/6	FGSL	WM	So	SISt	SIP	S
			10- 30	10YR 7/4	10YR 6/6	SIGSL	M	SIH	SISt	SIP	S
			30- +	7.5YR 7/4	10YR 6/6	GLS	M	So	NS	NP	S
	7	Nearly level	0 – 7	10YR 7/6	10YR 6/8	GS	W	So	NS	NP	AI
			7- 20	7.5YR 6/6	10YR 6/8	GS	WM	So	NS	NP	BR
			20- +	10YR 8/1	7.5YR 8/4	G	M	H	SISt	SIP	S
remnant of Eocene platue platforms (mesa)	8	Very gently sloping	0- 3	10YR 7/6	10YR 5/6	GSL	M	So	SISt	SIP	DS
			3- 15	7.5YR 7/6	10YR 6/6	GSL	M	So	SISt	SIP	C
			15- 60	7.5YR 7/4	10YR 6/8	GSL	M	H	SISt	SIP	C
			60- +	5YR 8/1	10YR 8/3	GSL	M	VH	SISt	SIP	C
	9	Gently sloping	0- 3	10YR 6/4	10YR 5/6	GSL	M	SIH	SISt	SIP	CS
			3- 10	10YR 6/4	10YR 5/6	GSL	M	So	SISt	SIP	CS
			10- 25	7.5YR 6/8	10YR 6/8	GSL	M	H	SISt	SIP	AS

G: gravel SI: slightly S: sand L: loam V: very M: massive W: weak P: platy H: hard
So: soft C: compact St: sticky N: non P: plastic CS: clear smooth GS: gradual smooth GW: gradual wavy
BR: broken AI; abrupt irregular DS: diffuse smooth AS: abrupt smooth OS: oblique smooth

RESULTS AND DISCUSSION

Heavy minerals content in the very fine sand and index figure for different soil profiles are given in Table (2). The data reveal that the index figures are relatively low in most soil samples. They range between 0.67 to 7.42% for older deltaic plain underlying by caliche, from 2.06 to 10.49% for eroded gravelly soils exposed with caliche and from 0.57 to 7.37% for remnant of Eocene plateau (Mesa) physiographic unit. The heavy minerals and the index figure values generally fluctuated with depth in most cases. The relatively high contents of heavy minerals in the deepest layers may be associated with the sedimentation regime rather than the effect of weathering processes. These results agree with those obtained by Gobran et al. (1991).

It is obvious that values of the index figure differ from one site to another. This may be rendered to many factors such as variations in nature of the soil parent materials, energy of transportional environment and the differential weathering strength of the same parent material deposited in different cycles. The obtained relatively low values of index figures fall in the range of some formations of either calcareous or siliceous nature, such as limestone and sandstones which may indicate an elementary weathering stage.

Microscopic inspection of the studied soil samples shows that opaques minerals are the most abundant minerals. The non-opaque are less abundant and include zircon, epidotes, amphiboles, pyroxenes, tourmaline, rutile, staurolite, garnet, kyanite, boitite and other minerals in decreasing amount (Table 2).

a) Opaque minerals:

Opaque form a considerable part of the heavy minerals in all samples examined. They are mostly composed of iron oxides (illmenite, magnetite, hematite and limonite), sulfides (pyrite) and hydroxides. Their values vary over a limited range in the different physiographic units being 56.3- 67.6%, 60.7- 72.6% and 51.7- 72.0 % for older deltaic plain underlying by caliche, eroded gravelly soils exposed with caliche and remnant of Eocene plateau (mesa) physiographic unit, respectively. Concerning the pattern of opaque distribution with depth, no specific trend in the studied profiles could be observed. This behavior may be attributed to differences in depositional regime of the original sediments.

b) Non-opaque minerals:

Zircon, epidotes and pyroboles (pyroxenes and amphiboles) minerals are the most abundant of non-opaque fraction in most soil samples (Table 2). Tourmaline, rutile, staurolite and garnet are found in relatively moderate amounts, while kyanite and boitite are present in less pronounced amounts. The frequency distribution of zircon ranges between 9.8- 15.7%, 1.6- 51.3% and 12.4- 19.1 % for older deltaic plain underlying by caliche, eroded gravelly soils exposed with caliche and remnant of Eocene plateau(Mesa) physiographic unit, respectively.

Table (2). Frequency distribution of heavy minerals and index figure in the studied soil profiles

phsiogrphic unit	Pro. No.	Depth cm	Opaques %	Epidotes %	Amphiboles %				Pyroxenes %				Zircon	Monazite	Garnet	Andalusite	Kyanite	Staurolite	Rutile	Bioitet	Tourmalin	Apatite	Index figure
					Hornblend	Actinolite	Glaucophan	Total	Augite	Dipsite	Hyperthene	Total											
older deltaic plain gravelly soils underlying by caliche	3	0 - 8	65.5	5.21	0.65	0.22	0.00	0.87	1.30	0.22	0.43	1.95	11.0	2.82	1.52	0.22	0.43	0.22	1.30	0.00	0.22	0.00	3.88
		8 - 20	60.6	5.28	0.50	0.00	0.00	0.50	1.26	0.00	0.25	1.51	13.2	3.77	1.26	0.50	0.25	0.75	1.76	0.00	0.50	0.00	0.70
		20 - 35	65.7	4.02	0.45	0.23	0.00	0.68	0.89	0.00	0.23	1.12	10.8	4.02	1.34	0.45	0.45	0.45	1.79	0.00	0.45	0.00	0.67
		35 - 48	62.4	3.85	0.59	0.30	0.00	0.89	1.78	0.00	0.30	2.07	13.2	3.55	1.18	0.30	0.30	0.30	1.48	0.00	0.30	0.00	1.41
		35 - 48	62.9	3.61	0.72	0.48	0.00	1.20	1.45	0.24	0.48	2.17	11.7	3.86	1.69	0.48	0.48	0.24	1.93	0.00	0.48	0.00	6.24
		48 - 90	58.2	3.19	0.53	0.27	0.27	1.06	1.60	0.00	0.27	1.86	15.7	3.72	1.60	0.53	0.53	0.53	1.06	0.00	0.53	0.00	3.77
		90 - +	63.6	4.62	0.54	0.27	0.00	0.82	1.36	0.00	0.27	1.63	11.9	3.53	1.63	0.27	0.27	0.54	1.63	0.00	0.27	0.00	5.76
	4	0 - 20	60.9	5.54	1.17	0.00	0.00	1.17	2.04	0.58	0.00	2.62	13.4	0.87	2.04	0.29	0.58	0.00	1.46	0.00	0.58	0.29	5.78
		20 - 75	67.6	6.42	0.99	0.00	0.00	0.99	1.48	0.76	0.00	2.24	9.8	0.49	1.97	0.00	0.49	0.00	1.48	0.00	0.49	0.00	3.97
		75 - 95	62.1	6.60	1.22	0.24	0.24	1.71	1.96	0.73	0.24	2.93	12.7	0.73	1.47	0.00	0.24	0.24	0.98	0.24	0.24	0.00	1.94
		95 - +	62.7	8.74	0.77	0.00	0.00	0.77	2.31	0.77	0.00	3.08	10.8	0.51	2.31	0.00	0.51	0.00	1.29	0.00	0.51	0.00	7.42
	5	0 - 8	58.9	5.45	1.47	0.00	0.00	1.47	1.89	0.21	0.21	2.31	14.5	2.94	0.42	0.00	0.63	0.00	1.47	0.21	0.63	0.21	0.96
		8 - 29	65.1	4.42	1.18	0.00	0.00	1.18	1.47	0.15	0.15	1.77	11.5	3.24	0.29	0.00	0.59	0.00	1.47	0.29	0.88	0.15	1.81
		29 - 40	60.1	6.55	1.54	0.19	0.00	1.73	1.73	0.00	0.19	1.93	11.7	4.43	0.19	0.00	0.77	0.19	1.73	0.39	0.96	0.00	1.50
		40 - 80	58.3	5.05	1.38	0.00	0.23	1.61	2.06	0.23	0.46	2.75	12.5	4.36	0.46	0.23	1.15	0.00	1.61	0.69	1.38	0.23	1.13
		80 - 100	56.3	5.44	1.46	0.21	0.00	1.67	2.30	0.21	0.21	2.72	13.1	5.65	0.63	0.00	1.26	0.00	1.05	0.42	1.46	0.21	2.93
		100-+	59.5	4.90	2.32	0.00	0.00	2.32	2.06	0.00	0.52	2.58	12.0	4.64	0.52	0.00	0.77	0.26	1.29	0.52	1.29	0.00	3.14
	10	0 - 15	63.1	2.56	3.13	0.28	0.00	3.41	0.57	1.42	0.28	2.27	12.3	0.57	3.13	0.28	0.00	0.00	0.85	0.00	1.14	0.85	1.97
		15 - +	61.7	5.10	3.88	0.49	0.00	4.37	0.73	0.73	0.49	1.94	12.9	0.49	1.46	0.00	0.24	0.00	0.49	0.24	0.73	0.49	1.51
	11	0 - 3	64.7	2.91	1.75	0.30	0.00	2.05	1.17	0.00	0.30	1.46	12.8	2.33	0.00	0.30	0.58	0.58	1.17	0.58	0.58	0.00	1.99
		3 - 35	56.7	6.42	2.06	0.46	0.23	2.75	1.61	0.23	0.46	2.29	12.8	3.21	1.15	0.46	0.69	0.92	0.92	0.92	0.69	0.23	3.35
		35 - +	58.2	3.26	1.48	0.89	0.00	2.37	2.67	0.00	0.30	2.97	13.7	1.78	2.67	0.30	0.89	0.89	1.48	0.59	0.59	0.00	2.76
eroded gravelly soils exposed with caliche	6	0 - 10	60.7	4.37	2.73	0.27	0.27	3.28	3.01	0.27	0.00	3.28	12.8	1.37	0.82	0.00	0.00	0.00	2.46	0.27	0.55	0.27	3.66
		10 - 30	66.0	4.40	2.93	0.25	0.00	3.18	1.96	0.00	0.00	1.96	10.5	0.98	0.98	0.00	0.00	0.00	2.44	0.49	0.49	0.00	9.09
		30 - +	72.6	6.51	4.79	0.68	0.34	5.82	3.42	0.34	0.00	3.77	1.6	2.05	1.37	0.34	0.00	0.34	3.08	0.68	0.34	0.00	6.80
	7	0 - 7	62.9	1.42	1.42	0.00	0.24	1.66	0.95	0.24	0.48	1.67	15.3	2.84	0.47	0.24	0.00	0.47	0.95	0.00	0.95	0.00	2.06
		7 - 20	61.3	1.83	1.31	0.26	0.26	1.83	1.57	0.26	0.26	2.09	15.2	3.66	0.26	0.26	0.26	0.00	1.31	0.00	0.52	0.26	10.5
remnant of Eocene platue platforms (mesa)	8	0 - 3	60.8	3.92	1.47	0.00	0.00	1.47	0.49	0.00	0.00	0.49	14.9	0.98	2.45	0.00	0.49	0.00	2.45	0.00	0.49	0.49	5.85
		3 - 15	53.8	4.68	1.17	0.00	0.19	1.36	0.58	0.19	0.19	0.97	17.3	2.14	3.12	0.19	0.58	0.19	2.53	0.00	0.39	0.58	4.60
		15 - 60	51.7	4.74	2.03	0.23	0.00	2.26	1.13	0.00	0.23	1.35	19.1	1.35	2.93	0.00	0.23	0.00	2.03	0.23	0.23	0.90	0.57
	9	0 - 3	65.2	2.88	1.83	0.00	0.26	2.09	0.26	0.79	0.00	1.05	13.7	0.79	2.09	0.00	0.26	0.00	0.52	0.00	0.79	0.26	1.95
		3 - 10	64.2	2.68	1.34	0.22	0.00	1.57	0.00	0.89	0.00	0.89	14.8	0.45	2.68	0.22	0.00	0.00	0.67	0.00	0.89	0.00	6.42
		10 - 25	72.0	1.57	0.79	0.00	0.00	0.79	0.00	0.40	0.00	0.40	12.4	0.39	1.97	0.00	0.00	0.00	0.39	0.00	0.39	0.00	7.37

Zircon is a widely distributed mineral in granite and other igneous rocks and also occurs in certain metamorphic rocks (Kerr, 1959).

Epidotes are metamorphic silicate minerals that consist of calcium-aluminum sorosilicates. These minerals represent the second most predominant of non-opaque minerals in most of the studied soil samples. The frequency distribution of epidotes ranges between 9.8- 15.7%, 1.6- 51.3% and 12.4- 19.1 % for older deltaic plain underlying by caliche, eroded gravelly soils exposed with caliche and remnant of Eocene plateau(Mesa) physiographic unit, respectively.

Monazite is less abundant than epidotes and it ranges between 0.49- 5.65%, 0.98- 3.66% and 0.39- 2.14 % for older deltaic plain underlying by caliche, eroded gravelly soils exposed with caliche and remnant of Eocene plateau(Mesa) physiographic unit, respectively.

Pyroxenes are the fourth most predominant group of non-opaques. This group of minerals ranges between 1.46- 3.08%, 1.67- 3.77% and 0.40- 1.35% for older deltaic plain underlying by caliche, eroded gravelly soils exposed with caliche and remnant of Eocene plateau(Mesa) physiographic unit, respectively. The most common mineral encountered in this group can be arranged in descending order of augite > diopside > hyperthene.

Amphiboles are nearly similar to pyroxenes in abundance in the non-opaque minerals. The frequency distribution of amphiboles ranges from 0.50- 4.37%, 1.66- 5.82% and 0.69- 2.26% for older deltaic plain underlying by caliche, eroded gravelly soils exposed with caliche and remnant of Eocene plateau(Mesa) physiographic unit, respectively. The most common mineral encountered in this group can be arranged in descending order of hornblende > actinolite > glaucophane.

The remain heavy minerals are existed in a miner amounts and could be arranged in descending order of rutile > garnet > tourmaline > kyanite > staurolite > biotite > andalusite apatite. The abundance of zircon and epidotes minerals, which are considered to be more resistant relative to those susceptible to weathering, may suggest an enrichment of parent materials with the ultra-stable minerals rather than pronounced maturity and soil development$_1$ (Haseman and Marshall, 1945). On the other hand, relatively low and inconsistent values of resistant minerals indicate that these soils are composed of stratified geological sediments and the pedogenic processes are minimal and/or at very recent stages (Noman et al., 1988). Moreover, the occurrence of epidotes in moderate contents, as well as the minor amounts of both ultra-stable (zircon, tourmaline and rutile) and parametamorphic (staurolite and kyanite) minerals may reflect the contribution of a crystalline metamorphic and sandstone as parent materials for these soils (Shendi, 1990). Also, the discrepancies between percentages of each mineral downward the profiles are probably caused by the depositional regime, which prevails during, soil formation.

Soil origin, uniformity and weathering ratio:

Several mineralogical studies are parameters to evaluate origin, uniformity, weathering and development of sediments and parent materials depending on variations in heavy mineral species and frequencies in the different soil layers. The distribution patterns of some minerals that are identified as relatively high resistant to weathering and persist for a long time such as zircon, rutile and tourmaline among profile layers can indicate soil uniformity. However, other minerals are relatively less stable such as amphiboles, pyeroxens and biotite. The ratios of these minerals are taken as indices of intensity and rate of weathering conditions (Brewer, 1964; Birkeland, 1974). Also, a decrease of the less stable minerals associated with a corresponding relative increase of the stable minerals provides a good indication of high intensity of chemical weathering (Huang, 1977). Many studies (Barshad, 1964; Brewer, 1964; Chapman and Horn, 1968) suggested that the ratio between two or more of the highly resistant minerals (Zr / T, Zr / R and Zr/ R + T), as well as the ratio between a highly resistant mineral and another one that is susceptible to weathering are taken as acceptable criteria for evaluation of parent material uniformity and soil profile maturity.

Data in Table (3) show ratios of *Zr/R,* Zr/T and Zr/R+T. These results indicate that these calculated ratios do not, mostly, have any specific trend, either among profile sites or with depth of all locations. So, soil material of each profile is not uniform in nature and is composed of stratified materials of multi-origin and/or derived from parent materials of heterogeneous nature. Uniformity ratios, however, are about the same in all inspected depth. This suggests that the soil materials are almost uniform throughout the soil profile due to homogeneity of sediments and the low effect of pedoginic processes.

Weathering ratios of Wr1 of (A+P) / (Zr+T) throughout the studied soil profiles is given in Table (3). Inspection of weathering ratios of soil samples reveals irregular distribution pattern among either layers or sites. This is expected due to the formation of soils from different parent materials of heterogonous nature and/or multi-depositional regimes. However, in some profiles, the weathering ratios are relatively lower in the surface than the subsurface layers. This may be due to a slight rate of weathering in surface layers than in subsurface ones and, also, to the occurrence of the resistant minerals in relatively higher and pronounced amounts in the original sediments. On the other hand, the relatively high values of weathering ratios in the surface then the subsoil in some cases are possibly due to contamination with other sediments of different nature. Similar results were found in El-Kharga and El-Dakhla oases by Abdel-Aal et al. (1977), Elwan and Abdel Hamid (1983) and Amira (1999).

Generally, the soils understudy is pedologically young and are weakly developed. This is the result of the prevailing arid climate that promotes physical weathering rather than chemical changes. In other words, the course of soil forming factors is not sufficient to cause any clear alteration. Moreover, processes of soil formation, in such locations, are usually interrupted by alternative water and wind actions. Also, in arid seasons, wind and gravity actions work together in transporting fine soil materials to different locations according to slopes (Abd El-Aziz, 1998). So, in this area, studies concerned with soil genesis and development are usually faced with many obstacles. Therefore, good and detailed knowledge of various local conditions, as well as, back history of every site are greatly required.

Table (3) Uniformity and Weathering ratio of the studied soil profiles

phsiogrphic unit	Profile No.	Depth cm	Uniformity Ratio			Weathering ratio
			Zr/R	Zr/T	Zr/(R+T)	Wr1
older deltaic plain gravelly soils underlying by caliche	3	0 - 8	50.48	8.41	7.21	0.25
		8 - 20	26.33	7.52	5.85	0.15
		20 - 35	24.15	6.04	4.83	0.16
		35 - 48	44.73	8.95	[illegible].45	0.22
		35 - 48	24.30	6.07	4.86	0.28
		48 - 90	29.50	14.75	9.83	0.18
		90 - +	43.62	7.27	6.23	0.20
	4	0 - 20	22.96	9.18	6.56	0.27
		20 - 75	19.76	6.59	4.94	0.32
		75 - 95	51.83	12.96	10.37	0.36
		95-+	21.06	8.42	6.02	0.34
	5	0 - 8	23.10	9.90	6.93	0.25
		8 - 29	13.01	7.80	4.88	0.24
		29 - 40	12.18	6.77	4.35	0.29
		40 - 80	9.10	7.80	4.20	0.31
		80 - 100	8.97	12.56	5.23	0.30
		100 - +	9.29	9.29	4.65	0.37
	10	0 - 15	10.81	14.41	6.18	0.42
		15 - +	17.68	26.53	10.61	0.46
	11	0 - 3	22.00	11.00	7.33	0.26
		3 - 35	18.61	13.96	7.98	0.37
		35 - +	23.02	9.21	6.58	0.37
eroded gravelly soils exposed with caliche	6	0 - 10	23.40	5.20	4.26	0.49
		10 - 30	21.56	4.31	3.59	0.47
		30 - +	4.57	0.51	0.46	5.03
	7	0 - 7	16.14	16.14	8.07	0.21
		7 - 20	29.10	11.64	8.31	0.25
remnant of Eocene platue platforms (mesa)	8	0 - 3	30.46	6.09	5.08	0.13
		3 - 15	44.26	6.81	5.90	0.13
		15 - 60	84.55	9.39	8.46	0.19
	9	0 - 3	17.43	26.15	10.46	0.22
		3 - 10	16.50	22.00	9.43	0.16
		10 - 25	31.47	31.47	15.73	0.09

Zr = Zircon **T = Tourmalin** **R = Rutile** **P = Pyroxenes** **A = Amphiboles**
B = Bioitet **Wr1= (P+A)/(Zr+T)**

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تحليل المعادن الثقيلة لبعض أراضى سهول دلتا قديمة بالصحراء الغربية – مصر

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تم إجراء دراسة معدنية على مكون الرمل لبعض قطاعات الأراضى الممثلة لمختلف الوحدات الأرضية فى المنطقة الواقعة بين سمالوط والواحات البحرية فى الصحراء الغربية المصرية بهدف التعرف على طبيعة تكوين هذه الأراضى.

وقد أظهرت النتائج أن نسبة المعادن الثقيلة ورقم الدليل (Index figure) كان منخفضاً نسبياً ويتذبذب مع العمق فى معظم القطاعات المدروسة والزيادة النسبية للمعادن الثقيلة فى الطبقات العميقة من المرجح إرجاعه إلى نظام الترسيب أكثرمن كونه ناتج من تأثير عمليات التعرية. وقد أظهرالفحص الميكرسكوبى للعينات أن المعادن المعتمة هى السائدة على المعادن الشفافة والتى منها الزيركون ، الإبيدوت ، الأمفيبولات ، البيروكسينات ، التورمالين ، الروتايل ، الإستروليت ، الجارنت ، الكاينيت ، البيوتيت ، ومعادن أخرى بكميات ضئيلة جداً وبينت قيم معامل التعرية للعينات عدم التجانس بين الطبقات فى القطاعات وربما يرجع هذا إلى تكوين هذه الأراضى من مواد أصل مختلفة مع إختلاف وتعدد نظم الترسيب.

وعموماً الأراضى محل الدراسة تعتبر حديثة التكوين وضعيفة التطور من الوجهه البيدولوجية وعمليات التكوين فى هذه المنطقة غالباً تمت بفعل تعاقب المياه والرياح ولذلك فإنه من المهم معرفة معلومات تفصيلية عن ظروف التكوين المحلية المختلفة بالإضاقة إلى معرفة تاريخ تكوين كل موقع.