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RELATION OF SOIL GENESIS AND UNIFORMITY OF SAND FRACTION TO SOIL EROSION IN THE NORTH WESTERN COAST OF EGYPT

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Abstract

Microscopic examination of the soil of Khashm El-Eish ridge, the north western coast of Egypt, revealed that the light mineral fraction was about 96% quartz. Opaque heavy minerals ranged from 55.6% to 71.6% in all samples. Non opaques consisted mainly of meta-stable minerals (pyroxines, staurolite and garnet) whereas little ultra-stable minerals (zircon, tourmaline and rutile) were detected.

Strong evidence is pressented that the soils of Khashm El-Eish ridge are weakly weathered, and their original sediments are mainly transported by surface flowing water action. and not by wind. Therefore, the soils are considered young order Entisols, according to USDA classification (1992).

Key words : Erosion, Genesis, Khashm El-Eish.

INTRODUCTION

El-Omayed area, located in the north-western coast of Egypt, (map1), undergoes severe soil erosion particularly in Khashm El-Eish ridge. Many rills and gullies, filled with sand deposits, are drastically formed in the ridge area.

Several investigations have been devoted to the study of origin, sedimentology and geomorphology of the nine main ridges parallel to the mediterranean coast (El-Shazly and Shata, 1969; and Hanna, 1987). Soil-crop and water management of El-Omayed area was previously studied by El-Hassanin (1977) and Arroug (1995).

The main features of the studied area:

Khashm El-Eish ridge has an elevation of 40-80 m. and formed of oolitic calcareous grains derived from the old bars which border the coast. (Shukri and Philip, 1956). Soil erosion in the ridge area is substantially governed by the prevailing arid Mediterranean climate of El-Omayed area, 77 Km west of Alexandria and 10 Km south of Alexandria-Sallum highway (Fig.1). Annual mean temperature is 20^{O}C (Max.25^{O}C, Min. 15^{O}C). Mean annual relative humidity at noon is 55% and the high is about 80% for the year. High evaporation is about 1500 mm. per annum. Rainfall is about 156 mm. and the rainy days are only 15-25 in autumn and winter and no rain in summer. The prevailing wind is during winter and early spring and its average velocity is about 20 to 25 Km/hr. The end of summer records many calm days, and the average of wind speed drops to 15 Km/hr.

The present study was conducted to:

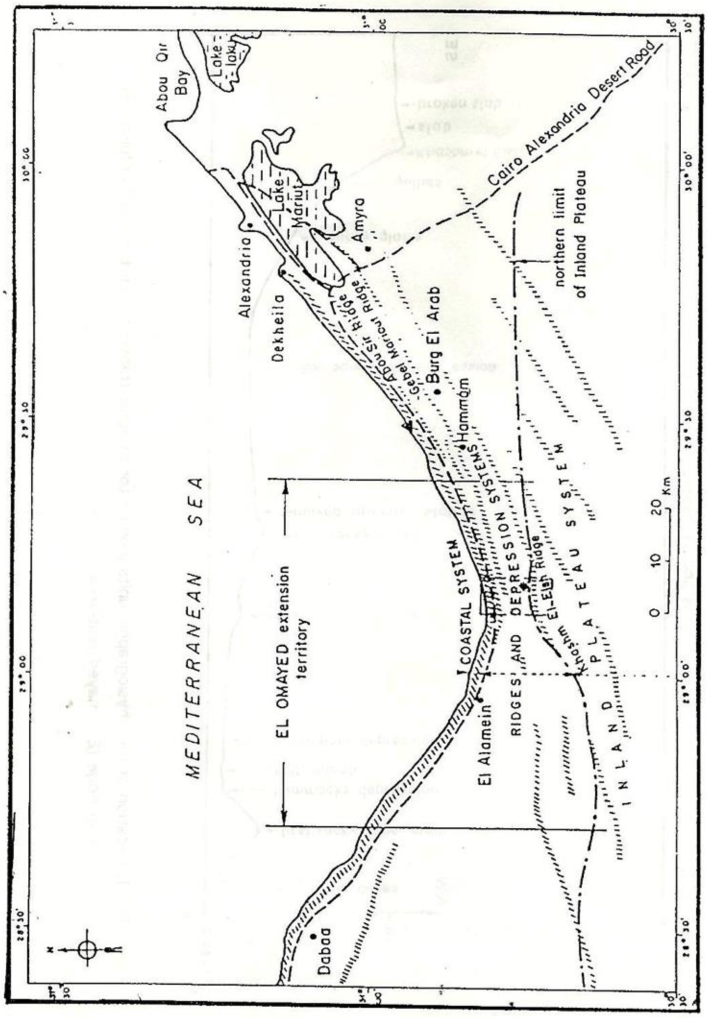
1- Study textural properties of the eroded sand sediments that fill the main gully at Khashm El-Eish ridge.
2 - Identify mineral composition of the eroded sand grains.
3 - Determine the source area and gensis of sand sediments.
4- Investigate wheather sand particles were trasported by either wind or water.

MATERIALS AND METHODS

Three main gullies are distingished in Khashm El-Eish ridge area their shape is like a delta with a depth ranges from 4m at the gully head to 1 m at the gully foot, after which, several rills are wide-spread. Due to the severe soil erosion in the left gully(Fig. 2) 12 soil profiles were dug along the main slope (3 Km length) and inside and outside the gully (1 Km width). The location of soil profiles have been selected to represent the flat depression and southern sandy slope.

Soil samples were taken from the different layers of the soil profiles. The disturbed soil sample were air dried, curshed and paseed through 2 mm-sieve and subjected to some physical chemical and mineralogical analyses.

Particle size distribution was conducted by dry sieving (Piper 1950). After the ordinary pretreatments, the sand fraction 63-125 m was separated from each sample by dry sieving, cleanned up and further differentiated into heavey and light minerals using bromoform (sp.gr.2.85 EMBED Equation 0.02) as indicated by Jackson (1975). The index figure (weight ratio of heavey to light minerals) was calculated. The heavy and light residues were mounted on slide in canda 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).



El Omayed site* Khashm El Eish ridge area □

Map 1. Location map of El Omayed ridge area and extension territory.

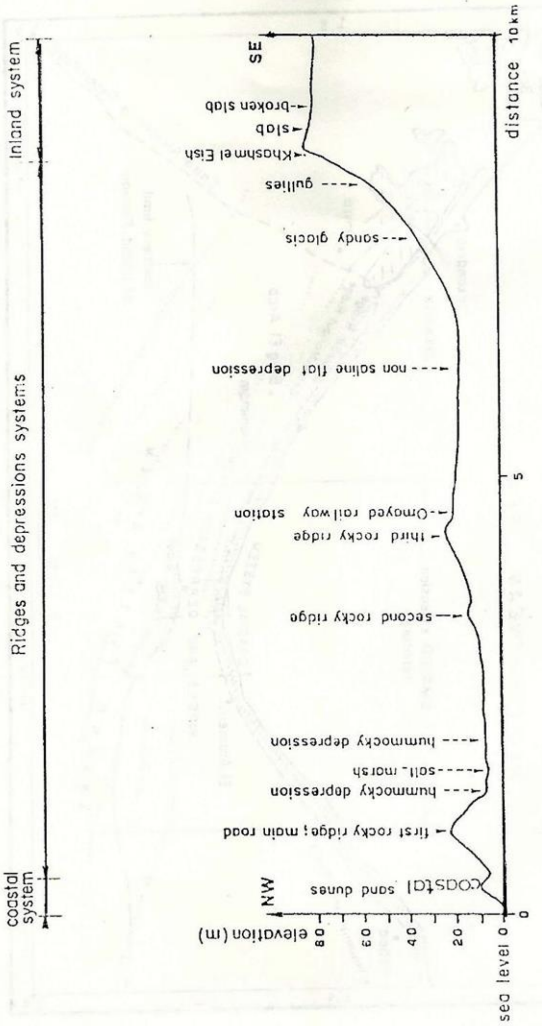


Fig. 1. Location of the physiographic units along a topographic transect from the sea to Khashm El Eish ridge (El Omayed test-area).

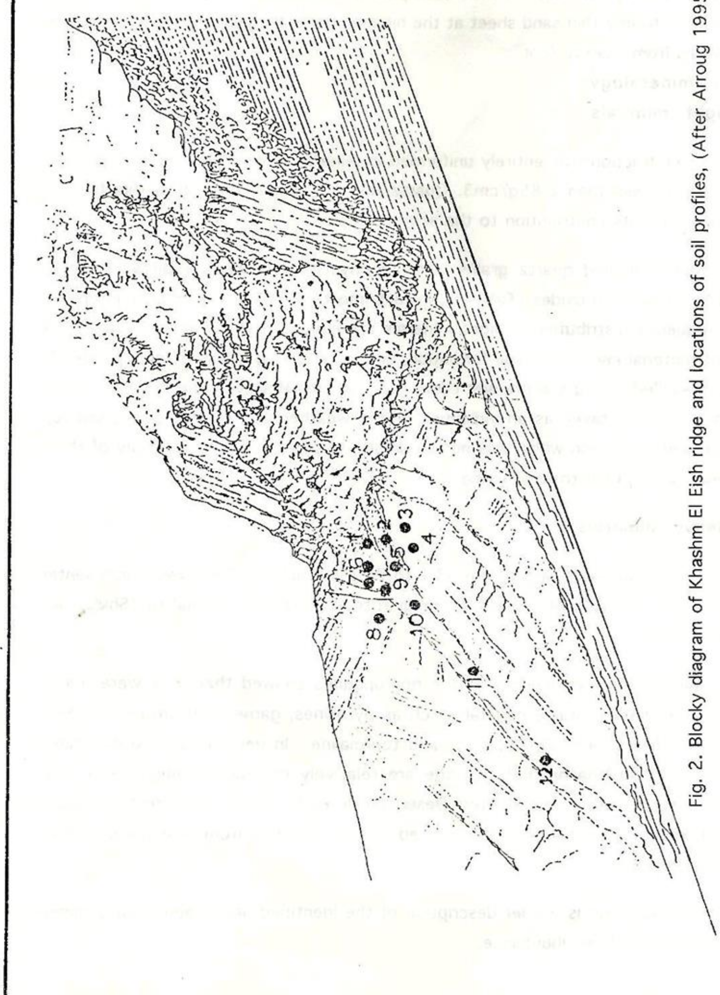


Fig. 2. Blocky diagram of Khashm El Eish ridge and locations of soil profiles, (After Arroug 1995).

RESULTS AND DISCUSSION

The main gully and several rills are dissecting the Khashm El-Eish ridge, and they are runing perpendicular to the main orientation of the ridge (NE-SW). The gully width is about 100 m near the main escarpment and decreases at the end, where the rills formed from a thin sand sheet at the hidden. The main gully has steep slope that decreases from head to foot.

Sand mineralogy:

Light minerals :

Light fraction was entirely uniformed in mineral composition and havig a specific gravity less than 2.85g/cm3. Quartz was the unique mineral in this fraction which reflects its contribution to the source rocks.

The examined quartz grains were mostly characterized by pitted surfaces filled by brown iorn oxides (Table 1). In fact, most of the variations. encountered in the frequency distribution of light minerals are expected to be inherited from the parent material involved in soil formation, and modified, to a less extent, by weathering prevailed during the pre-wet climatic conditions. However, the presence of feldspars could by taken as an indication of the weathering prevailed during soil formation and evaluation which was not so drastic to cause a complete decay of these minerals susceptible to weathering.

Heavy minerals :

Opaque minerals range from 53.1 to 73.8% (Table 2). They were represented in all ridges west of Alexandria by magnetite, ilmenite and hematite (Shukri and Philip, 1956).

Microscopic examination of the non-opaques showed that they were mainly composed of meta-stable minerals such as pyroxines, garnet and ultra-stable heavey minerals e.g. 435 Zircon, rutile and tourmaline . In general, ultra-stable minerals detected in Khashm El-Eish ridge are relatively considered much lower than those of dune sands of the Western Desert (Philip *et al.*, 1992). This provides second indication that sand particles transported a short distance from near place of Khashm El-Eish rige.

The following is a brief description of the identified non-opaque heavy minerals according to their abundance.

Table 1. Frequency distribution of light minerals in the sand fraction (0.125-0.063).

Profile No.	Depth (cm)	Quatlz	Orthoclase	Feldspars Plagioclas	Microcline	Total
(1) UO	00-15	98.90	0.21	0.86		1.10
	15-30	98.65	0.39	0.96		1.35
(2) UI	00-15	98.56	0.41	0.82	0.21	1.44
(3) UO	00-15	97.87	0.43	1.49	0.21	2.13
	15-30	98.62	0.20	0.98	0.20	1.38
	30-45					
(4) UO	00-15	97.89	0.58	1.15	0.38	2.11
	15-30	98.30	0.63	1.06		1.69
	30-45	98.48	0.23	0.86	0.43	1.52
(5) UI	00-15	96.51	0.82	2.05	0.62	1.65
	15-30	97.76	0.61	1.43	0.20	2.24
	30-45	97.29	0.76	1.76	0.19	2.71
(6) UO	00-15	97.52	0.62	0.62	0.21	2.48
	15-30	98.40	0.60	0.60		1.60
	30-45	98.66	0.38	0.38	0.19	1.34
(7) UI	00-15	98.55	0.42	0.42	0.20	1.45
	15-30	97.62	1.19	1.19	0.20	2.58
	30-45	97.28	1.17	1.55		2.72
(8) LO	00-15	96.09	1.23	2.06	0.62	3.91
	15-30	97.59	0.60	1.61	0.20	2.41
	30-45	98.38	0.40	1.01	0.20	1.61
(9) LI	00-15	99.03	0.39	0.58		0.97
	15-30	98.07	0.39	1.16	0.39	1.94
	30-45	97.44	0.70	1.40	0.47	2.57
(10) LI	00-15	97.19	0.65	1.51	0.65	2.81
	15-30	98.19	0.42	0.82	0.23	1.45
	30-45	97.91	0.52	1.57		2.09
(11) LI	00-15	96.53	1.19	2.18	0.40	3.77
	15-30	96.80	0.85	1.19	0.43	3.19
	30-45	96.77	0.81	2.02	0.40	3.23
(12) LI	00-15	97.70	0.63	1.67		2.30
	15-30	97.68	0.73	1.59		2.32
	30-45	96.68	1.4	1.87		3.32

U = upper gully   O = outside gully   L = lower gully   I = inside gully

Table 2. Frequency distribution of heavy minerals in the sand fraction (0.125-0.063) of the studied soils.

Profile No.	Depth (cm)	Opaq-ues	Aug-ite	Hyper-sthene	Diop-sidee	Total	Horn-blend	Glau-conite	Actin-olite	Total	Gam.-et	Staur-olite	Kay-nite	Silim-anite	Zirco-ne	Rutile	Tour-maline	Bioti-te	Epid-ote	Mona-zite	Ziolite	Index Figure
(1) UO	00-15	65.5	14.0	1.4	2.1	17.5	17.5	1.4	1.4	20.3	6.9	1.4	3.5	2.1	16.1	2.8	7.0	2.1	14.0	2.1	1.4	0.50
	15-30	63.5	3.6	8.9	1.3	13.8	18.4	1.3	3.8	23.5	5.1	1.9	1.9	3.8	15.8	2.5	5.7	1.3	17.1	1.9	1.9	0.50
(2) UI	00-15	63.7	4.3	5.5	4.3	14.1	18.9	3.5	1.8	24.3	7.9	1.8	4.9	1.8	14.0	2.4	5.5	1.2	17.1	1.2	1.8	2.04
(3) UO	00-15	67.1	13.1	4.5	2.2	19.8	17.5	4.5	2.3	24.3	4.4	1.5	2.9	3.6	11.7	2.9	5.2	1.5	16.1	2.2	1.5	0.50
	15-30	66.3	5.8	3.2	0.6	9.6	17.5	1.3	1.3	20.1	4.5	2.6	5.2	1.3	18.2	3.9	7.1	1.9	20.1	0.6	2.6	1.01
	30-45																					
	00-15	59.3	3.6	2.6	1.5	7.7	16.4	1.0	1.5	18.9	6.2	1.5	4.6	1.5	18.5	3.1	8.7	2.1	24.1	1.0	1.5	0.50
(4) UO	15-30	56.9	2.8	6.6	1.9	11.3	14.1	0.9	0.9	15.9	7.5	1.4	7.5	1.9	21.6	5.2	7.5	1.4	15.9	0.5	1.9	1.52
	30-45	57.0	5.5	1.9	1.4	8.6	15.2	1.4	1.0	17.6	10.0	1.9	7.6	1.4	19..1	3.8	10.0	1.0	17.1	1.0	2.9	1.01
(5) UI	00-15	71.6	7.4	10.2	1.8	19.4	21.3	1.8	0.9	24.0	2.8	1.8	6.5	2.8	10.2	3.7	6.5	2.8	12.3	0.9	2.8	1.01
	15-30	58.9	10.1	7.9	3.4	21.4	11.2	1.1	1.7	14.0	4.5	2.2	6.2	1.7	12.4	2.2	6.2	1.7	24.2	1.1	1.7	0.76
	30-45	58.9	9.7	5.7	1.6	17.2	15.1	1.1	1.6	17.8	5.9	1.1	3.2	1.1	16.7	3.8	8.6	1.1	22.5		1.6	1.01
(6) UO	00-15	60.3	9.4	3.5	2.3	21.2	13.5	1.8	1.2	16.5	6.4	2.3	2.9	1.8	15.8	2.3	5.3	2.3	19.9	1.2	1.8	1.52
	15-30	57.9	6.7	9.2	2.1	18.0	11.8	1.5	1.0	14.3	7.2	1.0	2.1	1.0	15.9	4.6	9.7	1.0	18.9	1.0	2.1	3.09
	30-45	69.5	11.8	5.5	0.8	18.1	18.1	2.4	2.4	14.3	4.7	0.8	5.5	2.4	13.4	3.1	5.5	2.4	17.3		2.4	2.04
(7) UI	00-15	57.7	5.7	6.7	1.5	13.9	16.5	2.1	1.5	22.9	7.6	1.5	6.2	2.1	17.1	6.2	8.8	1.5	14.4	0.5	1.5	0.50
	15-30	59.3	9.3	2.7	1.6	13.6	14.3	1.1		20.1	6.1	1.6	7.2	1.6	17.0	3.3	6.6	1.1	20.3	0.9	1.6	2.04
	30-45	57.1	7.5	3.9	1.3	12.7	14.1	1.8	1.3	15.4	7.1	1.3	7.1	0.9	16.7	4.4	7.9	1.8	21.3		1.2	1.52
(8) LO	00-15	59.9	14.9	1.1	1.7	17.7	19.3	0.6	1.7	17.2	4.9	1.1	6.6	1.7	12.7	3.3	6.6	1.1	18.2	1.1	1.7	8.70
	15-30	61.0	9.0	8.0	1.5	18.5	14.0	1.0	2.5	21.6	8.5	1.5	8.8	1.5	16.5	2.5	6.5	1.0	16.5		2.0	6.38
	30-45	57.3	9.1	5.9	2.6	17.6	19.9	1.1	1.5	17.5	6.9	1.5	6.5	1.5	14.9	2.9	5.5	1.0	17.5		1.5	8.70
	00-15	73.8	6.3	3.1	3.1	12.5	15.6	2.1	1.1	22.5	4.2	1.1	6.9	3.1	14.6	2.1	6.3	1.1	29.2		2.1	2.04
(9) LI	15-30	61.7	19.5	2.2	1.6	18.3	17.2	1.6	1.1	18.8	3.8	1.1	5.2	1.1	17.7	2.2	6.5	1.1	17.2	1.1	2.2	2.04
	30-45	59.7	12.6	3.7	0.9	17.2	11.7	0.9	0.9	19.9	7.9	0.9	8.1	1.9	18.2	3.7	5.5	0.5	19.6		1.9	2.04
(10) LI	00-15	57.5	14.7	8.8	2.9	26.4	12.7	1.5	1.9	13.5	5.9	0.5	6.1	0.9	20.1	3.4	6.3	0.9	15.2	0.9	1.9	2.04
	15-30	55.6	10.5	8.2	2.7	21.4	10.0	1.4	0.9	16.1	5.8	0.9	1.9	0.9	21.4	5.0	6.5	1.4	13.2	1.4	2.3	2.04
	30-45	64.5	12.9	7.8	1.3	22.0	9.1	1.9	1.3	12.3	4.8	2.6	1.4	1.3	16.9	3.9	8.4	1.3	16.2	0.6	1.9	2.04
(11) LI	00-15	63.3	13.5	10.2	1.8	25.5	12.1	1.2	1.8	15.1	4.8	1.8	4.5	2.4	14.5	4.8	7.4	1.8	13.9		3.6	2.56
	15-30	65.6	16.1	8.3	1.3	25.7	10.9	1.3	1.9	14.1	5.1	1.9	4.8	0.6	14.1	4.2	12.7	1.3	16.7	1.3	1.9	1.52
	30-45	60.8	10.3	9.2	1.1	20.6	11.4	1.1	2.2	14.7	9.2	0.5	2.6	1.1	17.9	2.2	10.4	1.1	16.3	0.5	1.6	2.56
(12) LI	00-15	54.1	9.6	5.3	0.9	15.8	14.9	0.9	1.3	17.1	8.3	1.3	4.9	0.9	18.9	3.9	7.2	1.3	15.4	0.4	1.3	2.04
	15-30	56.5	13.3	2.9	1.9	18.1	16.7	1.0	1.0	18.7	6.9	1.0	5.7	0.5	21.1	5.4	10.3	1.0	15.7	0.5	1.5	1.01
	30-45	53.1	10.9	7.7	1.4	20.0	18.1	1.4	1.8	21.3	9.5	1.0	1.5	2.7	17.2	6.3	9.2	1.4	10.4		1.8	3.63

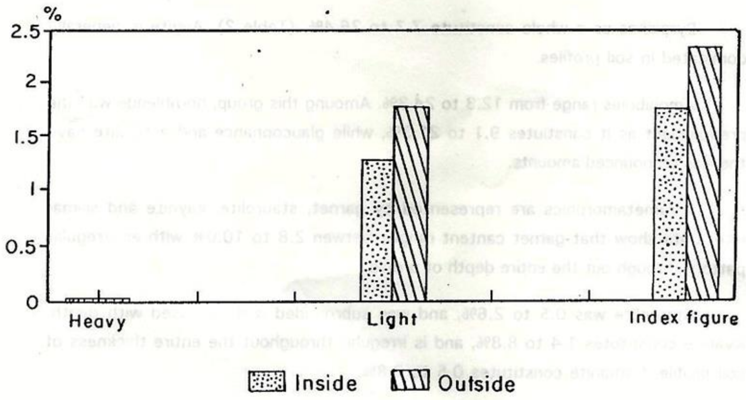


Fig. 2. Heavy & light minerals % and index figure, of surface soil samples inside and outside the gully.

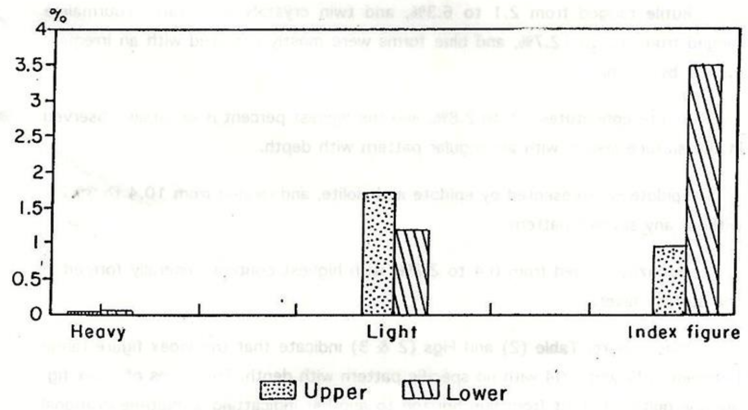


Fig. 3. Heavy & light minerals % and index figure, of surface soil samples inside and the upper and lower gully.

Pyroxines as a whole constitute 7.7 to 26.4%, (Table 2). Augite is generally dominated in soil profiles.

Amphiboles range from 12.3 to 24.3%. Amoung this group, hornblende was the predominant as it constiutes 9.1 to 21.3%, while glaucophance and antinolite have the less pronounced amounts.

Parametamorphics are represented by garnet, staurolite, kaynite and silimanite. Data show that garnet cantent ranges betwen 2.8 to 10.0% with an irregular pattern through out the entire depth of profile.

Staurolite was 0.5 to 2.6%, and was subrounded and increased with depth. Kyanite constitutes 1.4 to 8.8%, and is irregular throughout the entire thickness of soil profile. Silimanite constitutes 0.5 to 3.8%.

Ubibuitous is represented by zircon, rutile and tourmaline. Data show that ircon ranged from 10.2 to 21.6%. The hightest value was generally recorded in the 15-30 cm depth of all profiles, while the lowest one is assosiated with surface layers profiles.

Rutile ranged from 2.1 to 6.3%, and twin crystals were rare. Tourmaline ranged from 5.2 to 12.7%, and blue forms were mostly occurred with an irregular pattern by depth.

Biotite constitutes 0.5 to 2.8%, and the highest percent is generally observed in the surface layers, with an irrigular pattern with depth.

Epidote is represented by epidote and ziolite, and ranged from 10.4 to 29.2% without any specific pattern.

Monazite ranged from 0.4 to 2.2%, with highest content generally formed in the surface layer.

Index figure: Table (2) and Figs (2 & 3) indicate that the index figure range between 0.05 and 2.04 with no specific pattern with depth. The ratios of index figure are quite different from one horizon to another indicatting a multi-depositional regime. The results are more or less consistent with the morphological characteristics and the granulometric analyses data.

Weathering ratios: Data in Table (3) and Fig. (4) indicate that these soils are not well developed as revealed from the smoothness of the ratios through out the entire profiles. Calculated weathering ratios, i.e., wr1, wr2 and wr3 for the layers of each profile, provided a fairly good confirmation.

The soils constituting each profile are homogenous either due to their multi-origin or due to subsequent variations along the course of sedimentation, and therefore, are considered young from the pedological view point.

Thus it can be stated that sandy sediments were mainly eroded and transported by runoff water from a local near by area e.g. Khashm El-Eish ridge. During violent rain storms over the ridge area, both splash erosion and surface flow erosion are intensified. Splash erosion provides most of the detaching energy, while surface-flow erosion provides most of the transporting capacity. Direction of transportion is opposite to the prevailling wind indicating that most sandy sediments were mainly eroded by water. Perhaps wind erosion is the most active on level lands outside the ridge area. These results are in agreement with those oblained by El-Hassanin (1993).

Table 3. Frequency distribution of light minerals in the sand fraction (0.125-0.063).

Profile No.	Depth (cm)	Z/T	Z/T	Z/R	Z/T+R	Wrl P+A/Z+T	Wr3 B/Z+T
(1) UO	00-15	2.30	5.75	1.64	1.64	0.09	0.76
	15-30	2.77	6.32	1.64	1.73	0.06	0.86
(2) UI	00-15	2.55	5.84	1.77	1.96	0.06	0.97
(3) UO	00-15	2.25	4.03	1.40	2.61	0.06	1.04
	15-30	2.56	4.67	1.65	1.74	0.08	0.69
	30-45						
(4) UO	00-15	2.13	5.98	1.57	0.98	0.08	0.60
	15-30	2.88	4.15	1.70	0.93	0.05	0.48
	30-45	1.91	5.01	1.38	0.90	0.03	0.52
(5) UI	00-15	1.57	2.77	1.00	2.60	0.17	1.28
	15-30	2.00	5.64	1.48	1.90	0.09	0.60
	30-45	1.94	4.39	1.35	1.38	0.04	0.60
(6) UO	00-15	2.98	6.87	2.08	1.79	0.11	0.64
	15-30	1.64	3.46	1.10	1.26	0.04	0.46
	30-45	2.44	4.32	1.56	2.17	0.13	0.96
(7) UI	00-15	1.94	2.76	1.14	1.31	0.06	0.64
	15-30	2.58	5.16	1.72	1.23	0.05	0.61
	30-45	2.11	3.80	1.36	1.22	0.07	0.57
(8) LO	00-15	1.92	3.85	1.28	2.04	0.06	1.00
	15-30	2.54	6.60	1.83	1.57	0.04	0.61
	30-45	2.71	5.14	1.77	1.97	0.05	1.00
(9) LI	00-15	2.32	6.95	1.74	1.50	0.05	0.75
	15-30	2.72	8.05	2.03	1.58	0.05	0.71
	30-45	2.17	4.92	1.50	1.15	0.02	0.44
(10) LI	00-15	2.72	5.91	1.86	1.55	0.02	0.46
	15-30	1.69	4.28	1.21	1.60	0.04	0.29
	30-45	1.63	4.33	1.18	1.26	0.05	0.33
(11) LI	00-15	2.01	3.02	1.21	1.87	0.08	0.56
	15-30	1.37	3.13	0.95	1.63	0.05	0.45
	30-45	1.95	8.14	1.57	1.30	0.03	0.42
(12) LI	00-15	1.97	4.85	1.40	1.15	0.05	052
	15-30	2.54	3.91	1.54	1.25	0.03	0.57
	30-45	1.81	2.73	1.09	1.55	0.05	0.68

Z = Zircon R = Rutile P = Pyroxenes H = Hornblende

T = Tormaline A = Amphiboles B = Biotite

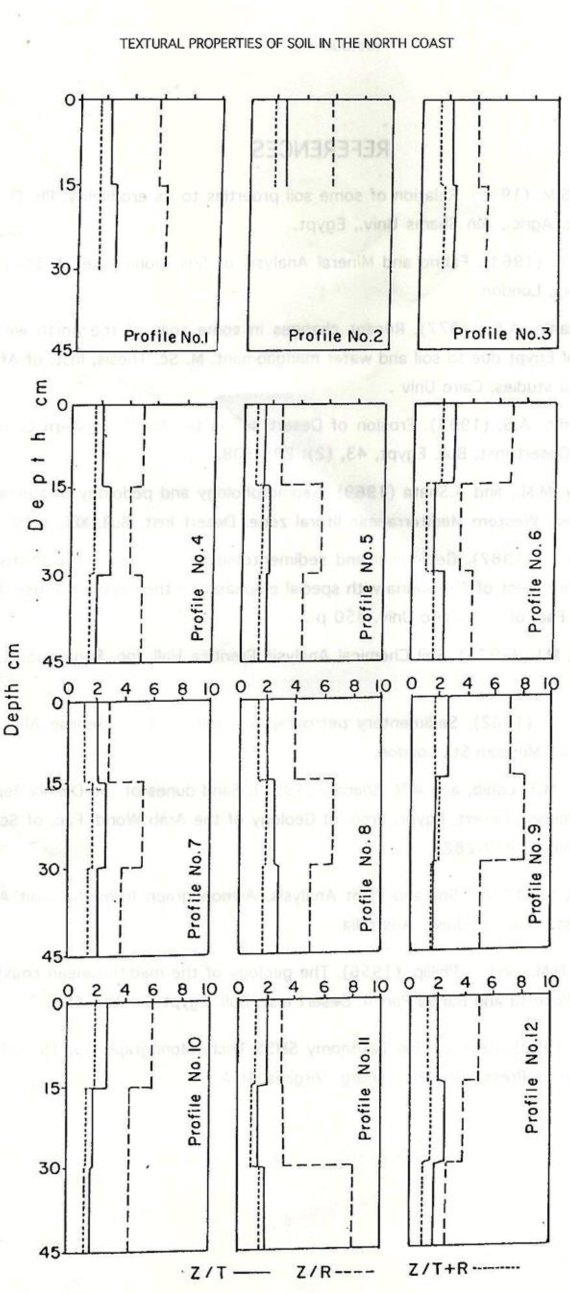


Fig. 4. Depthwise pattern of weathering ratios in the soil depthes .

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علاقة أصل التربة وتكوينها بالإنجراف فى الساحل الشمال الغربى لمصر

صلاح الدين مصطفى عروج

قسم حصر وتصنيف الأراضى - مركز البحوث الزراعية معهد الأراضى والمياه والبيئة .

تتعرض تربة تل خشم العش الواقع فى منطقة العميد بالساحل الشمالى الغربى الى أنجراف تربة شديد ويهدف هذا البحث الى تحديد علاقة أصل التربة وتكوينها بالأنحراف من خلال التركيب المعدنى.

أوضح الفحص الميكروسكوبى للمعادن الخفيفة أنها تتكون كلية من حبيبات الكوارتز حوالى ٩٦٪. ووجدت المعادن الثقيلة المعتمة فى جميع عينات التربة من ٦,٥٥٪ الى ٦,٧١٪.

كانت المعادن الثقيلة غير المعتمة فى معظمها من النوع متوسط الثبات مع سيادة معادن البيروكسين. الستوروليت، الجارنت بينما كانت نسبة المعادن الثقيلة عالية الثبات ضئيلة مع سيادة معادن الزركون، التورمالين ، الروتيل.

أوضحت النتائج أن التربة فى منطقة خشم العش تعانى من أنجراف شديد وأن نقل الرواسب تم بفعل المياه من أتجاه الجنوب الى الشمال وذلك عكس أتجاه الرياح السائد مما يؤكد أن أنجراف التربة فى منطقة خشم العش يتم بفعل المياه وليس بفعل الرياح علاوة أن أراضى المنطقة تعتبر ناضجة (انترسول).