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SOIL PROPERTIES OF A LITHOTOPOSEQUENCE AT EL-HANIA - MASSA, LIBYA

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ABSTRACT

A pedological study was carried out to investigate some morphological, physical, chemical, and mineralogical soil properties in relation to topography and parent material along a transect represents a litho-toposequence at El-Hania-Massa area, El-Gabal El-Akhdar region, Libya. Results indicate that texture has no relation with the topographic position. EC is relatively higher in the low-land area. Calcium carbonate content varies widely with depth and has no relation with elevation or slope. Heavy minerals identification revealed that hornblend and augite are the most abundant non-opaques heavy minerals in the sand fractions. On the other hand, kaolinite and illite are the dominant clay minerals in clay fraction.

The particle size distribution parameters show that most of the particles were transported by water. Also, the irregular distribution of the ratio between sand fractions, as well as resistant heavy minerals reflects the stratification of parent material.

INTRODUCTION

Although relief is viewed as a real factor in the development of soil, its exact role, however, is difficult to evaluate with examples of generalization nature. Therefore, it must be considered area by area (Buol *et al.*, 1980). Also, relation between parent material and soil properties was early reported by many workers. The soils that influenced by the interaction of topography and parent material are defined as a litho-toposequence. Milne (1936) reported that the correlation of soil properties in these sequences with either topographic position or parent material is relatively difficult. However, several studies were carried out to investigate the effect of topography and/or parent materials on soil development and properties. Marron and James (1986) exhibited that soil development as indicated by B-horizon clay content and redness was correlated with gradient, slope direction, and topography patterns. Ojanuga *et al.*(1976) observed a genetic relationship between both slope and/or parent material composition and many of the soil properties. Also, Alvarado and Buol (1975) reported the influence of parent material on the soil properties of a topsequence. Recently, Osher and Buol (1998) found that the landscape and topographic position as well as the texture of parent material controlled some of the morphological, physical, chemical, and mineralogical soil properties.

This study was carried out to investigate some morphological, physical, chemical, and mineralogical soil properties in relation to topography and parent material at El-Hania-Massa area, El-Gabal El-Akhdar region, Libya, since this area could be considered as a litho-toposequence. However, the information of the pedogenesis and soil properties at this area are very limited.

Area studied:

Location:

The studied area is a transect extended between El-Hania at the Mediterranean Sea coast in the north and Massa in the south, El-Gabal El-Akhdar region, Libya. The study was carried out through a transect about 15 km long (Fig.1).

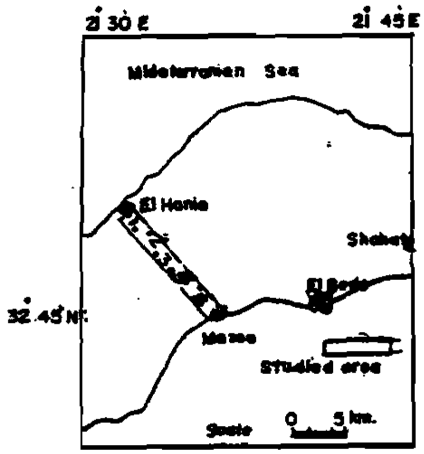

Figure 1: Location of the studied area and selected profiles.

Climate:

According to the available data in the nearest metrological station at Shahat, the area is characterized by the following climate:

a) Average annual rainfall 560 mm/year
b) Average maximum annual temperature 22°C.
c) Average minimum annual temperature 11.6°C.
d) Humidity percentage 55-79%
e) Annual evapotranspiration 1380 mm/year

Geology:

Geological studies indicated that most of the area was developed from hard limestone Darnah formation in the north while the southern part derived from marl and algal limestone of Al-Bayda formation (Rohlich, 1974).

Topography:

The area showed high variation in elevation, it ranges from about 500 m in the south to about 20 m in the north. The slope largely varied from less than 0.5 to more than 6% (Fig. 2).

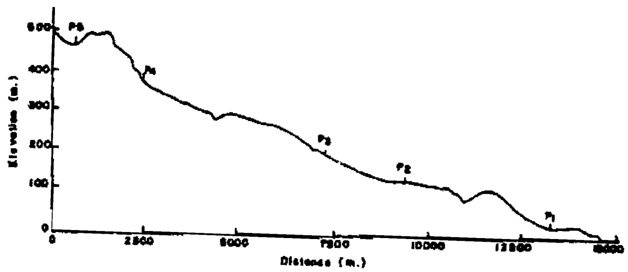

Figure 2: Topography of the study transection and location of selected profiles

MATERIALS AND METHODS

Field work:

Twelve soil profiles were selected along north-south cross section with different elevation and slope. These profiles were morphologically described according to FAO (1990) and samples were collected for laboratory analysis. Data of only five representative profiles were illustrated in the following results:

Profile No.	1	2	3	4	5
Elevation (m)	28	140	197	360	480
Slope (%)	1.3	0.4	4.6	6.3	2.1

Laboratory analysis:

The following analyses were carried out as described by Black (1965) and Hess (1971):

1- Particle size distribution by pipette method. Mean diameter (Mdϕ) and sorting deviation (PDϕ) were calculated as introduced by Griffiths (1967) to clarify the agent and mode of particles transportation.
2- Electrical conductivity, pH, and soluble ions in the saturated extract.
3- Calcium carbonate content
4- Free iron oxides.
5- Heavy minerals assemblage in fine and very fine sand fraction for some representative samples as reported by Milner (1962).
6- Clay minerals identification in the clay fraction by X-ray diffraction techniques.

RESULTS AND DISCUSSION

1. Particle size distribution:

Data of the particle size distribution (Table 1) show that texture largely varied from sandy loam to clay without obvious relation with elevation, slope, and depth. The significant differences in sand distribution with depth as well as the ratio between sand fractions may reflect the lithological discontinuities. Concerning the textural parameters, results revealed that most of the samples were transported by water (Fig.3). The data indicated also that suspension is the main mode of transportation.

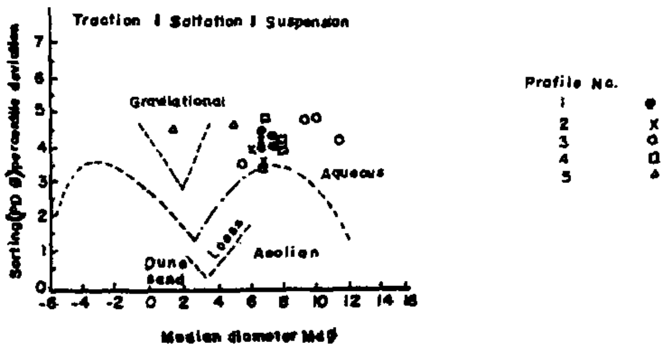

Figure 3: Relation between size (Mdϕ) and sorting (PDϕ) in the studied profile

Table (1): Particle size distribution and texture of the representative profiles

Profile No.	Depth (cm)	Diameter of particles (in microns)							Texture	Ratio between	
		2000 500	500 250	250 100	100 50	50 10	10 2	< 2		100-50 / 500-250 μ	100-50 / 250-100 μ
1	0 – 20	0.4	4.4	3.1	6.9	32.2	23.3	29.7	SL.C.L	1.57	2.22
	20 – 80	0.6	1.2	1.8	6.7	25.7	22.2	41.8	SL.C.	5.58	3.72
	80 – 100	0.5	0.9	1.3	5.3	26.9	28.7	36.4	SL.C.LSL.	5.89	4.08
	100+	0.1	1.4	1.1	5.2	24.6	33.8	33.8	C.L.	3.71	4.72
2	0 – 15	0.4	0.7	1.5	11.4	33.0	24.8	28.2	SL.C.L	16.28	7.60
	15 – 40	0.3	0.8	1.8	12.8	37.0	21.0	26.3	SL.C.LSL.	16.0	7 11
	40 – 60	2.2	4.3	5.9	5.7	27.2	25.7	29.0	C L	1 32	0 97
3	0 – 20	0.4	0.9	1.6	11.2	44.9	16.9	24.1	SL.C.	12.44	7.00
	20 – 50	0 2	0.4	0.7	5.9	19.0	13.8	60 0	C.	14 75	8.43
	50 – 80	0.2	0.5	1.0	8.5	18.9	13.5	57.4	C	17.0	6.50
	80+	0.1	0 4	1.2	8.9	20 2	12.9	56.3	C.	22.25	7 42
4	0 – 20	2.2	2.5	3.8	9.5	40.9	18.1	23 0	SL.L	3 80	2 50
	20 – 60	5.0	4.3	5.8	9.1	25.1	20.7	30.0	C.L.	2.12	1.57
	60 – 110	1.5	1.9	2.8	7.3	23.6	26.5	34.4	SL.C.LSL.	3.84	2 61
	110 – 150	0.2	0.6	1.6	5.6	25 2	27 5	39.3	C L.	9.33	3 50
5	0 – 30	16.6	6.4	7.6	10.8	20 2	14 8	23 6	C	1.69	1.42
	30 – 70	37.0	15 9	16.3	7.1	6 8	4.9	12 0	SA.L.	0 44	0.43

*** SL : Silty , C : Clay , L : Loam , SA: Sandy.**

3. Mineralogical soil properties:

The mineralogical analysis of fine and very (65.9 – 87.2%) fine sand indicated that opaques are the most common minerals. Heavy minerals identification revealed that amphiboles (hornblend) and pyroxenes (augite) are present in considerable amount. On the other hand, garnet, rutile, anataze, turmaline, monazite, biotite, zircon, hyperthine, and staurolite are present as accessory minerals (Table 3). This minerals assembelege reflects the igneous origin and might have been transported from other areas and deposited in the studied area. The data showed also that there is no relation between minerals distribution and either depth or topographic position. The irregular distribution of the heavy minerals and the ratio between some of the resistant minerals with depth confirm the stratification of the parent materials (Barshad, 1964).

Table (2): Some chemical properties of the representative profiles

Profile No.	Depth (cm)	PH	EC dS/m	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CaCO_3$ (%)	Free Fe_2O_3 (%)
				Meq./L.					
1	0 – 20	8.5	0 85	3.7	0.2	7 0	0.2	10.6	1.7
	20 – 80	8.4	1.10	4.2	0.1	9.0	0.2	8.2	1.7
	80 – 100	8.0	2.00	1.5	1.0	17.0	t*	4.3	1.8
	100+	7.7	3.20	3.5	3.0	20.9	0.1	4.1	1.8
2	0 – 15	7.3	0.36	2.8	0.2	0.7	0.2	0.9	0.8
	15 – 40	7.7	0.17	1.9	t	0.7	t	0.2	0.9
	40 – 60	7.9	0.21	1.0	t	0.9	t	25.6	0.8
3	0 – 20	7.4	0.28	1.3	0.3	0.9	0.1	0.3	0.5
	20 – 50	7.7	0.35	1.2	0.5	1.4	0.1	0.5	0.9
	50 – 80	7.4	0.81	2.9	0.5	1.8	0.1	0 1	0.9
	80+	7.3	1.00	5.7	3.7	3.2	t	0.2	2.1
4	0 – 20	7.8	0.29	1.5	0.7	0.5	0.1	7.1	1.0
	20 – 60	7.9	0.24	1.5	0.9	0.4	0.1	16 7	1 6
	60 – 110	8.0	0.23	0.9	0.7	0.7	t	4.7	1.8
	110 – 150	7.9	0.22	1.2	0.7	0.6	t	1.0	1.0
5	0 – 30		0.38	2.7	1.2	0.4	0.1	36.7	1.3
	30 – 70		0.37	2.0	1.1	0.4	0.1	85.1	0.8

*** t = traces**

Table (3): Heavy minerals per cent in very fine sand (100-50 μ).

Profile No.	Depth (cm)	Opaq-ues	Horn.	Aug.	Ru.	Satu.	Anat.	Tur.	Hyp.	Mon.	Biot.	Zir.	Gar.	Oth-ers	Anat. Ru.+Zir. + Tur.
1	0 – 20	78.5	8.3	0.5	-	3.9	2.8	1.7	0.5	0.6	0.6	0.6	-	-	1 22
	20 – 80	81.0	4.9	3.5	2.8	-	1.4	1.4	0.7	-	1.4	1 4	1 4	-	0.25
	100+	72.2	4.1	1.0	3.1	1.0	5.2	2.1	2.1	-	5.2	-	1.0	3.1	1.00
2	0 – 15	82.0	1.6	3.3	3.3	-	3.3	2.5	-	-	0.8	1.6	0.8	0.8	0.44
	15 – 40	87.2	2.7	2.7	1.8	-	2.7	-	0.9	-	1.8	-	-	-	1.50
3	0 – 20	85.8	3.7	1 5	-	-	2.2	1.5	-	1.5	1.5	2.2	-	-	0.59
	20 – 50	80.8	3.8	6.1	3.8	-	1 5	1.5	0.8	-	0 8	-	0 8	-	0.28
	80+	77.3	1.8	2.7	7.3	0.9	3.6	0.9	1.8	-	-	1.8	1.8	-	0.36
4	0 – 20	76.6	8.9	2.4	2.4	0.8	2.4	-	-	1.6	3.2	-	1.6	-	1 0
	20 – 60	74.0	9.3	3.7	1.8	-	-	-	-	3.7	3 7	-	-	3 7	-
	110 – 150	70.9	14.9	3.5	5.0	-	1 4	1.4	-	0.7	-	-	0.7	1 4	0 20
	0 – 30	65.9	16.4	3.3	1.6	-	4.1	1 6	0.8	-	-	1 6	2.7	4.1	0 85
5	30 – 70	80.0	8.0	1.3	1.3	-	1.3	4 0	-	-	-	-	1 3	2 7	0 25

Clay mineral analysis by X-ray indicated that kaolinite and illite are the dominant clay minerals (Fig4).This is due to the high intensity of (7.0 - 7.2A°)and (10.0–10.1A°) peak in the different treatments except the former peak which disappear in the heated treatment. Polygosskite and some interstratified minerals were also observed in some samples.This mineralogical composition was resulted from the calcareous nature of parent material and relatively humid climate in the area under consideration (Dixon and Weed, 1977).

Generally, it can be concluded that the above mentioned results indicated that the soil properties are partially influenced by the interaction of parent material and topography and consequently it could be considered as a lithotoposequence.

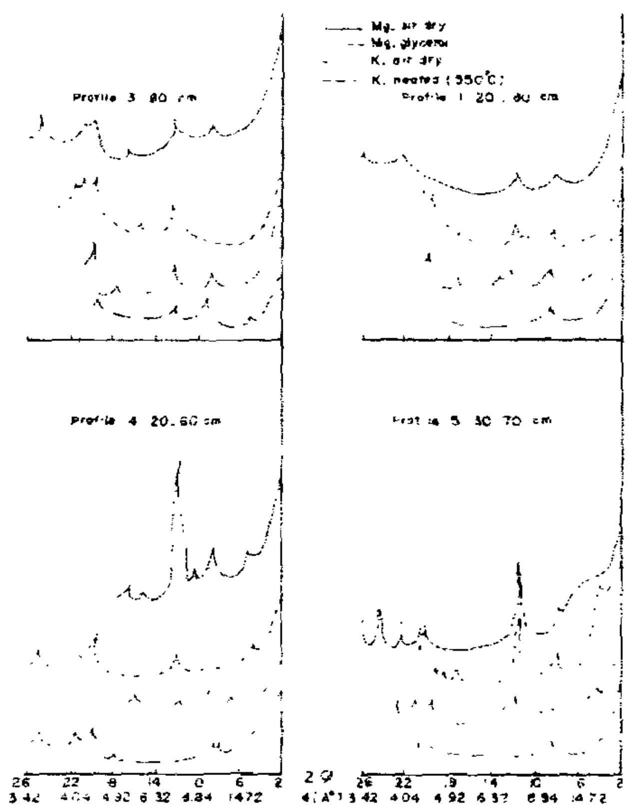

Figure 4: X-Ray diffraction patterns of clay fraction

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الخواص الأرضية لسلسلة طبوغرافية صخرية بمنطقة الحنية - مسَه ليبيا

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أجريت دراسة بيدولوجية لمعرفة الخواص المورفولوجية والفيزيائية والكيماوية والمعدنية للتربة ومدى ارتباطها بالطبوغرافيا ومادة الأصل فى سلسلة طبوغرافية صخرية بمنطقة الحنية - مسَه بمحافظة الجبل الأخضر - ليبيا. ولقد أوضحت الدراسة أن قوام التربة لا يرتبط بالموقع الطبوغرافى. كما بينت النتائج أن الملوحة (EC) كانت مرتفعة فى الأماكن المنخفضة كما إتضح أيضا أن توزيع كربونات الكالسيوم لا يرتبط معنويا بالارتفاع أو مقدار الميل.

ولقد أوضحت الدراسة المعدنية أن الهورنبلند والأوجيت كانت أكثر المعادن الثقيلة الغير معتمة انتشارا فى حبيبات الرمل، ومن ناحية أخرى دلت النتائج على أن الكاولينيت والأيلليت كانت أكثر معادن الطين سيادة فى حبيبات الطين.

كما تبين من دراسة التوزيع الحجمى للحبيبات أن معظم الحبيبات منقولة بواسطة المياه. ولقد أوضحت الدراسة أيضا طباقية وعدم تجالس مادة الأصل وتم الاستدلال على ذلك من عدم انتظام النسب بين حبيبات الرمل والنسب بين المعادن الثقيلة مع العمق.