

PEDOLOGICAL STUDIES ON THE SOILS OF WADI EL-ASYUTI, EASTERN DESERT, EGYPT

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ABSTRACT:

Wadi El-Asyuti is encompassing promising areas for the future projects of agricultural utilization, however, its soils are occupied an area of the Eastern Desert of Egypt. According to the aerial photo-interpretation technique, the identified main landforms could be assigned to five units, *i.e.*, Wadi plain, Wadi bottom, Rubble terraces, Alluvial fan, River terraces and Rocky area. The developed soils on these units were investigated throughout ten representative soil profiles. The obtained results indicated that the studied soils are characterized by texture class varies of sandy-silty clay loam, CaCO₃ content of 1.2-37.7 % and organic matter content of 0.05-0.61 %. Also, the soil salinity of the investigated soils ranged between non-saline to extremely-saline, soil pH tended to alkaline side, and soluble cations were generally categorized in an ascending order of Ca⁺⁺ > Na⁺ > Mg⁺⁺ > K⁺ vs soluble anions of SO₄⁻ ≥ Cl⁻, which were alternatively dominated and both exceed soluble HCO₃⁻.

Soils of coarse texture class have the highest soil bulk density values (Wadi plain and Rubble terraces soils), while the relatively fine texture soils (Alluvial fan and River terraces soils) have the lowest ones. On the contrary, soil total porosity values exhibited an opposite trend, the highest values were recorded in case of the fine soil texture and tended to decrease with increasing coarseness of soil texture. Also, the greatest values of hydraulic conductivity are associated with the soils of coarse texture class, and then decreased in the fine textured soils of alluvial fan and River terraces soils. In addition, available soil moisture range coincides very well with textural variations among soil profile layers. Moreover, the CEC values are more related with soil texture class, besides an exchangeable sodium percentage indicates that the studied soils are non-sodic.

Statistical size parameters revealed that the studied soil sediments of Wadi El-Asyuti are mostly transported and deposited through an aqueous environment, and locally combined action of aqueous-aeolian media. With regard to the mineralogical composition of the studied soils, the obtained data showed that heavy minerals are detected as opaques, pyroxenes and amphiboles in high amounts. Also, the ultra stable minerals of zircon, garnet and rutile are present in relatively moderate amounts, while the remaining ones are detected in less pronounced amounts. The ratios of ultra stable minerals and weathering values indicate that soils of Wadi El-Asyuti are formed of either multi-origin or multi-depositional regime, due to the heterogeneity of the parent materials prior to inception to geogenetic weathering or resulted in from the geochemical weathering prevailed in the source sediments.

Key words: Soils of Wadi El-Asyuti, Statistical parameters, Eastern Desert Wadies, Ultra stable minerals & their ratios, weathering values.

INTRODUCTION:

Egypt is suffering greatly from the gradual attack of building and other industrial establishments on the cultivated soils. Thousands of feddans of the very fertile agricultural lands are being lost every year, which consequently lowers the agricultural production and badly affects the national exhausted-economy. One of the best solutions for that problem is to encourage youth graduates to reclaim and occupy cultivable areas on both sides of the Nile Valley.

The Eastern Desert extends from the Nile Valley, in the west, to the Gulf of Suez and Red Sea, in the East. It occupies about 21% of Egypt's total area. The Eastern desert is also richness with soil and water resources and intensively dissected by Valleys and ravines. The surface of the Eastern Desert is intensively dissected by a great number of dry drainage vallies, which form two types. The eastward type drainages to the Red Sea by numerous independent and short wadies, while the westward type drainages to the Nile Valley, through a few number of great trunk channels such as Wadi Tarafa, El-Asyuti, Qena and Allaqui.

Said (1962) and Abu Al-Izz (1971) reported that Wadi El-Asyuti is the greatest Wadi in the Eastern Desert and runs over the surface of limestone plateau, and flows toward the River Nile in the west at Asyut city. The watershed of this wadi lies at the high cliffs of the Eocene plateau at Khashm Umm omeiyid (787m.a.s.L.), its water flows about 150 km driving in its front great amounts cobbles, conglomerates, gravels, sand and carbonates.

According to the High Dam Soil Survey Project (**HDSS, 1964**), the soils of Wadi El-Asyti could be evaluated according to their soil potentiality classes for irrigated agriculture. Also, **Land Master Plant (1986)** studied the soils of several transects across the soils of Wadi El-Asyti to execute soil survey, which was based on Aerial photo and Landsat Images as well as the soils were classified according to **USDA (1975)**.

The goal of this study is to evaluate the physical, chemical and mineralogical characteristics of the soils of Wadi El-Asyuti in order to be used as a scientific guide for soil reclamation for increasing the arable area to overcome the crucial situation of the fast increasing population.

MATERIAL AND METHODS:

To achieve the aforementioned target, the used data that cover the studied area (Figure, 1) are geometrically corrected raster layers of Aerial photos data by using the Aerial Photo-interpretation technique according to **Gossen (1967)** for delineating the physiographic and urban polygons by the visual interpretation resulting in a stereovision information system composite for the selected terrain as a soil map. According to the aerial photo-interpretation technique, the identified main landforms could be assigned to five units, *i.e.*, Wadi plain, Wadi bottom, Rubble terraces, Alluvial fan, River terraces and Rocky area.

Field truth was performed for review the soil mapping units (landform units) and to identify the boundaries between them as well as the main morphological characteristics at the representative ten soil sites using the soil described items following the guidelines undertaken after **FAO (1990)**. Soil

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samples were collected from the subsequent layers of each profile, and then dried, sieved through a 2 mm sieve and kept for the different soil analyses under investigation.

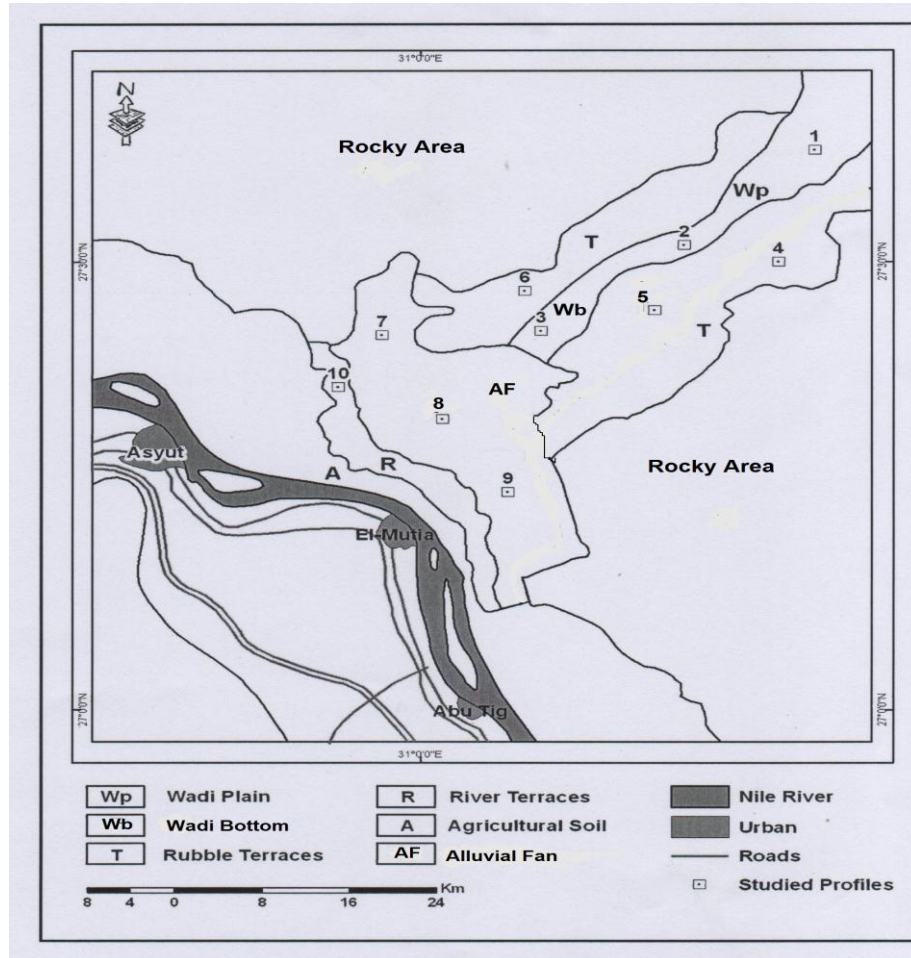


Fig. (1): Physiographic units and the studied soil profiles.

Particle size distribution was carried out according to the International Method (**Piper, 1950**). Soil bulk density was determined using undisturbed soil samples (**Vomocil, 1965**). Moisture retention values were determined using the pressure cooker at 0.1 and 0.33 atm as well as the pressure membrane apparatus at 15 atm. Hydraulic for undisturbed soil samples was determined (**Richards, 1954**). Total porosity was calculated from the obtained values of bulk density with assumption that the real density of the studied soils is 2.65 g cm^{-3} (**James, 1965**).

CaCO_3 content was estimated using the Collin's Calcimeter (**Piper, 1950**). Electrical conductivity (ECe) and soluble ions were determined in the soil paste extract (**Jackson, 1967**). Soil pH was measured in the soil paste (**Jackson, 1967**). Cation exchange capacity and exchangeable sodium were determined according to the method described by **Tucker (1954)**. The cumulative curves were drawn on semi-log paper using the phinotation of the equations of **Pettijohn (1957)** to identify the statistical size parameters of median, sorting and skeweness.

Mineralogical analysis of the sand fraction sized 125-63 μ after the ordinary pretreatments (**Jackson, 1965**) was separated from each sample by wet sieving, cleaned up and further differentiated into heavy and light minerals using Bromoform (Sp. Gr. 2.87 ± 0.02) as outlined by **Brewer (1964)**. Heavy minerals were washed, dried and mounted on glass slides using Canda Balsam. The minerals were examined under the polarized microscope, 500 grains in each case were counted under investigation to minimize the relative error.

RESULTS AND DISCUSSION:

1- Morphological and physico-chemical properties:

Morphological features and physico-chemical properties of the representative soil profiles are shown in Tables (1, 2 and 3). From the obtained data, it could be assigned a general view about the soil characteristics of the identified physiographic units, as follows:

a. Soils of Wadi plain and bottom:

The unit (Wadi) represents a natural drainage valley that may have the shape of elongate deeply-incised depressions or gullies. This unit (Wadi) could be differentiated into two landforms, *i.e.*, Wadi plain and Wadi bottom. Wadi plain includes the area without stream beds, which are occasionally flooded by run-off water from adjacent elevated areas, while Wadi bottom represents the lower parts of the natural drainage pathways showing one or more stream beds. These Wadi units are represented by profile Nos. 1, 2 and 3, however, the obtained data in Table (2) show that soil texture lies in the relatively coarse grade of sandy-loamy sand. Also, a pronounced CaCO_3 content of 12.5-20.9 % with an irregular distribution pattern with depth was occurred. An extremely low content of organic matter (0.02-0.15 %) was detected owing to the prevailing aridity in the region and its scattered natural vegetation. Accordingly, the CEC is rather relatively low due to the nature of relatively coarse texture grade, where its values fluctuate between 4.3 and 7.8 c molc kg^{-1} soil as well as ESP value ranged 3.4-11.2% indicating non-sodic soils, as shown in Table (2).

Soil bulk density depends on number of factors including soil texture packing, organic matter content, soluble salts, exchangeable cations and soil depth (Baver, 1963). According to this basis, soil bulk density value is relatively high and ranged 1.55-1.82 g cm^{-3} . Also, soil total porosity, which is an index of the relative volume of pores in the soil, showed an opposite trend for soil bulk density, and then its values varied from 18.9 to 45.5 %. Hydraulic conductivity is an important parameter for planning the design systems of irrigation and drainage as well as leaching operations of saline and sodic soils. In addition, it measures the rate of downward movement of water by gravity, however, the values of hydraulic conductivity ranged from 7.5 to 22.8 cm h^{-1} (Table 3).

Moisture characteristic is a useful tool that manifests pore space distribution and soil-water energy relation. Also, available moisture is a stable property that is considered characteristic for soil type. Data in Table (3) dictated the percentages of retained moisture as an available range. From the data presented, it can be observed that available moisture content in the soil tended to decrease in soils of Wadi plain and bottom, which are represented by soil profile Nos. 1, 2 and 3.

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Table (1): Morphological description of the studied soil profiles.

Land-form	Profile No.	Depth (cm)	Soil colour			Texture class	Structure	Consistency		Lower boundary		
			Hue	Dry	Moist			Dry	Moist			
Wadi plain	1	0-30	10 YR	8/4	5/6	LS	ma	lo	nsnpl	--		
		30-80				sg	ds					
		80-120				S	cs					
	2	0-35		7/3	5/6	S	sg			--		
		35-60		6/4	5/4	S				ds		
		60-130		7/3	5/6	S						
Wadi bottom	3	0-25	6/4	5/4	LS	ma	--					
		25-70			S	sg	cs					
		70-140			LS	ma						
Rubble terraces	4	0-25	5/3	4/4	L	wmsubk	sh	stspl	--			
		25-65	4/4	4/2	CL				ds			
		65-130			cs							
	5	0-35	4/6	4/3	L	wmsubk	sh	stspl	--			
		35-75	4/3	4/2	L				ds			
		75-140	8/3	8/6	S				sg	cs		
			8/3	8/4	LS				ma	lo	nsnpl	--
	6	0-40	8/3	8/6	S	sg	ds					
		40-80			7/3	7/2	S	sg				
		80-150	6/4	6/2	L	wmsubk	sh	stspl	--			
Alluvial fan	7	0-25	6/4	6/2	L	wmsubk	sh	stspl	ds			
		25-65	6/2	5/2	L				cs			
		65-125	6/4	5/4	SL				ma.	lo	nsnpl	cs
	8	0.35	5/2	4/4	4/2	L	wmsubk	h	stspl	--		
		35-80				ds						
		80-150	5/6	4/6	SiCL	mcsbk				st	pl	cw
		0.20	6/4	6/2	L	wmsubk				sh	stspl	--
	9	20-60	5/6	5/2	L	wmsubk	sh	stspl	dw			
		60.120	5/3	4/3	CL	mcsbk	h	stspl	--			
		0-40	5/6	5/2	L	wmsubk	sh	stspl	ds			
River terraces	10	0-40	5/6	5/3	L	wmsubk	sh	stspl	ds			
		40-80	5/6	5/2	L	wmsubk	sh	stspl	ds			
		80-150	5/6	5/3	L	wmsubk	sh	stspl	ds			

Texture class
 S = Sandy
 LS = Loamy sand
 SL = Sandy loam
 L = Loam
 CL = Clay loam
 SiCL = Silty clay loam

Structure
 sg = Single grain
 ma = Massive
 wmsubk = Weak medium subangular blocky
 mcsbk = Moderate coarse subangular blocky

Consistence
 lo = Loose
 sh = Slightly hard
 h = Hard
 sst = slightly sticky
 st = Sticky
 npl = Non plastic
 spl = slightly plastic
 mpl = Moderately plastic

Lower Boundary
 c = Clear
 s = Smooth
 d = Diffuse
 w = Wavy

This behaviour is more attributed to that these soils are poorer in the finer fractions, and then the values of available moisture range are mostly lower, *i.e.*, 4.70-9.55%. Such low available soil moisture content is also rendered to low energy of water retention on the low specific surface of the coarse particles of these soil sediments. In contrast, it is quite clear that the retained moisture for coarse textured soils of these units of Wadi landforms is slightly higher than those of quartzitic in nature, this is due to coatings of colloidal carbonates and free iron oxides which retain more water relative to uncoated quartz grains.

Table (2): Particle size distribution, CaCO₃, organic matter, CEC and ESP of the studied soil profiles.

Land-form	Profile No.	Depth (cm)	Particle size distribution %				Texture class	CaCO ₃ %	Organic matter %	CEC (c mole kg ⁻¹ soil)	ESP	
			Coarse sand	Fine sand	Silt	Clay						
Wadi plain	1	0-30	27.4	51.2	7.7	6.3	LS	17.20	0.14	7.80	3.40	
		30-80	79.8	38.4	8.7	6.4		22.30	0.05	4.90	9.33	
		80-120	87.6	6.3	1.5	4.6		16.50	0.05	5.90	11.20	
	2	0-35	80.8	15.8	0.6	2.8	S	20.50	0.12	4.50	8.40	
		35-60	42.7	52.6	1.7	3.0		20.90	0.02	4.30	5.40	
		60-130	37.6	59.9	0.9	1.6		15.30	0.03	5.20	6.80	
Wadi bottom	3	0-25	34.4	52.1	3.8	9.7	LS	18.60	0.15	6.20	8.60	
		25-75	64.0	35.0	3.6	4.4	S	12.50	0.02	6.60	8.20	
		70-140	61.4	27.6	4.8	6.2	LS	19.80	0.02	5.50	8.10	
Rubble terraces	4	0-25	19.2	27.0	36.0	17.8	L	22.70	0.30	15.30	4.60	
		25-65	16.0	23.8	34.5	25.9		3.20	0.21	18.50	8.20	
		65-130	11.0	24.7	35.6	28.7		CL	1.20	0.11	20.60	13.50
	5	0-35	18.8	20.3	40.9	20.9	L	22.10	0.21	17.50	3.80	
		35-75	12.0	22.1	40.1	25.8		28.10	0.20	19.30	3.50	
		75-140	59.1	31.9	3.6	5.4		S	7.20	0.10	5.20	3.80
	6	0-40	50.2	36.9	7.3	5.6	LS	6.70	0.10	5.20	3.50	
		40-80	78.1	12.4	4.6	4.9		S	2.50	0.13	4.60	8.20
		80-150	78.6	15.4	1.8	4.2			4.60	0.13	4.40	6.30
Alluvial fan	7	0-25	16.2	22.3	39.9	21.6	L	28.60	0.90	14.20	4.50	
		25-65	3.8	28.7	44.9	22.6		29.80	0.50	15.10	2.90	
		65-125	10.6	64.2	16.5	8.7		SL	20.20	0.40	7.10	5.30
	8	0-35	13.6	22.1	39.1	25.2	L	9.90	0.80	20.30	12.10	
		35-80	7.8	12.9	43.4	36.0		2.10	0.40	25.90	14.50	
		80-150	5.1	5.7	50.8	38.4		SiCL	2.60	0.30	32.50	10.30
	9	0-20	17.5	11.1	46.3	25.1	L	12.40	0.90	17.90	4.50	
		20-60	5.8	21.3	47.9	25.0		39.50	0.30	16.90	5.20	
		60-120	21.0	23.9	34.0	21.1		37.70	0.30	15.50	2.90	
River terraces	10	0-40	0.7	19.1	45.2	32.4	CL	30.20	0.70	15.70	4.50	
		40-80	12.7	28.1	36.2	23.0		L	13.90	0.57	12.60	3.90
		80-150	16.2	22.4	36.8	24.6			28.20	0.34	13.50	5.30

S= sandy, LS=Loamy sand, SL=Sandy loam, L=Loamy, CL=Clay loam, SiCL=silty clay loam

Concerning the chemical analysis of either soil paste or its extract, the obtained data in Table (4) showed that soil pH values range from 7.8 to 8.2, indicating that the soils are slightly to moderately alkaline. Also, the E_c values of the representative profiles reveal that soil salinity varied from non-saline to strongly saline, where E_c value ranged 2.35-37.20 dSm⁻¹. The cationic composition of soluble salts is mostly dominated by Ca⁺⁺ followed by Na⁺ and Mg⁺⁺, while K⁺ constitutes the least soluble cation. Soluble anions are characterized by the dominance of Cl⁻ followed by SO₄²⁻ and HCO₃⁻, except for profile 2 which SO₄²⁻ exceeds Cl⁻.

Table (3): Bulk density, total porosity and hydraulic conductivity of the studied soil profiles.

Land-form	Profile No	Depth (cm)	Bulk density (g/cm ³)	Total porosity %	Hydraulic conductivity (cm/h)	Available water range %
Wadi plain	1	0-30	1.82	40.5	15.20	7.30
		30-80	1.70	41.8	10.90	6.00
		80-120	1.55	45.5	7.50	5.97
	2	0-35	1.62	40.2	10.50	7.28
		35-60	1.80	34.1	12.50	5.60
60-130		1.90	40.3	10.90	4.70	
Wadi bottom	3	0-25	1.70	35.4	22.80	9.55
		25-70	1.81	20.6	20.90	8.85
		70-140	1.81	18.9	21.50	6.90
Rubble terraces	4	0-25	1.33	51.1	3.50	14.70
		25-65	1.35	49.9	3.20	17.30
		65-130	1.25	50.9	1.80	18.90
	5	0-35	1.35	50.5	2.60	15.40
		35-75	1.22	55.7	2.20	17.40
		75-140	1.55	35.5	5.90	6.80
	6	0-40	1.85	39.9	7.90	7.00
		40-80	1.85	38.8	6.50	6.10
80-150		1.61	40.1	8.50	5.00	
Alluvial fan	7	0-25	1.40	50.8	3.50	17.60
		25-65	1.53	45.9	2.40	16.50
		65-125	1.35	45.8	5.60	8.90
	8	0-35	1.40	53.2	2.65	15.30
		35-80	1.28	57.1	2.52	20.70
		80-150	1.05	58.5	0.94	21.00
	9	0-20	1.25	47.5	1.92	19.80
		20-60	1.21	50.5	1.46	18.60
60-120		1.19	49.2	1.33	16.10	
River terraces	10	0-40	1.15	60.4	1.35	21.80
		40-80	1.22	61.1	2.60	18.00
		80-150	1.31	49.3	1.92	17.00

b. Soils of Rubble terraces:

These soils occupy wide areas and extend about 20 km in length with a width ranging between 2 and 4 km along both Wadi rims. Soil surface is mainly flat-gently undulating and covered with desert pavement, Aeolian and alluvial deposits. This unit is represented by profiles 4, 5 and 6. Data presented in Table (2) revealed that soil texture is restated to four textural classes of sandy, loamy sand, loamy and clay loam, in general, each one occupied partly zones of the studied soil profiles. CaCO₃ content widely varied from 1.2 to 28.1%. Meanwhile, organic matter content is very low, where its values ranged 0.10-0.30 %, reflecting the hyper arid climatic conditions of the area and the absence of natural vegetation cover. As for cation exchange capacity, which is more related to the soil textural class, the CEC values revealed that some soil sediments are clay enriched vs ones are poorer with a corresponding range of 20.6-4.0 c molc kg⁻¹ soil. In general, the exchangeable sodium percentage (ESP) fluctuated from 3.5 to 13.5 %, indicate that the soils of Rubble terraces are non-sodic ones.

Table (4): Chemical analysis of the soil paste extract of the studied soil profiles.

Land-form	Profile No.	Depth (cm)	pH (soil paste)	ECe (dS/m)	Soluble ions (m molc L ⁻¹)							
					Cations				Anions			
					Ca ⁺⁺	Mg ⁺⁺	Na ⁺	K ⁺	CO ₃ ⁻⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻⁻
Wadi plain	1	0-30	7.8	11.49	46.20	11.10	56.87	1.92	0.00	3.00	51.00	62.09
		30-80	7.9	22.70	125.4	33.10	113.9	1.50	0.00	1.80	110.0	162.1
		80-120	8.2	37.20	250.0	37.00	271.1	2.00	0.00	2.00	290.0	267.1
	2	0-35	7.8	2.78	9.30	3.70	14.58	0.27	0.00	2.00	14.00	11.85
		35-60	8.1	2.35	8.60	5.70	9.60	0.20	0.00	2.00	11.00	11.10
		60-130	8.1	5.30	13.40	7.10	30.56	0.95	0.00	2.60	27.50	21.91
Wadi bottom	3	0-25	7.9	9.68	35.10	6.20	56.95	1.37	0.00	2.50	55.00	42.12
		25-70	8.0	12.00	53.20	25.80	53.00	1.88	0.00	2.40	55.00	76.48
		70-140	8.1	9.68	35.10	6.20	56.95	1.37	0.00	2.50	55.00	42.12
Rubble terraces	4	0-25	7.8	4.04	17.50	4.50	19.17	0.30	0.00	1.20	17.50	22.77
		25-65	7.9	4.95	21.20	5.10	25.80	1.96	0.00	2.30	25.00	26.76
		65-130	8.1	6.15	19.20	6.50	33.50	1.36	0.00	2.00	30.00	28.56
	5	0-35	8.0	1.35	7.20	4.20	3.50	0.25	0.00	2.30	2.50	10.35
		35-75	8.1	0.55	2.40	1.40	1.80	0.20	0.00	2.80	1.50	1.50
		75-140	8.2	1.28	6.10	2.90	4.50	0.27	0.00	2.00	5.50	7.27
	6	0-40	7.6	2.40	9.20	2.80	13.75	0.27	0.00	1.40	11.50	13.12
		40-80	7.7	4.55	17.40	6.00	22.20	0.75	0.00	1.80	25.00	19.53
		80-150	7.8	6.13	19.20	6.50	33.50	1.36	0.00	2.00	30.00	28.56
Alluvial fan	7	0-25	8.1	7.70	33.20	4.80	39.57	1.13	0.00	1.20	44.00	33.50
		25-65	8.2	2.60	4.60	3.60	18.11	0.30	0.00	2.40	15.00	9.21
		65-125	8.3	3.90	9.40	7.10	22.67	0.91	0.00	2.30	22.50	15.28
	8	0-35	7.6	14.30	52.80	11.20	96.75	2.05	0.00	2.60	94.00	66.20
		35-80	7.7	18.30	71.40	12.60	116.5	1.38	0.00	2.00	124.0	75.88
		80-150	7.9	19.50	75.20	10.80	114.5	1.60	0.00	2.00	121.5	78.60
	9	0-20	8.0	3.45	8.60	6.40	19.10	1.18	0.00	1.20	17.50	16.58
		20-60	8.2	1.60	7.60	2.40	7.48	0.33	0.00	1.80	6.50	9.51
		60-120	8.3	4.20	19.20	7.80	14.80	0.25	0.00	2.20	185.0	21.35
River terraces	10	0-40	8.1	1.83	7.60	4.50	7.48	0.97	0.00	2.20	7.00	11.35
		40-80	8.2	3.73	14.40	6.05	16.67	1.05	0.00	2.00	19.00	17.17
		80-150	8.4	2.68	9.00	4.20	13.70	0.50	0.00	1.50	11.50	14.40

Values of bulk density, Table (3), ranged 1.25-1.85 g cm⁻³, the highest value is associated with the coarse texture soil (sandy), while the lowest value (1.22 g cm⁻³) is detected in the texture grade of soil profile No. 5. The later case is expected, since the fine textured soil has more greatly developed structure which causes a decrease largely soil bulk density value. Total porosity is an index of the relative volume of pores in the soil, accordingly, its values for the representative soil sites are widely varied from 35.5 to 55.7 %, where the later value represents the relatively fine textured soil.

Soil hydraulic conductivity, Table (3), which measures the rate of downward movement of water by gravity, revealed that it values ranged 1.8-8.5 cm/h. The lowest value is found in the relatively fine textured soil (clay loam of soil profile No. 4), while the highest one represents the relatively coarse textured soil (sandy of soil profile No. 6). The later case may be due to the occurrence of highest percentage of quickly drainable pores between the dominant coarse sand particles which entails increasing hydraulic conductivity. On the contrary, the

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increase in soil clay contents leads to increase in the percentage of fine capillary pores, and consequently decrease the hydraulic conductivity.

From the data presented in Table (3), it can be noticed that soil available moisture content, which dictates the percentages of retained moisture on volume bases, tended to increase by increasing the finer fractions which if present they are mostly of inactive finely distigrated coarse texture class. The obtained data indicated that soil available moisture values range 5.0-18.9 %, where the lowest value (soil profile No. 6) is rendered to the low energy of water retention on soil particles due to the low specific surface of the coarse textured sediments. The relatively high content of soil available moisture, as shown in soil profile No. 4, is more attributed to the presence of certain clay minerals that have a quite high specific surface area to retain moisture.

Data presented in Table (4) revealed that Rubble terraces soils are almost neutral to moderately alkaline, where soil pH value ranged from 7.6 to 8.1. The ECe values indicated that the soils are non-saline to slightly saline as defined by ECe values which ranged from 0.55 to 6.15 dSm⁻¹. Soluble cations are dominated by Ca⁺⁺ and/or Na⁺ followed by Mg⁺⁺ and K⁺ vs soluble anions dominated by SO₄²⁻ and/or Cl⁻, while HCO₃⁻ represents the least abundant soluble anions.

c. Soils of Alluvial fan:

The soils of the Alluvial fan unit are generally, almost flat to gently undulating. They occupy a relatively large area covered with some rock fragments of different sizes. The soils are mainly affected by both past and current erosional processes with different degrees. These soils are represented by soil profile Nos. 7, 8 and 9, which are characterized by soil texture lies in the classes of sandy loam-silty clay loam, a wide range of CaCO₃ content (2.1-39.5 %). Also, a pronounced of 12.5-20.9 % with an irregular distribution pattern with depth was occurred. Also, an extremely low content of organic matter (0.30-0.90 %) was detected owing to the prevailing aridity in the region and its scattered natural vegetation. Accordingly, the CEC is rather relatively low due to the nature of relatively coarse texture grade, where its values fluctuate between 7.1 and 32.5 c molc kg⁻¹ soil as well as ESP value ranged 2.9-14.5 % indicating non-sodic soils, as shown in Table (2).

Data in Table (3) indicated that soil bulk density, total porosity, hydraulic conductivity and available moisture range values that depend on both soil texture and structure are varied widely between 1.05-1.40 g cm⁻³, 45.8-58.5 %, 0.94-5.60 cm h⁻¹ and 8.9-21.0 %, respectively. In addition, the chemical composition of the soil paste and its extract, Table (4), showed that soil reaction (pH) tends towards mildly alkaline (7.6-8.3) and ECe values of 1.6-19.5 dSm⁻¹, *i.e.*, non-saline to strongly saline soils. The cationic composition are dominated by Na⁺ followed by Ca⁺⁺ and Mg⁺⁺, while K⁼ ion represents the least abundant vs an anionic pattern dominated by Cl⁻ followed by SO₄²⁻ and HCO₃⁻.

d. Soils of River terraces:

This landform unit occupies remnants of the old Nile deposits (fluvial soils during a Sabilian period), and its soils are represented by soil profile No. 10, which its surface is characterized by almost flat. Also, this unit is extending along the eastern part of the cultivated area of the Nile Valley. Analytical data that are

given in Table (2) showed that the representative soil site comprises by an interference zone of fluvial-colluvial sediments, with narrow different soil texture grades, *i.e.*, loamy-clay loam. In general, the values of CaCO₃, organic matter, CEC and ESP, Table (2), widely varied from 13.9-32.2, 0.34-0.70 %, 12.6-15.5 cmolc kg⁻¹ soil and 3.9-5.3 %, respectively. Such data are reflecting the medium soil textural grade, calcareous in nature, either hyper arid climatic conditions of the area or the absence of natural vegetation cover and cation exchange capacity more related to the soil textural class, with a non-sodic condition.

Values of bulk density, total porosity, hydraulic conductivity and available moisture ranged between 1.15-1.31 g cm⁻³, 49.3-61.1 %, 1.35-2.60 cm h⁻¹ and 17.0-21.8 %, respectively. These favourable soil conditions are expected, since the relatively fine textured soil grade has more greatly developed structure, which causes a decrease largely soil bulk density value vs a relatively higher total porosity, however, it is an index of the relative volume of pores in the soil. Soil hydraulic conductivity value was relatively low, mainly due to the relatively fine textured soil (clay loam), and in turn a pronounced increase in the percentage of fine capillary pores, and consequently decrease the hydraulic conductivity. The reverse was true for soil available moisture content, which dictates the percentages of retained moisture on volume bases, tended to increase by increasing the finer fractions.

Data presented in Table (4) revealed that River Nile terraces soils tended towards alkaline side (soil pH≈8.1-8.4), non-saline condition, (ECe≈1.83-3.73 dSm⁻¹) and soluble cations are arranged in an ascending order of Na⁺ > Ca²⁺ > Mg²⁺ > K⁺ vs anions dominated by Cl⁻ and/or SO₄²⁻, while HCO₃⁻ represents the least abundant soluble anions.

In conclusion, it is quite clear that the retained soil moisture for coarse textured soils is more related with coatings of either colloidal secondary carbonates or free iron oxides which retain more water relative to uncoated quartz grains. In contrast, soils of Alluvial fan, Rubble and River terraces containing appreciable amounts of fine fractions retain more moisture if compared with those non-calcareous having correspondent textures. This can be explained on the premise that CaCO₃ content which is high in the fine fraction that is responsible for such diminution of water retention.

II. Origin of soil parent materials:

Certain statistical size parameters are often taken as indices for either origin of soil materials or their deposition mode. The statistical size parameters, *i.e.*, median diameter (Md), sorting (So) and Skeweness (SK) are calculated as described by **Pettijohn (1957)** and given in Table (5). Accordingly, the relationships between the statistical size parameters and either soil origin or its deposition mode among the studied soil sites profiles could be interpreted as follows. Soils that are represented by soil profile Nos. 1, 2 (Wadi plain unit) and 6 (Rubble terraces unit) are poorly sorted sediments in all the profiles layers, except of some profile layers that are moderately sorted sediments. That means these soils are mostly transported and deposited under water action, *i.e.*, aqueous media for the poorly sorted sediments as well as dual actions of water-wind (aqueous-aeolian deposits) for the moderately sorted sediments.

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Table (5): Statistical size parameters of the studied soil profiles.

Land-form	Profile No	Depth (em)	Q ₁	M _j	Q ₃	So	So index	Sk	Log Sk index	
									Value	Skewed index
Wadi plain	1	0-30	32	100	400	9.4	Poorly sorted	1.13	+0.053	Fine
		30-80	35	160	600	17.1	Poorly sorted	0.9206	-0.043	Coarse
		80-120	260	520	1000	3.8	Moderately sorted	0.981	-0.009	Coarse
	2	0-35	240	450	990	4.1	Moderately sorted	1.0832	+0.035	Fine
		35-60	52	140	500	9.6	Poorly sorted	1.1518	+0.061	Fine
		60-130	50	120	400	8.0	Poorly sorted	1.1785	+0.071	Fine
Wadi bottom	3	0-25	38	100	390	10.3	Poorly sorted	1.2174	+0.085	Fine
		25-70	90	350	800	8.9	Poorly sorted	0.7667	+0.115	Coarse
		70-140	60	300	790	13.2	Poorly sorted	0.7257	-0.139	Coarse
Rubble terraces	4	0-25	3.5	16	120	34.3	Poorly sorted	1.2809	+0.108	Fine
		25-65	-	10	80	-	-	-	-	-
		65-130	-	8	60	-	-	-	-	-
	5	0-35	3.5	16	120	34.3	Poorly sorted	1.3636	-0.134	Fine
		35-75	-	9	50	-	-	-	-	-
		75-140	60	270	700	11.7	Poorly sorted	0.7590	-0.120	Coarse
	6	0-40	40	200	640	16.0	Poorly sorted	0.80	-0.097	Coarse
		40-80	230	430	950	4.1	Moderately sorted	1.0871	+0.036	Fine
		80-150	230	430	1000	4.3	Moderately sorted	1.1153	+0.047	Fine
Alluvial fan	7	0-25	2.5	11	80	32.0	Poorly sorted	1.2856		Fine
		25-65	2.3	8	36	15.7	Poorly sorted	1.1374		Fine
		65-125	20	50	120	6.0	Poorly sorted	0.9798		Coarse
	8	0-35	-	9	62	-	-	-	-	-
		35-80	-	4.5	16	-	-	-	-	-
		80-150	-	3.5	11	-	-	-	-	-
	9	0-20	2.1	7	50	23.8	Poorly sorted	1.4639		Fine
		20-60	-	7	25	-	-			-
		60-120	2.7	14	130	48.1	Poorly sorted	1.3382		Fine
River terraces-	10	0-40	-	5	16	-	-	-	-	-
		40-80	2.4	10	61	25.4	Poorly sorted	1.2099		Fine
		80-150	2.1	10	7.1	33.8	Poorly sorted	0.4583		Coarse

Meanwhile, soils of profile Nos. 3 (Wadi bottom unit), 4 (Rubble terraces unit), 7, 8, 9 (alluvial fan unit) and 10 (River terraces unit) were fully transported and deposited by water action (aqueous media), due to these soils are characterized by poorly sorted sediments and fine to coarse skewed.

From the above mentioned results, it is clear that water action is considered the predominating agent for transportation and deposition for the majority of soil sediments (aqueous media) of Wadi El-Asyuti, due to the poorly sorted conditions and partly dual actions of water-wind (aqueous-aeolian deposits) for the moderately sorted ones in some profile layers at few soil sites under study.

III. Mineralogy of the sand fraction:

The mineralogical composition of the sand fraction sized 0.063-0.125 mm plays an important role in order to evaluate the soil genesis and uniformity for Wadi El-Asyuti area, however, heavy mineral contents and their assemblage are conducted, as shown in Table (6). The frequency distribution of heavy minerals indicates that opaque minerals besides pyroxenes and amphiboles are the most abundant heavy minerals.

Table (6): Frequency distribution of heavy minerals in the sand fraction sized 0.125-0.063 mm and uniformity ratios of the representative soil profiles.

Profile No.	Depth (cm)	Opagues %	Non-opagues %												Uniformity ratios		
			Pyroxenes	Amphiboles	Parametamorphic				Ubibuitous				Epidote	Monazite	Zr/R	Zr/T	Zr/R+T
					Garnet	Staurolite	Kyanite	Sillimanite	Zircon	Rutile	Tourmaline	Biotite					
1	0-30	46.9	42.5	14.3	6.9	2.7	2.8	0.5	10.4	4.2	7.1	0.5	2.2	5.1	2.4	1.5	0.9
	30-80	47.7	45.9	17.6	3.3	4.5	2.5	0.1	6.5	5.5	5.9	2.6	1.8	3.7	1.2	1.1	0.6
	80-120	55.5	51.1	20.9	2.1	2.2	1.7	0.1	6.9	2.2	4.2	4.1	1.1	2.8	3.1	1.6	1.1
3	0-25	36.3	50.2	31.2	2.9	1.4	2.3	--	4.1	1.5	1.1	1.4	1.7	2.5	2.7	3.7	1.6
	25-70	45.3	40.9	33.1	4.5	3.3	1.9	--	6.9	3.8	1.5	0.9	1.9	1.9	1.8	4.6	1.3
	70140	46.5	40.6	31.9	5.1	2.3	0.8	--	7.7	2.5	2.1	1.3	3.5	2.5	3.1	3.7	1.7
4	0-25	28.1	46.8	35.5	2.3	1.9	3.2	--	5.6	2.1	0.5	0.6	1.4	0.5	2.7	11.2	2.2
	25-65	30.4	48.7	26.7	2.1	0.6	1.5	--	6.9	4.8	1.5	2.9	2.9	1.7	1.4	4.6	1.1
	65-130	32.5	42.9	27.7	3.3	2.3	0.8	--	9.8	6.6	1.8	1.9	1.6	2.1	1.5	5.4	1.2
6	0-40	40.2	44.8	25.2	4.1	2.9	2.5	--	10.7	2.7	1.6	0.5	2.9	1.9	3.9	6.7	2.5
	40-80	25.1	49.2	32.6	3.5	1.1	1.9	--	4.8	0.6	1.6	1.3	1.3	1.9	8.0	3.0	2.2
	80-150	30.2	46.5	20.9	5.9	3.1	3.1	--	8.2	3.3	2.3	2.3	2.9	1.8	2.5	3.7	1.5
8	0-35	58.2	32.9	18.1	3.9	5.7	2.5	--	12.1	8.5	5.7	3.8	2.6	4.6	1.4	2.1	0.9
	35-80	47.9	42.7	24.4	4.9	2.8	2.9	0.5	9.1	2.6	3.9	1.9	1.9	4.7	3.5	2.3	1.4
	80-150	48.7	41.4	24.2	3.5	3.7	3.2	1.1	10.9	8.1	6.2	0.9	1.9	5.3	1.3	1.8	0.8
10	0-40	50.8	42.1	10.7	5.9	4.7	2.5	--	13.4	9.4	2.9	2.5	3.4	2.6	1.4	4.6	1.1
	40-80	54.6	45.2	19.1	4.7	3.2	4.9	1.3	8.7	2.4	3.5	1.3	1.3	5.4	3.6	2.5	1.5
	80-150	59.6	40.6	16.5	3.4	4.4	2.3	--	10.1	7.1	6.1	2.9	2.9	3.5	1.4	1.7	0.8

Also, zircon, garnet and rutile minerals are present in relatively moderate amounts, while the remaining minerals are detected in less pronounced amounts. The wide variations of the heavy minerals are mainly attributed to the different geological origins of soil parent materials as well as to the strength and intensity of weathering processes, erosion, transportation and deposition which have a considerable influence on the relative proportions of heavy minerals in the soils under study.

From the heavy minerals association and characteristics, it is evident that the studied soils are relatively recent formed due to they exhibit a weakly developed in nature. The later phenomenon is emphasized by the abundance of pyroxenes and amphiboles which are considered to be less stable minerals.

Using the mineralogical composition as a guide for evaluating the homogeneity or heterogeneity phases of soil parent materials could be established on the assumption that certain heavy minerals are more resistant to weathering, thus their diminish during the course of soil development. In this connection, the ratios of ultra stable resistant minerals ($Zr \approx$ Zircon, $T \approx$ Tourmaline and $R \approx$ Rutile) to weathering, *i.e.*, Zr/T , Zn/R and $Zr/T+R$ are taken as criteria for evaluating soil profile uniformity and weathering sequence for the soil sediments, Table (6). The obtained data of uniformity ratios showed that most of the studied

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soils of Wadi El-Asyuti have a state of stratification and heterogeneity of their parent materials. This may be the results of the contamination of more than one sediment or suggests the multi-depositional regime of these soils.

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دراسات بيولوجية على أراضي وادي الأسيوطي - الصحراء الشرقية - مصر

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وادي الأسيوطي يشتمل على مساحات واعدة لمشروعات التنمية الزراعية المستقبلية، حيث أن أراضيه تحتل منطقة من صحراء مصر الشرقية. وتبعاً لتكنيك تفسير الصور الجوية، فقد تم تحديد خمسة من الوحدات الجيومورفولوجية الرئيسية والتي تمثلت في سهل وقاع الوادي، المصاطب الصخرية، الترسبات المروحية، المصاطب النهرية، والتكوينات الصخرية. وقد تم دراسة الأراضي المتكونة على هذه الوحدات من خلال عشرة قطاعات أرضية ممثلة.

وتشير النتائج المتحصل عليها إلى أن الأراضي تحت الدراسة تتميز بدرجات متباينة من قوام التربة يتراوح ما بين الرمل - الطمي الطيني السلتى، ومحتوى من كربونات الكالسيوم يتراوح ما بين ١.٢ إلى ٣٧.٧٪، ومن المادة العضوية ما بين ٠.٠٥ إلى ٠.٦١٪. وأيضاً، ملوحة التربة للأراضي التي تم فحصها تتراوح ما بين غير ملحية إلى شديدة الملوحة، وقيم Soil pH تميل إلى الجانب القاعدي، وقد تميزت بنمط تنازلي لتوزيع الكاتيونات الذائبة كما هو في الترتيب التالي $Ca^{++} > Na^+ > Mg^{++} > K^+$ مقابل نمط توزيع للأنيونات الذائبة تميز بتبادل سيادة أنيون الكبريتات والكلوريدات كما هو في الترتيب التنازلي: $SO_4^{--} \geq Cl^- > HCO_3^-$.

وقد وجد أن القيم الأعلى للكثافة الظاهرية تميز الأراضي ذات القوام الخشن (سهل الوادي والمصاطب الصخرية)، بينما الأراضي ذات القوام الأنعم (الترسبات المروحية والمصاطب النهرية) تتميز بالقيم الأقل. وعلى العكس فإن قيم المسامية الكلية للتربة أظهرت إتجاهاً معاكساً، حيث ترتبط القيم الأعلى بالأراضي ناعمة القوام، ثم تميل إلى التناقص بزيادة خشونة قوام التربة. وأيضاً، فإن القيم الأعلى للتوصيل الهيدروليكي أظهرت علاقة طردية مع خشونة قوام التربة، ثم تتجه إلى التناقص مع نعومة قوام التربة كما هو حادث في أراضي الترسبات المروحية والمصاطب النهرية. بالإضافة إلى أن المدى الرطوبي الميسر في الأراضي المدروسة يرتبط تماماً مع الرتبة القوامية للتربة والتي تظهر تبايناً واضحاً خلال طبقات القطاع الأرضي. كما وجد أن قيم السعة التبادلية الكاتيونية للتربة متمشية لحد كبير مع قوام التربة، بجانب أن نسبة الصوديوم المتبادل تشير إلى أن الأراضي تحت الدراسة غير قلوية.

وتوضح نتائج معايير التحليل الإحصائي لحجوم حبيبات التربة أن رسوبيات أراضي وادي الأسيوطي المدروسة قد تم نقلها وترسيبها من خلال بيئة مائية، وفي بعض الأحيان بيئة مشتركة (مائية-هوائية) خلال بعض طبقات القطاع الأرضي. ومن الدراسة المنولوجية للرمل، وجد أن المعادن الثقيلة يسودها المعادن المعتمة Opaques، البيروكسينات، الأمفيبولات والتي تتواجد بكميات محسوسة. أما المعادن الأكثر مقاومة وثباتاً كالزركون، الجارنت، الروتيل فقد وجدت بكميات متوسطة، كما تتواجد باقي المعادن الثقيلة التي تم دراستها بكميات قليلة جداً. وقد أظهرت نتائج نسب المعادن الثقيلة الأكثر ثباتاً ومقاومة للتجوية، وكذا معاملات التجوية إلى أن أراضي وادي الأسيوطي حديثة التكوين، فضلاً عن أنها قد تكونت من مواد أصل متعددة، أو ترسبت مكوناتها تحت ظروف بيئة ترسيب متباينة، ويفسر ذلك عدم تجانس رسوبيات التربة خلال طبقات القطاع الأرضي، وذلك مرتبط لحد كبير بعمليات التجوية الموروثة عن التكوين الجيولوجي أو الناتجة من التجوية الكيميائية وكلاهما مرتبط لحد كبير بأصل رسوبيات التربة المدروسة.