J. Agric. Sci. Mansoura Univ., 32 (7): 5961 - 5976, 2007

STUDY ON PHYSIOGRAPHIC GENESIS AND SOIL TAXONOMIC UNITS OF SOUTH WADI EL RAYAN AREA, WESTERN DESERT, USING GIS STANDARDS

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ABSTRACT

The selected study area is located south west of Wadi El Rayan to be traced as promising area for agriculture development. Triangulated Irregular Network (TIN) was designed as a terrain model for generating slope and relief map. This TIN (vector display) was intersected with the remotely sensed data of Enhanced Thematic Mapper (ETM+) as a raster display and the produced physiographic display (vector layer) to specify an internal promising area for the purpose of agriculture development. GIS teqnique was integrated by coordinating land attributes, using the Glopal Positioning System (GPS). Physiographic genesis and the associated soil taxonomic units are characterized as follows: 1)Old alluvial terraces of paleodrainage alluvium with undulating developed sediments were deposited by the paleodrainage system of former fluvial periods. They are relatively elevated, having stony and gravelly surfaces and scattered petrified forests. In these terraces, gypsic, petrogypgsic and calcic horizons developed in skeletal solum forming soils of Calcic Petrogypsids, loamy skeletal, gypsic, hyperthermic and Typic Calcigypsids, loamy skeletal, gypsic, hyperthermic. 2) Old alluvial terraces of paleodrainage alluvium with gently undulating relatively developed sediments were derived from the elevated old terraces by water during relatively recent eras of fluvial periods. They were erroded from the higher terraces, having less developed parent material and gravely surfaces compared with that of the undulating elevated ones. Gypgsic and calcic horizons developed in fine soil matrix forming Typic Calcigypsids, fine loamy, gypsic, hyperthermic and Typic Calcigypsids, coarse loamy, mixed, hyperthermic. 3) Young terraces of River Nile gently undulating alluvium with consequent streams. These streams follow the initial slopes, resuming down-cutting, and resulting in terraces of gravely gently undulating surfaces. As the soils include calcic horizone, they are Typic Haplocalcids, sandy, mixed, hyperthermic. 4) Alluvial plains are confined as almost flat surfaces between the terraces and the higher rock lands, which supported the plains with sediments. These sediments also were most probably transported by drainage system, that act on limestone mountaineous region in the eastern desert. In these plains gypsic horizon developed in coarse soil matrix forming Leptic Haplogypsids, sandy, mixed, hyperthermic. 5) Waterlogged playas are depressed areas of flat surfaces. The sediments formed as a result of former water stagnation on the surface, having water table as sourced from the drained water in the Wadi El Rayan water body. As they are endclosed drainage basin, salic and gypsic horizons developed in a medium soil matrix, forming Gypsic Aquisalids, coarse loamy, mixed, hyperthermic. 6) Aeolian plains were deposited by wind action, having undulating to gently undulating surfaces. They are partly occupied by aeolian dunes oriented to south-east direction. These plains include loose soil matrix, fitting the taxonomic unit of Typic Torripsamments, mixed (calcareous), hyperthermic. 7) Rock structures are isolated scattered structures standing in the forms of rock outcrops, platuex, mesas and ridges. They were left out as a result of their resistance to the erosion process.

Keywords : Physiographic genesis, soil taxonomic units, GIS and Western Desert

INTRODUCTION

Tracing more promising areas to be under demand for the agriculture development must become the supreme interest of pedologists. This task will be realized since they believe to have careful understanding of how to develop the work approach and the used tools to affect the main issue of equity and efficiency in the best of land use for increasing agricultural areas and exaggerating their productivity. The study findings are based on systematic and uniform cartographic and mapping specifications to scan the landscapes of the Western Desert for their potentialities renascence. The approach is to use the modern techniques for the input and output data. In this study, the Geographic Information Systems (GIS) help for integrating the displays of the Triangulated Irregular Network (TIN), the remotely sensed data, interpreted physiography and coordinated identified soil attributes. TIN is a generated digital data as a terrain model designed by Peuker and Douglas. (1975). Its structure can be used to generate slope maps, maps showing shaded relief, contour maps, block diagrams, network and drainage basin delineation. Information about surface cover can be incorporated by overlaying and intersecting the TIN structure with the topological polygon structure used for many thematic maps.

The objectives of this study is to derive soil mapping units by intersecting the relevant geographic data and TIN structure and remotely sensed data. On this base, the data are produced as digital and hard print of physiography and soil maps, that can be used for developing the environmental resources and improving the local reference level of the Landsat data interpretation in the Western Desert.

MATERIALS AND METHODS

GIS Integration based on the displays of : 1) topographic data (raster maps of 1) 100 000 scale) for the manipulating contour lines, and spot hights to produce the triangulated irregular network (TIN). 2) ETM+ Landsat data 3) Delineated physiographic units by visual interrpretation, using the physiographic approch. 4) Geographic coordinated land attributes , using GPS. These layers were manipulated, using the cartographic softwae of Erdas Imagine (".img" extention for raster displays) and both of Arcview and ArcGIS (".shp" extention for vector displays).

Field truth for mapping and soil identification was done at representative sites coordinated by GPS tool. Soil taxa were termed and categorized according to the Soil Survey Manual of USDA (2003) and the key of Soil Taxonomy (2003), respectively.

Lab. analyses were carried out for particle size distribution using the pipette method (Piper, 1950), calcium carbonate using calcimeter (Black et al., 1965), gypsum content by precipitation with acetone and soil pH in the soil paste using pH meter (USDA, 1954). The total salinity in the soil paste extract was expressed as electrical conductivity (EC). Soluble ions were determined in the soil saturation extract (Na^+ and K^+ by flame photometer according to Jackson (1958) Ca^{++} ; Mg^{++} by titration with versinate; Cl^{-} by pricipitation with silver nitrate; $CO_3^{=}$ and HCO_3^{-} by titration with hydrochloric acid).

Etymology contemplation of nomenclature and terms was traced with reference to the Compton's Illustrated Science Dictionary (Richardson et al., 1968); the Glossary of Geology (Bates and Jackson, 1980); and the Latin English Dictionary (Smith and Locckwood, l996).

RESULTS AND DISCUSSIONS

I-Tracing the promissing area by GIS displays:

The Triangulated Irregular Network (TIN) is a digital data structure used in the Geographic Information System (GIS). It was derived from the elevation data input made up of irregularly distributed nodes and lines with three dimensional coordinates (x, y, and z). It is used as a vector that represent the physical land surface and to allow dense information in complex areas and sparse information in simpler or more homogeneous ones. In this study TIN dataset includes topological relationships between points and their neighboring triangles. It implement terrain analysis as an efficient way that simulates the configuration of the earth's surface with a group of digital data representing locations on the land surface. By the aid of TIN model, the slope shaded and the profile graph (showing the different altitudes values along a specified transect) were produced. (Fig 1).The displayed layers of the landsat ETM 7 (raster) and phsiographic features (vector); that intersect the TIN model gave a good view to extract the study area to be more promissing for the agriculture land use. This promising study area was reproduced including physiographic units as displayed on top of TIN. Accordingly the mapping units can further be characterized with respect to physiography and altitude above sea level. Also, there is a possibility of displaying the map on top of rectified ETM image. These alternatives of layer displays within the GIS will help for detailed mapping units and soil boundaries drawing on image reflectance variations and other relevant bases.

2-Physiographic units genesis:

Physiography; etymology: Greek "*Physis*"= nature and "*graphein*"= to draw. It is the description of physical earth surface features, including the processes responsible for parent material development. **Goosen (1967)** stated that, physiographic approach can provide a good basis for explaining geomorphology through aerospace image interpretation. The physiographic units as reflected in the spectral signatures of the landsat data are shown in (Fig.2). The physiographic genesis was performed to find a colective and quick land attribute illustration for a vast area, using a harmony of knoweledge (parent rock, parent material and the paleo and recent drainage patterns as mediators between the high and lowlands). This approach succsesfully help as detection, that was in turn confirmed by the representative ground truth observation. The physiographic features and genesis. are cheracterized as follows

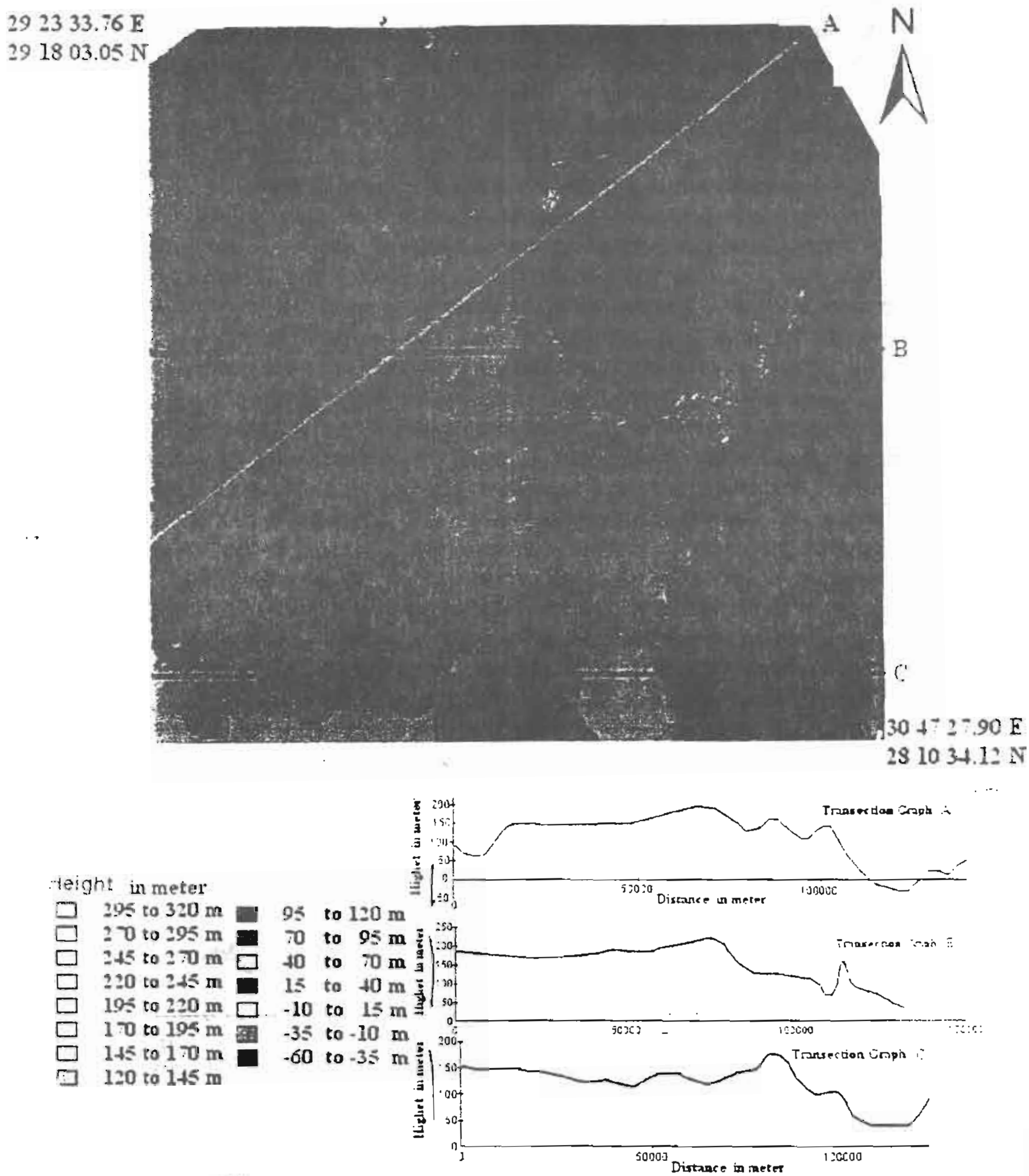
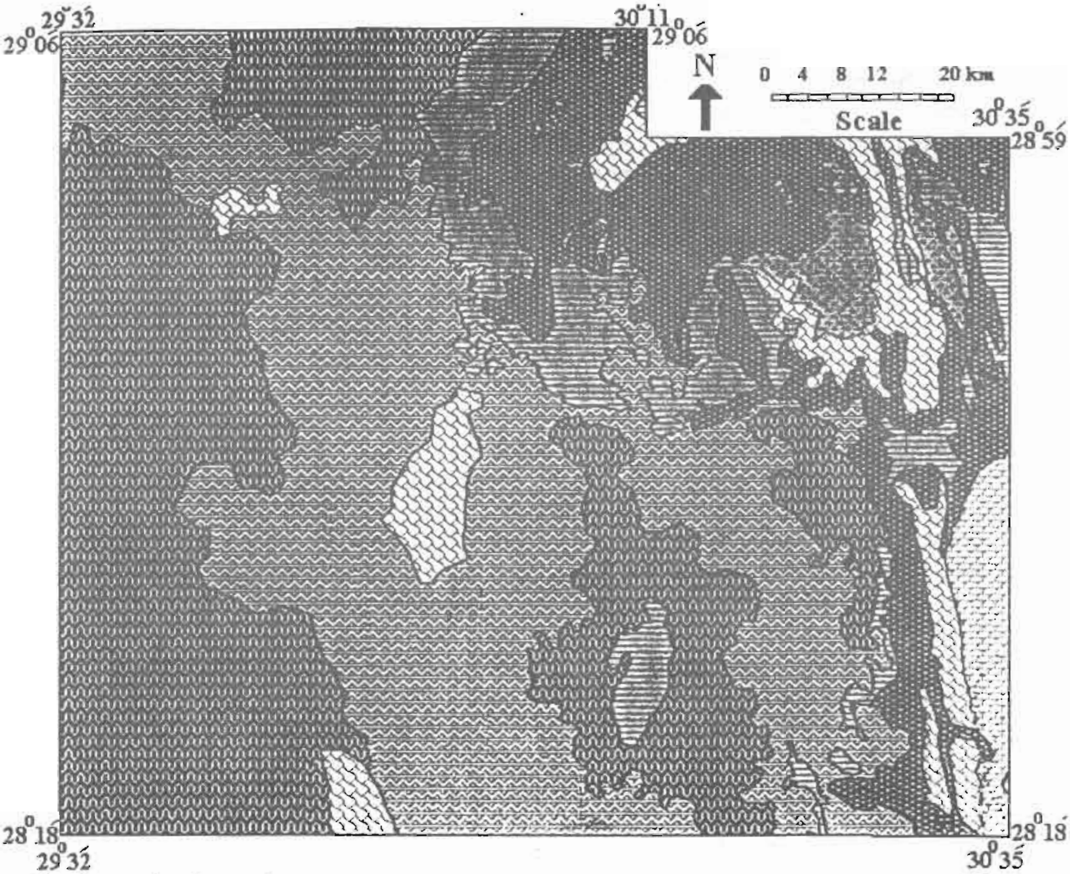


Figure 1 The Triangulated Irregular Network (TIN) as a digital elevation model covering the study area and its outskirts



Physiographic Legend

AT1 Old terraces of paleodrainage alluvium

AT1.1- Old terraces of undulating developed sediments

AT1.2- Old terraces of gently undulating relatively developed sediments

AT2- Young terraces of River Nile alluvium (gently undulating)

AP- Alluvial plains (almost flat)

WP- Waterlogged playa (almost flat)

E- Aeolian plain (undulating to gently undulating)

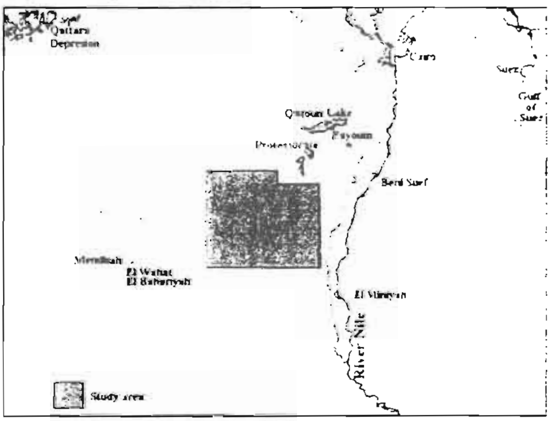
R- Rock structures

Conventional signs

Water body

Settlement

Asphalted road



Location map of the study

Figure 2 Physiographic map of the studied area

AT- Alluvial terraces:

The alluvial terraces are mostly characterizing the study area, having different surface features, elevations and ages. Afify (1999) used the physiographic terms for specifying these terraces as "alluvial terraces", being their parent materials were transported by water. He also termed them as old or young since they reflect the landscape evolution and the degree of parent material development. According to this concept these physiographic units were delineated as follows:

AT1- Old terraces of paleodrainage alluvium:

Paleo; etymology: Greek "palaios"=old. These terraces were deposited by the former flooding action via paleodrainage of the fluvial periods. Issawi and McCauley (1992) attributed the origin of these sediments to the Red Sea Mountains since they begin to rise in the early Oligocene, tipping the plate from the east. Rivers flowing to the northwest drain the north of the Red Sea Mountains, including Issawi's Bown Kiaus River, which deposited a delta across the Fayoum as deep fossiliferous Oligocene sands and gravels, which covered the Fayoum region. By cutting deep canyons and vigorously backwards from the north, the Nile precursor called the "Eonile" captures the headwaters of the Quena river. The streams in advanced step drain the Fayoum cut down through the Oligocene river sediments. In the study area, two types of these old terraces were identified according to the landscape genesis and parent material development as follows:

AT1.1- Old terraces of undulating developed sediments:

The sediments of these terraces are mostly located within the Oligocene era.(The Egyptian General Petroleum corporation (1987). Their parent materials were derived from sedimentary rocks (limestone), including fragments transported from those rocks by the paleodrainage network, which formerly was the mediator between the study region and those rocks in the highlands. These terraces represent the sites which most probably were left out after regional erosion processes as a result of other later fluvial era. The resultant was dissected surfaces by channels and gullies that follow the general slopes northwards and north-westwards, on complex slopes of undulating surfaces. These terraces are standing now as old terraces relatively elevated with more developed parent material having more fragments as a result of the outwash process compared with their outskirts. They are locally covered by petrified forests (rocky trees features), stones, gravel, and have local rock outcrops. The polygons of these terraces are mostly distributed in western part of the study area and locally in other different sites. They are represented by profiles 1 and 2

AT1.2- Old terraces of gently undulating relatively developed sediments

The sediments of these terraces were derived from the old terraces of paleo drainage alluvium and transported by water during rather fluvial periods in relatively recent eras. According to the geological map of Egypt of the Egyptian General Petroleum corporation (1987), these sediments are mostly located within the Oligocene to Pleistocene eras. The surface level of these terraces is a resultant of the erosion processes, which deepened the former higher surfaces, that preceded the present level of the terraces.This erosin action also sorted more finer parent material during the dissection in the higher levels and shifting the loads to the lower ones. They have relatively less developed parent material, compared with the undulating ones, having rilled and gravelly surfaces of gently undulating pattern (less than 2% slope). They are distributed in the middle part of the study area and are mostly adjacent to the old terraces.They are represented by profiles 3 and 4

AT2- Young terraces of River Nile alluvium:

According to Said (2001), these terraces are remnants of formerly deposited floodplain in pleistocene era during a process preceded the recent River Nile deposits of Holocene Era. Afify et al (2005) stated that, on this terraces, consequent streams, that follows the initial slope of the land that were rejuvenated, resuming down-cutting, thereby forming terraces. In the study area, the erosion action on these sediments resulted in gullied gravelly surfaces of concave convex complex slopes (gently undulating topography). This landscape mode of recent parent material caused locally a somewhat parent material development. These terraces are delineated in the eastern part of the study area adjacent the alluvial plain represented by profile No.5

AP- Alluvial plains :

These alluvial plains are mostly deposited in the western part of the study area. They are relatively low, having parent materials of less fragments compared with those of the alluvial terraces. The sediments of these plains are almost flat. They were deposited by the old streams of the pluvial periods, that derived the parent materials by reworking the formerly deposited sediments on the adjacent higher locations. This alluvial plains are mostly confined in a depressed area between the terraces and the higher rock lands and locally received the sediments from them. It is most probably that these plains were supported with sediments by rather old drainage system, that were regionally flowing from the limestone mountaineous region in the eastern desert This physiographic unit is represented by profiles 6 and 7

WP- Waterlogged playa:

The term playa means "strand" (Spanish). According to Di Gregorio and Janson (2000) the main characteristic of the waterlogged area is the high water table. In this study, the playa sediments have saline water table as a result of the effect of the drainage water seepage from the artificial water body of Wadi El Rayan lakes. These sediments are mostly located in the shelter of the relatively lower areas compared with the suraunding landscapes, having a halophytic vegetation in salt affected soils of flat surfaces. The parent material of this unit was deposited by water in sites on the end point of the drainage system, which is most probably merging with a fault line, devided the study area east and west facing these playa with ascending slopes (to south, south-east and north-west directions). The sites of these playas are naturally adapted to be a depressed areas, that mostly received the fine sediments as a result of former water stagnation on the surface. The presence of water table that could seep under soil surface in a relatively depressed area under the aridic condition resulting in salt accumulation and moistening of the soil solum. These units have flat surface with a slope less than 1%, looking as endclosed drainage basin and is locally covered with hummocks. They were recognized in the study area as few polygons represented by profile 8.

E- Aeolian plain :

Aeolian; etymology: Latin "aeolus" = god of the wind. These aeolian plains were deposited by wind action in the open landscapes, having undulating to gently undulating surfaces, are partly occupied by longitutional aeolian dunes, which are mostly oriented to south-east direction. El-Baz (1998) suggested that groundwater resources may be inferred from large accumulations of sand in the eastern Sahara sand-buried courses of paleo-rivers that lead to depressions. The hypothesis relates the origin of the sand to fluvial erosion of the Nubian Sandstone, which is exposed in the southern part of the desert. It involves the down-gradient transport of the sand grains toward the north. This occured in the courses of ancient rivers that led to inland depressions, where the sand was deposited in horizontal laminae. As dry climates set in, the wind mobilized the sand and shaped it into various dune forms. Thus, the hypothesis implies that sand was born by water and sculptured by the wind. These aeolian plains are located in the eastern, middle and north of the study area. They are represented by profiles 9, and 10

R- Rock structures :

These rock structures are remnants of the former bigger rock structure, which were mostly dissected and eroded. The present small isolated rock structures still standing in the forms of rock outcrops, platuex [elevated tracts of relatively level land (French)], mesas [high table lands (Spanish)]and ridges. They are standing up, scattering within the study area as a result of their resistance to the former action the erosion process.

3- Soil Taxonomy:

Taxa are plural of taxon (characteristic) [etymology: Latin "taxo" = to rate]. Since these taxa are well processed and sorted, the Soil Taxonomy is used as standard reference terms to identify soil map units. The climatic data of the study area, that issued by the Meteorological Authority of Egypt (2005) were processed according to (USDA 2003) to be concluded as "hyperthermic temperature regime" and " torric moisture regime".

Soil taxa of the study area (Table 1, 2 and 3) were categorized according to the Taxonomy key-manual (USDA, 2003) resulting in two orders (Aridisols, and Entisols). Processing the meteorological data of the study area led to the soil .tempreture regim of *hyperthermic* [*hyper* = over+ *therme*=heat (Greek)]All the soils are not dominated by certain soil mineral (mixed) Taxonomic classes are shown in figure3 associated directly with the physiographic layer being reflect the natural bodies of them as components of soil taxonomic units. They are described as follows:

a) *__Aridisols:__*

Arid; etymology: Latin "aridus" = dry. These soils were developed under the prevailing climatic conditions, which is specified within soil strata of the study area as an aridic moisture regime and temperature regime. The soils of this order have an ochric epipedon. [ochric; etymology: Greek "okrus" = pale].These soils include one or more of the diagnostic horizons as salic, gypsic and calcic. In the current study, seven families were identified under Aridisols as follows:

Table1: Morphological description of the studied soil profiles.

Physiographic unit	Profile No.	Depth (cm)	Horizon	Color		Modified Texture class	Structure	Consistency	Secondary formation %		Effervescence	Boundary
				dry	moist				$CaCO_3$	$CaSO_4.2H_2O$		
AT1.1 Old alluvial terraces of undulating paleodrainage developed alluvium,	1	0 – 20	ABky	10YR6/6	10YR5/8	VGSL	massive	sh	15	15	moderate	cw
		20 – 75	BKy	7.5YR6/8	7.5YR4/8	VGSL	massive	h	30	20	high	aw-
		75--	BKym	10YR6/6	10YR5/8	EGLS	massive	eh	30	20	high	
	2	0 – 15	ABky	10YR6/6	10YR4/6	LS	massive	so	5	10	moderate	cw
		15 – 50	Bky1	10YR6/8	10YR5/8	VGSL	massive	sh	7	25	high	gw
		50–150	BKy2	7.5YR6/8	7.5YR5/8	VGSL	massive	sh	15	20	high	--
AT1.2 Old alluvial terraces of gently undulating paleodrainage alluvium,	3	0 – 10	ABk	10YR7/4	10YR5/6	SGSL	massive	sh	10	10	high	aw
		10 – 40	Bky	10YR6/6	10YR5/6	SGSCL	massive	sh	25	20	high	aw
		40 – 80	By1	5Y6/6	5Y5/8	GCL	massive	h	<5	20	high	gw
		80–150	By2	5Y6/4	5Y5/6	GCL	massive	h	<5	15	high	--
	4	0 – 20	ABy	10YR7/6	10YR5/6	SGSCL	csb	so	<5	5	high	gw
		20 – 70	BKy1	10YR7/4	10YR4/6	GSL	mwb	so	10	10	weak	cw
		70–150	Bky2	10YR6/6	10YR4/6	SGSL	mwb	so	10	5	moderate	--
AT2 Young terraces of gently undulating River Nile alluvium	5	0 – 20	ABk	10YR5/6	10YR6/8	VGSL	massive	sh	10	<5	weak	gw
		20 – 60	C1	10YR6/6	10YR5/6	S	massive	so	<5	<5	weak	gw
		60–125	C2	10YR8/4	10YR6/4	S	massive	so	<5	<5	weak	cs
		125–180	C2	10YR5/8	10YR4/6	S	massive	h	<5	<5	weak	cs
AP Alluvial plain (almost flat)	6	0 – 20	ABy	10YR7/4	10YR5/6	SGS	massive	so	<5	5	moderate	aw
		20 – 50	By1	10YR8/4	10YR6/4	GS	massive	so	<5	5	moderate	cw
		50–150	By2	10YR7/4	10YR6/6	GLS	massive	so	<5	5	moderate	--
	7	0 – 25	ABy	10YR8/6	10YR6/6	LS	massive	so	<5	20	moderate	cw
		25 – 70	By1	10YR7/6	10YR5/6	S	massive	so	<5	15	moderate	cw
		70–150	By2	10YR7/4	10YR5/6	SL	massive	so	<5	10	moderate	--
WP Water logged Playa (flat)	8	0 – 20	AByz	10yr6/3	10yr3/6	SCL	csb	sk	<5	5	moderate	as
		20 – 50	Byzg	-	10yr5/6	SL	mwb	sk	<5	5	moderate	as
		50 – 65	Cg	-	10yr5/4	S	massive	so	<5	5	moderate	--
		65----	Water table									
E Aeolian plain (undulating to gently undulating)	9	0 – 50	C1	10yr7/4	10yr6/6	S	sg	lo	<5	<5	weak	dw
		50–150	C2	10yr7/4	10yr5/6	S	sg	lo	<5	<5	weak	--
	10	0 – 50	C1	10yr8/6	10yr5/8	S	sg	lo	<5	<5	weak	cw
		50 – 150	C2	10yr8/4	10yr6/4	S	sg	lo	<5	<5	weak	--

EG= extremely gravelly, VG=very gravelly, G=gravelly, SG=slightly gravelly, S=sandy, LS=loamy sand, SL=sandy loam, SCL=sandy clay loam, Cl=clay loam, sg=single grains, csb=coarse sub angular blocky, mwb=moderate weak sub angular blocky, so=soft, h=hard, sh=slightly hard, h=hard, eh= extremely hard sk=slightly sticky, lo=loose.,.aw=abrupt wavy, cw=clear wavy, cs=clear smooth, gw=gradual wavy, as=abrupt smooth , clear, d=diffuse wavy A, B and C = master horizons, g =strong gleying, k=accumulation of carbonates, m=cementation or Indurations, y=accumulation of gypsum, z=accumulation of salts more soluble than gypsum

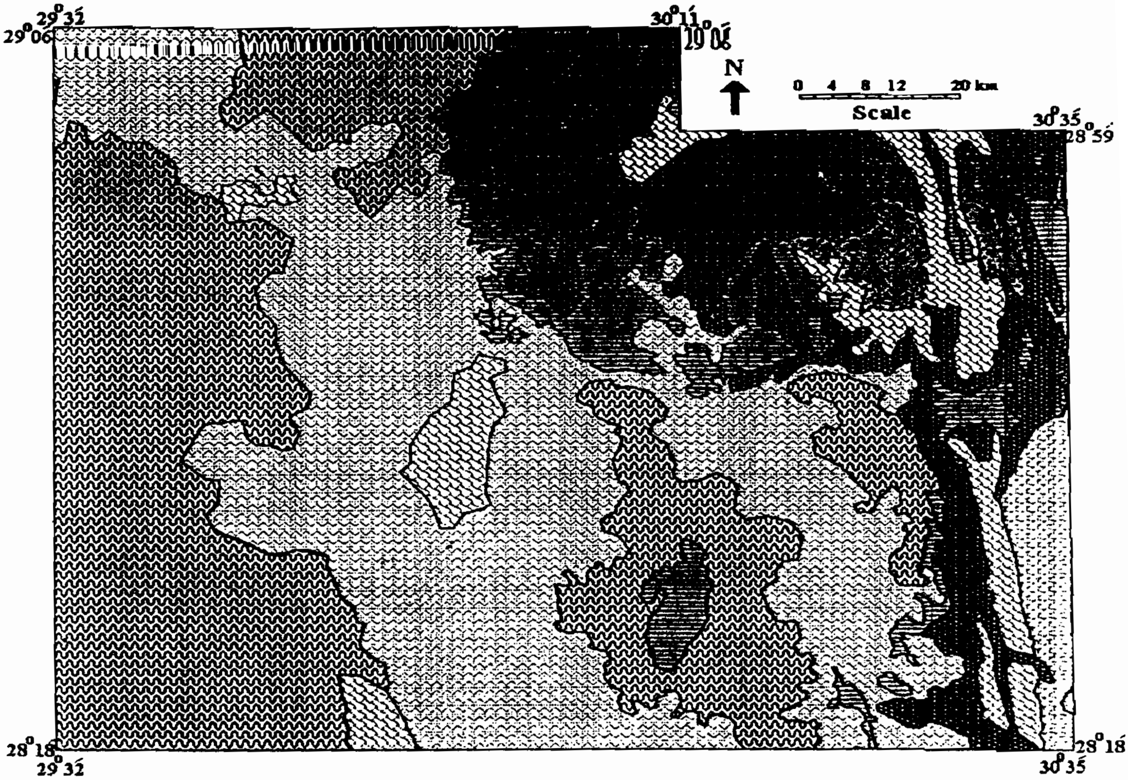
Table 2: Physical analysis of the studied profiles.

Physiographic units	Profile No..	Depth (cm)	Horizon	Gravel %	Coarse Sand %	Fine sand.%	Sil %	Clay %	Modified Texture class	$CaSO_4$ %	$CaCO_3$ %
AT1.1 Old alluvial terraces of undulating paleodrainage developed alluvium	1	0 – 20	ABky	35	22.9	35.8	22.5	18.8	VGSL	33.1	22.4
		20 – 75	BKy	40	35.4	22.3	25.8	16.5	VGSL	28.7	48.0
		75---	BKym	70	35.5	21.7	26.4	16.4	EGSL	40.6	35.5
	2	0 – 15	ABky	5	26.8	58.2	5.2	9.8	LS	15.5	12.4
		15 – 50	Bky1	50	35.4	34.9	12.8	16.9	VGSL	25.3	15.1
		50 – 150	BKy2	70	31.6	33.6	16.5	18.3	VGSL	36.9	16.3
AT1.2 Old alluvial terraces of gently ndulating paleodrainage alluvium	3	0 – 10	ABk	10	22.1	35.6	22.8	19.5	SGSL	17.8	22.5
		10 – 40	Bky	15	20.5	30.2	23.1	26.2	SGSCL	23.5	42.0
		40 – 80	By1	25	13.5	23.1	25.1	38.3	GCL	46.1	5.0
		80 – 150	By2	30	12.8	25.9	28.2	33.1	GCL	71.3	5.0
	4	0 – 20	ABy	10	7.3	38.5	28.1	26.1	SGSCL	6.7	2.1
		20 – 70	BKy1	20	20.9	43.7	18.3	17.1	GSL	14.3	8.6
		70 – 150	Bky2	10	23.5	39.8	16.5	20.2	SGSL	12.5	10.4
AT2 Young terraces of gently undulating River Nile alluvium	5	0 – 20	ABk	50	45.3	27.10	9.3	18.3	VGSL	2.9	16.4
		20 – 60	C1	5	60.6	35.4	0.8	3.2	S	3.8	2.8
		60 – 125	C2	5	65.3	30.9	1.3	2.5	S	2.6	3.0
		125 – 180	C2	5	45.4	49.9	1.8	2.9	S	3.5	2.0
AP Alluvial plain (almost flat)	6	0 – 20	ABy	10	55.1	39.4	1.6	3.9	SGS	8.1	13.2
		20 – 50	By1	30	43.3	51.9	2.3	2.5	GS	9.5	18.0
		50 – 150	By2	25	48.2	37.7	6.1	8.0	GLS	12.4	14.0
	7	0 – 25	ABy	-	59.1	35.7	1.9	3.3	LS	24.6	19.0
		25 – 70	By1	-	59.8	36.2	1.4	2.6	S	21.4	18.0
		70 – 150	By2	-	35.3	38.1	10.1	16.5	SL	23.8	15.0
WP Water logged Playa (flat)	8	0 – 20	ABYz	-	38.2	17.7	15.8	28.3	SCL	9.5	15.0
		20 – 50	Byzg	-	41.4	30.5	12.7	15.4	SL	11.0	16.0
		50 – 65	Cg Water	-	60.8	31.3	4.1	3.8	S	6.7	11.5
		65----			table						
E Aeolian plain (undulating to gently undulating)	9	0 – 50	C1	-	47.6	45.8	3.7	2.9	S	3.4	10.0
		50 – 150	C2	-	41.3	50.8	2.6	5.3	S	5.5	15.0
	10	0 – 50	C1	-	30.3	65.3	1.3	3.1	S	3.5	14.0
		50 – 150	C2	-	40.2	55.4	1.8	2.6	S	3.4	8.0

EG= extremely gravelly, VG=very gravelly, G=gravelly, SG=slightly gravely, S=sandy, S=loamy sand, SL=sandy loam, SCL=sandy clay loam, Cl=clay loam

Table 3: Chemical analysis of the studied profiles.

Physiographic unit	Profile No.	Depth (cm)	Horizon	pH	EC dsm^{-1}	HCO_3^-	Cl^-	$SO_4^=$	Ca^{++}	Mg^{++}	Na^+	K^+
						Meq/L						
AT1.1 Old alluvial terraces of undulating paleodrainage developed alluvium	1	0 – 20	ABky	7.5	36.5	1.3	670.0	69.3	97.4	92.2	538.5	12.5
		20 – 75	Bky	7.9	27.5	1.4	480.	28.6	53.0	47.0	397.5	12.5
		75--	Bkym	7.6	60.8	1.2	830.0	80.5	110.6	90.4	695.9	14.8
	2	0 – 15	ABky	8.1	3.34	3.8	25.3	26.5	15.9	19.6	22.45	2.8
		15 – 50	Bky1	7.9.	16.3	1.1	201.7	53.6	28.1	26.6	194.0	7.6
		50 – 150	Bky2	7.6	34.4	2.1	531.6	97.2	90.1	67.9	442.5	12.0
AT1.2 Old alluvial terraces of gently undulating paleo drainage alluvium,	3	0 – 10	ABk	8.1	10.8	1.1	113.8	72.3	38.3	28.0	105.3	5.6
		10 – 40	Bky	7.9	38.5	1.6	819.1	30.1	44.2	40.0	750.0	16.5
		40 – 80	By1	6.9	116.2	1.8	5832.0	226.5	282.5	270.3	5525.0	82.5
		80 – 150	By2	7.1	91.0	2.0	5900.0	343.6	249.0	209.1	5612.5	75.0
	4	0 – 20	ABy	7.8	7.7	1.9	91.2	40.6	29.7	23.0	77.3	3.8
		20 – 70	Bky1	8.1	21.7	1.1	465.3	43.2	47.5	42.0	408.3	13.7
		70 – 150	Bky2	7.7	32.8	2.1	545.0	87.0	19.9	17.3	586.0	11.2
AT2 Young terraces of gently undulating River Nile alluvium	5	0 – 20	ABk	7.5	28.8	1.8	250.8	183.9	78.2	30.0	317.3	9.0
		20 – 60	C1	7.9	10.6	2.0	90.1	62.2	43.3	20.2	87.8	3.1
		60 – 125	C2	7.9	12.0	2.1	115.8	42.9	31.1	25.3	101.8	2.8
		125 – 150	C2	8.1	15.4	3.0	150.3	31.3	46.1	20.0	115.8	2.7
AP Alluvial plain (almost flat)	6	0 – 20	ABy	7.7	42.8	2.1	1280.0	173.2	87.2	40.0	1308.0	10.
		20 – 50	By1	8.2	6.1	3.0	35.1	48.8	31.3	19.5	33.7	2.5
		50 – 150	By2	7.6	25.0	3.1	318.1	127.7	92.4	70.2	278.8	7.5
	7	0 – 25	ABy	8.1	13.3	3.1	130.1	40.4	30.4	27.5	109.7	6.0
		25 – 70	By1	7.9	11.8	2.1	121.5	74.5	44.3	40.2	107.9	6.0
		70 – 150	By2	8.3	21.3	2.1	453.1	50.4	47.0	38.3	408.8	12.5
WP Water logged Playa (flat)	8	0 – 20	ABYz	7.5	100.0	4.6	6295.2	314.2	231.0	180.8	6186	16.2
		20 – 50	Byzg	7.9	90.5	3.9	5501.9	374.2	270.6	148.0	5442.5	19.0
		50 – 65	Cg	7,8	47.4	3.1	1270.1	94.6	68.0	34.2	1253.9	12.5
		65---			Water	table						
E Aeolian plain (undulating to gently undulating)	9	0 – 50	C1	7.4	12.6	1.9	120.8	49.5	43.5	25.0	101.8	2.0
		50 – 150	C2	8.3	11.6	1.6	115.3	22.5	16.5	10.4	110.5	2.0
	10	0 – 50	C1	7,5	8.0	2.3	70.9	86.7	51.7	30.0	73.2	5.0
		50 – 150	C2	7.7	20.6	2.1	210.1	77.7	35.0	25.6	225.2	4.0



Physiography-Soil Taxonomy Legend

Physiographic unit	Soil Taxonomic unit
Old terraces AT1.1	*Calcic Petrogypsids, loamy skeletal, gypsic, hyperthermic* *Typic Claci gypsids, loamy skeletal, gypsic, hyperthermic*
AT1.2	*Typic Calcigypsids, fine loamy, gypsic, hyperthermic* *Typic Calcigypsids, coarse loamy,mixed, hyperthermic*
Young terraces AT2	*Typic Haplocalcids, sandy, mixed, hyperthermic*
Alluvial plains AP	*Leptic Haplogypsids, sandy, mixed, hyperthermic*
Waterlogged playa WP	*Gypsic Aquisalids, coarse loamy, mixed, hyperthermic*
Aeolian plain E	*Typic Torripsamments, mixed (calcareous), hyperthermic*

R- Rock structures

Conventional signs:
Settlement **Asphalted road**

Figure 3 Physiographic units and the associated Soil Taxonomy in the study area

a1) Gypsic Aquisalids, coarse loamy, mixed, hyperthermic

Aqui; etymology: Latin "aqua" = water. *Aquisalids* were developed in alluvium of medium soil matrix to have salic horizon (EC from 94.5 to 101.5 dSm^{-1}) associated with gypsic horizon (9.5 % gypsum and 5% by volume as secondary visible gypsum) in soil surface "AByz". In sub surface "Byzg" the salic horizon is also associated with gypsic horizon (11.0 % and 5% gypsum by volume as secondary visible gypsum) but with redoxmorphic features underlain by ground water table at 60 cm. The control section is dominated by sandy loams "coarse loamy" These soils were identified in the waterlogged playa, represented by profile 8.

a2) Calcic Petrogypsids loamy skeletal, gypsic, hyperthermic

Petro; etymology: Greek "*petra*" = rock. These soils have *Petrogypsic horizon* "Bym" at 75 cm cemented by gypsum to be *Petrogypsids* (40.6 % gypsum asociated with calcic horizon of 35.5 % $CaCO_3$ equivalent). On the *Petrogypsic horizon*, two layers of gypsic horizon "By" developed (28.7 to 33.1 % gypsum and 15 % to 20 % by volume as secondary visible gypsum). They are associated with calcic horizon "Bk" (22.4 % to 48.0 % $CaCO_3$ equivalent and 15% to 30% by volume identifiable $CaCO_3$) forming together the horizons "ABky" and Bky At the family level, since the control section is dominated by very gravelly sandy loams (till 75cm from the soil surface), followed by cemented stones and gravel , the soils are grouped as loamy skeletal. The soil matrix is gypsic since it has the total weight of carbonates plus gypsum is more than 40% and gypsum is more than 35 percent of this weight. These soils occurred in the soils of the old terraces of undulating developed sediments represented by profile1.

a3) Typic Clacigypsids, loamy skeletal, gypsic, hyperthermic

These *Clacigypsids* are representing the central concept of their great group "*Typic*" developed in alluvium of medium soil matrix intersected by fragments. The soils have gypsic horizon "By" developed throughout the solum (15.5% to 36.9 % gypsum and 10 % to 25 % by volume as secondary visible gypsum). Calcic horizon "Bk" also devloped (12.4 % to 16.3 % $CaCO_3$ equivalent and 5% to 15% by volume identifiable $CaCO_3$) associated with the gypsic one "Bky" The control section is dominated by very gravely sandy loams "*loamy skeletal*", which is characterized as gypsic. These soils were identified in the old terraces of undulating developed sediments represented by profile 2.

a4) Typic Calcigypsids, fine loamy, gypsic, hyperthermic

These *Clacigypsids* are representing the central concept of their great group "*Typic*" developed in alluvium of fine soil matrix. The soils have gypsic horizon "By" developed throughout the solum (17.8% to 71.3 % gypsum and 10 % to 20% by volume as secondary visible gypsum). Calcic horizon "Bk" also devloped, but only in soil surface and sub surface (22.5 % to 42.0 % $CaCO_3$ equivalent and 10 % to 25 % by volume identifiable $CaCO_3$). At the family level, since the control section is dominated by sandy clay loams, soils are grouped as fine loamy, which is charecterized as gypsic. These soils are identified in the old terraces of paleodrainage alluvium of gently undulating relatively developed sediments. They are represented by profile .3

a5) *Typic Calcigypsids, coarse loamy,mixed, hyperthermic*

These *Clacigypsids* are representing the central concept of their great group "*Typic*" developed in alluvium of medium soil matrix. The soils have gypsic horizon "By" developed throughout the solum (6.7 % to 14.3 % gypsum and 5 % to 10 % by volume as secondary visible gypsum). Calcic horizon "Bk" also devloped, but within the soil control section and sub stratum (8.6 % to 10.4 % $CaCO_3$ equivalent and 10 % by volume identifiable $CaCO_3$). Since the control section is dominated by sandy loams, the soils are grouped as coarse loamy, mixed. These soils are identified in the old terraces of paleodrainage alluvium of gently undulating relatively developed sediments. They are represented by profile 4

a6) Leptic Haplogypsids, sandy, mixed, hyperthermic

These soils have gypsic horizon "By" developed throughout the solum (8.1% to 24.6 % gypsum and 5 to 20 % by volume as secondary visible gypsum having simple soil profiles (*Haplogypsids*) [Haplo; etymology: Greek "*haplus*" = simple]. They are *Leptic*, being have gypsic horizon intersecting soil surface[Leptic from Latin "leptus"=top]. Since the soil control section is dominated by sands, they are categorized as sandy at the family level. These soils were identified in the Alluvial Plains of almost flat. They are represented by profile 6 and 7.

a7) Typic Haplocalcids, sandy, mixed, hyperthermic

These soils have calcic horizon "Bk" developed in the epipedon (16.4 % $CaCO_3$ equivalent and 10 % by volume identifiable $CaCO_3$by volume, having simple soil profiles (Haplocalcids). Since the soil control section is dominated by sands, they are categorized as sandy at the family level. These soils were identified in the young terraces of River Nile alluvium. They are represented by profile 5.

b) Entisols:

[Ent. Implying recent, the last 3 letters of the word "recent"]. Smith (1986) considered the Entisols as azonal soils, lacking subsurface diagnostic horizons.They are either losing material too rapidly through truncation or receiving additions too rapidly for horizons to form. Climate is shown only at the great group level because suborder level is first sorted out according to the reasons as why they had no subsurface diagnostic horizon. In the current study, only one soil family was identified. as follow:

Typic Torripsamments, mixed (calcareous), hyperthermic

[Psamment; etymology: Greek "Psamos" = sand]. This suborder express itself as including only sandy soils and lacking rock fragments, being were transported and deposited by wind action,.These "*Torripsamments*" are "calcareous" since their fine earth of the control section between the depth 25 cm to 50 cm effervesces strongly in all parts with cold dilute HCl These recent soils were identified in the aeolian plain. They are represented by profiles 9 and10

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دراسة على المنشأ الفزيوجرافى ووحدات التربة التصنيفية فـــى جنـــوب منطقـــة وادى الريان بالصحراء الغربية

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معهد بحوث الاراضى والمياة والبيئة ، مركز البحوث الزراعية ، الجيـــزة ،جمهوريـــة مـــصر العربية

اجريت هذه الدراسة على منطقة واعدة من اجل الاستغلال الزراعى تقع جنوب وادى الريان فى الصحراء الغربية حيث تم تصميم نموذج ارضى لشبكة المثلثات غير المنتظمة Triangulated Irregular Network (TIN) ومنه تم معرفة الميول واتجاهاتها وشكل بيانى يوضح مناسيب الارض فى مسار شرق-غرب وقد تم اظهار هذا النموذج مع صورة القمر الصناعى ETM باستخدام حزم الطاقة الكهرومغناطيسية (Spectral Bands) ٢،٣،٤ حيث حددت منطقة الدراسة جزئيا داخل اطار النموذج الارضى TIN لتحديد وحداتها الفزيوجرافية فى طبقة معلومات ثالثة، وقد تكامل هذا النظام المعلوماتى الجغرافى (GIS) باستخدام نظام التحديد الارضى (GPS) للخواص الارضية حيث تم تحديد مواصفات ومنشأ الوحدات الفزيوجرافية وتعريف وحدات التربة التصنيفية المرتبطة بها وهى:

١. الشرفات القديمة ذات رسوبيات متطورة ومتموجة تكونت بفعل الصرف القديم فى العصور المطيرة وتظهر مرتفعة نسبيا مغطاة ببقايا غابات متحجرة متفرقة واحجار وحصى يتخللها بروزات صخرية وتشتمل اراضيها على الافاق التشخيصية الجبسى والجبسى المتحجر والجيرى فى تربة هيكلية مكونة وحدتى التصنيف
Calcic Petrogypsids, loamy skeletal, gypsic, hyperthermic and Typic Clacigypsids, loamy skeletal, gypsic, hyperthermic

٢. الشرفات القديمة ذات رسوبيات متطورة نوعا وخفيفة التموج ذات سطح حصوى تكونت بفعل الصرف القديم فى عصور مطيرة احدث نقلت اليها مادة الاصل فى مواقع منخفضة نسبيا نتيجة لعمليات النحر على الشرفات الاقدم وتشتمل هذه الشرفات على اراضى هيكلية اقل تطوراً ذات الافاق التشخيصية الجبسى والجيرى تمثلها وحدتى التصنيف
Typic Calcigypsids, fine loamy, gypsic, hyperthermic and Typic Calcigypsids, coarse loamy,mixed, hyperthermic

٣. الشرفات الحديثة لنهر النيل وهى ذات تموجا خفيف وتتميز بوجود مجارى مائية جافة تابعة لاتجاه الميل والتى ادت الى اعادة انجراف الترسيبات الاصلية مكونة هذه الشرفات التى تحتوى على اراض ذات الوحدة التصنيفية
Typic Haplocalcids, sandy, mixed, hyperthermic

٤. السهول الرسوبية والتي توجد في منسوب مستوى نوعا ومنخفض بين الشرفات الرسوبية والتركيبات الصخرية وقد تكونت عن طريق تاثير النحر على الترسيبات السابقة فى المواقع المتاخمة وربما تراكمت ترسيباتها ايضا عن طريق تاثير نظام الصرف على الصخور الجيرية فى الصحراء الغربية وتتميز اراضى هذه السهول بوجود الافق الجيرى فى تربة خشنة تمثلها الوحدة التصنيفية *Leptic Haplogypsids, sandy, mixed, hyperthermic*

٥. البلايا المتاثرة بالماء الارضى وتوجد فى مناطق مستوية ومنخفضة تكونت ترسيباتها سابقا عن طريق ركود المياه فوق هذه المناطق المنخفضة وقد تاثرت حديثا بالماء الارضى الذى تسرب من بحيرة وادى الريان حيث ادى ذلك الى تطور الافق الملحى فى تربة متوسطة القوام تمثلها الوحدة التصنيفية Gypsic Aquisalids, coarse loamy, mixed, hyperthermic.

٦. السهول التى تكونت بواسطة الرياح وتبدو متموجة الى خفيفة التموج وتحتوى جزئيا على كثبان رملية طولية تمتد الى الجنوب الشرقى وتشتمل هذه الترسيبات على الوحدة التصنيفية
Typic Torripsamments, mixed (calcareous), hyperthermic

٧. التكوينات الصخرية وهى تكوينات متفرقة منعزلة فى شكل بروزات صخرية، هضاب، موائد صحراوية وقواطع وقد بقيت هذه التكوينات نظراً لقدرتها على مقاومة عمليات النحر، ولا تشتمل هذه الوحدات على مادة أصل للتربة.